USAID | ASIA
FROM THE AMERICAN PEOPLE

USAID MEKONG SAFEGUARDS ACTIVITY

Task 2.2.1 Conduct PEA of CLMTV Energy and Transportation Infrastructure Decision-Making Process

Submission Date: May 4 2021

Cooperative Agreement Number: 72048618CA00009
Activity Start Date and End Date: August 22, 2018 to August 21, 2023
AOR: Ms. Pornpun Pinweha

Submitted by: Winston K.H. Chow
Chief of Party
The Asia Foundation
Chalanttip Building, 6D Floor
38 Convent Road, Silom
Bangkok 10500, Thailand
Tel. +660625254428
Email: Winston.chow@asiafoundation.org

TABLE OF CONTENTS

ACTIVITY OVERVIEW

Activity Name:	USAID Mekong Safeguards
Activity/Mechanism Start Date and End Date:	August 22, 2018 to August 21, 2023
Name of Prime Implementing Partner:	The Asia Foundation
Agreement Number:	72048618CA00009
Name of Subawardees:	The Henry L. Stimson Center Global Environmental Institute (GEI) China International Contractors Association (CHINCA) Beijing Rongzhi Corporate Social Responsibility Institute (Rongzhi)
Geographic Coverage (States/Provinces and Countries)	China and the lower Mekong countries of Cambodia, Laos, Myanmar, Thailand, and Vietnam.
Reporting Period:	August 22, 2018 to August 21, 2023

ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ACMECS	Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy
ADB	Asian Development Bank
AEDP	Alternate Energy Development Plan
AFD	Agence Française de Développement
AIMS	ASEAN Interconnection Master Plan Study
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
APGCC	ASEAN Power Grid Consultative Committee
bcm	billion cubic meters
BEP	Basic Energy Plan
BOT	build-operate-transfer
CDC	Council on Development of Cambodia
CFL	compact fluorescent lamp
CLMTV	Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, and Vietnam
CO_2	carbon dioxide
COM	Council of Ministers
COP	Chief of Party
CSO	civil society organization
DEB	Department of Energy Business
DEDE	Department of Alternative Energy Development and Efficiency
DEPQP	Department of Environmental Quality and Promotion
DPA	Development and Partnership in Action
DSM	demand-side management
EAC	Electricity Authority of Cambodia
ECD	Environmental Conservation Department
EDC	Electricité de Cambodge
EDL	Électricité du Laos
EE	energy efficiency
EEC	energy efficiency and conservation
EEDP	Energy Efficiency Development Plan
EEP	Energy Efficiency Plan
EGAT	Electricity Generating Authority Thailand
EIA	Environmental Impact Assessment
EMP	Energy Master Plan
EMSP	Environmental Management Support Programme
EPC	engineering, procurement, and construction
EPGE	Electric Power Generation Enterprise
EPPO	Energy Policy and Planning Office
ERAV	Electricity Regulatory Authority of Vietnam
ERC	Energy Regulatory Commission
EREA	Electricity and Renewable Energy Agency
ERIA	Economic Research Institute for ASEAN and East Asia
EU	European Union
EV	electric vehicle
EVN	Vietnam Electricity
FIT	feed-in tariff

FPV	floating solar PV
GDE	General Directorate of Energy
GDP	gross domestic production
GHG	greenhouse gas
GMS	Greater Mekong Subregion
GW	gigawatts
GWh	gigawatt-hour
HAPUA	Heads of ASEAN Power Utilities/Authorities
HPPF	Healthy Public Policy Foundation
IE	Institute of Energy
IEA	International Energy Agency
IFC	International Finance Corporation
INGO	international non-governmental organization
IPP	independent power producer
IRENA	International Renewable Energy Agency
IRP	integrated resource planning
JICA	Japan International Cooperation Agency
kg	kilogram
kWh	kilowatt-hour
Lao PDR	Lao People's Democratic Republic
LCOE	levelized cost of energy
LEAP	Long-range Energy Alternatives Planning
LED	light-emitting diode
LHSE	Lao Holding State Enterprise
LNG	liquified natural gas
LS2	Lower Sesan 2
m^3	cubic meter
MDB	multilateral development bank
MEF	Ministry of Economy and Finance
MEM	Ministry of Energy and Mines
MEMP	Myanmar Energy Master Plan
MIT	Mekong Infrastructure Tracker
MME	Ministry of Mines and Energy
MOE	Ministry of Energy
MOE	Ministry of Environment
MOEE	Ministry of Electricity and Energy
MOEP	Ministry of Electric Power
MOI	Ministry of Industry
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MONREC	Ministry of Natural Resources and Environmental Conservation
MOP	Ministry of Planning
MOU	memorandum of understanding
MPI	Ministry of Planning and Investment
Mt-C	million tons of carbon
Mtoe	million tonnes of oil equivalent
MW	megawatt
NCSD	National Council for Sustainable Development
NDC	Nationally Determined Contribution
NEP	National Electrification Program
NEPC	National Energy Policy Council

NESDC	National Economic and Social Development Council
NGO	non-government organization
NO_x	nitrogen oxide
NPA	non-profit association
NSDP	National Strategic Development Plan
NSEDP	National Socio-Economic Development Plan
ONEP	Office of Natural Resources and Environmental Policy and Planning
PDP	Power Development Plan
PEA	political economy analysis
PetroVietnam	Vietnam Oil and Gas Group
PRC	People's Republic of China
RDMA	Regional Development Mission for Asia
RE	renewable energy
REAM	Renewable Energy Association Myanmar
RED	Renewable Energy Directive
RIF	Regional Investment Framework
RPCC	Regional Power Coordination Center
RPTCC	Regional Power Trade Coordination Committee
SEA	Strategic Environment Assessment
SEDP	Socio-Economic Development Plan
SF_6	sulfur hexafluoride
SHPP	small hydropower project
SHS	solar home system
SOE	state-owned enterprise
SO_x	sulfur oxide
TAGP	Trans ASEAN Gas Pipeline
TIEB	Thailand Integrated Energy Blueprint
TOR	terms of reference
TPES	total primary energy supply
TSRI	Thai Solar PV Roadmap Initiative
TWh/yr	terawatt per year
USAID	United States Agency for International Development
Vinacomin	Vietnam National Coal and Mineral Industries Group
VRE	Variable Renewable Energy
VSHPP	very small hydropower project
WWF	World Wide Fund for Nature

1. EXECUTIVE SUMMARY

USAID Mekong Safeguards ("the Activity") is a five-year program (2018–2023) that supports the countries of Cambodia, Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Vietnam (CLMTV) to strengthen capacity for the consistent application of environmental, social, and governance standards, particularly for the electric power and transport sectors.

This political economic analysis (PEA) examines the current planning and decision-making approach, actors, relationships, interests, and power dynamics in the power-development subsector. This requires systematically analyzing and evaluating the Power Development Plan (PDP) processes in each CLMTV country and evaluating or benchmarking them against acceptable international practices for integrated planning. Each country is different in its approach to planning, so seven criteria pertaining to integrated resource planning (IRP) are used to compare national efforts against good international practices. These criteria are load forecasting and energy efficiency, demand-side management, scenarios, generation expansion plan, transmission expansion plan, externalities, and stakeholder consultations.

CLMTV countries share common yet differentiated energy security and environmental management concerns. Lao PDR and Myanmar have rich energy resources and aspire to generate revenue through export to neighboring countries to meet their socio-economic development needs. For other countries, growing reliance on energy imports is raising the energy security concern. Doubling or tripling in energy consumption is expected for these countries over the next 15 to 20 years, further compounding the problem.

The power systems in the CLMTV countries justify power trade in the region. Thailand expects to rely heavily on imported gas. Vietnam, too, seems to be committed to increasing the use of gas, displacing coal substantially. Cambodia is planning to build more hydropower, coal-fired, and natural gas–fired power plants. Lao PDR and Myanmar have relatively low demands and potential surpluses of hydropower. Interconnected systems can enable power exchange to achieve reduced system-wide cost by utilizing the rich hydropower resources in the region and increased energy security to manage shortages during dry seasons and from interruptions to imported coal and gas supplies.

Nevertheless, electricity demand is increasing across the CLMTV, and this trend will continue, requiring extensive expansion of the power systems. This significant expansion in the power sector in the CLMTV countries will bring added environmental and social pressures resulting from the cumulative impacts of power plants around major cities and along river systems.

Increased use of renewable energy (RE) can reduce dependence on imported fuels, lower carbon dioxide emissions, and increase distributed grid development options in remote areas (in contrast to a centralized, large-scale power system). Despite the potential of RE and energy efficiency (EE), however, their use in the CLMTV has been limited, due in part to the limitations of the conventional PDP preparation process.

PDP determines the development of energy infrastructure for the generation and distribution of electricity in the region. In general, the PDPs in the region are prepared based on prioritizing the least-cost electricity-generation options to meet the electricity demand forecast for the specified time horizon. The demand forecasts are usually derived from the econometric models, which serve as the reference to determine and optimize the generation options.

In recent years, countries such as Thailand and Vietnam have increasingly adopted the principles and process of IRP to prepare their respective PDPs. For instance, the Thailand PDP focuses on (i) energy

security: dealing with increased demand while ensuring fuel diversification; (ii) economy: maintaining an appropriate cost of power generation and implementing EE; and (iii) ecology: reducing environmental and social impacts by lessening carbon dioxide generation.

Thailand seeks a significant structural change to power generation through an increase in RE, incorporating more EE measures, reduced dependency on gas, and a significant increase in regional integration through greater power imports from adjacent countries. While the new PDP is consistent with good practice in IRP preparation, it still falls short of internalizing the full range of environmental externalities in the PDP. Although Thailand has strong policies on social and environmental safeguards, the PDP does not have a formal strategic environmental assessment (SEA). SEA in strategic planning has been voluntary and consequently used only for a few pilot exercises.

Vietnam might have the most advanced PDP systems in the Mekong region, incorporating IRP principles and processes. In Vietnam, the PDP process recognizes the need to ensure that full social and environmental costs and "nontraditional" options such as demand-side management and RE are fully integrated into PDP preparation. The PDP is aligned with national goals, and it addresses the environment, climate change, EE, and RE. The PDP considers the significant costs and benefits of environmental and social impacts such as the cost of greenhouse gas (GHG) emissions, air and water pollution, loss of amenity, and the impact on endangered species, all traditionally treated as "externalities."

The PDP process in countries such as Cambodia, Lao PDR, and Myanmar are less developed. While legal requirements clearly define the need, purpose, and institutional arrangement to develop PDPs, detailed procedures and guidelines are still missing. PDP preparation is conducted along traditional lines, using donor-supported consultants. New legal requirements in these countries increasingly mandate the integration of SEA in PDP. For instance, Environmental Protection Law of Lao PDR states that the SEA shall be conducted while developing the policies, strategic plans, and programs, particularly of the energy and mining sectors. In Myanmar, rapid progress is being made in formalizing the requirement that SEA is included in strategic planning for key development sectors. This is reflected in the 2012 Law on Environmental Conservation, which established the requirement for Environmental Impact Assessments (EIAs) and refers to SEAs in strategic planning. Similarly, the draft Environment and Natural Resources Code of Cambodia contains detailed and specific provisions on SEA. However, institutional and technical capacity to implement SEA remains weak.

PDP and SEA have been often criticized for not having enough stakeholder consultations built into the preparation process. PDP preparation is often exclusively within energy-sector line agencies. Irrespective of environment line ministries' increasing interest in engaging at the strategic planning level, their regulatory role has been limited to reviewing project-level EIA. As of now, they exert very little or no influence on PDP development. Academia and think tanks are requested to provide input on specific issues and hold no influence in the process or the outcome. With the increasing liberalization of the energy sector in these countries, the private sector's involvement, role, and influence is growing.

The adoption of IRP in PDP might sound new and ambitious; however, CLMTV countries, to a varying degree, have already adopted several of its key components in their respective PDPs. Achieving full IRP is a gradual process that evolves with experience and capacity. High-level policy support is essential.

New approaches require significant awareness raising to ensure their applicability is understood. The targeted awareness raising involving high-level officials through national, regional, and international exchange events and study visits are useful means of generating interest in new approaches/methodologies.

To achieve fully integrated PDPs in CLMTV countries, the Activity could support the following power sector development planning related to technical capacity-building activities.

- Demonstrate applicability and value of IRP by supporting a hands-on pilot case study applying a learning-by-doing approach involving power system planners.

- Develop country-specific technical guidelines on IRP, building on the pilot case study's learning experience.

- Conduct in-depth training on specialized areas pertinent to IRP, based on the country-specific needs. The following are some of the identified areas:

    - Bottom-up load forecasting; however, this depends on the availability of disaggregated data. Collecting, generating, and maintaining such data will require sustained support to develop a robust information management system.

    - Methodology to integrate energy efficiency in load forecasting.

    - Scenario analysis for managing load demand and optimizing power supply options applicable to country-specific planning context.

    - Long-term power system planning software packages for generation, transmission, and analytical capacity.

The progress in formalizing legislation in CLMTV countries means that an SEA becomes a legal requirement in PDP. But there is little awareness of the implications of this for PDP preparation in the agencies involved in the PDP process. There is an urgent need to increase awareness of what an SEA entails, along with an IRP approach to PDP preparation. The Activity could support capacity-building activities on SEA, including valuation of environmental and social externalities of energy generation options.

Several countries in the region are interested in learning from Vietnam's PDP and SEA experience. Vietnam already has several acceptable practices for PDP. The Activity can help compile those acceptable practices and develop a knowledge product for broader dissemination. Similarly, the Activity could organize regional knowledge-sharing experience to share knowledge emerging from countries such as Thailand and Vietnam.

Strengthening regional cooperation in the region is galvanizing new infrastructure investment vehicles such as the ASEAN Infrastructure Fund, Greater Mekong Subregion (GMS) Regional Investment Framework (RIF), Belt and Road Initiative, the Lancang-Mekong Cooperation Mechanism, and the ACMECS Infrastructure Fund. Similarly, regional collaboration, strategic planning, and investment decision frameworks are also rapidly evolving in the region, associated with financing vehicles. ASEAN and GMS are probably most advanced in charting the clear strategic framework, road map, and institutional and governance mechanism.

Platforms like ASEAN and GMS provide an opportunity to raise awareness of high-level officials, engage in policy dialogue to harmonize standards and procedures, and facilitate knowledge exchange. GMS RIF also offers a chance to anticipate and engage in infrastructure-related investment decisions. The Activity should actively engage with these platforms and facilitate development partners' coordination and collaboration on knowledge-generation and sharing activities. The knowledge product generated by the Activity could be presented and showcased during the high-level official meetings of ASEAN and GMS.

2. INTRODUCTION

2.1 Activity Description

USAID Mekong Safeguards ("the Activity") is a five-year program (2018–2023) that supports policy makers, government regulators, planners, major financiers, developers, and contractors with information and tools to foster the consistent application of environmental, social, and governance standards, particularly for electric power and transport sectors. The Activity operationalizes the vision of sustainable infrastructure development that lower Mekong countries have put forward in their national green growth strategies and regional platforms. This vision has been publicly championed by major infrastructure financiers such as the World Bank, the Asian Development Bank (ADB), and several bilateral donors, including the governments of Australia, European Union (EU), Japan, and the United States (US).

Major donors and lenders are ramping up infrastructure investments in the affected countries, joining new investment vehicles such as ASEAN Infrastructure Fund, the GMS Regional Investment Framework, the Belt and Road Initiative, the Lancang-Mekong Cooperation Mechanism, and the Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS) Infrastructure Fund. With this projected new investment, the total installed electric power generation capacity is expected to grow from 96 gigawatts (GW) to at least 280 GW over the next decade, mainly through the development of new hydropower and thermal power plants. Developers of road and railway infrastructure plans are projecting that, over the same period, railway infrastructure is likely to increase by at least 20 percent, and high-speed railway capacity will increase by more than 50 percent.

However, environmental regulations and mitigation efforts are not keeping pace; the sheer numbers and cumulative effects of projects are damaging the Mekong ecosystem and affecting fisheries, forestry, farming, air quality, water quality, and flood regulation. Negative impacts on these and other ecosystem services, in turn, threaten lower Mekong populations' food security, health, homes, and livelihoods. While recognizing the economic-growth imperative of the developing economic region and the role of infrastructure in contributing to growth, the Activity promotes profitable economic growth supported by sustainable infrastructure that causes less harm to the environment, biodiversity, and people.

The Activity aims to (i) minimize negative environmental impacts of infrastructure projects by fostering a more robust and consistent application of environmental, social, and governance standards and (ii) encourage decision-makers to avoid unnecessary, harmful infrastructure through smart technologies, system-scale infrastructure planning, and innovations.

2.2 Task 2.2.1 Conduct PEA of CLMTV Energy and Transportation Infrastructure Decision-Making Process

Description and Rationale:

Infrastructure development covers multiple economic sectors and often impacts multiple segments of society. As countries work toward improving the level of integration in infrastructure planning, it is important to understand the current systematic approach, actors, relationships, interests, and power dynamics to infrastructure decision-making. For example, a country can approach infrastructure planning systematically, but political dynamics take precedence. Furthermore, countries can have adequate laws and policies in place that require environmental and social factors to be integrated into the decision-making process at appropriate intervals of the project-development process, but in practice, these factors are not integrated or are integrated at very late stages, when the project decision

or design is too far advanced to change. Understanding this context will enable the Activity to support efforts to update current policies and adjust practices both by understanding how infrastructure-investment decisions are made in practice and by building relationships and expanding knowledge of the landscape of interests and influence while retaining the flexibility to adjust program strategy and tactics as new information or unexpected opportunities become available. Therefore, the Activity will conduct a PEA of the infrastructure planning processes in each CLMTV country. This PEA will focus primarily on electricity infrastructure. It will be used to identify policy priorities, legal requirements and institutional arrangements, stakeholders, partners, information sources, approaches, and gaps for the continued execution of Task 2.2.2 (Provide capacity building for CLMTV decision-makers on integrated infrastructure planning) and Task 2.2.3 (Convene dialogues to engage CLMTV decision-makers on integrated infrastructure planning). Relevant summaries of the PEA studies can be shared on the Mekong Infrastructure Tracker (MIT) and with stakeholders to inform opportunities and new trends and progress with integrated, multicriteria infrastructure planning at the national and regional level. International practices show that an IRP process could lead to avoiding over- or underdevelopment of capital-intensive infrastructure projects, significantly reducing the level of effort.
Subtasks: • Confirm the CLMTV countries to conduct studies with USAID / Regional Development Mission for Asia (RDMA). • Conduct the PEA in each approved country; first, desk research will be conducted remotely based on publicly available information, and then findings will be confirmed through in-person consultation meetings in each CLMTV country. • Prepare draft report.
Resource Requirements: • TAF: Chief of Party (COP) • External consultant • TAF: CLMTV offices as required • Equipment: None
Country of Implementation: CLMTV
Outputs: • Written PEA for each of the CLMTV countries for energy infrastructure.
Outcome/Result(s) Expected: Conducting Task 2.2.1 permits the Activity to confirm its desk research findings as it finalizes Task 1.1.1 (Map policy and legal frameworks mandating ESG standards) and to understand the current systematic approaches, actors, relationships, interests, and power dynamics to electricity infrastructure decision-making. Understanding this context will enable the Activity to support efforts to update current policies and adjust practices both by understanding how infrastructure investment decisions are made in practice and by building relationships and expanding knowledge of the landscape of interests and influence, while retaining the flexibility to adjust program strategy and tactics as new information or unexpected opportunities become available.

2.3 Task Approach and Methodology

2.3.1 Introduction

The decision-making of power sector infrastructure development in each country of the lower Mekong region is highly centralized and primarily guided by their respective national PDPs. The PDPs in the region are generally prepared based on the prioritization of the least-cost electricity-generation options to meet the electricity demand forecasted for the specified time horizon. The demand forecasts are usually derived from the econometric models, which serve as the reference to determine and optimize the generation and transmission system expansion options.

Conventional least-cost generation expansion planning usually results in suboptimal outcomes. This approach usually does not factor the requisite set of variables into the decision-making process. For instance, the least-cost generation expansion planning generally does not factor in bottom-up load forecasting, demand-side management (DSM) options and costs, environmental and social impacts costs, and public involvement.

In recent years, however, countries such as Thailand and Vietnam have been increasingly adopting a more integrated approach in power system long-term planning, which incorporates crucial parameters such as better load demand forecasting scenarios, DSM including EE, energy conservation, demand response, and distributed generation, an increase in RE in the generation mix, and integration of higher levels of power trade from adjacent countries. There also have been efforts to include the environmental and social costs and benefits, particularly GHG emissions, which are traditionally treated as "externalities." The PDP process in countries such as Cambodia, Lao PDR, and Myanmar are less developed. While there are legal requirements clearly defining the need, purpose, and institutional arrangement to develop PDPs, detailed procedures and guidelines are still missing. All lower Mekong countries have attempted to adopt SEA as a planning tool to internalize environmental and social externalities into PDPs by developing and formalizing a legal and institutional framework.

However, several gaps remain both within and across the lower Mekong countries to realize full IRP, which results in lower costs, lower risk, and outcomes that minimize environmental and social impacts. However, each lower Mekong country is unique and at a different stage of development or capability to make decisions about their power infrastructure in an integrated manner, which would improve the environmental and social outcomes of new energy infrastructure, result in lower long-term costs, and make it easier for governments to attract investment.

2.3.2 Integrated Planning

This task requires systematically analyzing and evaluating the PDP processes in each CLMTV country and evaluating or benchmarking them against acceptable international practices for integrated planning. Many countries worldwide are increasingly adopting the IRP approach in the energy sector for its demonstrated value in improving sustainability. Compared to the traditional least-cost planning that considers only limited supply options, IRP can achieve lower overall costs, result in more fuel savings, and minimize environmental and social impacts.

Because each country is different in its approach to planning, the IRP is divided into the following seven components to allow meaningful benchmarking to assess the status of each of the CLMTV countries in terms of integrated power development planning and to identify a harmonized response:

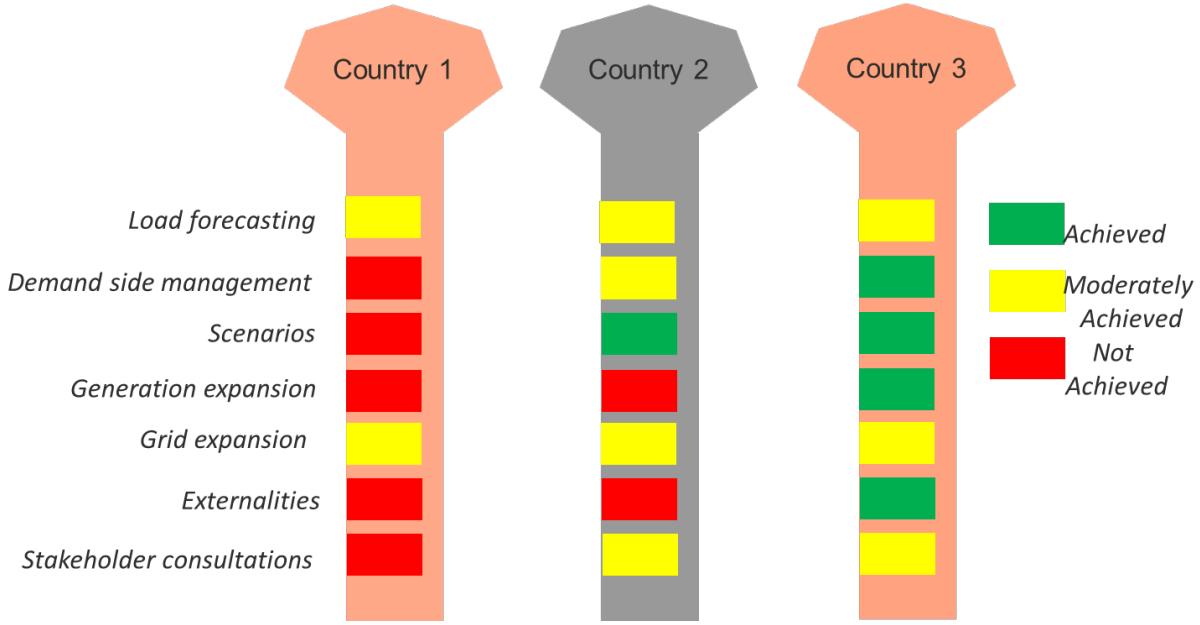
Component	Description
Load forecasting	Methodology for load forecasting (bottom-up, top-down). Preparation of long-term load-growth scenarios using a preselected methodology, considering factors such as population, employment, economic activity, commercial activity, electricity intensity, rural electrification, electricity price, new step load, fuel switch, and switch of the captive load to grid.
Demand-side management and energy efficiency	Incorporation of DSM and EE options and costs. Identification and analysis of DSM programs that could be economically viable to implement and taken into consideration in the development of the PDP. In addition to its cost, each DSM program could be characterized using its potential achievement in terms of reduction in peak load, energy, and/or load pattern. DSM covers EE, energy conservation, demand response, and distributed generation.

Scenarios	Scenario and sensitivity analysis to ensure "least-cost" under different cost or demand assumptions. Generation expansion themes/scenarios are formulated and analyzed as per the applicable laws and regulations, government energy policies, and industrial standards, leading to greater uptake of more sustainable expansion of electricity-generation options.
Generation expansion plan	Optimization based on optimum reserve margin, levelized generation and system costs, and risks (dependency on import and price volatility), considering the applicable reliability criteria, capital cost, operation, and maintenance cost, fuel cost, expected unsupplied energy cost, GHGs, and other emissions offset allowances. A transmission line's cost could be part of a generation project's cost if it is fully used to evacuate power from the plant and transfer it to the grid. Sensitivity analysis of a few critical parameters to the total generation cost is carried out to examine the top-ranked generation expansion scenarios' robustness. The combined generation and transmission and transmission scenarios are further analyzed, taking into account total generation and transmission cost as well as important risk factors such as fuel security, load growth variability, RE contribution or extremely high GHG offset allowance, fuel diversification, capital fund availability, development/operation flexibility, and foreign exchange rate.
Transmission Grid expansion plan	One or two transmission grid-expansion scenarios are prepared and analyzed for each of the top-ranked generation expansion plans, taking into account capital cost, operation and maintenance cost, and capacity and energy losses. The technical studies of each combined generation and transmission scenario could include power flow, short circuit, and stability.
Externalities	Best practices in internalizing social and environmental "externality" costs associated with all the generation options; legal provisioning and compliance for more integrated planning, including SEA. The full range of environmental and social externalities are quantified and monetized as a part of least-cost analysis and prioritization of candidate plants.
Stakeholder consultations	Active involvement of stakeholders in the development process of the PDP. Both interministerial and public consultations.

Each CLMTV country's PDP, as demarcated into these seven constituent parts, is examined to identify each country's current state of the capability to develop its PDP-integrating IRP approach. The analysis categorizes national achievements into the following color-coded categories:

- Achieved (green)
- Moderately achieved (yellow)
- Not achieved (red)

For example:



The analysis and recommendations draw from the existing literature prepared in the region. The ADB recently completed a review of IRP in the GMS. Similarly, several SEA reports are available for both regional power trade and national power-development plans. These reports are valuable resources to complete the initial analysis. The analysis is validated and finalized through consultations with the relevant stakeholders.

2.3.3 Political Economy Analysis

The PEA is conducted to understand how best to interact with decision-makers in a particular country to execute Task 2.2.2 (Provide capacity building for CLMTV decision-makers on integrated infrastructure planning) and Task 2.2.3 (Convene dialogues to engage CLMTV decision-makers on integrated infrastructure planning) in a way that is successful, systematic, and scalable.

PEA for the electric power sector is conducted to understand better interactions between structures, institutions, and players/actors that influence both the process and outcomes of the electricity infrastructure investment decisions. Structures are mostly understood as the more enduring (for example, a country's political and administrative apparatuses, which change slowly or not at all). Institutions are the "rules of the game." This may include formal legal codes and regulations as well as informal

conventions and cultural norms that shape human behavior. These formal and informal institutions are not static and are often the focus of aid interventions. Players can be individuals, organizations, or coalitions from the public sector, private sector, or civil society.

In terms of the structure, an attempt is made to understand and appreciate political and administrative motivations to invest in electricity infrastructure to achieve (i) electricity supply reliability to meet rapidly increasing electricity demand fueled by rapid economic growth, and (ii) social inclusiveness and environmental sustainability agendas associated with these investments. The institutional analysis in power-generation infrastructure entails policy priorities to achieve energy security, sustainable development goals, green growth, and low-carbon development. The legal provisions of the PDP, social and environmental safeguards, and due diligence during strategic planning are analyzed. The key players relevant to IRPs are national energy policy makers, energy regulator, state-owned enterprises involved in power generation, transmission, and distribution, regional bodies such as GMS Regional Power Trade Coordination Committee (RPTCC), increasing involvement of the private sector in power-generation infrastructure, investors (multilateral financing institutions, foreign direct investments, and national financing institutions), think tank organizations and national practitioners, civic society, consumer, and rights groups. A detailed stakeholder analysis is conducted as part of the PEA.

The PEA has three parts:

(i) Policy: Understanding the context, including national priorities and political and policy commitments.

(ii) Legal and Institution: Maintaining administrative mechanisms (legal framework and institutional arrangements) pertinent to social-economic development, energy security, social and environmental issues.

(iii) Stakeholder: Assessing and mapping interest, roles, and influence based on a detailed stakeholder analysis involved in the power development planning process.

The findings of IRP analysis and PEA provide feedback into strategy and work plan for the Activity's future interventions to promote fully integrated PDPs.

3. CAMBODIA

Summary

The energy and electricity demand has multiplied significantly in Cambodia due to robust economic growth. Access to electricity has also been a remarkable achievement. However, high tariffs continue to make electricity less affordable to the poor. While the import of electricity has gradually decreased in recent years, a lack of reliable supply could result in electricity shortages and power outages that affect industrial growth in Cambodia.

Cambodia's energy supply is heavily dependent on traditional sources and urgently needs modernization. The country has no oil production and is entirely dependent on imports of petroleum products. The energy intensity is improving; however, it could be enhanced through EE technologies and the electrification of agriculture and transport sectors.

Its electricity supply is dominated by hydro (almost half), oil, coal, biomass, and imports accounting for the rest. In recent years, Cambodia saw a surge in new electricity-generation facilities of thermal power, increasing its dependency on imported fuels for power generation.

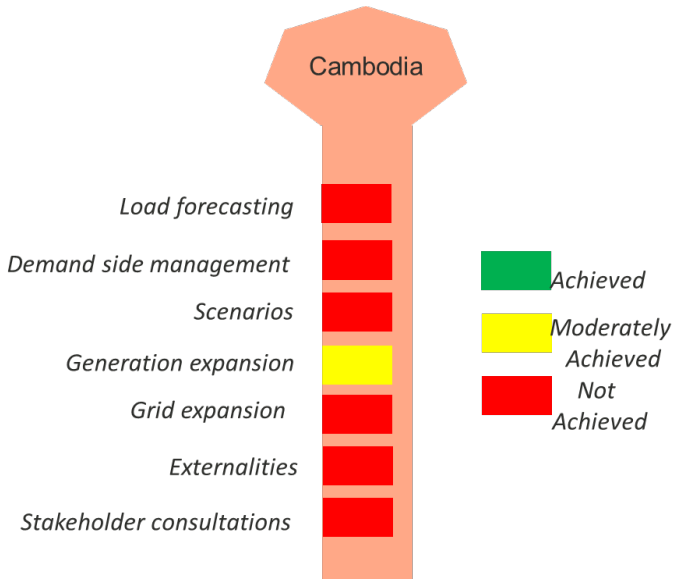
Cambodia imports all coal and oil products that it consumes, even though it has untapped potential for petroleum extraction, both inland and offshore. It also has modest technical hydropower potential, strong solar resources, viable wind potential, and considerable biomass energy resources.

Cambodia's government is planning to build more hydropower, coal-fired, and natural gas–fired power plants, potentially resulting in increased long-term environmental risks and impacts. There is a growing concern over the potential impacts of thermal power plants on climate change, air pollution, and public health, and over the cumulative impacts of the proposed hydro dams on the natural ecosystems, fisheries, and people's livelihoods.

RE such as solar, wind, and biomass can meet Cambodia's electricity needs with less environmental impact. Nevertheless, Cambodia needs to overcome technical and financial barriers. DSM, energy conservation, and EE programs could be economically and technically viable to reduce electricity demand and lower the environmental footprint.

Cambodia's PDP is the master investment plan for power system development, which determines the fuel type, generation technology, size, and number of generating units that should be built (and when and where they should be built) to meet the forecasted load demand in terms of peak and energy at the predetermined reliability level.

Cambodia's PDP is evolving and has adopted critical principles and parameters of IRP; however, it is still weak in many respects. The following figure summarizes Cambodia's PDP as demarcated and compared against seven IRP components.



The methodology for load forecasting is not transparent; however, it appears to be based on a top-bottom econometric model for high-, medium-, and low-growth scenarios. There is little attempt to improve forecasting, disaggregating data by geographical area or consumption sector, and other parameters. Similarly, PDP does not consider DSM in the demand forecasting. There is not yet a practice of applying scenario-based analysis for generation expansion. Even though Cambodia applies a systematic approach to plan generation expansion, there are several areas where the methodology could be strengthened, such as determination of reserve margin and capacity factors, use of levelized cost of energy (LCOE), and appropriate application of suitable optimization models. PDP does not factor transmission costs in optimizing the grid system. PDP does not consider environmental and social externalities. Interinstitutional (e.g., Ministry of Environment) and public consultations are very weak.

Cambodia's policy framework is evolving, setting a foundation for the uptake of principles of IRP in power development. Energy security, environmental sustainability, and climate change are policy priorities. However, these priorities are fragmented and often compete during implementation, usually due to institutional mandates and biases. For example, the Ministry of Mines and Energy (MME) is primarily concerned about the reliability of electricity supply, and the Ministry of Environment (MOE) is only interested in environmental sustainability.

Irrespective of growing interest in environmental issues pertinent to electricity generation, the Ministry of Environment has no engagement or influence on preparing the PDP. The table below highlights key stakeholders relevant to Cambodia's power development, their role/interest, and influence.

	Role/ Interest	*Influence*
Regulators		
Ministry of Mines and Energy	High	High
Ministry of Environment	Medium	Low
Owner		
Electricité de Cambodge	High	High
Investors		
Government	High	High
FDI and private sector	High	Medium
Multilateral banks (MBDs)	High	Medium
Development partners (ADB and JICA)	Medium	Medium
Non-government organizations and civil society	Low	Low
Consultancies, academia, and think tanks	Low	Low

Achieving full IRP is a gradual process that evolves with experience and capacity. High-level policy support is essential to promote uptake of the best available methodologies and to encourage broader stakeholder engagement and public consultations. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Cambodia, particularly in the area of sensitizing high-level officials on the importance of achieving IRP, building targeted capacity on quantification and valuation of environmental and social externalities, and encouraging broader and effective public consultations.

3.1 Approach to Decision-Making

3.1.1 Background

1. <u>Power sector development needs and challenges</u>

The demand for energy and electricity increased rapidly in Cambodia from 1995 to 2015. The country has undergone rapid population growth, economic growth, and urbanization, driving the high demand growth for energy and electricity. Energy demand in Cambodia has grown at an average annual rate of 4.3 percent, from 2.54 million tonnes of oil equivalent (Mtoe) in 1995 to 5.93 Mtoe in 2015.[1] ADB in 2018 predicted that the country's energy needs would double by 2030.[2] Hydropower and coal or natural gas–fired thermal generation are replacing oil products–fueled electricity generation.

Rural access to electricity continues to improve; however, the challenge remains. By December 2019, the Electricity Authority of Cambodia (EAC) supplied electricity to 99.5 percent of all the villages in Cambodia, creating an opportunity for electricity access to almost all the households for the first time. However, nearly 25 percent of Cambodian households do not have access to grid electricity and rely on car batteries and other traditional fuels for energy. Yet it is a remarkable achievement.[3]

[1] ERIA, 2019. Energy Outlook and Energy Saving Potential in East Asia.
[2] ADB 2018. Cambodia Energy Sector Assessment.
[3] EAC 2019, Salient Features of Power Development in Kingdom of Cambodia. Electricity Authority of Cambodia, Phnom Penh.

The country's high electricity tariff made access to electricity less affordable to the poor; however, significant improvement has been achieved. Electricity has traditionally been expensive in Cambodia, and prices have historically been much higher in rural areas than in towns and cities (due to the requirement of additional equipment, sparsely distributed customers, low consumption per unit area, and high losses). Reduced reliance on diesel and imports and grid expansion resulted in the lower cost of supply and stable tariffs in recent years. At the end of 2019, only 10 of the 374 licensed areas were still adopting higher tariff structures.[4] Cambodia needs to continue its grid expansion and further lower electricity prices to ensure universal access to electricity for all.

Electricity demand. Electricity demand increased by 18 percent per year from 2010 to 2016.[5] Cambodia entirely depended on oil products fueled by power generation and imports from neighboring countries in the past. In the last decade, coal-fired and hydropower generation has increased rapidly, reducing electricity import significantly compared to 2010. The current projections indicate that Cambodia's demand will increase by 7.5 times from 2015 to 2040.[6]

Electricity supply. Electricity production increased by 19 percent per year from 2010 to 2016.[7] The total electricity generation in 2017 was 8,073 GWh, including approximately 1,440 GWh of imports primarily from Vietnam (1,095 GWh), Thailand (291 GWh), and Laos (54 GWh). Domestic installed generation capacity increased by 21 percent from 2016.[8] At the end of 2017, the EAC reported that the total domestic installed generation capacity was 1,878 MW, of which 980 MW (52 percent) was from hydropower, 564 MW (30 percent) from coal-fired, 295 MW (16 percent) from diesel, 29 MW (less than 2 percent) from biomass, and 10 MW (less than 1 percent) from solar. Independent power producers (IPPs) own over 92 percent of the domestic installed capacity, Electricité de Cambodge (EDC) owns 6 percent, and the other licensees own the rest.[9]

The 2015–2030 PDP projects that hydropower and thermal power will account for roughly half of the electricity production by 2030.[10]

While Cambodia's electric power sector has gone through a significant reform, ensuring access to modern and sustainable energy sources by all citizens requires overcoming several impediments. Pressing challenges include (i) overcoming electricity shortages and power outages, (ii) reducing the high price of electricity, (iii) developing an otherwise fragmented power grid and securing finance for grid development, (iv) reducing heavy dependence on imported fossil fuels and electricity, which has resulted in energy security concerns, (v) addressing the issue of the high environmental impact of hydropower and coal-fired electricity generators, and (vi) demonstrating technical viability and bankability of RE to attract investments (penetration of high intermittent RE levels into a power system requires extensive technical studies).

---

[4] EAC 2019, Salient Features of Power Development in Kingdom of Cambodia. Electricity Authority of Cambodia, Phnom Penh.
[5] MMEC 2019, Cambodia Basic Energy Plan.
[6] MMEC 2019, Cambodia Basic Energy Plan.
[7] MMEC 2019, Cambodia Basic Energy Plan.
[8] EDC. 2017. Cambodia Country Presentation. Presentation prepared for the 23rd Meeting of the Regional Power Trade Coordination Committee (RPTCC). Lao PDR. 13–15 December. The total is more than 100 percent because of rounding. Cited in ADB 2018. Cambodia Energy Sector Assessment.
[9] EAC 2019. Salient Features of Power Development in Kingdom of Cambodia. Electricity Authority of Cambodia, Phnom Penh.
[10] Chugoku Electric Power Co., Inc. 2015. The Project on Revision of Cambodia Power Development Master Plan. Presentation prepared for the Government of Cambodia. Phnom Penh. September. Unpublished.

2. Energy intensity

The energy intensity[11] is improving in Cambodia; however, higher efficiency could be achieved. Primary energy intensity decreased from 775 toe/million US$ in 1995 to 442 toe/million US$ in 2015. Based on the Economic Research Institute for ASEAN and East Asia's (ERIA's) projection, energy intensity will further decrease to 251 toe/million US$ by 2040. The decrease is because electricity is likely to displace conventional biomass use in rural areas, which have lower conversion efficiency.[12] The new opportunity for electrification of growth sectors such as agriculture, manufacturing, and transportation in the near future helps Cambodia further improve its energy intensity.

3. Energy resources

Cambodia's energy supply is heavily dependent on traditional sources and urgently needs modernization. The country's total primary energy supply in 2015 stood at 7 million Mtoe. Conventional RE, primarily biomass, represented the largest share of the energy supply at 62.4 percent, followed by oil at 27.4 percent, and coal at 8.3 percent. The remaining percentage is electricity imports (1.9 percent). Total energy consumption was about 6 million Mtoe in 2015. The country depends entirely on imports of petroleum products, having no oil production and processing facilities in its operation. Its electricity supply is dominated by hydro at 45.5 percent, with oil, coal, biomass, and imports accounting for the rest. The PDP prepared in 2015 (PDP 2015) projects hydropower to dominate the electricity supply in the near term. The coal-fired power stations based on imported coal are also expected to be a significant source by 2022.

Fossil fuel resources. Cambodia imports all coal and oil products that it consumes. Preliminary estimates for national coal deposits are small at about 7 million tons, and no commercial-scale mining has been developed.[13] Cambodia also has minimal oil exploration drilling and no refinery in operation. The country has an unquantified amount of untapped potential for petroleum extraction. Several geological factors, including similarities to adjacent oil and gas-producing areas in Vietnam and Thailand, indicate economically viable oil and gas potential. The seismic data show that inland areas contain three times more potential petroleum resources than offshore areas.[14]

Cambodia has no refinery facility in operation. In May 2017, construction began on a US$2.3 billion refinery project located on a land of 390 hectares (ha) in Preah Sihanouk Province. Cambodian Petrochemical Company, a private company, is constructing this refinery, which has an annual processing capacity of five million tons of oil.[15] Its original schedule of completion in 2019 has been pushed back to

[11] A ratio between energy supply and gross domestic product measured at purchasing power parity. Energy intensity is an indication of how much energy is used to produce one unit of economic output. Lower ratio indicates that less energy is used to produce one unit of output.
[12] ERIA 2019. Energy Outlook and Energy Saving Potential in East Asia.
[13] Cambodian National Petroleum Authority (retrieved from Open Development Mekong). In March 2014, the Cambodian National Petroleum Authority was integrated into the Ministry of Mines and Energy (MME) as the General Department of Petroleum. Cited in ADB 2018. Cambodia Energy Sector Assessment.
[14] C. Y. Cheang. 2016. OTC 2016: Cambodia Decision on First Oilfield Development by Year End. Rigzone. 2 May. Cited in ADB 2018. Cambodia Energy Sector Assessment.
[15] H. Kimsay and K. Kotoski. 2017. Ground Broken for Oil Refinery. The Phnom Penh Post. 5 May. and K. Kotoski. 2016. Chinese Firm Bags Contract for Oil Refinery. The Phnom Penh Post. 5 May. Cited in ADB 2018. Cambodia Energy Sector Assessment.

2021 following several delays. Once the refinery starts its commercial operation, it is expected to reduce oil product imports, lower oil product costs, and improve national energy security.[16]

From 2013 to 2019, Cambodia saw a surge in new electricity-generation facilities of thermal power, including 617 MW of coal-fired generation and 227 MW of fuel oil–fired generation,[17] increasing its dependency on the import of fuels for power generation.

Hydropower. Cambodia's technical hydropower potential was estimated at approximately 10,000 MW.[18] Around 50 percent of hydropower resources are located on the Mekong River, 40 percent on the Mekong River's tributaries, and 10 percent in the southwestern coastal highlands.[19] Out of the 10,000 MW, only 1,329 MW of capacity has been built.[20]

Solar power. Cambodia has a high degree of solar irradiation accumulating into strong solar resource potential. Some 65 percent of the country was estimated to have viable solar radiation levels, resulting in about 8.1 GW of technical potential.[21] Cambodia's maximum technical solar energy potential is estimated to be just under 12 terawatt per year (TWh/yr).[22]

By the end of 2017, Cambodia had installed over 60,000 Solar Home System units as part of a program under the Rural Electrification Fund.[23]

Wind power. Wind assessments in Cambodia indicate that parts of the country have viable medium-intensity wind resources appropriate for utility-scale turbines. Cambodia has a theoretical potential wind capacity of 65 GW and a possible energy production of 154 TWh/yr. Cambodia's technical wind potential is estimated much lower at 18 MW to 72 MW due to the grid's low absorption capacity. ADB's 2015 analysis finds that wind could be economically feasible in areas with wind speeds greater than six meters per second per year and with access to the grid or in small, off-grid applications.[24]

Biomass energy. Cambodia is endowed with considerable biomass energy resources from rubber plantation forests, fast-growing tropical trees such as Gliricidia and Acacia, and agricultural residues. The large-scale processing mills could potentially utilize these by-products for power generation. Using 2010

---

[16] Chea Vannak. 2019. Oil refinery construction pushed to 2021, *Khamer Times*. Cited in ADB 2018. Cambodia Energy Sector Assessment.
[17] EAC, 2019, Salient Features of Power Development in Kingdom of Cambodia. Electricity Authority of Cambodia, Phnom Penh.
[18] MME. 2016. Current Status of Renewable Energy in Cambodia. Presentation prepared for the International Renewable Energy Agency's Renewable Energy Statistics Training. Bangkok, Thailand. 12–14 December.
[19] Cambodia National Mekong Committee. 2003. National Sector Review 2003: Hydropower. Phnom Penh. Quoted in Open Development Cambodia. Hydropower Dams.
[20] EAC, 2019, Salient Features of Power Development in Kingdom of Cambodia. Electricity Authority of Cambodia, Phnom Penh.
[21] Wide variations in estimates of current energy consumption make a comparison of potential vs. current consumption unrealistic. Estimates by the Association of Southeast Asian Nations Plus Three (ASEAN+3), by the Economic Research Institute for ASEAN and East Asia (ERIA) in 2009, and by the World Bank in 2011 were arrived at through different data-collection methods and are not comparable. Most Cambodians use biomass as their primary fuel source, complicating the task of estimating energy demand. Cited in ADB 2015, Renewable energy developments and potential in the GMS.
[22] ADB 2015, Renewable energy developments and potential in the GMS.
[23] R. de Ferranti et al. 2016. Switching On: Cambodia's Path to Sustainable Energy Security. Phnom Penh: Mekong Strategic Partners.
[24] ADB 2015, Renewable Energy Developments and Potential in the GMS.

data obtained from the Ministry of Agriculture, Forestry, and Fisheries, ADB estimates that the combined theoretical potential of agricultural residues is about 15,000 GW per year (GWh/yr).[25] By the end of 2017, Cambodia had seven biomass-generation power plants in operation, with a total capacity of 39 MW.[26]

4. Environmental concerns

The Mekong region's current power mix, including Cambodia, is primarily based on hydropower and fossil fuels. Cambodia's government plans to build more hydropower, coal-fired, and natural gas-fired power plants, potentially increasing long-term environmental risks and impacts. There is a growing concern over the potential impacts of thermal power plants on climate change, air pollution, public health, and cumulative impacts of the proposed hydro dams on the natural ecosystems, fisheries, and people's livelihoods.

Burning fossil fuels for power generation negatively impacts air pollution, the health of local communities, and global climate change. Lifetime impacts of a typical advanced 550 MW supercritical coal plant with pollution controls are still significant, including 150 million tonnes of carbon dioxide (CO_2); 470,000 tonnes of methane; 7,800 kilograms (kg) of lead; 760 kg of mercury; 54,000 tonnes of nitrogen oxide (NO_x); 64,000 tonnes of sulfur oxide (SO_x); 12,000 tonnes of particulates; 4,000 tonnes of carbon monoxide (CO); 15,000 kg of nitrous oxide (N_2O); 440,000 kg of ammonia (NH_3); 24,000 kg of sulfur hexafluoride (SF_6); consumption of 420 million cubic meters (m^3) of freshwater; consumption of 220 million m^3 of water; discharge of 206 million m^3 of wastewater.[27]

An assessment projects CO_2 emissions from energy consumption to increase by 5.4 percent per year from 2.02 million tons of carbon (Mt-C) in 2015 to 7.60 Mt-C in 2040 if the current energy use trajectory continues in Cambodia. The largest carbon emissions from oil are increasing rapidly from 1.39 Mt-C in 2015 to 3.55 Mt-C in 2040. Emissions from coal are growing the fastest at 6.8 percent per year, from 0.63 Mt-C in 2015 to 3.24 Mt-C in 2040.[28] Cambodia is also concerned that the country is importing retired power plants from China to meet its rising electricity demand.[29]

Similarly, hydropower development also has significant negative impacts on national and regional water ecosystems. For example, large hydro dams, such as the Lower Sesan 2 (LS2) at the confluence of the Sesan and the Srepok, fragment rivers and massively reduce ecosystem productivity.[30] A 2011 study estimated that the LS2 would reduce the total Mekong fish biomass by 9.3 percent. When the LS2 was complete in 2018, 2,388 km of the Sesan and Srepok were disconnected from the Mekong, equivalent to a 55.4 percent loss in the connectivity of three river systems (i.e., Sesan, Srepok, and Sekong).[31] Such fragmentation inhibits the movement of many of the Mekong's long-distance migratory fish, of which there are hundreds of species that spawn in the upstream portions of the Sesan and Srepok, together with Sekong. Most of these fish spend their lives migrating to and from the Tonle Sap each year. The lake provides a nutritious habitat during the wet season for fish eggs and larvae to mature and then return to spawning grounds upstream during the dry season. The Tonle Sap produces up to 500,000 tons/year of fish catch. Much of the Mekong's total annual catch of 2.6 million tons, the world's largest for a single

[25] ADB 2015. Renewable Energy Developments and Potential in the GMS.
[26] ADB 2018. Cambodia Energy Sector Assessment.
[27] US Department of Energy, 2010; EndCoal.org, no date. Cited in WWF 2016, GMS Power Sector Vision 2050.
[28] MMEC 2018, Presentation on Energy Outlook in Cambodia.
[29] Sokhorng Cheng, 2019. As it cleans up at home, China is exporting coal power equipment and carbon emissions. China Dialogue.
[30] STIMSON 2020, Stimson 3S energy profile.
[31] 2012, 3S Rivers Under Threat, International Rivers.

river system, also spends some of their life in the Tonle Sap. These fish provide Cambodians with 50 percent to 70 percent of their protein intake.[32]

The large hydro and coal-fired power plants face opposition from civil society, owing to environmental concerns. Recently, the government announced a moratorium on the construction of new hydropower dams until 2020. The proposed projects at Stung Treng (900 MW) and Sambor (2,600 MW), two mainstream dams on the Mekong River that created significant controversy, were dropped from the PDP.[33]

Renewable energy such as solar, wind, and biomass can meet Cambodia's electricity needs with less environmental impact, mainly because LCOE has significantly reduced in recent years. However, solar and wind power's intermittent nature poses an additional challenge for meeting Cambodia's electricity needs. Battery and other energy storage continue to be very expensive, with the government providing incentives such as subsidies. Furthermore, RE, especially wind and solar power, requires a sizable footprint. There is almost no experience in assessing these impacts and costs of externalities. The limited availability of alternative lands means that it is likely to compete with that agricultural land, raising a severe food security concern.

DSM, energy conservation, and EE programs could be economically and technically viable to reduce electricity demand.

3.1.2 Current Approach

Cambodia's PDP is the master investment plan for power system development, which determines the fuel type, generation technology, size, and number of generating units that should be built (and when and where they should be built) to meet the forecasted load demand in terms of peak and energy at the predetermined reliability level. The PDP should ideally provide a cohesive basis for linking national policies pertinent to energy development and physical infrastructure plans (including generation, transmission, and distribution). It should also reconcile often-unsolicited bids and business-to-business arrangements for new power generation.

The regulatory basis for PDP preparation comes from Article 3 of the Second Amendment of the Electricity Law of Cambodia (2015), which states that the formulation and administration of power policies, strategies, and plans fall under the jurisdiction of the MME. However, the law does not make any specific reference to the timing or scope of PDPs.

The government last updated the PDP in 2017 for the planning horizon from 2017 to 2030 (PDP 2017), with support from an overseas consultant and MME. EDC and EAC supervised the PDP preparation.[34]

It is understood that ADB is now supporting the development of a 20-year PDP, which will include demand forecasts for 2020−2040, generation planning scenarios, transmission and distribution scenarios, and an economic and environmental assessment of the options (e.g., on GHG emissions). However, details are not yet available for this work.

[32] STIMSON 2020, Stimson 3S energy profile.
[33] ADB 2018. Cambodia Energy Sector Assessment.
[34] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.

The preparation of PDPs in Cambodia is conducted along traditional lines. The latest PDP was prepared by a Japanese consultancy, Chugoku Electrical Power Company, and illustrates the character of PDP preparation well. Only large-scale conventional generation sources, mainly coal and large-scale hydropower, were included in the generation options, and EE measures were not considered in the demand forecasts. RE was predetermined to be of marginal potential and consequently not included in any significant degree. The plan was prepared on a least-cost basis, with only technical and financial data considered.

There appears to be no involvement of organizations outside the MME or more comprehensive stakeholder consultation during the PDP preparation. The PDP's detailed preparation is outsourced to overseas consultants, MME, EDC, and the regulator. EAC prepares only the PDP terms of reference (TORs) and supervises and discusses the consultants' results.

More recently, the General Department of Energy of MME prepared Cambodia's Basic Energy Plan (BEP) with technical support from the ERIA. The plan outlines policy targets with numerical values, as much as possible, for energy fields such as oil, electricity supply, RE, EE, energy security, and the energy outlook. The plan includes alternate sustainable electricity development pathways that include more solar/wind and biomass power and mainly hydropower generation compared to PDP 2017. One of the BEP aims is to provide guidelines for the next iteration of the PDP.

The section below benchmarks and evaluates current power development planning in Cambodia against the international best practice of IRP under the seven broad topics. The assessment is based on available information on PDP 2017 and Cambodia BEP:

1. Load forecasting

The exact methodology used for demand forecasting in the PDP 2017 is not transparent. The past PDP and Cambodia BEP review suggest that the forecast used an econometric model and a combination of time series and regression analysis. Most likely, an Excel sheet–based end-use model was applied, as in the case of neighboring countries (Thailand and Vietnam). The population and gross domestic production (GDP) growth rate are key drivers of estimating electricity demand. The forecasting also considers data on electricity sales and daily and annual load curve. In the past, the demand forecast was validated with the actual trend and readjusted by extrapolating data from residential, industrial, commercial, and service sectors. Then the demand forecast also took account of the connection of each area load to the grid. However, bottom-up forecasting is usually restricted due to the availability of data.

The forecasted peak demand figure is vital, because the peak demand and a reserve margin determine the amount of installed generation capacity necessary to ensure the country's adequate power supply as per the current reliability planning criteria.[35] The inaccurate forecasts could lead to either a deficit supply situation (too few power plants built) or a surplus supply situation (too many power plants built). Each has significant economic ramifications to a power utility and its customers. Cambodia is facing a power shortage; this has more to do with the slow development of power-generation projects than the inaccurate forecast. Cambodia's general concern is increasingly overestimating demand forecast to accommodate commitments to a new wave of investments in coal-powered power plants. Neighboring countries like Thailand and Vietnam have often overestimated demand forecast, resulting in over-accumulation of assets, financial losses, and associated environmental impacts (particularly in hydropower). Cambodia has to be careful of similar concerns as power demand increases.

[35] International Rivers 2013. An Introduction to Integrated Resources Planning.

PDP development is based on high-, medium-, and low-demand forecast scenarios, based on GDP growth.

Assessment: The load forecasting methodology is not transparent; however, it generally appears to be based on the top-bottom econometric model for high-, medium-, and low-growth scenarios. There is little attempt to improve the forecasting by disaggregating data by geographical area or sector. Cambodia's PDP process for load forecasting is rated "not achieved" compared to the acceptable international practices on IRP.

2. Demand-side management and energy efficiency

PDP 2017 and BEP do not consider DSM or EE measures in the demand forecasts.[36] The demand forecasts were prepared separately before PDP.

Energy Efficiency Policy sets a target to reduce future national energy demand by 20 percent until 2035, based on the consumption in 2010.[37] ERIA's assessment illustrates that energy saving will amount to 21.5 percent of Cambodia's energy consumption in 2040, if EEC programs are implemented, compared to business as usual. This saving translates into a reduction of 2.797 million tons of carbon (Mt-C).[38] This kind of assessment is not included in PDP development yet. The PDP could deduct the DSM program's potential achievements in terms of the peak from the load forecast. However, in the absence of monitoring data and regular evaluation of DSM programs in Cambodia, such an assessment is difficult to perform.

Assessment: PDP and BEF do not consider DSM and EE in the demand forecasting. Therefore, the PDP process in Cambodia is rated "not achieved" for DSM and EE.

3. Scenarios

PDP does not include any supply scenarios. The BEP considered the additional power-development scenario with increased hydropower and the addition of RE in the generation mix.

Assessment: There is no practice of applying scenario-based analysis for PDP development in Cambodia yet. However, the scenario analysis in the BEP could potentially inform the next iteration of the PDP. The PDP process is rated "not achieved" for the scenarios.

4. Generation expansion plan

The current demand and supply projections indicate peak supply with a reserve margin of more than 20 percent in 2030,[39] within the accepted international norms. However, it is not clear how this was calculated and what assumptions are used for each generating plant. A proper amount of reserve margin (typically 10 percent to 30 percent) is a balance between cost and achieving high-reliability standards (by building and maintaining a large surplus capacity to account for generators' maintenance outages and unexpected outage events).[40] However, once the country sufficiently diversifies the supply by introducing a higher amount of RE in the energy mix, this reserve margin might have to be increased to account for higher intermittent generation. The PDP optimized the energy supply options for high-, medium-, and

[36] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[37] MME 2018, Presentation on Energy Outlook in Cambodia.
[38] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.
[39] MME/ERIA 2019. Cambodia Basic Energy Plan.
[40] MME 2018, Presentation on Energy Outlook in Cambodia.

low-case load forecast-based selection and prioritization of candidate plants applying the least-cost approach.

In balancing the generation options, both PDP and BEP are using a capacity factor of 85 percent for coal/gas, 85 percent for oil, 35 percent for hydro, 40 percent for biomass, 15 percent for solar, and 20 percent for wind. The PDP uses the capacity factor of 35 percent for hydro plants in the dry season. The figures on the capacity factor used for coal/gas and oil are higher than the international practices. However, it is improbable that any proposed candidate plants meet such specifications, mainly since there is no due diligence to check the import of low-quality technologies.

The capacity factor used for hydropower, however, is significantly low. The capacity factor of a hydro plant, solar, or wind depends on the associated power plant's available resource and reliability. It is plausible that the lower capacity factor for hydro might be because of lower generation potential during the dry season. The lower capacity factor for hydro also translates into higher generation costs. While the capacity factor for renewable and wind is generally low compared to coal or hydro, Cambodia's value is significantly lower than international practices. As the technology is getting better, the capacity factors for solar- and wind-generation options are also improving, lowering the generation costs.

BEP takes into consideration the LCOE for thermal and hydropower while optimizing supply options. The LCOE of coal is relatively lower than for hydropower plants. It also considers that the LCOE costs for coal are higher than hydro in the future due to an increase in the imported coal price. Due to the size and other factors, a generation option with lower LCOE does not necessarily mean it is the least-cost option to the system. There is a sound basis for PDP's next iteration to apply LCOE to compute and determine the system's least-cost option.

In the PDP, RE was predetermined to be of marginal potential and consequently not included in any significant degree. The BEP considered the additional power development scenario with RE-generation options. However, the actual optimization modeling based on least-cost or levelized cost excludes RE, and hence BEP presents it only as an appendix.

In general, PDP sometimes does not consider the options beyond large coal and hydro due to the limitations of modeling software. EDC has the OptGen software program for optimizing generation expansion, which was provided by Japan International Cooperation Agency (JICA). They also use WASP IV and in-house Microsoft Excel spreadsheet models.[41] However, WASP is not ideal for hydro-thermal systems where there are numerous existing and candidate hydro projects. It is also not suitable for incorporating RE into PDP development or for preparation of a PDP to a hydro-dominated power system. In addition to the software, assumptions and skills are also very important.

Assessment: Cambodia applies a systematic approach to plan generation expansion. However, there are several areas where the methodology could be strengthened, such as determination of reserve margin and capacity factors, use of LCOE, and appropriate application of suitable models. The PDP development process in Cambodia is assessed as "moderately achieved" compared to the acceptable practices of IRP.

5. Transmission expansion plan

PDP 2017 does not include transmission and distribution costs while optimizing generation options instead of being added separately. It is apparent that the PDP process in Cambodia, on the evidence of the past two JICA-supported plans, has generally ignored non–large hydro RE for the primary interconnected grid.

[41] MME/ERIA. 2019. Cambodia Basic Energy Plan.

The perceived wisdom of the Cambodian agencies is that intermittent RE such as wind and solar is costly and likely to destabilize the grid.[42]

International transmission interconnections are somewhat more positive; the Cambodian agencies recognize their domestic hydropower seasonality, hence the need to trade with neighbors such as Vietnam, Thailand, and Myanmar. Cambodia has constructed 230 kV interconnections with Vietnam. A 500 kV DC interconnector between Cambodia, Vietnam, and Laos is under serious consideration.[43]

Assessment: PDP does not factor transmission cost in optimizing generation options. Hence, the PDP is rated "not achieved" for the transmission expansion.

6. **Externalities**

PDP does not attempt to identify potential social or environmental impacts, and so does not include externalities in the planning or cost calculations. The plan to develop five large hydropower projects and related transmission lines in the Cardamom Mountains, an area with high biodiversity value, suggests that environmental and social costs were not considered at the PDP planning stage.

BEP takes into consideration GHG emission from thermal power plants. However, it does not consider any other environmental impacts such as air pollution, public health, and loss of ecosystem and ecosystem services.

Neither PDP nor BEP considers the economic valuation of social and environmental impacts. This means that the plan's financial data is likely to be misleading, as social costs (such as resettlement) or environmental impact mitigation measures are not part of the cost data presented in the PDP.

There is little or no reflection of SEA principles in PDP preparation, either in terms of the PDP's technical content or concerning stakeholder consultation processes. The relevant agencies have little or no knowledge of SEA as a concept nor any concern about considering social and environmental impact issues. The sector line agencies view SEA as "business" of the Ministry of Environment (MOE). Considering these issues at the EIA stage of individual projects was considered adequate, as this is a statutory requirement under existing legislation.[44]

The national experience on SEA in Cambodia is limited. An SEA was conducted in 2009 for a tourism study supported by ADB. Despite this limited experience, interest is growing in doing more of these assessments, and SEAs are formally part of a proposed new environment and natural resources code. The eleventh draft of a new Environment and Natural Resources Code of Cambodia was submitted for review in 2018 after extensive stakeholder consultations. It has yet to go before the National Assembly for approval.

The purpose of the code is to enable the sustainable development of the Kingdom of Cambodia by protecting the environment and conserving, managing, and restoring natural and cultural resources. The draft code contains detailed and specific provisions on SEA. The code states that the environmental considerations shall be integrated into the development of policies, strategic plans, and programs of the

[42] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[43] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[44] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.

Royal Government of Cambodia and include a review of comments received from relevant stakeholders.[45] Under the code, the National Council for Sustainable Development (NCSD) will be responsible for SEA, including establishing a cross-sector SEA committee. However, more than five years have passed since the government first began working on the code. The most recent draft was submitted two years ago, and the bill has yet to be passed.

During 2017, NCSD developed the TORs for the SEA committee. In the absence of an environment code, the NCSD initiated the drafting of a Prime Minister's Decision on SEAs. This would have effectively been an ad hoc version of a subdecree, and it would have provided basic regulatory support for SEAs. A draft was readied in mid-2017, but the initiative has not proceeded further.

Cambodia has no experience or expertise in quantifying and valuing environmental externalities pertinent to PDP. In addition, Cambodia also needs to develop SEA appraisal and compliance systems, which will mature only with experience implementing SEA over a sustained period of time.

Assessment: PDP does not consider environmental and social externalities. Discussion within the MOE to promote SEA are stuck in a political process. There is a general apprehension within the energy sector, as it is still perceived as an obstruction to the sector's development. The PDP process in Cambodia is rated "not achieved" for externalities.

7. Stakeholder consultations

There appears to be no involvement of organizations outside the MME nor any attempt at more extensive stakeholder consultation during PDP preparation. The government outsourced the detailed preparation of the PDP to overseas consultants. In the absence of regulatory requirements or institutional arrangements, environmental regulating agencies such as the Ministry of Environment are limited in preparing PDP. There is no practice of disclosing PDP so the general public and practitioners can seek input; neither is there any evidence of public consultations during PDP preparation.

The proposed code stipulates the right to public participation. However, experts have pointed out issues related to public involvement in the draft code: non-government organizations (NGOs) felt the emphasis on community participation should be more robust and called for the law to require community participation at all stages of a project.

Assessment: Stakeholder consultation is very weak. The PDP process in Cambodia is rated "not achieved" for the stakeholder consultations.

3.2 PEA

The PDP plays a critical role in setting the tone for the electricity infrastructure decisions regarding what, where, and when. Overall, national policies pertinent to power development determine the enabling conditions for such decisions. Institutions, coordination, and the nature of involvement of relevant stakeholders play a crucial role in the decisions on the development of power infrastructure.

[45]Revised Ninth Draft (Draft 9.1), Environment and Natural Resources Code of Cambodia, 25 July 2017 https://data.opendevelopmentmekong.net/dataset/eedccd06-df86-45d2-8e96-72afe074284b/resource/adbd2e13-ffbb-43d9-8b73-00bbe837e8e5/download/enr-code-draft-9.1-in-english-25.07.2017.pdf

3.2.1 Policy

Cambodia's policy framework is evolving, setting a foundation for the uptake of IRP for power sector development. The national policies provide general direction and some targets. The detailed description and analysis of these laws and policies are provided below:[46]

While addressing the shortfall of energy supply remains the primary priority, the policies recognize the need to develop the energy sector affordably and sustainably. Developing the energy sector is an essential priority of the country's National Strategic Development Plan (NSDP) 2019–2023. Recognizing that expanded access to modern and affordable forms of energy is essential for Cambodia's social and economic advancement, the Government of Cambodia's NSDP 2019–2023[47]directs MME to continue its priority activities in managing and promoting the power sector development to achieve an adequate, reliable, quality, and affordable electricity supply for all types of users and to manage and promote the development of EE and energy saving.

The Rural Electrification by Renewable Energy Policy 2006[48] aims to create an enabling framework to increase rural access to electricity rates through RE resources. Its principal objective is that by 2020, 100 percent of rural villages should have access to electricity. By 2030, at least 70 percent of the nation should have access to the national electricity grid, ensuring social inclusiveness.

The NSDP 2014–2018 also defines the Government of Cambodia's commitment to mitigate the adverse environmental and social impacts of energy consumption and energy projects while promoting economic efficiency and each project's environmental sustainability. The NSDP includes actions to implement the government's priorities related to energy, including (i) developing a legal and regulatory framework for the energy sector to ensure efficient management and use of resources and (ii) encouraging the efficient use of energy with minimal impact on the environment.

Cambodia's Nationally Determined Contribution, enshrined in the 2015 Paris Agreement,[49] commits to a 16 percent reduction in GHG emissions from the energy sector from a business-as-usual scenario by 2030.[50] An additional 7 percent reduction is to be achieved from the promotion of EE and RE initiatives in the manufacturing sector; and a further 1 percent reduction from the promotion of building EE and improved cookstoves, the use of biodigesters and water filters in waste management, and the use of RE for irrigation and lighting (solar lamps).

The MME is committed to increasing EE as a cost-effective strategy for reducing the high energy costs that hamper economic and social development. In 2017, a National Policy, Strategy, and Action Plan on Energy Efficiency was prepared by the MME in cooperation with the European Union (EU) Energy Initiative Partnership Dialogue Facility and KnowlEdge Srl.[51] Under this plan, by 2035, the MME commit to (i) reducing national energy consumption by 20 percent compared to business-as-usual projections; and (ii) reducing national carbon dioxide emissions to 3 million tons annually, or 28.5 cumulative million tons from

[46] Adopted from ADB 2018. Cambodia Energy Sector Assessment.
[47] Government of Cambodia 2019. National Strategic Development Plan, 2019–2023. Phnom Penh.
[48] Energy policy and administration | Open Development Cambodia (ODC)
[49] The Paris Agreement entered into force on 4 November 2016.
[50] Government of Cambodia. 2015. Cambodia's Intended Nationally Determined Contribution. Phnom Penh.
[51] A. M. Bassi and S. Rey. 2017. National Policy, Strategy, and Action Plan on Energy Efficiency in Cambodia. Eschborn, Germany: EU Energy Initiative Partnership Dialogue Facility. This is an update to the 2013 draft version of the same name.

2017 to 2035, relative to the business-as-usual scenario. The plan identified three priority sectors, namely buildings, industry, and transport to achieve the targets.

MOE is developing a new Environmental and Natural Resources Code of Cambodia. By March 2018, a 10th draft was available for feedback. The draft code includes general principles, environmental impact assessment, strategic environmental assessment, biodiversity, and endangered species protection. It establishes biodiversity conservation corridors to provide linkages and protection for high-conservation areas. It also addresses cultural heritage preservation, public participation and access to information, a collaborative management process, and dispute resolution procedures.

3.2.2 Regulation and Institution

The regulatory basis for PDP preparation comes from Article 3 of the Second Amendment of the Electricity Law of Cambodia (2015), which states that the formulation and administration of power policies, strategies, and plans fall under the jurisdiction of the MME.

The organization structure of the electricity in Cambodia follows the 2001 Electricity Law and subsequent amendments of 2007 and 2015.[52] The Electricity Law stipulates the separation of responsibilities between the two organizations governing the power sector, the EAC and MME, with a clear definition of the mandate and responsibilities. The following section outlines the description of the mandate, roles, and responsibilities of different agencies involved in power development in Cambodia.[53]

The EAC, the electricity regulator, is an autonomous agency with authority to issue rules, regulations, and procedures on power market operations; award licenses; and set tariffs. The EAC is led by a chairperson and two members appointed by the Prime Minister and confirmed by royal decree, and the agency is funded from license applications and fees. All power generators, suppliers, and distributors must be licensed by the EAC.

The MME takes the lead in developing government policy, strategies, plans (including PDP), and technical standards for the energy sector and ensures required inter- and intraministry coordination.

EDC, as the state-owned, vertically integrated power utility, generates, transmits, and distributes electricity in areas assigned to it by the EAC. It is jointly owned by the MME and Ministry of Economy and Finance (MEF) and is the only public sector licensee of the EAC. Most of EDC's electricity is sold in Phnom Penh and the principal provincial towns. EDC's mandate also covers extending and integrating the local grids of private energy producers into one national grid and further extending the national grid to rural areas. To facilitate rural electrification, which involves enormous capital costs and a low payback, the government provides support and subsidies to EDC.

The MEF, as co-owner of EDC, facilitates its access to long-term and concessional finance and plays an essential role in setting energy policy. The MEF is the government's focal point for structural reform, international economic and financial cooperation and integration, lobbying for foreign aid, and plans for borrowing and repayment of foreign loans.

---

[52] EAC 2018. Report on the Power Sector of the Kingdom of Cambodia, 2018 Edition. Phnom Penh.
[53] Adopted from ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS and ADB 2019, Lao Energy Sector Assessment.

Per the 1996 Law on Environmental Protection and Natural Resource Management requirements, the MOE has the authority to review and approve the environmental assessments and environmental management plans for all energy projects.

MOE will be responsible for regulating SEA once the Environment and Natural Resources Code of Cambodia become effective. However, they are not involved in the PDP-development process yet. MOE's mandate is also to lead decision-making for EIA policy development and EIA approval, including the assessment, law enforcement, and implementation. The difficulty is that EIAs are closely linked to project approvals through the Council on Development of Cambodia (CDC) or the Council of Ministers (COM). MOE leads technical EIA issues, but many project decisions are made at higher levels, often before the EIA has been completed. Some projects are reportedly fast-tracked: for large-scale investment, CDC or the COM may influence the process to push through the investment opportunity and contribute to economic growth. Once approval is received, the proponent can begin implementing the project.[54]

MOE's interest and role in electricity infrastructure have grown in recent years due to EIA requirements and are likely to increase further with the institutionalization of SEA. However, its influence on PDP development remains limited. The limited influence is due to the lack of enabling policy environment, institutional arrangement, and technical and human resources capacity.

3.2.3 Stakeholders

In addition to the institutions mentioned in the previous section ("Regulation and Institution"), more PDP stakeholders are summarized below:

Owner of electricity infrastructures. EDC is the primary owner of most power-generation facilities in Cambodia. In addition, China is the single largest hydropower project owner based on the existing and planned projects. China also sponsors solar photovoltaics (PV) while the EU and Japan develop petroleum-based electricity. Besides Cambodia, only Japan is funding biomass or biogas projects. The United States, Australia, and multilateral development banks (MDBs) own no current or planned energy projects in Cambodia.

Other notable Cambodian project owners include the Royal Group of Cambodia. Notable Chinese project owners include Hydro-Lancang and CIIDG, Erdos Hongjun Electric Power, Huadian, and PowerChina. Vietnam's EVN also owns several projects.[55]

EDC is the primary owner of most power-generation facilities and holds the most interest and influence in the power-development planning process.

Investors. China or Chinese firms fund a majority of generation capacity, primarily through the Export-Import Bank of China. The Cambodian government and firms also fund several projects. The EU, MDBs, the US, and Japan are financing the balance. The ADB is the most notable MDB, funding 16 energy sector projects in Cambodia.[56]

[54] Wells-Dang 2016. A Political Economy of Environmental Impact Assessment in the Mekong Region.
[55] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Cambodia Focus: Q2-2019.
[56] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Cambodia Focus: Q2-2019.

The private sector's interest and influence have also grown since the liberalization of Cambodia's energy market. Chinese investors hold the most interest and sway among FDI and private sector investment in Cambodia's power sector development. Among the MDBs, ADB, due to its long engagement in Cambodia, is perceived as a trusted partner by the government and holds the most interest and influence on Cambodia's power sector development.

Development partners. Development partners play a crucial role in shaping power development by providing investments and technical support. JICA and ERIA have been directly supporting PDP and BEP preparation. ADB has been providing technical support to promote IRP and strategic environmental assessment in Cambodia. ADB is also supporting the next iteration of PDP and regional cooperation on power trade through the GMS RPTCC.

Development partners like ADB and JICA continue to hold strong interest and influence in PDP due to the direct technical and financial support they have been providing for its development.

Non-governmental organizations and civil society. The role of NGOs has been extremely limited in the preparation of power-development plans and infrastructure development in Cambodia. The World Wide Fund for Nature (WWF) supported the preparation of Power Development Vision; however, there has been no uptake in the PDP and BEP development process. NGOs are, however, highly active in the review of EIAs. Cambodia has established mechanisms for including civil society voices in EIA policy. In Cambodia, an EIA technical working group, chaired by MOE, was set up in 2011 with donors' facilitation. The NGO Forum on Cambodia and Development and Partnership in Action (DPA), among others, are included as civil society representatives of the working group.

NGOs and civil society are increasingly interested in the PDP process, mainly due to social and environmental concerns. However, they hold very little influence on PDP, as they have not been allowed any opportunity to engage in its development. Yet their advocacy role has increasingly caught media attention and has helped express and shape public opinion on power development infrastructure.

Consultancies, academia, and think tanks. The preparation of PDPs in Cambodia is conducted along traditional lines. The latest PDP, dating from September 2015, was prepared by a Japanese consultancy, Chugoku Electrical Power Company. Local academia and practitioners are engaged only through foreign consulting firms on a need basis. There are currently at least 15 local EIA consulting firms. However, they do not have any engagement in the PDP process.[57] The role and influence of local consultancies, academia, and think tanks are limited in the preparation of PDP in Cambodia.

3.3 Recommendations for Future Engagement

The IRP for power sector development might sound new and ambitious; however, Cambodia has already adopted several of its key components, particularly in the BEP. High-level officials (Director General level) were involved in the formulation of BEP, and it is safe to assume they are familiar with the key concepts and their value. However, fully integrating the BEP in the PDP remains a challenge. Achieving full IRP is a gradual process that evolves with experience and capacity. High-level policy support is essential. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Cambodia.

[57] Wells-Dang. 2016. A Political Economy of Environmental Impact Assessment in the Mekong Region.

3.3.1 Awareness Raising and Broader Stakeholder Engagement

The uptake of the IRP approach in PDP in Cambodia will be a new concept, as PDP is still prepared along traditional lines. The integration of sustainability parameters is a contentious issue, depending on the stakeholder. The level of acceptance and understanding in the institutions directly involved in power sector planning, MME, EDC, and EAC is, at best, limited. This included resistance to the ideas of the detailed consideration of RE and EE in PDP preparation, and the analysis of social and environmental impacts are considered the business of the MOE and not their concern. There was almost no awareness of SEA as an approach. No consideration has been given to adapting the PDP development process to consider issues beyond conventional power-generation options' technical and financial characteristics. The existing approach to PDP preparation, which considers only large-scale hydropower and coal as generation options based solely on technical and financial criteria, is seen as adequate.

In contrast, there is strong support for the formalization of SEA as a legal requirement within MOE, NCSD, and the Ministry of Planning (MOP). Current steps for formalizing legislation mean that an SEA will be a legal requirement in PDP soon. Still, the people and institutions responsible for preparing the PDP will have a minimal understanding of this requirement's implications. There is a clear need to build on and support this process, including extending awareness and appreciation of SEA in power sector institutions and ensuring that the institutions responsible for preparing future PDPs can implement a legal requirement for an SEA as a part of the PDP process.

There is an urgent need to increase awareness of what an SEA entails and an IRP approach to PDP preparation beyond the traditional process. Such a shift will be a lot for the institutions to absorb, and this will require the development of awareness and capacities incrementally and practically. The targeted awareness raising involving high-level officials through national, regional, and international exchange events and study visits are useful means of generating interest in new approaches/methodologies.

The current power planning process in Cambodia is weak in broader stakeholder consultations. IRP and SEAs could be used to promote better institutional coordination between energy and other sectors in the power system development process by embedding robust stakeholder consultation measures. Consultations are inherently built into the IRP and SEA process and are often systematically included in their implementation guidelines. The Activity could potentially play a neutral facilitator's role if there is government buy-in, which requires constructive engagement with the government and building trust.

3.3.2 Policy Support

There is also a need for a more specific policy on the scope and character of a PDP to come from the highest policy level, to ensure that the contents of the PDP are in line with national approaches to national sustainable development and that the scope of the PDP includes the consideration of social and environmental issues as an integral part of the planning process. This necessitates more effective interministry coordination, which is likely facilitated by the recent formation of the NCSD. Legal frameworks are crucial for the broader uptake of new tools and approaches. Cambodia does not have a legal requirement for IRP.

Cambodia is in the process of finalizing legal requirements for SEA. However, power sector–specific guidance is still missing. Current steps to formalize legislation mean that an SEA will become a legal requirement in PDP preparation soon. Still, there seems to be little interest in or awareness of the implications of this for PDP preparation in the different agencies involved in the PDP process. There is an urgent need to increase understanding of what an SEA entails and an IRP approach to PDP preparation. The Activity could provide advisory support on the formulation of policy and legal frameworks pertinent to power development subsector-specific guidance on IRP and SEA.

3.3.3 Technical Capacity

Japanese consultants, supported by JICA, updated Cambodia's most recent PDP in 2017. As with previous PDPs in the country, EDC worked alongside the foreign consultants but did not take a leading role. The past PDPs were prepared without integrating sustainability parameters. Energy efficiency is not considered in the PDP preparation or demand forecasts. Similarly, there is no consideration of environmental costs or any form of environmental impacts in preparing the PDP. This includes no consideration of such costs or impacts for the two main generation options (coal and large hydropower), despite international recognition of the need to recognize such impacts in power sector planning. The concept of integrating DSM into least-cost planning is at the heart of IRP. This approach has been applied in the power sector since the 1970s, but not universally.

Consequently, the capacity building in Cambodia would need to include the fundamentals of IRP and the application of SEA to IRP. As noted, environmental costs do not appear to feature in past PDPs in Cambodia. It is understood that ADB is now supporting the development of a new 20-year PDP, which is expected to be an improved version, including demand forecasts for 2020−2040, generation planning scenarios, transmission and distribution scenarios, and an economic and environmental assessment of the options (e.g., on GHG emissions). However, it will take a substantial amount of resources and time to build capacity to strengthen PDP, which is probably impossible to achieve during this iteration on PDP. To achieve full IRP for the power sector development planning in Cambodia, the Activity could support the following power sector development planning related to technical capacity-building activities.

- Demonstrate applicability and value of IRP by supporting a hands-on pilot case study applying a learning-by-doing approach involving power system planners.

- Develop Cambodia-specific technical guidelines on integrated planning, building on the learning experience from the pilot case study.

- Conduct in-depth training on specialized areas pertinent to IRP based on Cambodia's specific needs. The following are identified areas:

    - Bottom-up load forecasting; however, this depends on the availability of disaggregated data. Collecting, generating, and maintaining such data will require sustained support to develop a robust information management system.

    - Capacity needs to be built to access the potential reduction of electricity consumption because planned DSM programs need to be reflected in the PDP electricity demand forecast. Therefore, processes need to be modified to accommodate DSM and EE. Also, the costs of the DSM programs leading to the reduction of electricity consumption need to be reflected in the PDP's total costs to ensure an adequate overall assessment of the PDP costs and benefits.

    - Capacity for scenario analysis for managing load demand and optimizing power supply options for Cambodia-specific planning needs to be built.

    - Cambodia uses old modeling software (WASP IV) that is not compatible with IRP. However, it is understood that they have access to the OptGen software program for optimizing generation expansion—which was provided by JICA—and they have been trained in its use. The OptGen package has many of the attributes required to assist with

IRP preparation. EDC should continue to seek support to gain experience with this package.

Cambodia will need to include capacity building on the fundamentals of internalizing external social and environmental costs into the PDP's economic analysis. Given the urgency of developing SEA capacity in Cambodia, the Activity could support capacity-building activities on the power system planning–specific application of SEA, including valuation of environmental and social externalities of energy generation options.

3.3.4 Data and Knowledge Management and Sharing

Proper planning depends on the availability of quality data and information. Cambodia will have to strengthen data collection to fulfill the sophisticated modeling and assessment requirements for IRP and SEA. Data generation will require a considerable investment; however, in the absence of capacity to identify data need, data prioritization, and data sharing, even the available data are not utilized correctly. For instance, several studies have been conducted for the valuation of ecosystem services. However, there is little awareness among PDP line agencies about the availability and applicability of such data. The Activity could support Cambodia's government to raise awareness of such data and establish an information management system to ensure data sharing.

4. LAO PDR

Summary

The regional demand for electricity produced in Lao PDR is high, mainly for hydropower export to the neighboring countries. Nearly half of the forthcoming hydropower projects in Lao PDR are reserved for cross-border exports. Hydropower makes a significant contribution to the overall economy, earning revenue from taxes, royalties, and dividends.

While Lao PDR harbors an ambitious electricity export plan, Lao PDR's per capita electricity consumption remains one of the lowest in Southeast Asia. The electrification rate in Lao PDR has significantly improved in the last decade.

Lao PDR does, however, face challenges to realize the ambition of exporting electricity to become the "Battery of Southeast Asia." These include the financing burden and social and environmental impact of such projects, the requirement to develop enabling transmission infrastructure, the potential competition from cheaper exports from southern China, where considerable surplus capacity exists, and the recent trend of importing countries to shore up their generation mix with increased RE and battery storage.

As Lao PDR endeavors to move toward an efficient and competitive economy and promote sustainable development, energy intensity for both final and primary energy is likely to reduce significantly. However, the energy intensity of its economy is still higher than its neighbors. An increase in the electrification rate and subsequent electricity use displacing traditional fuels in agri-processing, manufacturing, and transportation is likely to improve the energy intensity of Lao PDR.

The country's primary energy supply consists of coal, oil, hydro, and others (biomass, biofuels, and exported electricity). In 2015, coal was the energy used the most (7.04 Mtoe), followed by hydro (1.33 Mtoe) and biomass (1.3 Mtoe). The reason for coal being used the most is the beginning of the Hongsa Thermal Power Plant operation.

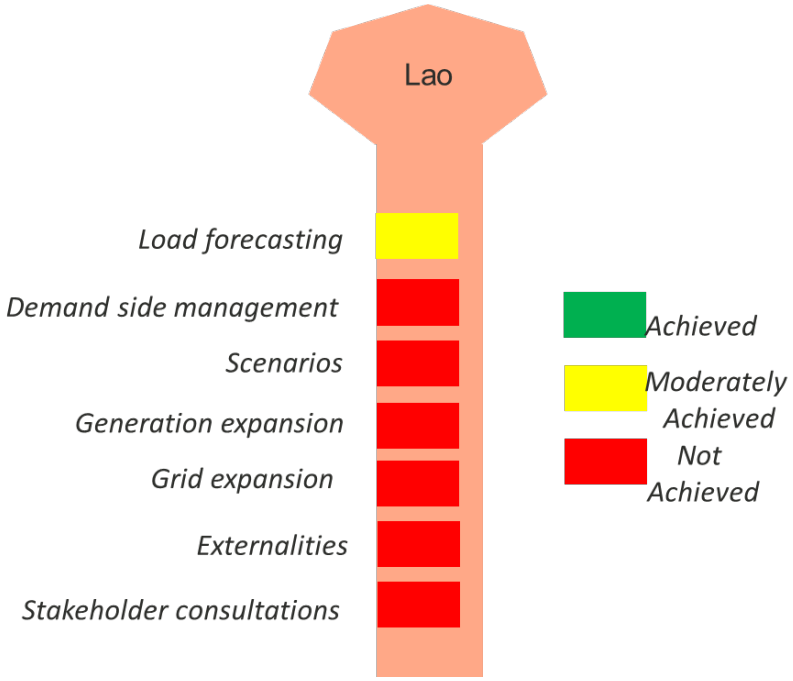
Despite having modest fossil fuel resources, Lao PDR has a vast hydropower potential due to its positioning within the Mekong River, high precipitation levels, and mountainous topography that provides high runoff levels. Lao PDR also has significant resource potential for non-hydro renewables, including solar, biomass, small or mini-hydro, and wind. There has been no comprehensive study of the country's overall energy potential that would otherwise allow an integrated approach to the country's planning and development for energy resources.

All the electricity-generation projects in Lao PDR were traditionally based on hydropower, although this has recently changed with the Hong Sa Project's commissioning in Xayaboury Province. With this, the total installed generation capacity experienced a sharp rise. Several hydropower plants serving the domestic market were also commissioned, such as Nam Ou 2/5/6, Nam Ngiep 2, and Houay Lamphangnay, resulting in a state of excess generation capacity.

Hydropower can have severe social and environmental impacts. The share of thermal power in Lao PDR has increased in recent years. Fossil fuels also have impacts on the local communities and the broader environment.

Lao PDR is at a pivotal stage for the development of integrated planning and SEA. Legislation will require an integrated approach to all power development and SEA to be integrated into the preparation of strategic plans. However, capacities and awareness are minimal, and the structure of an IRP approach

suitable for Lao PDR conditions would need to be developed. The figure below summarizes Lao PDR as demarcated and compared against seven constituent parts of IRP.



While attempts have been made to use a combination of top-bottom and bottom-up approaches, it still needs to be strengthened. There is little analysis of actual export demand and potential risk in terms of competition. The PDP process does not consider EE measures in load forecasts. Lao PDR has yet to incorporate generation development scenarios to select the least-cost one. PDP does not cover large-scale export-oriented IPPs or off-grid RE. Only large-scale conventional generation sources, such as hydropower, are included in the generation mix, while the coal plants are included to meet baseload. As such, coverage of PDP is very limiting. PDP is restrictive to RE and diversification and promotes hydropower solely. The transmission line planning is done on a case-by-case planning and is fragmented from overall PDP. The PDP does not consider environmental and social externalities, and SEA is yet to be applied. Both interinstitutional and public consultations during the preparation of PDP are weak in Lao PDR.

The policy framework in Lao PDR is evolving; however, it remains fragmented. An integrated planning framework must bring together otherwise disjointed components such as large-scale IPP hydropower schemes, small hydropower projects (SHPPs) and very small hydropower projects (VSHPP), and transmission lines, which are not covered by the current PDP. However, the policy framework provides clear targets for power development, RE, and EE.

The Electricity Law of 1997, later revised in 2008, 2011, and 2017, provides the legal framework underpinning Lao PDR's power. The Electricity Law promotes the sustainable and efficient use of energy resources to support socio-economic development. As the Ministry of Planning and Investment (MPI) holds the authority to countersign any investment agreement on the government's behalf, it keeps high interest and influence regarding Lao PDR's power-development infrastructure.

Irrespective of growing interest in environmental issues pertinent to electricity generation, the Ministry of Environment and Natural Resources (MONRE) has no engagement or influence on power development in Lao PDP. The following table highlights key stakeholders relevant to power development in Lao PDR, their role/interest, and influence.

	Role/ Interest	*Influence*
Regulators		
Ministry of Energy and Mines	High	High
Ministry of Natural Resources and Environment	Medium	Low
Ministry of Planning and Investment	High	High
Owner		
Électricité du Laos	High	High
Investors		
Government	High	High
FDI and private sector	High	Medium
Multilateral banks (MBDs)	High	Medium
Development partners (ADB and JICA)	Medium	Medium
Non-government organizations and civil society	Low	Low
Consultancies, academia, and think tanks	Low	Low

Achieving full IRP is a gradual process that evolves with experience and capacity. High-level policy support is essential to promote uptake of best available methodologies and encourage broader stakeholder engagement and public consultations. Lao PDR has worked with USAID in the past on Integrated Resource and Resilience Planning (IRRP). This is an activity conducted under the USAID Clean Power Asia project. USAID Clean Power Asia is a multi-year initiative designed to mobilise investment and promote the development of clean energy projects in Southeast Asia. It is being implemented by Abt Associates, under which SEI is a subcontractor for a number of planning and capacity building activities.

SEI's two most significant activities under the project fall into two different themes, related to gender and energy, respectively. SEI is undertaking a gender strategy assessment by surveying renewable energy sectors in Lower Mekong countries to assess gender equality issues, and to make recommendations for promoting gender equality and responsiveness within the energy planning process. SEI is also executing a number of activities designed to identify priority areas for technical assistance and capacity building needs in Cambodia, Lao PDR and Thailand.

Among these activities, the largest is the development and execution of a program of capacity building on Integrated Resource and Resilience Planning (IRRP) in Lao PDR. Over a period of twenty months, SEI will work closely with the Lao Ministry of Energy and Mines (MEM) and Électricité du Laos (EDL) to deliver the program, which is aimed at guiding a core group of participants from these institutions through an IRRP process. The work will feature a number of tasks and missions focused on devising low-regrets power development pathways: development plans that best satisfy a range of planning objectives given multiple uncertainties and possible futures. The analytical framework for the analysis and capacity building will be SEI's Long-range Energy Alternatives Planning system (LEAP) platform, which will be enhanced in key areas to provide planners with a complete toolkit designed specifically around the IRRP process.

In addition to the IRRP work under USAID Clean Power Asia, USAID Mekong Safeguards and the Lao PDR Energy Security project could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Lao PDR, particularly in the area of sensitizing high-level officials on the importance of achieving IRP and building targeted capacity on quantification and valuation of environmental and social externalities and encouraging broader and effective public consultations.

4.1 Approach to Decision-Making

4.1.1 Background

1. Power-generation needs and challenges

The regional demand for electricity produced in Lao PDR is high. While Lao PDR's economy, with a GDP of $17.95 billion (2018) is relatively small compared to its neighbors in Southeast Asia, there is an increasing electricity demand, particularly for export to neighboring countries. Lao PDR's ability to monetize its vast hydrological resources, for both existing and future hydropower plants, is expected to have significant impacts on its ambition to graduate from least-developed country status by 2026, in line with its national socio-economic development plan.[58]

Hydropower production makes a significant contribution to the nation's overall economy. The government earns revenue from taxes, royalties, and dividends from Électricité du Laos (EDL) and IPPs. More broadly, the country benefits from substantial foreign private investment. Its revenue from hydropower is forecast at 1.2 percent of the national GDP in 2018, with royalties accounting for 0.8 percent.[59] Nearly half of the forthcoming hydropower projects in Lao PDR are targeted to cross-border exports. The country's central location within the GMS allows it to supply electricity to sizable neighboring markets such as Thailand and Vietnam; and, to a lesser extent, to Cambodia and Myanmar.

While Lao PDR harbors an ambitious electricity export plan, its electricity consumption per capita was at 725 kilowatt-hours (kWh) in 2017, which remains one of the lowest in Southeast Asia.[60] The country's electrification rate has significantly improved in the last decade and stood at 92.39 percent in 2016.[61] Improved electrification is expected to contribute to the government's priorities to eradicate poverty in the country.

Lao PDR does, however, face challenges on several fronts to realize the ambition of exporting electricity to become the "Battery of Southeast Asia." These include the financing burden and social and environmental impacts of such projects, the requirement to develop enabling transmission infrastructure, potential competition from cheaper exports from southern China, where considerable surplus generation capacity exists, and the recent trend of importing countries shoring up their generation mix with increased RE and battery storage.

Electricity Demand. Lao PDR's domestic annual peak demand for electricity stood at 928.2 MW in 2017. The country has experienced a rapid increase in domestic electricity demand in recent years, experiencing an annual growth rate of close to 9.5 percent during 2007–2017. Memorandums of understanding (MOUs) and cooperation agreements are in place to supply Thailand up to 9 GW, Vietnam up to 5 GW, and Cambodia up to 1.5 GW by 2020. MEM has also signed an MOU with Myanmar's Ministry of Electricity and Energy, intending to secure exports for an amount ranging from 300 MW to 500 MW.[62]

Electricity Supply. The total installed generation capacity in Lao PDR experienced a sharp rise between 2014 and 2017, owing mainly to the commencement of the Hongsa mine-mouth lignite-fired power plant, a principally export-driven project. In addition, several hydropower plants serving the domestic market were commissioned, such as Nam Ou 2/5/6, Nam Ngiep 2, and Houay Lamphangnay, resulting in a state of excess generation capacity, wherein the capacity at the end of 2017 was 2,526 MW with an annual generation of 7.0 TWh, compared with an annual peak demand of 928.2 MW. The generation capacity allocated for export was 4,550 MW, with an estimated generation of 24.3 TWh. The contracted power

[58] ADB 2019, Lao PDR Energy Sector Assessment.
[59] IMF. 2017. Lao PDR IMF Country Report. No. 17/53. Cited in ADB 2019, Lao PDR Energy Sector Assessment.
[60] ADB 2019, Lao PDR Energy Sector Assessment.
[61] EDL, 2016, Electricity Statistic Report 2016.
[62] ADB 2019, Lao Energy Sector Assessment.

export is forecast to rise to 50 TWh by 2030 from 16 TWh in 2016, at an annual growth rate of 9 percent.[63]

There may be a greater desire to sell exports (and increase domestic demand) than there is a demand for exports. Lao PDR does, however, face challenges on several fronts to realize these ambitions. These include the financing burden of generation and transmission infrastructure, as well as the following:

- Potential competition from cheaper exports from southern China, where considerable surplus generation capacity exists, and the recent trend of importing countries shoring up their generation mix with increased RE and battery storage.

- Social and environmental impact of such power development projects.

Transmission and generation should be planned at the same time. Investments in generation by EDL, EDL-Gen, and the private sector have not been matched with a proportionate investment in transmission and distribution infrastructure, and there is a heightened need for the requisite infrastructure to allow excess power to be evacuated. Such a build-out of transmission infrastructure could place further pressure on EDL's finances, because the cost of developing transmission infrastructure in Lao PDR is exceptionally high.

There is a strong emphasis on large-scale hydropower development in Lao PDR, both for export and for domestic consumption. There have been concerns both within the country and internationally on whether these investor-led hydropower schemes were being developed in a manner that met good international practice. The government, to address these concerns, approved the Decree on the Approval and Promulgation of the Policy on Sustainable Hydropower Development in Lao PDR in January 2015. This decree states that the development of hydropower should be based on principles of economic, social, and environmental sustainability, and that the planning of all hydropower schemes must include a comprehensive Environmental and Social Impact Assessment. However, there is no reference to these issues being addressed at the earlier strategic planning stage, as represented by the PDP. Despite this and given the dominance of hydropower in power sector development in the country, the decree represents an important initiative that needs to be reflected during PDP preparation.[64]

2. Energy intensity

As Lao PDR moves toward an efficient and competitive economy and promotes sustainable development, energy intensity for both final and primary energy is likely to reduce significantly. In 2020, Lao PDR's energy intensity reached the highest level of 1,872 toe/million 2010 US$ and is expected to decline to 1,076 toe/million 2010 US$ by 2035. Similarly, energy intensity is projected to decline even further, from 1,791 toe/million 2010 US$ by 2020 to 888 toe/million 2010 US$ by 2035. This gain is attributable to the implementation of EE and conservation (EEC) programs.[65]

However, the nation's energy intensity is still higher than its neighboring countries, such as Indonesia, Myanmar, and the Philippines, yet lower than Vietnam. Lao PDR also has very low carbon emissions, at 0.30 metric tons per capita in 2014, or 6 percent of the global average equivalent of 4.97 metric tons.[66]

---

[63] ADB 2019, Lao Energy Sector Assessment.
[64] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[65] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.
[66] ADB 2019, Lao Energy Sector Assessment.

An increase in the electrification rate and subsequent electricity use displacing traditional fuels in agri-processing, manufacturing, and transportation is likely to improve Lao PDR's energy intensity.

3. Energy resources

The country's primary energy supply consists of coal, oil, water, and others (biomass, biofuels, and exported electricity). In 2015, coal was the energy used most (7.04 Mtoe), followed by water (1.33 Mtoe) and biomass (1.3 Mtoe). The reason for coal being used most is the beginning of the Hongsa Thermal Power Plant's commercial operation.[67]

Fossil fuel resources. Compared with neighboring countries in the GMS, principally Thailand and Vietnam, Lao PDR does not have many fossil fuel resources. The country relies on imports of close to 100 percent of petroleum products. Petroleum products are used by the transport and industrial sectors, along with households in off-grid areas.[68]

Estimates of coal reserves range between 600 and 700 million tons and mostly comprise lignite and small amounts of anthracite.[69] Lao PDR's lignite resources are concentrated in Hongsa in Xayabouri Province to the northwest, where reserves are estimated to contain greater than 400 million tons.[70] The pattern of coal use has changed markedly in recent years, following the commissioning of the 1,878 megawatt (MW) lignite-fired thermal plant in Hongsa in 2015, which accounted for 34.9 percent of the overall generation mix in 2017.[71] Most electricity generated from this plant (1,778 MW) is exported to Thailand, and only 100 MW is sold to Lao PDR's state utility, EDL.[72]

Hydropower. In addition to having modest fossil fuel resources, Lao PDR has a vast hydropower potential owing to its positioning within the Mekong River, high precipitation levels, and mountainous topography that provides high levels of runoff.[73] The country's exploitable hydro potential is estimated to be 23,000 MW, and only 5,172 MW of hydropower capacity had been commissioned as of 2017, with several forthcoming projects at varying stages of development.[74]

Renewable energy. In addition to large hydropower plants, Lao PDR is also endowed with significant resource potential for other renewables such as solar, biomass, small or mini-hydro, and wind. There is no comprehensive study of the country's overall energy potential that would otherwise allow an integrated approach to the country's energy resources planning and development.

Solar. Lao PDR's technical solar potential is estimated to be 11.7 TWh/yr.[75] Conditions for solar power are less favorable than most other ASEAN member countries due to Lao PDR's mountainous and forested

---

[67] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.
[68] ADB 2019, Lao Energy Sector Assessment.
[69] A. Vongsay. 2013. Energy Sector Development in Lao PDR. Presented to Energy Policy Training Course. Tokyo. 24 June–12 July. Cited in ADB 2019, Lao Energy Sector Assessment.
[70] A. Vongsay. 2013. Energy Sector Development in Lao PDR. Presented to Energy Policy Training Course. Tokyo. 24 June–12 July. Cited in ADB 2019, Lao Energy Sector Assessment.
[71] Government of the Lao PDR, Ministry of Energy and Mines. 2018. Electricity Statistics 2017. Cited in ADB 2019, Lao Energy Sector Assessment.
[72] ERIA 2018, Lao PDR Energy Statistics 2018. Cited in ADB 2019, Lao Energy Sector Assessment.
[73] Mekong Flows. Mekong Basin. http://mekongriver.info/mekong-basin. Cited in ADB 2019, Lao Energy Sector Assessment.
[74] Government of the Lao PDR, Ministry of Energy and Mines. 2018. Electricity Statistics 2017. Cited in ADB 2019, Lao Energy Sector Assessment.
[75] ADB 2015, Renewable energy developments and potential in the GMS.

terrain. These are, therefore, a limiting factor for developing utility-scale solar projects. That said, hydropower and solar irradiation occur at different times of the year, thus complementing each other and providing the potential for balancing year-round variations in generation and supply.[76]

Given Lao PDR's geography, there are inherent practical challenges to developing conventional ground-mounted solar power projects. With the help of ADB and other development partners, the country is considering installing floating solar power projects on reservoirs used for hydropower generation and irrigation dams. In November 2017, ADB identified the potential for several GW of floating solar power projects within the nation, of which over 1 GW could conservatively be deployed at the vast reservoirs of Nam Ngum 1, Nam Ngum 2, Nakai, and Nam Gnouang.[77]

Wind. Lao PDR has considerable wind resource potential, with 20 percent of the total land area having average wind speeds greater than six m/s, the minimum needed for modern wind turbines. The nation has a theoretical wind power potential of 455 GW and potential energy production of about 1,112 TWh/yr. The country's technical wind energy potential is much less because of the limitations of the overall power-generation and transmission grid systems. Daily, monthly, and seasonal variations in wind power would need to be balanced and firmed by alternative generation technologies. If balancing and stability considerations require limiting wind power input to 5 percent of overall power-generation installed capacity, then the technical wind power potential would be less than 100 MW. If the wind power input could be increased to 20 percent of the overall installed generation capacity, the technical potential could be about 380 MW.[78]

Biomass. Lao PDR also has significant biomass resources from agricultural and forestry wastes such as rice straw and husks, sawdust, and corncob. The theoretical potential biomass energy from the combustion of rice husk, rice straw, maize cob, cassava stalks, sugarcane bagasse, oil palm residues, and coconut residues was estimated to a total of 6,400 GWh. About 70 percent of this would be from rice residues and 15 percent from maize residues.[79]

In terms of biomass use in electricity generation, two bagasse-fueled plants totaling 39.7 MW of installed capacity are operational in the south of the country, and a 60 MW plant is under construction.[80]

Renewable energy (solar, wind, biomass) can meet the nation's electricity needs with less environmental impact. With 88.9 percent of households electrified, the country has been making rapid progress in bringing electricity to its population.

Through its Renewable Energy Development Strategy, 2011–2025, the country promotes non-large hydropower renewable resources to reach a 30 percent share of its total energy demand by 2025.[81] Thus far, the commercial-scale application of these renewable generation technologies is still very much in its infancy, limited in part by the absence of a feed-in tariff scheme.

---

[76] ADB 2019, Lao Energy Sector Assessment.
[77] ADB 2019, Lao Energy Sector Assessment.
[78] ADB 2015, Renewable energy developments and potential in the GMS.
[79] ADB 2015, Renewable energy developments and potential in the GMS.
[80] ASEAN Centre for Energy. 2017. Renewable Energy Development in Lao PDR. http://usaidcleanpowerasia.aseanenergy.org/resource/renewable-energy-development-in-lao-pdr/. Cited in ADB 2019, Lao Energy Sector Assessment.
[81] Government of the Lao PDR. 2011. Renewable Energy Development Strategy in Lao PDR. Cited in ADB 2019, Lao Energy Sector Assessment.

4. Environmental concerns

All the operational generation projects in Lao PDR were traditionally based on hydropower. However, this has been recently changed with the commissioning of the 626 MW Hong Sa Lignite Power Project in Xayaboury Province in early 2015. Hydropower and coal-based power generation could potentially result in environmental impacts.

Hydropower can have severe social and environmental impacts. Whereas sustainable hydropower can boost economies and help provide energy security, concerns have intensified over large dams' potential cumulative impacts on the environment, fisheries, and people's livelihoods. Each year, a large and diverse fish migration to spawning grounds occurs along the Lower Mekong River. Up to 70 percent of commercial fish are long-distance migratory species. If this fish migration is blocked by large infrastructure such as hydropower development, fish will not reach spawning grounds. The risk is that fish populations will decline, and some species may vanish. The region's fisheries industry, integral to the livelihoods of people, will suffer enormous impacts. "The combined effects of dams already built on tributaries and the loss of floodplains to agriculture is expected to reduce fish catch by 150,000 to 480,000 tonnes between 2000 and 2015."[82]

While yields from aquaculture are increasing, they cannot replace the region's wild fish stocks. Around 49 percent of Lao households' total animal protein intake comes from freshwater fish (29 kg/capita/year, on average).[83] There are no realistic alternatives to the river as a source of food security and livelihoods. Replacing fish protein with domestic livestock protein would require up to 63 percent more pasture lands and up to 17 percent more water, exerting even more strain on forests and water resources. "Tributary dams alone are expected to reduce total fish stocks by 10 percent to 26 percent by 2030, and dams proposed for the mainstream of the Lower Mekong Basin could cause a further 60 percent to 70 percent loss of fish catch."[84]

The share of thermal power in Lao PDR has increased in recent years. Fossil fuels also have impacts on the local communities and the broader environment. Lifetime impacts of a typical 550 MW supercritical coal plant with pollution controls are still significant, including 150 million tonnes of CO_2; 470,000 tonnes of methane; 7,800 kg of lead; 760 kg of mercury; 54,000 tonnes of NO_x; 64,000 tonnes of SO_x; 12,000 tonnes of particulates; 4,000 tonnes of CO; 15,000 kg of N_2O; 440,000 kg of NH_3; 24,000 kg of SF_6; withdrawal of 420 million m^3 of freshwater; consumption of 220 million m^3 of water; discharge of 206 million m^3 of wastewater.[85] If continued with the current trajectory of the energy mix and use in Lao PDR, CO_2 emissions from energy consumption are projected to amount to 40.943 Mt-C by 2040.[86]

4.1.2 Current Approach

The most recent revision to the Electricity Law, promulgated in August 2018, requires a 10-year power development strategy to set out the power sector's road map. This law has yet to be fully implemented. At present, the Ministry of Energy and Mines (MEM) assigns the detailed preparation of the PDP to EDL,

[82] ICEM, 2010. Strategic Environmental Assessment of Hydro Power on the Mekong Mainstream: Summary of the Final Report. International Centre for Environmental Management, Ha Noi, Vietnam.
[83] MRC. 2014. Catch and Culture. Volume 20, No. 1 April 2014.
[84] Orr, S., J. Pittock, A. Chapagain and D. Dumaresq, Dams on the Mekong River: Lost fish protein and the implications for land and water resources. Global Environmental Change, 2012. 22(4): p. 925-932.
[85] https://wwfasia.awsassets.panda.org/downloads/wwf_greater_mekong_power_sector_vision_2050_laos.pdf
[86] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.

a state-owned electricity utility under MEM. The PDP, when drafted, is submitted to MEM for review and approval.

The Electricity Law also stipulates that PDPs be prepared at both the national and provincial levels and that such PDPs cover five years, marking a change from previous PDPs that spanned 10- to 15-year windows. PDPs set out generation and transmission requirements to meet forecasted domestic and export demand and are supplemented by a funding and budgetary plan to develop new projects. To a country dominated by large hydropower plants and mountainous transmission lines, the lead time (for study, financing, environmental impact assessment and social impact assessment, resettlement) for a generation/transmission project could be long. A study horizon of 10 years for the system development plan/strategy could be too short.

Also, the existing PDP in Lao PDR is far from comprehensive and does not include significant parts of the power-generation system. The PDP does not cover large-scale IPP hydropower schemes that produce electricity for export. These schemes have dedicated transmission lines to their purchasing country that are not connected to the grid. The rural electrification covered by the PDP considers only supplying electricity to rural areas using on-grid connections. Off-grid, a part of rural development plans, is solely realized by deploying small-scale RE plants (e.g., solar home systems [SHSs], SHPP, and VSHPP).

While notionally prepared for ten years, the PDPs are regularly amended and updated, with subsequent adjustments to the period they cover; for example, the current PDP (2015–2025) is a revision of the PDP 2010–2020. While this is an efficient approach in terms of effort devoted to the PDPs, it does mean that the basic structure and approach of earlier PDPs is carried forward with only minor revisions and without any consideration as to whether the entire scope of the PDP should be adjusted.[87]

It is worth repeating that hydropower development, especially for the export market, is investor-led. There are 70 sites in the country with an MOU to undertake studies. The World Bank river basin study identified all the candidate hydropower sites; however, the sequencing of development has not been undertaken in an optimal, least-cost manner. The improvements need to be made in prioritizing and sequencing generation-expansion projects, which currently operate on a first-come, first-served basis. The new Electricity Law, awaiting Parliamentary approval, is expected to address this issue.[88]

EDL is developing a new PDP 2020–2030 (which will also include an SEA) and is likely to be closer to the Optimal Power Sector Plan envisaged in the 2012 law. If done correctly, a new PDP is more likely to determine what kind and quantity of power plants get built, where, and when, with better certainty.

The following section benchmarks and evaluates current power-development planning in Lao PDR against the international best practice of IRP under the seven broad topics:

1. Load forecasting

The previous PDP (2016–2025) considered only GDP growth and system losses.[89] The current PDP forecast is a more comprehensive combination of top-bottom and bottom-up approaches. PDP 2020–2030 demand forecasting is still primarily based on an econometric model, with GDP being the key driver. However, it also considers secondary drivers, such as new electricity tariffs and increased electric vehicles.

[87] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[88] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[89] EDL, Presentation on EDL's Power Development Plan 2016–2025.

The forecasted peak demand figure is vital because the peak demand and a reserve margin determine the amount of installed generation capacity necessary to ensure the country's reliable power supply.[90] Inaccurate forecasts could also lead to either a generation shortage situation (too few power plants built) or generation surplus situations (too many power plants built). The country has historically relied on imports from Thailand to offset the impacts of the dry season, where both high domestic demand and lower dependable hydropower generation coincide to drive system tightness, further compounded by lack of transmission capacity. An accurate forecast is therefore essential.

The electricity demand in its neighboring countries drives power generation in Lao PDR. Power exports are projected to increase sharply because of the government's agreements with neighboring countries that, by 2020, Lao PDR would export 7,000 MW to Thailand and 5,000 MW to Vietnam.[91] Little analysis of the actual export demand has been undertaken, nor is there a cost-benefit analysis of exports, given the small tax and royalty gains and the high cost of investment in both power and transmission infrastructure.[92] It is essential that Lao PDR ensures export-oriented IPPs have firm off-take arrangements and that EDL does not take this risk.[93]

Assessment: While attempts have been made to use a combination of top-bottom and bottom-up approaches, it still needs to be strengthened. There is little analysis of actual export demand and potential risk in terms of competition. Lao PDR's PDP process is assessed as "moderately achieved" for load forecasting compared to acceptable international practices of IRP.

2. **Demand-side management and energy efficiency**

The past Lao PDR PDP did not consider EE measures in the demand forecasts. The review of the new PDP 2020–2030 indicates that there has been little effort to consider EE. There was no modification of the demand forecasts used in the PDP preparation to reflect EE opportunities.[94] ERIA's assessment illustrates the energy-saving potential of 10 percent if EEC programs are implemented compared to the business-as-usual scenario in 2040. This saving amounts to the reduction of 2.797 million tons of carbon (Mt-C).[95] However, it is difficult to adopt the EEC programs now if the 10 percent of achievement would be in 2040, which is 20 years away, and there are many uncertainties of each EE program.

While PDP does not directly incorporate EE, the Lao PDR mandates promote EE and conservation by reducing 10 percent of energy consumption by 2030.[96]

Assessment: Currently, the PDP process does not consider EE measures in load forecasts. The PDP process in Lao PDR is assessed "not achieved" for the DSM and EE.

3. **Scenarios**

[90] International Rivers 2013, An Introduction to Integrated Resources Planning.
[91] ERIA 2019, Energy Outlook and Energy Saving Potential.
[92] ADB 2019, Lao Energy Sector Assessment.
[93] ADB 2019, Lao Energy Sector Assessment.
[94] MEM 2020, Presentation on Power Development Plan 2020–2030 of Lao PDR.
[95] ERIA 2019, Energy Outlook and Energy Saving Potential, ERIA.
[96] MMEC, Energy Outlook Presentation.

The past PDP (2016–2025) considered only the business-as-usual demand projection scenario. The new PDP 2020–2030 incorporates four cases of power demand forecast: (i) base case or business as usual, (ii) increased electric vehicle (EV) case, (iii) increased industries case, and (iv) increased EV industries case. The PDP does not include any scenario analysis for generation options.[97] The PDP does not consider any scenario on the generation mix. It should investigate generation development scenarios and select the least-cost one.

Assessment: Lao PDR has yet to incorporate generation development scenarios to select the least-cost one. The PDP process is assessed as "not achieved" for the scenarios.

4. Generation expansion plan

The PDP 2020–2030 is being prepared based on the following priorities:

- Promote hydropower development with reservoirs and projects that can supply power during the dry season; meet the demand in Vientiane Capital and Central region.

- Utilize a coal power plant to meet the baseload of the system to secure power stability and maintain the power security of the Vientiane Capital and Central region.

- Ensure the generation cost from renewables such as solar, wind, and biomass is no more than 90 percent of the hydro cost in the dry season to maintain the retail tariff.

Electricity-generation planning is based on four case studies of the power demand forecast. The current projections of supply and demand balance indicate a negative reserve margin post-2025. Energy policy aims for the electricity reserve margin to reach 15 percent of peak demand.[98] However, ADB assessment indicates a contrasting picture, which suggests that in the immediate future, the addition of 6,250 MW of domestic hydropower plants is likely to shift the domestic power sector to a state of substantial excess capacity, which is reflected in an adjusted wet season reserve margin that reaches 52.6 percent by 2023, and which is expected to entirely remove the need for imports within the next two years, even during the dry season.[99] Based on the ADB analysis, its present trajectory, the substantial increase in generation capacity, and oversupply in the coming years will likely not improve until the late 2020s, when adjusted reserve margins level off to reach 26.7 percent by 2030.[100]

Only large-scale conventional generation sources, such as hydropower, are included in the generation mix, while the coal plant is included to meet baseload. The inclusion of RE continues to be marginal. The Renewable Energy Directive's (RED'S) proposed targets for RE share to be up to 30 percent of energy consumption by 2025 (7 percent by 2015 and 20 percent by 2020), with a detailed breakdown by technology. Biofuels, small hydropower, solar energy, biogas, biomass, and wind energy were all considered as having the potential to contribute to meeting the 2025 target. However, EDL is not considering RE for the interconnected grid.[101] Given that the hydropower plants have large reservoirs and reasonable capacity factors, such as 60 percent or less, high wind and solar power penetration could be possible. A study on penetration of renewable power should be carried out based on the following: (i) load demand and its pattern, (ii) hydropower generation capacity, reservoir capacity and in-flows, and

[97] MEM 2020, Presentation on Power Development Plan 2020–2030 of Lao PDR.
[98] MEM 2020, Presentation on Power Development Plan 2020–2030 of Lao PDR.
[99] ADB 2019, Lao Energy Sector Assessment.
[100] ADB 2019, Lao Energy Sector Assessment.
[101] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.

ramping speed, (iii) other types of generation in the system, (iv) transmission system, and (v) operating reserve and other reserve requirements.

With a view to lower the seasonality risks associated with the high weighting of hydropower in the generation mix, the authorities in Lao PDR have indicated a desire to introduce more thermal capacity in the fuel mix. This is most likely to be lignite-fired plants, but progress on proposed projects is slow.[102] Non-hydro renewables, such as solar and wind, would similarly provide a means for Lao PDR to diversify its generation mix, yet these currently lack any visibility into Lao PDR's long-term PDP.[103]

The PDP does not cover large-scale IPP hydropower schemes that produce electricity for export. These schemes have dedicated transmission lines to their purchasing country that are not connected to the grid. Off-grid options—solely realized by deploying small-sized RE plants (e.g., SHS and small and very small hydropower plants [SHPPs and VSHPPs])—are also not part of the new PDP.

Generation is export-oriented; however, it does not consider risks arising from potential competition from cheaper exports from southern China, where considerable surplus capacity exists, and from the recent trend of importing countries that shore up their generation mix with increased RE and battery storage.[104]

EDL does not have licensed software to optimize generation expansion. EDL will need simulation software to analyze generation scheduling and dispatch to derive the least-cost generation expansion plan, taking into account constraints such as laws, acts, regulations, policies, fuel resources, and technology, reliability, cost, environmental and social impacts.

Lastly, although Lao PDR holds strong ambitions to becoming the "Battery of Southeast Asia" there are complications associated with negotiations to connect transmission lines to neighboring countries specifically for non-IPP projects.

Assessment: PDP does not cover large-scale export-oriented IPP. Only large-scale conventional generation sources, such as hydropower, are included in the generation mix, while the coal plant is included to meet baseload. As such, coverage of PDP is very limiting. PDP restricts RE and diversification and promotes hydropower solely. The PDP process in Lao PDR is assessed "not achieved" for the generation expansion.

5. Transmission expansion plan

Transmission and distribution costs are not an integral part of PDP in Lao PDR. A separate Transmission Line Development Plan is in development, considering (i) power system reliability, (ii) economy, and (iii) environment. It will be aligned with (i) electricity generation plan, (ii) GMS power interconnection plan, and (iii) ASEAN Power Grid (APG) power cooperation MOU. Transmission lines have been addressed on a case-by-case basis to evacuate electricity from large power plants for export. RE is ignored while planning transmission infrastructure. This fragmented approach to planning transmission is likely to further increase the financial burden on EDL, in addition to associated environmental impacts. The proposed new Electricity Law anticipates a national grid in Lao PDR.

---

[102] Four plants summing to 2,700 MW are at the planning or MOU stage: Houa Muang (Lignite), Sam Tai (Lignite), Lamam (Lignite), and M Kalum (Lignite).
[103] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[104] ADB 2019, Lao Energy Sector Assessment.

Transmission expansion should be developed together with the generation expansion plan, as transmission facilities would be required entirely for the evacuation of power from a power plant. Transmission facilities would be needed to enhance the grid to send power from power plants to load centers.

Assessment: The transmission line planning is done on a case-by-case basis and is fragmented from overall PDP. The PDP process is assessed as "not achieved" for the transmission line.

6. **Externalities**

Neither past nor new PDPs attempt to identify potential social or environmental impacts, and such issues were not included in the time planning or cost calculations. No economic valuation of a full set of social and environmental impacts was considered in the past or new PDP. This means that the plan's financial data is likely to be misleading as social costs (such as resettlement) or environmental impact mitigation measures are not part of the cost data presented in these PDPs.[105]

There is little or no reflection of SEA principles in PDP preparation, either in terms of the PDP's technical content or in relation to stakeholder consultation processes. There was a plan to include SEA during the preparation of PDP 2020–2030. However, its status was not known during the preparation of this report.

National experience on SEA in Lao PDR is limited. Recent moves have been made to formalize SEA as a requirement in strategic planning for key sectors, including power generation. Article 19 of the Environmental Protection Law (Revised Version, 2013) states that an SEA shall be conducted while developing the policies, strategic plans, and programs, particularly of the energy and mining sectors.

MONRE has received some support in SEA preparation from the Government of Finland through the Environmental Management Support Programme (EMSP) Phase I that ran from 2010 to 2015. EMSP covered a range of issues concerning strategic planning, the legal and regulatory framework, and capacity development in relation to natural resources and the environment, including Component 2: Strengthening the Application of SEA. This component included working with the ADB and focused on awareness raising and assistance to prepare policies, strategies, and guidelines on SEA. Although progress was made, as far as can be found, these were not completed during the project period but were instead the basis for the process being completed by Department of Environment (previously known as the Department of Environmental Quality and Promotion, [or DEPQP]) in MONRE.

One of the most significant recent developments in strategic planning was MONRE's Decision 483 on SEAs. The authorities have intended to develop such regulation since the Environmental Protection Law was revised. The decision sets out the basic implementation principles and stipulates that SEAs are required for policies, strategies, and programs undertaken by all development sector ministries.

Draft Guidelines that specify a seven-step SEA process were prepared by DEPQP with support from the World Bank. However, the Decision on SEA has necessitated a reconsideration of these guidelines. The next draft of the Guidelines is required to be submitted for ministerial approval. They will be issued to agencies responsible for implementing SEAs as part of their strategic planning process.

A pilot province-level SEA is planned for Oudomxay Province (in northeast Lao) to cover provincial-level planning, most probably for agriculture, small hydro, and some other sectors. The MEM and the World Bank have also proposed to undertake a pilot SEA for hydropower. The possibility of changing the coverage of this pilot to the whole power sector is now under discussion. The need to coordinate these

[105] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.

provincial and sectoral pilot SEAs with the overall national SEA guidelines has been recognized by the different agencies involved.

Other recent SEA initiatives include completing a World Bank–supported strategic environmental and social assessment of the mining sector, and establishing a 20-member, cross-ministry alumni group trained under the Government of Sweden's SEA International Training Program.

Assessment: PDP does not consider environmental and social externalities, and SEA has yet to be applied. The PDP process is assessed "not achieved" for the externalities.

7. <u>Stakeholder consultations</u>

There appears to be no involvement of organizations outside the EDL nor any attempt at more comprehensive stakeholder consultation during the PDP preparation. The detailed preparation of the PDP is outsourced to international consultants.[106] For a long-term goal, Lao PDR should build up their indigenous analytical capacity in preparation of IRP involving relevant stakeholders such as local academia and practitioners.

Assessment: Both interinstitutional and public consultations during the preparation of PDP is weak in Lao PDR. The PDP process in Lao PDR is assessed as "not achieved" for the consultations.

4.2 PEA

The PDP plays a critical role in setting the tone for the electricity infrastructure decisions regarding what, where, and when. The national policies pertinent to power development determine the enabling conditions for such decisions. Furthermore, institutions involved, coordination, and the nature of involvement of relevant stakeholders play a crucial role in the decisions about the development of power infrastructure.

4.2.1 Policy

The policy framework in Lao PDR is evolving; however, it remains fragmented. The current policy framework in the country is adequate to promote IRP in power sector development. An IRP framework must bring together otherwise disjointed components such as large-scale IPP hydropower schemes, SHPP and VSHPP, and transmission lines, which are not covered by the current PDP. However, the policy framework provides clear targets for power development, RE, and EE.

An amendment to the Electricity Law has been drafted (with support provided by the World Bank), proposing an integrated planning approach to all power development (i.e., generation and transmission projects for both export and domestic purposes). The draft has been submitted to the Ministry of Justice for review before it proceeds to the Prime Minister's Office for approval. The enactment of a new law is expected to pave the way for more holistic power development planning based on an IRP approach.

The detailed description and analysis of the applicable laws and policies to the power sector are provided below:[107]

---

[106] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[107] Adopted from ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS and ADB 2019, Lao Energy Sector Assessment.

Lao PDR's energy-sector policy aims to ensure the power system's reliability and security in line with the National Socio-Economic Development Plan (NSEDP). Its emphasis is (i) to diversify the variety of electricity generation such as hydropower, coal, solar, and wind, (ii) to expand the transmission and distribution system to get in line with electricity generation plan and power demand both for domestic and export, and (iii) to reduce power import from neighboring countries and increase power supply during peak demand in the dry season. It is aimed at targets pertinent to (i) energy security by reducing import, diversifying generation, and improving reserve margin, (ii) environmental sustainability: clean coal technology, RE, and energy conservation, and (iii) increased access through better distribution and an affordable tariff. Specific actions and targets to achieve energy-sector policy goals are listed below:

- Reduce petroleum fuel import by increasing EV in the transport sector.
- Promote utilization of biogas in the rural area.
- Adopt clean coal technology in the utilization of coal for power generation.
- Increase the RE share up to 30 percent of total energy consumption by 2025.
- Achieve the diversity of energy generation: hydropower 65 percent, coal 30 percent, RE 5 percent.
- Develop the transmission system throughout the country and integrate the export and domestic systems into one national grid system.
- Promote the investment in high-voltage transmission lines with different modes to reduce state budget: engineering, procurement, and construction (EPC), build-operate-transfer (BOT).
- Increase the electrification rate up to 95 percent (2020), 98 percent (2025), and 100 percent (2030).
- Build fuel stock to be able to meet within 60 days by 2025 and 90 days by 2030 (in case of emergency).
- The electricity reserve margin should reach 15 percent of peak demand.
- Develop the power market toward a competitive acquisition of projects and keep it working under the "Single Buyer" mode.
- Recognize the government as the regulator of electricity tariff structure.
- Implement reasonable and affordable tariff by reducing subsidies and promoting priority sectors.
- Promote energy saving and conservation and achieve a 10 percent reduction by 2030.

The Eighth NSEDP 2016–2020 identifies the direction required for the energy sector: "Focus on hydropower development, thermal power generation, solar energy, and industrial power plants to turn the power sector into a sustainable income-generating sector to support productions and solve the people's poverty."[108]

The Policy on Sustainable Hydropower Development in Lao PDR targets hydropower projects with installed generation capacity larger than 15 MW. It provides policy guidance to agencies that manage hydropower investment projects and raises awareness.[109]

4.2.2 Regulation and Institution

The Electricity Law of 1997, later revised in 2008, 2011, and 2017, provides the legal framework underpinning Lao PDR's power sector and establishes the principles, regulations, and measures that

[108] OpenDevelopmentLaos, Energy Policy and Administration. https://laos.opendevelopmentmekong.net/topics/energy-policy-and-administration#ref-1854-3
[109] OpenDevelopmentLaos, Energy Policy and Administration. https://laos.opendevelopmentmekong.net/topics/energy-policy-and-administration#ref-1854-3

govern activities therein. The Electricity Law seeks to promote the sustainable and efficient use of energy resources to support socio-economic development. At a more actionable level, the Electricity Law requires that electricity development plans be developed at a strategic level and overlong-, medium-, and short-term time frames, with the dual objective of promoting cross-border power exports and meeting domestic electricity requirements to drive socio-economic growth.

Article 19 of the Environmental Protection Law (Revised Version, 2012) states that an SEA shall be conducted while developing the policies, strategic plans, and programs, particularly of the energy and mining sectors.

The organization and regulation of Lao PDR power sector follow Electricity Law and inherit the fragmented nature. The section summarizes the mandate, roles, and responsibilities of different agencies involved in the power sector in Lao PDR:

In Lao PDR, the National Assembly plays an active role in environmental policy-making. The National Assembly of Laos is legally mandated to approve all large projects, such as dams, on government ministries' recommendation.

Within the government, the MEM is primarily responsible for the country's power sector, with jurisdiction over energy policy, strategy, and management of the energy and the mining industries. MEM oversees several state-owned enterprises (SOEs) involved in the energy sector: EDL, EDL-Gen, and its subsidiary EDL-Gen Solar.

The Ministry of Finance supports MEM's role by ensuring financial management and accountability within the energy sector while also being in charge of strategy and investments of the SOEs and Lao Holding State Enterprise (LHSE).[110]

The MPI and the MONRE also provide additional oversight to MEM.

The Department of Energy Business (DEB) in the MEM is in charge of private sector investments, project development, and project monitoring within Lao PDR's power sector. The Department of Energy Policy and Planning is responsible for formulating national energy policies and plans, implementing pricing policies for all types of supply, and supporting the DEB with environmental engineering, promotion, and review of hydropower projects at the MOU stage.

Outside of central government, provincial authorities support rural electrification through the operation of 85 mini-grids supplied by diesel generators, small hydropower, or other renewable sources, and they assist with the preparation of regional PDPs. The MPI is responsible for national and regional planning and investment decisions and seeks development assistance.

MONRE is responsible for implementing the Environmental Protection Law, including the provision on SEA. However, the SEA has not been applied in the energy sector yet. Hence, MONRE has very little engagement and influence on PDP.

4.2.3 Stakeholders

[110] Agence Française de Developpement. 2017. Aide-Memoire: Lao PDR Energy Sector Prospection Mission ADB 2019, Lao Energy Sector Assessment.

In addition to the institutions mentioned in the previous section (Regulation and Institution), more PDP stakeholders are summarized below:

Owner of electricity infrastructures. EDL is sponsoring investment in the highest number of energy projects. Chinese firms sponsor fewer but more substantial projects. As importers of Laotian electricity, Thai firms also have energy interests in Lao PDR; for example, Pongsak Group is developing two projects, and Phongsapthawi Construction is developing eight projects. Notable Laotian project owners/sponsors include EDL and Chaleun Sekong. Notable Chinese project owners include Power Construction Corporation, China Kanchang, and China International Water and Electric.[111]

EDL and Chinese project owners hold the most significant interest and influence on the PDP by being the sponsor of the highest number of projects.

Investors. China is funding one-third of power-generation projects in Lao PDR, primarily through the Export-Import Bank of China and China Development Bank. The MDBs and neighbor/customer Thailand is also funding hydropower and all planned wind power. Investors include Vietnam, Japan, South Korea, Malaysia, Lao PDR, and the EU. The ADB and Thai banks are providing financing for some projects.[112]

Chinese and Thai investors and MDBs such as the ADB and World Bank hold significant interest and influence on PDP in Lao PDP.

Development partners. Development partners play a crucial role in shaping power development by providing investments and providing technical support. JICA has been directly supporting the preparation of PDP. World Bank is supporting an amendment to the Electricity Law proposing an IRP approach to all power development (i.e., generation and transmission projects for both export and domestic purposes). The draft has been submitted to the Ministry of Justice for review before it proceeds to the Prime Minister's Office for approval. The ADB has also been providing technical support to promote IRP and strategic environmental assessment. The ADB also supports regional cooperation on power trade through the GMS RPTCC.

Development partners such as JICA and ADB provide direct technical support in preparing the PDP, and they hold significant influence.

Non-governmental organizations and civil society. Many observers hold Lao PDR to be the most restricted context for civil society action in the region. For instance, no known consultations were held to gather input to revise the EIA Decree or other related ministerial instructions. Lao non-profit associations (NPAs) participate in environmental consultations, but often in a supporting rather than an active role. WWF supported the preparation of Power Development Vision; however, there has been no uptake in the PDP process.[113]

NGOs and civil society in recent years have shown some interest with limited engagement in the PDP process. They do not have any influence in shaping PDP.

---

[111] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Lao PDR Focus: Q2-2019.
[112] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Lao PDR Focus: Q2-2019.
[113] WWF 2016, GMS Power Sector Vision 2050.

Consultancies, academia, and think tanks. PDPs' preparation in the Lao PDR is conducted along traditional lines by external consultants, usually hired by development partners. Academics also represent a possible venue for influencing and dialogue. National consultants, academia, and think tanks have minimal engagement in the preparation of PDP. Hence, they don't have any influence on PDP.

4.3 Recommendations for Future Engagement

Lao PDR is at a pivotal stage for the development of an integrated resource plan and SEA. There is a conjunction of the passing of legislation that will require an integrated approach to all power development and SEA to be integrated into the preparation of strategic plans. However, capacities and awareness are minimal, and the structure of an IRP approach suitable for the country's conditions would need to be developed. This early stage of development could in itself be an opportunity, as the PDP process is not "locked into" a traditional approach. There is recognition of the need to build capacities and procedures that will be significantly different from those that have characterized the PDP process in the past.

There is consequently a need for agencies and national and international development partners involved in the future development of the PDP to work together in a coherent and coordinated manner. There are numerous donors involved in power sector reform in Lao PDR; it will be necessary to coordinate the capacity building between ADB, World Bank, JICA, and USAID programs.

Achieving full IRP will be a gradual process as experience is gained and capacities develop. High-level policy support will be essential. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment.

4.3.1 Awareness Raising and Broader Stakeholder Engagement

USAID Clean Power Asia has undertaken preliminary assessment and awareness raising to promote IRP in Lao PDR. It has been working closely with the Lao MEM and EDL to deliver the program, which aims to guide a core group of participants from these institutions through an IRP process. The analytical framework for analysis and capacity building is based on SEI's Long-range Energy Alternatives Planning (LEAP) platform, which is expected to provide planners with a complete toolkit explicitly designed for the IRP process. As a result, there is some awareness of the benefits of applying IRP in PDP with MEM and EDL.

EDL appreciates the need for sustainable development and for integrated planning in the power sector. In addition, EDL accepts that they need to apply SEA soon. Similarly, the DEPQP of MONRE will acquire new responsibilities concerning SEA and recognize that they do not have sufficient capacity to manage these new responsibilities effectively.

However, the present PDP system is extremely limited both in terms of the plans' coverage and the consideration of social and environmental issues in their preparation. There is a need for all agencies involved to understand the implications of new PDP and SEA laws. EDL is likely to be a key agency for implementing SEA in PDP development, while DEPQP will be pivotal for developing the SEA system.

The Activity could potentially play a mentor's role to build awareness and capacity to apply SEA and IRP, if there is government buy-in.

4.3.2 Policy Support

Legal frameworks are crucial for the broader uptake of new tools and approaches such as IRP and SEA. In recent years, Lao PDR, with the help of the World Bank, has developed legal requirements for integrated planning. The country also has a legal requirement for SEA in place. However, sector-specific detailed guidance is still missing. The Activity could provide advisory support on the formulation of legal frameworks pertinent to power sector development–specific guidance on IRP and SEA.

4.3.3 Technical Capacity

Capacities are minimal, and an IRP structure including an SEA approach suitable for Lao conditions needs to be developed. There has been little effort to consider either EE or DSM or broader social and environmental issues in preparing the PDP or in the power sector's overall development. As far as can be established, there was no modification of the demand forecasts used in the PDP preparation to reflect EE opportunities.

Implementing an integrated approach to the entire power sector as per the new law requirement requires considerable capacity building, including screening and using suitable models for the expansion planning process. To achieve full IRP for power system planning in Lao PDR, the Activity could support the following technical capacity-building activities:

- Demonstrate applicability and value of IRP by supporting hands-on pilot case study applying a learning-by-doing approach, involving power system planners.
- Develop specific technical guidelines on IRP, building on the learning experience from the pilot case study.
- Conduct in-depth training on specialized areas pertinent to IRP based on country-specific needs. Identified areas are outlined below:
    - Bottom-up load forecasting; however, this depends on the availability of disaggregated data. Generating and maintaining such data requires sustained support for developing a robust information management system.
    - The methodology needs to be developed and applied to integrate energy efficiency in load forecasting. Similarly, capacity needs to be developed to apply scenario analysis to manage power demand and optimize supply options applicable to Lao PDR–specific planning context.
    - EDL does not have licensed software to optimize the generation expansion program, and it has generally used the software provided by consultants and IPP developers. Once a decision is made on software suited to the Lao PDR system's needs, the support to build capacity should be provided to EDL.

Lao PDR is at the conjunction of the passing of legislation that will require an SEA to be integrated into the preparation of strategic plans. EDL does not have the necessary technical capacity to conduct an SEA of PDP. Similarly, the DEPQP of MONRE has acquired new responsibilities to monitor the SEA, and at present, they do not have sufficient capacity to manage these new responsibilities effectively. There is a benefit for EDL and DEPQP to learning from countries such as Vietnam, where SEA is more advanced.

The Activity could also provide hands-on capacity-building support on the power system planning–specific application of SEA, including evaluating environmental and social externalities of energy-generation options and facilitating study visits and conducting regional knowledge-sharing events.

4.3.4 Data and Knowledge Management and Sharing

As in Cambodia, quality data availability is a significant constraint to undertake robust modeling and assessment work; for instance, moving to bottom-up load forecasting will require considerable effort to collect primary data and maintain a database. Similarly, the ability to apply more sophisticated simulation software to develop a least-cost generation expansion plan will depend on the availability of quality data. Data generation and sharing required for IRP are still weak in Lao PDR. The Activity could support the government in identifying data needs and support assessments relevant to IRP development.

5. MYANMAR

Summary

Myanmar is looking at its abundant energy resources endowment as a revenue source to meet its development goals. Natural gas is already a significant export resource, and it also has vast hydropower potential. Since 2013, Myanmar has exported electricity to neighboring countries such as Thailand and China from hydroelectric plants. However, in the short term over the next few years, Myanmar is still likely to be a net importer of electricity to meet the shortage.

The demand for energy from industry, commerce, and residential sectors is rising, placing pressure on the limited energy infrastructure. The inadequate power supply has emerged as one of the most severe infrastructure constraints for its sustainable economic growth. A small portion of the population has access to electricity (34 percent in 2014), and Myanmar is ranked as one of the world's lowest countries for per capita electricity consumption.

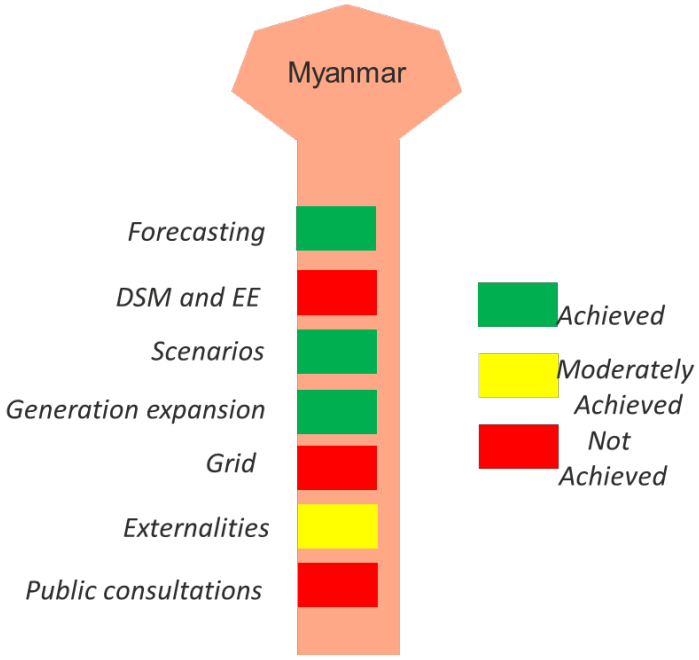
The energy intensity is declining, helped by increasing electrification to displace traditional fuel sources, and is expected to continue to do better with significant potential in its industrial and commercial activities for substantial savings in energy consumption.

Myanmar is endowed with abundant natural resources to produce commercial energy. Its current sources of energy are crude oil, natural gas, hydroelectricity, biomass, and coal. Besides these, wind, solar, geothermal, bioethanol, biodiesel, and biogas are potential energy sources found in the country.

Myanmar also has diverse and rich RE resources. In addition to hydropower, solar and wind energy are likely to play significant roles in fulfilling the additional energy requirements, particularly in remote areas.

Most electricity in Myanmar is generated by hydropower. SEA of Myanmar Hydro Power Sector indicated that the development would result in broad-scale biophysical changes to Myanmar's rivers under the business-as-usual scenario. There has also been public outcry because of the environmental impact of coal-fired power plants. NGOs have raised concerns regarding the Tigyit coal power station in Pinlaung township, southern Shan State.

Myanmar is at a pivotal stage in the development of IRP and SEA. Legislation will require an integrated approach to all power development and SEA to be integrated into the preparation of strategic plans. However, capacities and awareness are minimal, and the structure of an IRP approach suitable for Myanmar conditions would need to be developed. The following figure summarizes Myanmar's electricity planning process as demarcated and compared against seven constituent parts of IRP.



Myanmar is applying a combination of top-bottom and bottom-up approaches for load forecasting. While there is a discrepancy in forecast figures, there is an accepted practice of using standard methodology. While there is an attempt to deal with EE in the electricity planning process, it is not being done in an integrated manner. Different generation expansion scenarios are considered and analyzed in optimizing the generation expansion plan. Myanmar is applying comprehensive assessment and modeling for optimizing the generation expansion plan. However, transmission costs are not yet included while optimizing generation options. While there has been an attempt to integrate environmental costs into the least-cost plan, it has been limited to CO_2 emissions. Myanmar has conducted an SEA for the hydropower sector. However, the results have not yet been fed into electricity generation expansion plans. While there have been attempts to involve public consultations in the preparation of SEA, there have been no interministerial and public consultations to prepare the electricity expansion plan.

Myanmar's policy framework is quickly evolving, setting a foundation for the uptake of IRP for power development. The national policy provides general direction and targets. Myanmar Electricity Law provides the legal basis for the uptake of IRP for power development.

In Myanmar, environmental protection is managed by the Ministry of Natural Resources and Environmental Conservation (MONREC), responsible for all aspects of environmental policy, monitoring, and enforcement of regulations regarding natural resources and environmental protection. However, to date they have no role in preparing electricity generation expansion plans and hence no influence. The following table highlights key stakeholders relevant to Myanmar's power development, their role/ interest, and influence.

	Role/ Interest	***Influence***
Regulators		
Ministry of Energy and Electric Power	High	High
Ministry of Natural Resources Environmental Conservation	Medium	Low
Owner		
	High	High
Investors		
Government	High	High
FDI and private sector	High	Medium
Multilateral banks (MDBs)	High	Medium
Development partners (ADB and JICA)	High	Medium
Non-government organizations and civil society	Medium	Low
Consultancies, academia, and think tanks	Low	Low

Achieving full IRP is a gradual process that evolves with experience and capacity. High-level policy support is essential to promote uptake of best available methodologies and encourage broader stakeholder engagement and public consultations. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Myanmar, particularly in the area of sensitizing high-level officials on the importance of achieving IRP and building targeted capacity on quantification and valuation of environmental and social externalities and encouraging broader and effective public consultations.

5.1 Approach to Decision-Making

5.1.1 Background

1. <u>Power development needs and challenges</u>

Myanmar has abundant energy resources, particularly natural gas and hydropower. Since reconnecting with the world economy after its reforms in 2011, Myanmar has been looking at its energy resources endowment as a revenue source to meet its development goals. Strategically located between Bangladesh, India, China, Lao PDR, and Thailand, Myanmar can export energy resources to these countries to fulfill their high energy needs.

Natural gas is a significant export resource, which generated US$2.1 billion in export revenue in the first half of 2014. Additional revenue of about US$2.7 billion per year is likely from new gas fields. Overall, the energy sector accounted for 55 percent of export earnings and 86 percent of foreign direct investment in 2013.[114] Myanmar also has a vast hydropower potential, estimated to be more than 100,000 MW. Since 2013, Myanmar has exported electricity to neighboring countries such as Thailand and China (for example, 2,381.34 GWh in 2016).[115] The exported electricity all came from hydroelectric plants. However, over the next few years, Myanmar is likely to be a net importer of electricity to meet its shortage.

[114] ADB 2016, Myanmar Energy Sector Assessment.
[115] ERIA 2019, Myanmar Energy Statistics 2019.

Since the country's reforms in 2011, the demand for energy from industry, commerce, and residential sectors rose, placing pressure on the limited energy infrastructure.[116] However, the country's energy sector has been underdeveloped due to a lack of financial and technical capacity and global isolation. Furthermore, the inadequate power supply has emerged as one of the most severe infrastructure constraints for its sustainable economic growth. For example, only 34 percent of the total population had access to electricity in 2014. In terms of electricity consumption per capita, Myanmar is ranked one of the lowest countries globally, with 110 KWh per capita in 2011, which is much lower than the world average of 3,000 kWh per capita. In recent years, electrification in Myanmar has been improving. The country's average electrification ratio had grown from about 16 percent in 2006 to 26 percent in 2011 to 34 percent in 2015.[117]

In conjunction with the Myanmar Energy Master Plan (MEMP), the Government of Myanmar and the Myanmar National Electrification Program (NEP) have established benchmarks to provide 47 percent sustainable power by 2020, 76 percent by 2025, and 100 percent by 2030. To accomplish this goal, a grid electrification rollout and the off-grid program will be implemented under the NEP. A total investment of US$5.4 billion will be required to initiate the electrification rollout, and US$40 billion will be required for investment in the transmission and distribution portions.[118]

Power consumption. Total electricity consumption was 11,252 GWh in 2015, of which Yangon accounted for 44 percent. According to the Ministry of Electricity and Energy (MOEE), the annual electricity consumption in Myanmar is increasing at 15 percent to 17 percent.[119]
Power generation. The total installed capacity at mid-2016 is 4,764 MW, with 2,820 MW (59.2 percent) from hydropower, 1,824 MW (38.3 percent) from natural gas, and 120 MW (2.5 percent) from coal. The MOEE owns about 75 percent of the total installed capacity, and the rest is owned by the private sector. The available capacity is approximately 50 percent of the installed capacity. Gas and coal power plants could not be operated at their full capacity due to poor maintenance, and during the dry season, hydropower plants could not be operated at their full capacity due to low volume of water. Of the hydropower capacity, 520 MW is reserved for export to China. Nine new projects were to be added by the end of 2016, with the MOEE adding 220 MW and the private sector adding 300 MW. Projects of about 1,500 MW are under development for completion by 2020.[120,121] The current power-generation mix is exceedingly dependent on hydropower and requires diversification to ensure grid stability.

Limited and unreliable electricity supply is the main challenge of power development in Myanmar, with major cities like Yangon still experiencing power outages that affect economic activity. Private households applying for electricity connection face long waiting times. Those eventually connected to the grid also suffer frequent planned and unplanned power cuts and low power quality.[122]

---

[116] ADB 2016, Myanmar Energy Sector Assessment.
[117] ADB 2016, Myanmar Energy Sector Assessment.
[118] ADB 2016, Myanmar Energy Sector Assessment.
[119] ADB 2016, Myanmar Energy Sector Assessment.
[120] ADB 2016, Myanmar Energy Sector Assessment.
[121] There are memorandums of understanding (MOUs) to develop wind power projects. The MOU with the Thailand-based Gunkul Engineering Public Company includes plans to develop 2,930 MW wind power plants in Mon State, Kayin State, Thaninthayi Region, Shan State, and Kaya State; and the MOU with the PRC-based Three Gorges Company includes plans for 1,102 MW wind power plants in Chin State, Rakhine State, Ayeyawady Region, and Yangon Region.
[122] US Embassies abroad, 2019, Burma – Energy, https://www.export.gov/apex/article2?id=Burma-Energy

Lack of enabling regulatory framework and institutional fragmentation impedes power sector development. The lack of a comprehensive and integrated identifying and sequencing priority investment projects have held back the expansion of infrastructure investments and pose the risk of ad hoc investment decisions.

SOEs still provide most electricity, and the private sector's role is minimal, as no formal public-private partnership framework exists. Institutional and human resource capacity remains weak after long isolation.

2. Energy intensity

The energy intensity declined from 2000 to 2016, which could indicate an improved EE. The power in 2016 was 62 percent lower than it was in 2000. The intensity is projected to continue to decrease to 132 toe/million 2010 US$ by 2040 at an average rate of 3 percent per year.[123] Increasing electrification to displace traditional fuel sources is helping Myanmar to improve its energy intensity.

Myanmar has significant potential in its industrial and commercial activities for substantial savings in energy consumption. The potential savings are estimated at 45 percent for the iron and steel industry, 65 percent for pulp and paper, and 35 percent for sugar mills due to their high electrical and thermal demands. In the commercial sector, office buildings and hotels continue using inefficient incandescent lighting and electric hot water systems. Significant energy savings could be achieved using a high-efficiency compact fluorescent lamp (CFL) and light-emitting diode (LED) lighting, and solar hot water systems. In addition, there is no official EE certification that can be applied to new commercial buildings or those refurbished to meet such standards.[124]

Biomass, which accounted for 77 percent of the total energy consumption in 2012, is primarily consumed by the rural population, comprising 70 percent of the total population. Hence, the adoption of efficient technologies and subsequent electrification, especially in cooking, would significantly contribute to improving energy intensity and the quality of life of rural households. The current market penetration of energy-efficient products such as lights, air conditioners, refrigerators, and other home appliances is low. Most electrical products are imported mainly from the People's Republic of China (PRC) and India and have no labeling on energy performance. Energy-rated products from Thailand are available in some stores but with a meager market share due to their higher costs. There is potential for significant energy savings by introducing Minimum Energy Performance Standards and Energy Labeling schemes.[125]

The initial target for EE set by the Ministry of Energy in 2008 was a 5 percent reduction in total energy consumption by 2015 and 8 percent by 2020 from the 2005 level.[126]

3. Energy resources

Myanmar is endowed with abundant natural resources to produce commercially viable energy. Its current sources of energy are crude oil, natural gas, hydro, biomass, and coal. Besides these, wind, solar, geothermal, bioethanol, biodiesel, and biogas are potential energy sources found in the country. The

[123] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.
[124] ADB 2016, Myanmar Energy Sector Assessment.
[125] ADB 2016, Myanmar Energy Sector Assessment.
[126] ADB 2016, Myanmar Energy Sector Assessment.

country is a net exporter of energy, exporting substantial amounts of natural gas and coal to neighboring countries. However, it imports around 90 percent of its total oil product requirements.[127]

Oil and gas. Myanmar's proven energy reserves in 2017 comprised 105 million barrels of oil and 6.58 trillion cubic feet of gas. Myanmar was one of the earlier countries with a national oil and gas industry in the Southeast Asia region. No new oil reservoirs were discovered in the last 20 years, and the production caliber per well is limited because of the natural depletion of reservoirs. The monthly oil production fell from about 1 million barrels in 1984 to about 0.2 million barrels in 2014.[128]

The discovery of large offshore natural gas deposits in the early 1990s led the government to export the gas partly due to low domestic usage at the time. Myanmar's production of offshore gas started in 1998 from the Yadana gas field, followed by the Yetagun gas field in 2000, the Shwe gas field in 2013, and the Zawtika field in mid-2014.[129]

There are two gas export markets: China and Thailand. Export to the PRC is from the Shwe gas field, which started in 2013 for 4.5 trillion cubic feet of gas over 30 years via an 870 km 40-inch gas pipeline financed and operated by the PRC. Export to Thailand started from the Yadana field in 1998. The Yadana gas field contains more than 150 billion cubic meters of natural gas and has an expected field life of over 30 years.[130]

Coal. Coal existed in 565 places with an estimated 540 million tonnes, which is generally low-quality lignite and sub-bituminous. Coal extraction and use have been at a slow pace, and there is little interest because of low investment and the remoteness of the deposits. Prior to 2010, there were only three active coal mines in the Sagaing Region and the north of the Shan State, but now as many as 57 private and government mines are operational. Because all mines are opencast, special attention is required to address environmental and social issues. Coal production reached its highest level of about 1,400 thousand tonnes per year in 2007 but decreased to less than 700,000 tonnes per year in 2013.[131]

About half of the country's coal is used for power generation at the 120 MW coal-fired power plant in Tigyit. With the increasing demand for coal in the industry sector and thermal power plants, its production is expected to increase to 5 million tons a year by 2030.[132]

All contracts for coal-fired power plants signed by the former government with international and regional companies have stalled due to public opposition and concerns about pollution and other environmental impacts. Although Myanmar has estimated domestic coal resources of 540 million tonnes, coal extraction has remained slow due to low investment and the country's identified coal sites' remoteness.[133]

Myanmar also has diverse and rich RE resources. In addition to hydropower, solar and wind energy are likely to play significant roles in fulfilling the additional energy requirements, particularly in remote areas.[134]

---

[127] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.
[128] ADB 2016, Myanmar Energy Sector Assessment.
[129] ADB 2016, Myanmar Energy Sector Assessment.
[130] ADB 2016, Myanmar Energy Sector Assessment.
[131] ADB 2016, Myanmar Energy Sector Assessment.
[132] ADB 2016, Myanmar Energy Sector Assessment.
[133] U.S. Embassies abroad, 2019, Burma – Energy, https://www.export.gov/apex/article2?id=Burma-Energy.
[134] U.S. Embassies abroad, 2019, Burma – Energy, https://www.export.gov/apex/article2?id=Burma-Energy.

Large hydropower plants. Myanmar has vast hydropower potential that drains the four main basins of the Ayeyarwady, Chindwin, Thanlwin, and Sittaung rivers. It is estimated that there is more than 100,000 MW of installed capacity potential. Myanmar has identified 92 large hydropower projects with a total installed capacity of 46,000 MW, while hydropower plants' current installed capacity is only 3,033 MW.[135]

According to MOEE, the Yazakyo hydropower project with 9 MW capacity in the Sagaing region started its operation in 2018. Two additional projects in the upper Kyaing Taung and upper Yeywa region in Shan State with 51 MW and 280 MW are planned to be implemented during 2019–2021.[136]

Micro- and mini-hydropower plants. A total of 26 micro-hydro and nine mini-hydro projects have been implemented with installed capacity ranging from 24 kilowatts (kW) to 5,000 kW to reach remote areas. The government plans to develop approximately 40 MW of small-scale hydropower plants by 2030.[137]

Solar energy. Myanmar has good solar resource potential, with 60 percent of the land area suitable for PV development. Given the installable capacity per unit of the area of 0.06 kWp/m^2, Myanmar's maximum technical solar power potential is estimated at 40 TWh/yr.[138]

The MOEE is conducting a preliminary investigation to construct solar power plants with foreign direct investment in Minbu, Magway Region, Myingyan, Mandalay Region, and Wundwin.[139,140,141]

Wind energy. In general, Myanmar has low average wind speeds (below four m/s). Myanmar has less than 3,400 km^2 of the area with sufficient average wind speeds to make a wind project feasible. The theoretical installed wind capacity is about 33 GW, and the theoretical generation potential could be in the order of 80 TWh/yr. Myanmar's limited grid and system capacity are critical factors hampering large-scale wind, solar, and other intermittent generation types. Therefore, the technical potential for wind energy development is low—only about 86 MW if grid input is limited to 5 percent of total installed capacity, and 343 MW if grid input could be as high as 20 percent.[142]

Foreign investment proposals for a total of 4,032 MW of wind power have been received, but none of them has begun any activities.[143] Also, there are small-scale experimental projects.[144] As the first project for wind power in Myanmar, MOEE signed an agreement with China's Three Gorges Corporation to develop a 30 MW wind power project in Chaung Thar, Ayeyarwady Region.[145]

---

[135] ADB 2016, Myanmar Energy Sector Assessment.
[136] U.S. Embassies abroad, 2019, Burma – Energy, https://www.export.gov/apex/article2?id=Burma-Energy
[137] ADB 2016, Myanmar Energy Sector Assessment.
[138] ADB 2015, Renewable energy developments and potential in the GMS.
[139] ADB 2016, Myanmar Energy Sector Assessment.
[140] In August 2014, the Ministry of Electric Power, currently the Ministry of Electricity and Energy, signed the first agreement with the US firm ACO Investment for an investment of $480 million under a build–operate–transfer scheme for the construction of a 300 MW photovoltaic (2 × 150 MW) grid-connected solar power plant in two locations in the Mandalay Region.
[141] US Embassies abroad, 2019, Burma – Energy, https://www.export.gov/apex/article2?id=Burma-Energy
[142] ADB 2015, Renewable energy developments and potential in the GMS.
[143] There are MOUs to develop wind power projects. The MOU with the Thailand-based Gunkul Engineering Public Company includes plans to develop 2,930 MW wind power plants in Mon State, Kayin State, Thaninthayi Region, Shan State, and Kaya State; and the MOU with the PRC-based Three Gorges Company includes plans for 1,102 MW wind power plants in Chin State, Rakhine State, Ayeyawady Region, and Yangon Region.
[144] Three microwind power projects (smaller than 3 kW) are operating between Yangon University and the MOEE.
[145] US Embassies abroad, 2019, Burma – Energy, https://www.export.gov/apex/article2?id=Burma-Energy

Biomass. The estimated total theoretical energy potential of these agricultural residues is almost 60,000 GWh, about 80 percent of this from rice residues.[146] Around 190 biogas digesters of varying capacities (5, 15, and 25 kW) have been installed all over the country for lighting and cooking purposes.[147] For waste-to-energy, there is a significant opportunity to develop waste-to-energy projects in urban areas. There is a potential for at least 20 MW of waste-to-energy installed capacity.[148]

Geothermal and tidal. There are 93 potential locations for commercial geothermal-generated electricity throughout the country for geothermal energy. Around 43 of these sites are being assessed and tested. There are no studies for tidal energy to assess its potential in Myanmar despite a coastal line of 2,832 km. The first tidal power plant (3 kW) was installed in 2007 in Kanbalar village, providing electricity to about 220 households (approximately 1,200 persons).[149]

4. Environmental concerns

Most electricity in Myanmar is generated by hydropower. SEA of Myanmar Hydro Power Sector[150] indicated that under the business-as-usual scenario, the development would result in broad-scale biophysical changes to Myanmar's rivers, including:

- altered seasonal and daily river flows in most river basins: increased dry season flows and reduced wet-season flows from storage projects, daily flow fluctuations from peaking generation, a delay in the onset of monsoonal river flows when large reservoirs refill, and the potential decrease in flood flows.
- a substantial increase in total basin area with flow regulation and fragmented river systems.
- changes to water quality caused by the seasonal retention of water in reservoirs.
- reduced downstream sediment loads, altered sediment size distribution, and increased bank erosion resulting in changes to river and delta geomorphology.
- aquatic habitat fragmentation, with most dams and altered flow conditions preventing fish, larvae, and egg movement upstream and downstream terrestrial habitat fragmentation and reduced biodiversity, from the construction of reservoirs, roads, and transmission lines, and any illegal forest harvesting by the workforce and camp followers.
- loss of riverine and terrestrial natural resources. In addition, large-scale resettlement and the loss of livelihoods from reduced access to natural resources is expected to occur, while conflict may be exacerbated in some areas.

Significant irreversible basin-scale changes would occur to river flows, geomorphic, and ecological processes and functions of the Ayeyarwady and Thanlwin basins covering three-quarters (74.5 percent) of the country. Hydropower development across Myanmar would triple basin fragmentation, from 14.4 percent of the national land area at present to 45.0 percent.

[146] ADB 2015, Renewable energy developments and potential in the GMS.
[147] ADB 2016, Myanmar Energy Sector Assessment.
[148] ADB 2016, Myanmar Energy Sector Assessment.
[149] ADB 2016, Myanmar Energy Sector Assessment.
[150] IFC 2018, SEA of the Myanmar Hydropower Sector.

There has also been public outcry because of the environmental impacts of coal-fired power plants. NGOs have raised concerns about the Tigyit coal power station in Pinlaung township, southern Shan State. Two nearby villages of Lai Khar and Taung Pola were forced to relocate for the project, and over 500 acres of farmlands have been confiscated. Farming families facing eviction and loss of lands are going hungry and have turned to cutting down trees to sell for firewood or have migrated to survive. Explosions from the mine have destroyed local pagodas. Air and water pollution are threatening the agriculture and health of nearly 12,000 people that live within a five-mile radius of the project, and they may eventually have to move out. Currently, 50 percent of the local population is suffering from skin rashes.[151]

5.1.2 Current Approach

The 2014 Electricity Law defined the need for and the purpose of power system planning "to systematically manage, based on the present policies … electricity activities to better develop the electric power sector, satisfy the country's need for electric power, and supervise and control electricity activities."

MOEE prepared the "Long-Term Power Development Programme" in 2013, with 2011–2012 as the base year and a 30-year time horizon. The plan was defined as covering all aspects of power generation, transmission, and distribution.

Subsequently, ADB assisted with preparing the Energy Master Plan (EMP), including the Least-Cost Power Expansion Plan in 2015. JICA and the World Bank assisted with drafting the Myanmar National Electrification Plan (NEP) in 2014. The need for consistency in concurrent energy and power sector master plans for relevant Myanmar Government agencies[152] was recognized by government and development partners. JICA is now helping to revise the 2014 PDP.

The JICA PDP was due for completion in 2019 and was also due to include an SEA. The status of both reports is unknown.

As indicated, PDP preparation in Myanmar is a development partners–driven process. The power sector receives assistance from the international donor community for preparing PDP, which is beneficial, but it also further exacerbates coordination issues. One issue of concern is that the PDPs and Master Plans have produced a wide range of estimates and forecasts for the power sector. For example, the MoEE's 2013 PDP included a demand forecast for 2031 of 111,100 GWh. In contrast, the 2014 JICA PDP included, for 2030, a low-case scenario of 48,639 GWh and a high case of 77,730 GWh. The National Energy Master Plan figure for 2030 is 57,654 GWh, and the current ADB PDP forecast is 91,525 GWh. Some of the figures' variations could reflect whether the different reports forecast power generation or final consumption (which are different because of transmission and distribution losses). Still, there is considerable uncertainty over the provenance of figures from the PDP and energy-planning exercises of recent years, adding to concerns over coherence and coordination in the sector. Some of the PDP figures' variations may also be due to low availability and poor data quality.

The following sections benchmark and evaluate current power development planning in Myanmar against the international best practice of IRP under the seven broad topics. The assessment is based on the ADB-supported EMP, including the Least-Cost Power Expansion Plan and available information on JICA-assisted

[151] PYO (2011) Poison Clouds. http://burmacampaign.org.uk/ images/uploads/PoisonClouds.pdf.
[152] The relevant Myanmar Government agencies include: MOE (Ministry of Energy); MOEP (Ministry of Electric Power); NEMC (National Energy Management Committee).

Myanmar National Electricity Master Plan through literature review. Further analysis could be added once the JICA-assisted Myanmar NEMP is available for review.

1. Demand forecasting

In the EMP study, micro and bottom-up approaches are applied to project electric load demand by examining historical consumption and demand trends of households and commercial, agriculture, and industrial sectors for each of Myanmar's 14 states and regions. Electricity consumption drivers include (i) households: cooking, lighting, water heating, TV/entertainment, and cooling services; (ii) commercial: restaurants, hotels, retail space, office space, (iii) agriculture: tractors, power tillers, harvesters, irrigation pumps, and (iv) industry: production of steel, nonmetallic minerals (bricks, cement, glass), nonmetallic metals (copper, zinc, tin), food (sugar), electronics, plastics, ice storage, food processing, automotive parts, footwear, and garments. GDP growth rate for 2013–2030 is assumed as (i) for a high-growth case, 9.5 percent, which is the highest growth rate forecasted from ADB's Country Diagnostic Study (2014), (ii) for a medium-growth scenario, 7.1 percent, which is the government growth forecast, and (iii) for a low-growth scenario, 4.8 percent, which is the lowest growth rate forecasted from ADB's Country Diagnostic Study (2014). As a result, peak demand in 2030 is projected as 13.4 GW for a high-growth case, 9.5 GW for a medium-growth case, and 6.8 GW for a low-growth case. The EMP study uses the medium-growth case as a base case for estimating fuel requirements from all sectors, including the power sector.

In the NEMP study, a macro and top-down approach are applied to project electric load demand growth rate by multiplying elasticity and GDP growth rate. The elasticity of 1.4 is used based on its analysis of the average elasticity during 2002–2010, and GDP growth rate for 2013–2030 is assumed as (i) for a high-growth case, 8.7 percent, which is the growth rate of 2011–2012, and (ii) for a low-growth case, 6.4 percent based on IMF Economic Outlook. As a result, peak demand in 2030 is projected as 14.5 GW for its high-growth case and 9.1 GW for its low-growth case. The NEMP study analyzed the high-growth case as a base case for preparing the power expansion plan.

One issue of concern is that the PDPs and Master Plans have produced a wide range of estimates and forecasts for the power sector. For example, the MOEE's 2013 PDP included a demand forecast for 2031 of 111,100 GWh. In contrast, the 2014 JICA PDP had, for 2030, a low-case scenario of 48,639 GWh and a high case of 77,730 GWh. The NEMP figure for 2030 is 57,654 GWh, and the current ADB PDP forecast is for 91,525 GWh.[153]

Assessment: Myanmar is applying a combination of top-bottom and bottom-up approaches for load forecasting. While there is a discrepancy in forecast figures, there is an accepted practice of using standard methodology. The planning process in Myanmar is assessed as "achieved" for the load forecasting.

2. Demand-side management and energy efficiency

Both 2014 JICA-supported NEMP and ADB-supported EMP are emphatically focused only on the supply-side, and the demand-side analysis is superficial. There is no mention in the reports of EE or DSM.[154] ERIA's assessment illustrates the energy-saving potential of 20.7 percent, and power generation will be

[153] 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS, ADB.
[154] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.

reduced by 20 percent compared to the business-as-usual scenario. The reduction in power generation will be from natural gas, coal, and hydro plants; the highest reduction will be coal power. This saving amounts to reducing 8.9 million Mt-C or 38 percent lower than the business-as-usual scenario.[155] However, this kind of assessment has not yet been included in PDP development.

The National Energy Efficiency and Conservation Policy, Strategy, and Roadmap for Myanmar 2015 were supported by the ADB and the Japan Fund for Poverty Reduction. Based on the calculated potential energy savings, the National Energy Efficiency Policy targets the following objectives by 2020, using 2012 as a baseline: (i) to reduce national electricity demand by 12 percent, (ii) to reduce biomass consumption by 2.3 percent, and (iii) to reduce national carbon dioxide emissions by 78,690 tonnes. To reach the overall EE objective, it is necessary to develop a strategy to save energy for important energy-intensive sectors such as industry, transport, commercial, and residential sectors.[156]

Nonetheless, Ministry of Industry (MOI) currently experienced the problem of how to implement them and how to deal with the lack of data on energy consumption. While EE is being addressed in Myanmar, it is not being done in a fully integrated way. For example, MOI is not involved in the PDP process, and it is questionable whether the EE policy targets have been taken into account in the PDP preparation.[157]

Assessment: While there is an attempt to deal with EE in the electricity-planning process, it is not being done in an integrated manner. The electricity generation expansion planning in Myanmar is assessed "not achieved" for DSM and EE.

3. Scenarios

For EMP, five expansion cases were defined based on a practical consideration of available resources, recent policy direction, and the Ministry of Electric Power's advice. The five cases were chosen to represent the broadest possible spread of fuel mixes.

Case 1, **Planned Hydro / Coal.** This includes all committed and planned hydro, existing coal, and gas-fired generation 300 MW solar PV starting from 2016, and moderate to large coal expansion beginning from 2026.

Case 2, **Balanced (Hydro / Coal / Solar PV).** This is the same as the base case but with less planned hydro displaced by a balance of large thermal resources and solar PV resource (the solar PV balances the hydropower).

Case 3, **Maximum Hydro.** This is the same as the base case but with maximum dependence on hydropower (including existing, committed, and planned resources, the latter to the maximum technically feasible) and no new thermal capacity.

Case 4, **Maximum Coal.** This is the same as the base case but without planned hydro (only existing and committed) and large-scale coal-fired power development.

---

[155] ERIA 2019, Energy Outlook and Energy Saving Potential.
[156] 2019, Energy Outlook and Energy Saving Potential, ERIA.
[157] 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS, ADB

Case 5, **Maximum Solar PV / Wind.** This is the same as the base case but with large-scale solar PV and wind development.

NEP is being updated based on three scenarios: (i) domestic energy consumption predominantly supplied by large-scale hydro, (ii) least-cost expansion when present values of all options are compared at test discount rate, and (iii) power resources balance.

Assessment: Different generation expansion scenarios are considered and analyzed in optimizing the generation expansion plan in Myanmar. The planning process is assessed as "achieved" for scenarios.

4. Generation expansion plan

An optimization model was used to identify the optimal long-term fuel mix. The model comprises three modules: (i) an Economic Dispatch Model; (ii) a Portfolio Analysis Model; and (iii) a Portfolio Prioritization & Ranking Model (a Multicriteria Decision Model).

As JICA's NEMP study finalized generation expansion plans using the WASP IV for a high-growth case, ADB decided and MOE/NEMC agreed to complete the remaining chapter using WASP IV to analyze a medium growth case, to provide robust results and ensure consistency between the EMP and NEMP studies.

The objective of applying the WASP IV model is identifying an optimum generation expansion plan for the Myanmar power sector and determining the associated system costs, fuel requirements, and environmental emissions under the EMP's medium-growth case.

Both EMP and NEMP studies used a discount rate of 10 percent in the present worth calculation, discounting all costs to the reference year of 2013.

A minimum reserve margin of 20 percent is applied in the EMP study. As countries in the region typically use a value between 15 percent and 30 percent for planning purposes, sensitivity analyses were performed to evaluate the costs and benefits of the more or less stringent reserve margin constraints.

NEMP will look into Power Resources Balance. Power Resources Balance is where the best combination of power resources is proposed, considering the feasibility of project implementation and the primary energy forecast. In this scenario, hydropower plants with higher priority will be selected, namely realistic hydropower project plans with a shorter lead time to completion and shorter distance to demand centers. Gas-fired plants will be fully developed as long as adequate gas supplies can be expected. However, the capacity of domestic energy resources such as hydropower, gas, and RE is insufficient for future demand and comprises some risks in the power supply. Coal-fired thermal power plants will be developed to complement them. It is considered the most effective approach when balancing power resources from the viewpoint of energy security.

Assessment: Myanmar is applying comprehensive assessment and modeling for optimizing the generation expansion plan. The planning process is assessed as "achieved" for the generation expansion plan.

5. Transmission expansion plan

Transmission related costs are not considered in EMP and NEMP. A separate Myanmar National Electrification Plan is being prepared with the support of the World Bank. Transmission cost should be included in analyzing a hydropower plant if used to evacuate power from the plant.

Assessment: Transmission costs are not yet included while optimizing generation options. The planning process is assessed as "not achieved" for transmission.

6. Externalities

Only CO_2 emission cost is used to analyze the effect of environmental considerations on the least-cost plan. The expansion strategy was re-optimized using carbon pricing rates of 10 US$/$tCO_2$ and 15 US$/ tCO_2. No economic valuation on other social and environmental impacts are considered. This means that the plan's financial data is likely to be misleading, as social costs (such as resettlement) or environmental impact mitigation measures are not part of the cost data presented in EMP and NEMP.[158]

The International Finance Corporation (IFC) recently supported the SEA of Myanmar Hydro Power Sector. However, this was not part of the formal energy or electricity planning process. The development of SEA in Myanmar is a relatively recent phenomenon, and experience is very limited. Despite this, rapid progress is being made in formalizing the requirement that SEA is included in strategic planning for crucial development sectors. This is reflected in the 2012 Law on Environmental Conservation, which establishes the requirement for EIAs and references SEAs in strategic planning and the 2015 Environmental Impact Assessment Procedure, which details EIA implementation procedures.

The 2015 procedure contains a section (Chapter X) on SEA that specifies that the MONREC "may require that SEA guidelines issued by the Ministry shall screen policies, strategies, development plans, frameworks, and program."

The Environmental Conservation Department (ECD) of the MONREC is responsible for environmental issues. Myanmar's SEA procedures or regulations still need to be developed, though the department is committed to gradually adopting SEAs to support environmental planning processes. A provision for doing this is in the Environmental Impact Assessment Code, 2016 (Chapter 10, paragraphs 123 and 124). JICA is providing critical assistance to MOEE staff with developing SEA guidelines.

Experience with SEA in Myanmar is improving. IFC supported SEA of Myanmar Hydro Power Sector. The IFC is also supporting an SEA for setting up a hydropower database, understanding socio-economic conflicts, and developing a "sustainability analysis."

In addition to the energy sector, several other sectors have started applying SEA and gradually building in-country technical capacity. Recent SEA studies include:

- Strategic Urban Development Plan of Greater Yangon, 2014
- Myanmar Tourism Sector-Wide Assessment, 2015
- Myanmar Oil and Gas Sector-Wide Assessment, 2014
- Strategic Environmental Assessment of Phase 2 of the Development of the Thilawa Special Economic Zone

Planned SEAs include:

- Integrated Ayeyarwady Delta Strategy

[158] 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS, ADB.

- SEA for offshore oil and gas development
- SEA for Kyaukphyu Special Economic Zone

Assessment: While there has been an attempt to integrate environmental costs into the least-cost plan, it has been limited to CO_2 emissions. Myanmar has conducted an SEA for the hydropower sector. However, the results have not yet been fed into the electricity generation expansion plan. The planning process in Myanmar is assessed as "moderately achieved" for externalities.

7. Stakeholder consultations

Myanmar is already experiencing severe project delays due to opposition and legal challenges from NGOs and affected groups. To solve this issue, stakeholder consultation mechanisms need to be overhauled. A formal consultation process for PDPs—and eventually SEAs—needs to be established in Myanmar through legislation.

There seems to be a reasonable degree of coordination between government and development partners (JICA, World Bank, ADB) while preparing different energy sector–related plans. MOEE outsourced the detailed preparation of both EMP and NEMP to international consultants. There appears to be no involvement of organizations outside the MOEE nor any stakeholder consultation during the PDP preparation.

SEA of Myanmar Hydro Power Sector, however, involved substantial stakeholder engagement activities with the government, civil society organizations (CSOs), and hydropower companies, including multistakeholder workshops, regional river basin consultations, information sessions, direct discussions, and technical advisory group meetings.

While there has been an attempt to involve public consultations in SEA preparation, there have been no interministerial and public consultations to prepare the electricity expansion plan. The electricity planning process in Myanmar has been assessed as "not achieved" for the consultation.

5.2 PEA

PDP plays a critical role in setting the tone for the electricity infrastructure decisions regarding what, where, and when. The national policies pertinent to power development determine the enabling conditions for such decisions. Furthermore, institutions involved, coordination, and the nature of relevant stakeholder involvement play a crucial role in the decisions about the development of electric power infrastructure.

5.2.1 Policy

Myanmar's policy framework is quickly evolving, setting a foundation for the uptake of IRP for power sector development, for which Myanmar Electricity Law provides a legal basis. The national policy provides general direction and some targets. The summary description and analysis of these laws and policies are provided below:[159]

[159] Adopted from ADB 2015, Power Sector Development in Myanmar.

The government has prepared a set of reform programs aiming to transform the country into a modern, democratic, and developed nation by 2030. The framework for these reforms was laid down in the 2011–2031 National Comprehensive Development Plan.

The 2012 Framework for Economic and Social Reforms was aimed to achieve poverty alleviation, improved infrastructure, and capacity building through many plans, such as (i) rural development and poverty alleviation; (ii) human resources development, investment, and trade sector development; (iii) industrial development; (iv) finance sector development; and (v) regional and sector-wise development, which will require an integrated approach.

Existing power sector policies cover the following:

(i) Expand the national power grid for effective utilization of generated power from the available energy resources such as hydro, wind, solar, thermal, and other alternative ones to achieve sufficient electricity supply throughout the country.

(ii) Conduct electricity generation and distribution in accordance with advanced technologies, and enhance private participation in regional distribution activities.

(iii) Conduct Environmental and Social Impact Assessments for power-generation and transmission projects to minimize negative impacts.

(iv) Restructure the power sector with the cooperation of boards, private companies, and regional organizations toward more participation of local and foreign investments and the formation of competitive power utilities.

(v) Encourage the expansion of a power transmission and distribution network throughout the country and the employment of a public-private partnership in each sector.

(vi) Reach millennium development goals in areas covering the construction of thermal power plants and hydropower plants.

To achieve energy sustainability, the government aims to increase electricity generation from RE resources. It sees these as vital to electrifying rural areas and therefore promotes (i) capacity building of those involved in RE-generation activities, (ii) awareness of alternative RE sources, (iii) public-private partnerships and foreign investment for implementing RE-related business, (iv) research and development of RE, and (v) EE. These are all crucial elements of IRP.

5.2.2 Regulation and Institution

The following laws govern the power sector:

(i) Electricity Act of 1948, as amended in 1967.

(ii) Myanmar Electricity Law (1984) sets the requirements for the electricity authority, the duties and responsibilities of electricity inspectors, and the punishments and fines for various offenses, and empowers the government to grant rights to specified organizations, including foreigners, to participate within the sector.

(iii) Electricity Rules (1985), which supplements the 1984 law.

(iv) Myanmar Electricity Law of 2014, which repeals that of 1984 and establishes the Electricity Regulatory Commission (ERC) and grants regulatory responsibilities to the ERC; and authorizes the Ministry of Electric Power (MOEP), region and state governments, and leading bodies of self-administrated zones and self-administrated divisions the power to grant permits to entities to engage in electricity-related works such as generation, transmission, and distribution, thereby encouraging foreign and domestic investments in power projects.

(v) 2012 Law on Environmental Conservation, which establishes the requirement for EIAs, references SEAs in strategic planning and the 2015 Environmental Impact Assessment Procedure, which details implementation procedures for EIA.

The institutional setup pertinent to the power system development plan remains fragmented irrespective of some consolidation in the recent past, well illustrated by the fact that there are five different ministries and numerous departments under these ministries responsible for other aspects of the development of the sector.[160] The following outlines the description of the mandate, roles, and responsibilities of agencies involved in power development in Myanmar:[161]

In April 2016, the government restructured its organization and reduced ministries from 36 to 21. This included merging the Ministry of Energy and the MOEP into the new MOEE, which is responsible for oil and gas and electricity operations. Other ministries related to the energy sector include (i) Ministry of Agriculture, Livestock, and Irrigation, with responsibility for off-grid rural electrification, (ii) MONREC, with responsibility for coal mining, and (iii) MOI, with responsibility for EE.

The MOEE oversees policy formulation in the power sector to cover the following:

(i) Development, implementation, operation, and maintenance of all large hydropower plants.

(ii) Development, implementation, operation, and maintenance of coal-fired thermal power plants.

(iii) Construction, operation, and maintenance of the transmission and distribution systems throughout the country.

(iv) Operation and maintenance of gas-fired thermal power generation.

(v) Planning, implementation, and operation of mini-hydropower plants.

To strengthen coordination and planning among the energy sector's institutions, the government in January 2013 established the National Energy Management Committee and the Energy Development Committee to improve IRP and oversee investment in electricity sector development.

The minister-level National Energy Management Committee, sitting under vice president no. 2, formulates energy policy and plans in coordination with key energy-related ministries. The Energy Development Committee, composed primarily of deputy ministers, is responsible for implementing the National Energy

[160] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[161] Adopted from ADB 2015, Power Sector Development in Myanmar and ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.

Management Committee's policies and plans. The national committee's secretariat is composed of staff seconded from the energy-related ministries, and the deputy minister for energy supervises its daily operation.

The regulatory framework and relevant institutions specific to the power sector have yet to be established, meaning that transition to a competitive market or any functional unbundling necessary to allow more efficient and reliable service has not occurred. Therefore, the government is reviewing the Electricity Law to include amendments that can address issues relating to supply security, electricity pricing, and equitable access to good quality service.

In Myanmar, environmental protection is managed by the MONREC, responsible for all aspects of environmental policy, monitoring, and enforcement of regulations regarding natural resources and environmental protection. However, to date, they have no role in the preparation of the electricity generation expansion plan and hence no influence.

5.2.3 Stakeholders

In addition to the institutions mentioned in the previous section (Regulation and Institution), more PDP stakeholders are summarized below:

Owner of electricity infrastructures. While the government encourages private sector participation, the electricity sector remains a largely state-owned vertically integrated utility. There are 10 MOEE-owned gas-fired power plants for a total capacity of 943 MW and one MOEE-owned coal-fired power plant with a capacity of 120 MW. Nine privately owned gas-fired power plants for a total capacity of 661 MW have been added since 2012. The availability of the non-IPP plants is approximately 31 percent. Replacement of the Thaton 51 MW open-cycle gas turbine power plant with a 106 MW combined-cycle gas turbine power plant financed by the World Bank is under implementation. The award of an IPP contract to construct the Myingyan 250 MW combined-cycle gas turbine was done in 2015. Other government and IPP projects are under development.[162]

The Myanmar Electric Power Enterprise, the entity responsible for gas-fired electricity generation and transmission, was the single buyer having the authority to purchase electricity from different operators, including IPPs, through individual power purchase agreements and sell it to state-owned distributors. In 2016, Myanmar Electric Power Enterprise's functions were split between the Power Transmission and System Control Department and the Electric Power Generation Enterprise (EPGE). Single buyer responsibility is now allocated to EPGE.[163]

All the oil and gas subsectors' operations are handled and governed by the government (Myanma Oil and Gas Enterprise, Myanmar Petrochemical Enterprise, and Myanmar Petroleum Products Enterprise) under the MOEE. Their technical, managerial, and negotiation skills are much lower than the competing international companies.[164]

The state-owned utility owns and handles almost all the power plants in Myanmar. Hence, they hold a high level of interest and influence in the power-generation expansion plan. The role and influence of IPP are expected to grow in the future.

[162] ADB 2016, Myanmar Energy Sector Assessment.
[163] ADB 2016, Myanmar Energy Sector Assessment.
[164] ADB 2016, Myanmar Energy Sector Assessment.

Investors. The private sector has actively responded to the needs for generation investment by proposing unsolicited hydro, thermal, and solar power projects, resulting in approximately 60 MOUs signed between developers and the government. One competition for thermal generation, conducted with support from the ADB and World Bank, has resulted in the Myingyan 225 MW gas-fired power plant. The ADB, the World Bank, and JICA are the major investors in Myanmar's power development infrastructure.[165]

Private sector interest and influence are growing in the electricity generation expansion in Myanmar; it is inevitable they will be seeking a broader role in the development of a plan, which has been traditionally dominated by government and development partners.

Development partners. Development partners play a crucial role in shaping the power sector by providing investments and providing technical support. Since 2012, the ADB has been a lead development partner in the energy sector. The ADB offers technical assistance in the following areas:

(i) Policy, strategy, and energy master plan development.

(ii) Capacity development and institutional support.

(iii) Legal and regulatory framework development.

(iv) Off-grid RE demonstration.

(v) Investment project identification and feasibility study.

(vi) Financial management assessment of the energy sector.

(vii) Country safeguard system strengthening.

(viii) Public-private partnership framework development.

Investing in building and rehabilitating the distribution network and developing generation plants.[166]

Since May 2013, the World Bank Group has been assisting MOEE and the Ministry of Agriculture, Livestock, and Irrigation in preparing the NEP, focusing on power distribution extension and off-grid applications.[167]

Since June 2013, JICA has been assisting the MOEE in preparing the National Electricity Master Plan focusing on power sector generation and transmission sector planning. The report was submitted in September 2014, and JICA is now assisting in its update and revision. The ongoing and planned JICA loans and grants, totaling more than $1 billion, cover all power subsectors, spread in generation, transmission, and distribution components.[168]

[165] ADB 2016, Myanmar Energy Sector Assessment.
[166] ADB 2016, Myanmar Energy Sector Assessment.
[167] ADB 2016, Myanmar Energy Sector Assessment.
[168] ADB 2016, Myanmar Energy Sector Assessment.

KfW and GIZ, Thailand, and Norway are other notable development partners supporting capacity-building activities in the Myanmar power sector.[169]

Development partners such as ADB, World Bank, and JICA are heavily involved in preparing the energy-sector plan in Myanmar; hence they play a significant role and exert substantial influence in the development of the electricity expansion plan.

NGOs and civil society. There has been no engagement with the civil institutions during the power system development processes in Myanmar. WWF supported the preparation of Power Development Vision; however, there has been no uptake in the PDP process.[170]

Apart from international NGOs that vigorously scrutinize large hydropower projects in the country, Myanmar has developed many very active and able national NGOs that also protect social and environmental interests impacted by proposed generation and transmission projects. Civil society is also involved in advocacy regarding environmental concerns of power sector development. The Myanmar Land Core Group, a network of INGOs, national NGOs, businesses, and individuals come under the UN-sponsored Agriculture and Food Security Working Group. Its members are fully aware of transboundary environmental issues. One NGO, BANCA, carried out an EIA on the Myitsone dam project and participated in the Dawei (Tavoy) port project. The Pa-Oh Youth Organization and Kyoju Action Network have been monitoring the Tigyit coal power station since 2010 and urged the companies and government to suspend operations pending full environment, social, and health impact assessments. A local CSO also sent a complaint letter to the Thai Human Rights Commission and issued the investors in Dawei. During the process of drafting the Environmental Conservation Law (2012), MOECAF's ECD invited only a handful of registered CSOs for consultation meetings, such as the Renewable Energy Association Myanmar (REAM).[171]

While NGOs and civil society are active and vocal regarding electricity development in Myanmar, they are not directly involved in preparing electricity expansion plans and hence exert very little influence.

Consultancies, academia, and think tanks. Preparation of PDPs in Myanmar is conducted along traditional lines by external consultants usually hired by development partners.[172] National consultancies, academia, and think tanks do not have much involvement or influence in preparing electricity generation plans in Myanmar.

5.3 Recommendations for Future Engagement

Like Cambodia and Lao PDR, Myanmar is at a pivotal stage for the development of its IRP and SEA. Legislation will require an integrated approach to all power sector development and SEA to be integrated into the preparation of strategic plans. However, capacities and awareness are minimal, and the structure and approach of an IRP with the SEA suitable for Myanmar conditions would need to be developed.

Consequently, there is a need for the different agencies and national and international development partners involved in the IRP's future development to work together in a coherent and coordinated manner. Proper coordination is required to ensure that the IRP process evolves to reflect Myanmar's

[169] ADB 2016, Myanmar Energy Sector Assessment.
[170] WWF 2016, GMS Power Sector Vision 2050.
[171] Wells-Dang 2016, A Political Economy of Environmental Impact Assessment in the Mekong Region.
[172] 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS, ADB.

conditions and follows good international practice on IRP with SEA. Achieving full IRP will be a gradual process as experience is gained and capacities increase. High-level policy support will be essential. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Myanmar.

5.3.1 Awareness Raising and Broader Stakeholder Engagement

Myanmar has made remarkable progress in power sector planning in recent years and is now in a strong position to pursue a more IRP approach. Uptake of the new approach requires significant awareness raising to ensure their utility is understood. The targeted awareness raising involving high-level officials through national, regional, and international exchange events and study visits are useful means of generating interest in new tools. The Activity could potentially play the role of a neutral facilitator if there is government buy-in. This will require constructive engagement with the government and building trust.

5.3.2 Policy Support

Legal frameworks are crucial for the broader uptake of new tools and approaches. In recent years, with the ADB help, Myanmar has developed legal requirements for integrated planning. Myanmar also has a legal requirement for SEA in place. However, sector-specific detailed guidance is still missing. The Activity could provide advisory support on the formulation of legal frameworks pertinent to power development subsector-specific guidance on IRP and SEA.

5.3.3 Technical Capacity

Recent power sector planning in Myanmar has created a solid methodological base. The most recent PDP of Myanmar included elements consistent with an IRP approach. For instance, Myanmar is applying the bottom-up load forecasting approach. Myanmar has also made remarkable progress in doing scenario-based analysis incorporated with sensitivity analyses. A multicriteria approach was used to evaluate alternative scenarios and assist with decision-making regarding environmental and social considerations. GHG emissions were to be mitigated using ultra-supercritical coal, integrated coal gasification combined cycle, and CO_2 capture and storage technologies. The potential detrimental environmental and social impacts of power development were recognized—albeit without monetizing the impacts—using an approach with similarities to the SEA. However, the recent past planning exercise has mostly been done by the external consultants, which means minimal in-country capacity.

Myanmar is planning to update its PDP next year with the support of ADB. In developing the IRP with SEA process in Myanmar, consideration should be given to the approach adopted in Vietnam, where the first SEA, of hydropower in PDP 6, was a retrospective one that was used as a learning lesson and would not disrupt or delay the process of PDP preparation. This could be considered as an approach for Myanmar, examining all or part of the next PDP. Implementation of an IRP approach for the power sector requires considerable modeling and analytical capacity building. The Activity could support the following technical capacity-building activities:

- Demonstrate applicability and value of IRP by supporting a hands-on pilot case study applying a learning-by-doing approach involving power system planners.
- Develop Myanmar-specific technical guidelines on IRP, building on the learning experience from the pilot case study.
- Conduct in-depth training on specialized areas pertinent to IRP, based on Myanmar's specific needs. The following are identified areas:

- Discrepancies between the projections and demand forecasts in recent years could be overcome by improving the relevant local institutions' quality and the quality of the input data. Mechanisms to monitor and evaluate the accuracy of forecasts from previous PDPs should be instituted.

- A methodology could be used to integrate energy efficiency in load forecasting. Capacity-building assistance is needed in (i) implementing the EEC Law and achieving the established targets, including the assessment of EEC potential, preparation, monitoring, and evaluation of the impact of EE and conservation programs; and (ii) adequately incorporating EE impacts on both supply and demand sides in the PDP process, in consideration of the impact on electricity demand and overall costs of the PDP.

- Myanmar is still using old modeling software, which is not fully compatible with IRP. It is understood that consultants working with MOEE on recent PDP preparation have used both GTMax and WASP IV, and capacity building in the use of these packages has been provided to MOEE staff. While WASP IV by itself has limitations, GTMax has a mixed integer linear programming routine for optimization and has many of the key attributes needed for IRP preparation in Myanmar.

SEA of Myanmar Hydro Power Sector has raised understanding and interest in scaling up its interest. Myanmar already has frameworks for environmental protection, based on the 2012 Law on Environmental Conservation, which requires EIA and references SEA in the 2015 EIA Procedures. SEA of NEMP ensuring the internalization of the full set of externalities could be included in the future PDPs. Nevertheless, capacity is likely to be a significant constraint, initially, despite considerable donor support for SEA in recent times. Irrespective of JICA's support for PDP including an SEA, Myanmar still needs capacity-building support, particularly in the valuation of impacts. Given the critical role of MONREC in reviewing SEAs and the current lack of capacity for such reviews, it will be useful to consider including relevant MONREC staff to practice developing SEA guidelines.

There is a need to overhaul the stakeholder engagement and public consultations. Ensuring adequate coordination between the ministries and agencies involved in RE work—through a higher authority interministerial coordinating body, or through a dedicated unit at the MOEE, absorbing RE experts from the ministries of education and agriculture—is essential for enhancing the PDP process.

The Activity could support Power Development Planning–specific application of SEA, including valuation of environmental and social externalities. Such exercise could cover an entire next iteration of PDP or a group of candidate projects covering one or two pilot states and regions.

5.3.4 Data and Knowledge Management and Sharing

Keeping in mind the next iteration of PDP in Myanmar, it is essential to recognize preparation of robust PDP that applies IRP and SEA is dependent on the availability of quality data and information. The development of several planning documents with development partners' support has generated important data and information in recent years. However, it remains fragmented and disorganized and relatively inaccessible. The Activity could support Myanmar's government to establish a centralized information management system for power planning, keeping in mind the next iteration of PDP. Such a database will help conduct robust modeling and analytical work on time, an essential requirement for PDP preparation.

There is a strong interest within Myanmar to learn about Vietnam's experience with integrating SEAs in Vietnam's power planning process. Study visits to Vietnam are advised to learn from their experience on SEAs.

6. THAILAND

Summary

Energy has played a crucial role in Thailand's economic growth. However, energy security is becoming a concern, as it is becoming more dependent on energy import. Thailand has a well-developed power grid infrastructure that provides nearly universal access to electricity, and power production has been steadily increasing to meet growing demand.

It is now imperative for Thailand to improve EE, diversify the energy mix, and maximize the use of abundantly available domestic RE resources to ensure security and sustainability. Thailand is also pushing for regional energy trading by building a Southeast Asia electricity super-grid to meet its growing electricity demand.

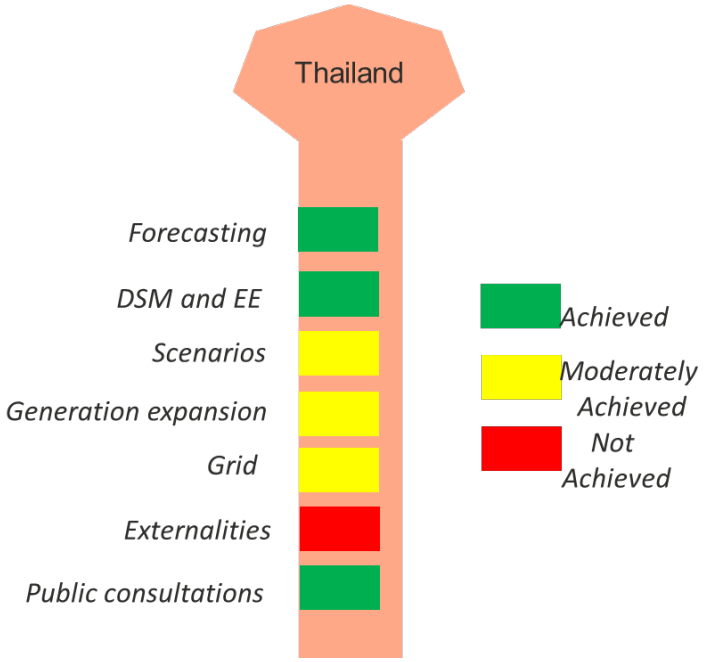
Thanks to the deployment of advanced technologies, Thailand's energy intensity remains high compared to industrialized and neighboring countries (e.g., the thermal efficiency of natural gas in power generation has improved remarkably since the deployment of combined-cycle gas turbine technology). The power subsector is expected to continue contributing significantly to achieve EE, the target with the transport and industrial sector's electrification.

However, Thailand's energy resources are modest. They are being depleted and are highly dependent on energy imports. The share of fossil fuels in electricity production has decreased slightly yet remains exceptionally high.

Although some RE resources are in plentiful supply, development continues to be challenging. Installed RE generating capacity has doubled over the past decade and has seen a steeper ramp-up in recent years. Hydropower and bioenergy account for the largest share. In contrast, solar PV and wind power share have quickly caught up, attributed mainly to the great adder rates and favorable feed-in tariffs (FITs). Inadequate transmission lines and other infrastructure hampers further uptake of renewables.

Reliance on fossil fuels for energy has led to worsening air pollution. The power subsector contribution to air pollution-related mortality is significant. There is massive public opposition to coal-fired thermal plants. Thailand has constructed several major dams for power generation; however, opposition among rural communities has significantly increased in recent years, which has virtually halted new dam construction in Thailand. To meet energy needs, Thailand plans to import hydropower from neighboring Lao PDR and Myanmar, which risks shifting the ecological and environmental impact of hydropower development to the neighboring countries.

The Thailand PDP 2018–2037 continued to focus on (i) energy security (system reliability and fuel diversification, (ii) economy (cost of power generation and EE measures), and (iii) ecology (environmental impacts, particularly CO_2 emission). Thailand probably has the best competence and capacity to prepare integrated PDP. This is particularly true concerning the extent to which RE and EE are integrated into PDP preparation; however, there are also gaps in the present situation. The following figure summarizes Thailand's PDP as demarcated and compared against seven constituent parts of IRP to identify each country's current capability to achieve integrated PDPs fully.



Thailand uses a combination of top-bottom and bottom-up demand forecasting, and significant progress has been achieved in reducing overestimation. Energy efficiency targets set as a part of the Energy Efficiency Plan (EEP) are fully integrated into the demand forecasting. PDP 2018 is applying a deterministic approach. However, a scenario-based method was used when formulating EEP and Alternate Energy Development Plan (AEDP) while setting the targets. The targets have been integrated into PDP 2018. However, the analytical capacity to define and analyze scenarios based on the right set of policy questions needs to be strengthened. PDP incorporates a transmission plan even though the cost of transmission is not considered when optimizing the generation mix. Separate studies have been conducted on assessing grid flexibility to accommodate RE. However, it has only been partially used and is expected to be fully integrated into PDP's next iteration. While there is a strong emphasis on GHG reduction, no consideration has been given to other environmental and social externalities while preparing the PDP. There is no uptake of SEA in PDP yet. PDP preparation in Thailand goes through a robust public consultation process.

The policy targets required for IRP are in place and harmonized primarily through Thailand Integrated Energy Blueprint (TIEB), supported by other RE and EE specific plans.

The legal basis for the requirements for IRP for power development is also well established in Thailand through (i) the National Energy Policy Council Act, (ii) the Energy Development and Promotion Act, and (iii) the Energy Conservation Promotion Act.

Irrespective of growing interest in environmental issues pertinent to electricity generation, Ministry of Natural Resources and Environment (MNRE) has no engagement or influence on power development. The following table highlights key stakeholders relevant to power development in Thailand, their role/ interest, and influence.

	Role/ Interest	*Influence*
Regulators		
Ministry of Energy	High	High
Ministry of Natural Resources and Environment	Medium	Low
Owner		
Electricity Generating Authority of Thailand	High	High
Investors		
Government	High	High
FDI and private sector	Low	Low
Multilateral banks	Medium	Low
Development partners	Low	Low
Nongoverment organizations and civil society	High	Medium
Consultancies, academia, and think tanks	Medium	Low

Thailand probably has the best competence and capacity to apply IRP principles in the preparation of power development planning. Achieving full IRP is a gradual process that evolves with experience and capacity. There are also gaps in the present situation, including the lack of internalizing externalities and a formal SEA in the PDP process. The Activity could help Thailand to develop a full economic costing of different options to include in the PDP.

6.1 Approach to Decision-Making

6.1.1 Background

1. <u>Power sector development needs and challenges</u>

Thailand is one of the most economically developed countries in Southeast Asia. Energy has played a crucial role in its economic growth. However, energy security is becoming a concern, as Thailand is becoming more dependent on energy imports. The share of energy imports in energy consumption steadily increased from 57 percent in 2013 to 64 percent in 2017.[173] Thailand has limited domestic energy resources projected to be depleted soon (oil resources within two years and natural gas within five years).[174] The hydropower potential in Thailand has also almost been entirely used up without any future possibility for significant development. The lack of energy resources poses a challenge to the security of energy supply and expenditure.[175]

While Thailand's energy expenditure had halved in 2015, compared to the peak of 12 percent of Thailand's GDP in 2008,[176] its energy dependence ratios on import remain a concern. The combination of high dependence ratios and intensified energy-commodity price volatility could pose a more significant energy security challenge in the future.

Thailand has a well-developed power grid providing nearly universal access to electricity. Power production has been steadily increasing to meet the growing demand. However, the country can still

[173] ERIA 2017, Study of Renewable Energy Potential and Its Effective Usage in East Asia Summit Countries.
[174] EPPO 2017, Energy Statistics of Thailand 2017.
[175] IRENA 2017, Renewable Energy Outlook Thailand.
[176] High energy expenditure in 20018 is attributable to oil price surge.

improve the reliability of electricity. In 2016, 8.6 percent of businesses were affected by power outages, with an average 0.2 outages per month.

Thailand must improve EE, diversify its energy mix, and maximize the use of abundantly available domestic RE resources. Thailand has stepped up its effort in diversifying the power mix by increasing solar and wind power-generation capacity.[177]

Thailand is also pushing for regional energy trading by building a Southeast Asia electricity super-grid. It is believed that such a grid could make better use of the existing infrastructure and power plants to improve the security of supply and system resiliency. Using its grid more efficiently, Thailand could earn additional revenue from transmitting electricity across the region, and the cost of electricity would likely be cheaper in the long run.[178]

Thailand has an MOU with three neighboring countries to purchase electricity, 9,000 MW from Lao PDR, and unknown quantities from Cambodia and Myanmar.[179]

Electricity demand. The electricity demand increased by an average annual rate of 3.5 percent during 2009–2018. Total electricity consumption in 2018 was 184,577 GWh, a 1.4 percent increase from 181,989 GWh in 2017. Peak demand in 2018 was 28,338 MW, a slight decline of 0.8 percent from 28,578 MW in 2017. Peak demand hit a record high of 30,120 MW in April 2019, primarily caused by hot weather.[180] Thailand's new Power Demand Forecast would grow 2.67 percent annually from 2014 to 2036.[181] By 2036, the expected energy and power demand would be 367,458 GWh and 53,997 MW, respectively.[182]

Electricity supply. As of May 2019, Thailand had installed a generation capacity of 42,835 MW (including imports), of which 14,566 MW (34 percent) was accounted for by Electricity Generating Authority Thailand's (EGAT's) power plants, 14,949 MW (35 percent) by IPPs, 9,443 MW (22 percent) by small producers, and 3,878 MW (9 percent) by foreign producers of imported power. Power production depends heavily on fossil fuels, with 57 percent generated from natural gas, 10 percent from lignite, and 8 percent from coal.[183] Renewable energy sources contribute only 10 percent, but several factors (fluctuating prices for fossil fuel, fuel shortages, and the government's promotion of alternative energy) are expected to increase RE share.

According to Thailand's Power Development Plan 2018–2037 (PDP 2018), the total installed capacity is expected to be 77,211 MW by 2037, including 56,431 MW of new installation, which will help replace the 25,310 MW of generation that is expected to retire. The PDP 2018 aims to diversify fuel sources by increasing the use of RE and EE. It projects that by 2037, 53 percent of power generation will be generated by natural gas, 34 percent by RE (including hydropower) and EE, and 13 percent by clean coal (including lignite).[184]

---

[177] IRENA 2017, Renewable Energy Outlook Thailand.
[178] *Bangkok Post*, Thailand aims to be Southeast Asia's power-trading middleman https://www.bangkokpost.com/business/1736995/thailand-aims-to-be-southeast-asias-power-trading-middleman
[179] MOE 2018, Thailand Power Development Plan 2017–2037 (PDP2018).
[180] EPPO 2019, Thailand Energy Statistics 2019, cited in ADB 2019, Eastern Economic Corridor Independent Power Project: Sector Assessment.
[181] MOE 2018, Thailand Power Development Plan 2017–2037 (PDP2018).
[182] MOE 2018, Thailand Power Development Plan 2017–2037 (PDP2018).
[183] EPPO 2019, Thailand: Installed Generating Capacity (April 2019), cited in ADB 2019, Eastern Economic Corridor Independent Power Project: Sector Assessment.
[184] MOE 2018, Thailand Power Development Plan 2017–2037 (PDP2018).

The security of the energy supply is the biggest challenge for power sector development in Thailand. Threats to a competitive and stable electricity supply include (i) the rising market price of oil and gas, (ii) scarce and dwindling domestic resources, (iii) uncertain reliability of nondomestic sources of energy, and (iv) increasing domestic demand. Complementing the electricity-generation expansion are the increasing concerns about climate change and other associated environmental impacts.

While Thailand has abundant RE sources, the RE industry is in a nascent stage partly due to the perceived high cost of power generation. Utilizing RE resources requires understanding actual system cost and financial support, particularly the implementation of financial incentives and risk mitigation to attract independent power producers by improving commercial viability.

Thailand currently imports electricity from the Lao PDR (hydropower and coal) and gas from Myanmar. Risks include the following: (i) supply could be subject to political risk and, in the case of hydropower, dry seasons; (ii) imports are uncertain due to protracted project development periods; and (iii) international criticism could arise for the perception of shifting environmental problems and obligations to the neighboring countries.

1. Energy intensity

The energy intensity of Thailand's economy continues to remain high compared to industrialized and neighboring countries. It remained constant between 2000 and 2017, varying between 5.2 (2001) and 5.56 (2013) MJ/$2011 PPP GDP.[185] ERIA study shows that natural gas's thermal efficiency in power generation has improved remarkably since the deployment of combined-cycle gas turbine technology. The 40 percent efficiency of natural gas in 1990 jumped to 48 percent in 2015 and is expected to remain unchanged until 2040. Coal thermal efficiency declined by almost 4.0 percent from 1990 to 2015. But the efficiency is also assumed to be improved from 33.9 percent in 2015 to 37.3 percent in 2040. The study projects energy intensity to decline by 1.2 percent per year under the business-as-usual scenario.[186]

Thailand has set its target to reduce energy intensity by 30 percent of the 2010 level by 2036. To achieve this target, the Ministry of Energy has developed an EEP, allocating targets to development sectors. The power sector is expected to contribute significantly to achieve the target. If EEP is implemented, the demand reduction for electricity will be 89,672 GWh, and fuel and heating demand could drop by 44 Mtoe by 2036.[187] The electrification of transport and industrial sectors is a significant portion of the EE strategy in Thailand. For example, one of the critical assumptions used in EEP is that more than 70 percent of energy saving can be achieved by electric motorcycles, compared with the ordinary ones. The share of electric motorcycles sold in 2030 will be 70 percent of new motorcycles.[188]

2. Energy resources

Thailand's energy resources are modest and being depleted. Thailand is highly dependent on energy imports, with 79 percent of its crude oil and 32 percent of its natural gas supply coming from abroad.[189] It has domestic oil and natural gas reserves; however, they are depleting quickly. The coal it produces is

[185] Climate Analytics.
[186] ERIA 2019, Energy Outlook and Energy Saving Potential in East Asia 2019.
[187] APEC 2019, Energy Outlook 7th Edition Vol II.
[188] MOE 2011, Thailand 20 year energy efficiency development plan (2011–2030).
[189] APEC 2019, Energy Outlook 7th Edition Vol II.

of mediocre quality and does not meet its demand. Thailand has a small reserve of hydropower resources, the majority of which has already been developed. Unutilized RE resources are abundant in the country.

Fossil fuel (oil and natural gas). At the end of 2016, Thailand had proven reserves of 350 million barrels (Mbbl) of oil, 200 billion cubic meters (bcm) of natural gas, and 1,063 million tonnes (Mt) of coal.[190] Based on the current production rates, domestic supplies will be depleted in the near future (oil resources within two years and natural gas within five years).[191] Erawan and Bongkot fields produce up to 75 percent of Thailand's total natural gas production.[192]

The share of fossil fuels in electricity production fluctuated between 91.5 percent and 93 percent from 2000 to 2015. Yet it remained too high compared to middle-income countries (71 percent in 2014).[193]

Coal. Thailand holds 1,063 million tonnes of proven coal reserves as of 2018, accounting for a tiny fraction (for about 0.1 percent) of the world's total coal reserves of 1,054,782 million tonnes.[194] Domestically produced coal is mostly lignite and sub-bituminous and is used in power generation. Most coal-fired power plants in Thailand use low-quality coal. Still, the newly developed replacement project at the Mae Moh power plant is adopting ultra-supercritical technology that will reduce CO_2 and particulate emissions but require imports of bituminous coal. The share of coal in electricity production has stayed constant at around 19 percent between 2000 and 2015.[195]

Hydro. Hydropower has been developed for power generation since 1964. The potential of hydropower in Thailand is estimated at 15,155 megawatts (MW). Installed hydropower capacity in Thailand reached 7,962 MW in 2015, which leaves little room for further development of large plants because of its potential environmental impacts and opposition from civil society. Small hydropower has been on the rise but at a modest rate.[196]

Renewable. Thailand's RE potential was assessed as part of the AEDP 2015. Although some RE resources are in plentiful supply, development may be challenging. As far as the power sector is concerned, installed RE generating capacity has doubled over the past decade and seen a steeper ramp-up since 2012. Among the power mix, hydropower and bioenergy account for the largest share. In contrast, solar PV and wind power share have quickly caught up, attributed mainly to the great adder rates and favorable FITs.[197] Inadequate transmission lines and other infrastructure hampers further uptake of renewables.[198]

Solar. Thailand has intense solar irradiation and resource potential. More than 70 percent of the country has high solar radiation. Thailand has about 380,000 km^2 that could be suitable for solar PV systems. As a result, Thailand's maximum technical solar potential is about 33.4 TWh/yr, more than 90 percent of which is attributable to high irradiation levels.[199]

---

[190] BP 2019, BP Statistical Review of World Energy 2019, 68th edition.
[191] EPPO 2017. Energy Statistics of Thailand 2017.
[192] APEC 2019, Energy Outlook 7th Edition Vol II.
[193] Climate Analytics 2019, Country Profile Thailand, Decarbonising South and South East Asia.
[194] https://www.worldometers.info/coal/thailand-coal
[195] Climate Analytics 2019, Country Profile Thailand, Decarbonising South and South East Asia.
[196] IRENA 2017, Renewable Energy Outlook Thailand.
[197] IRENA 2017, Renewable Energy Outlook Thailand.
[198] APEC 2019, Energy Outlook 7th Edition Vol II.
[199] 2015, Renewable energy developments and potential in the GMS, ADB.

Solar has so far reached only 22 percent of the 6,000 MW target set in the AEDP 2015.[200]

Wind. Thailand has a theoretical wind energy potential of slightly more than 380 GW, assuming 38,000 km^2 of suitable land area with sufficient wind speeds and an installation density of 10 MW/km^2. The technical potential is much less than this because of the extensive protected areas, the difficulty of installing wind turbines in mountainous or remote areas, and the need for a grid system nearby. The Department of Alternative Energy Development and Efficiency (DEDE) has estimated the wind power capacity's overall technical potential at 1,600 MW.[201]

Thailand started to exploit its wind energy as early as 1983, with several small wind turbines ranging from 1 kW to 150 kW in Phuket Island in southern Thailand. Still, the country has scaled down deployment at a modest growth rate due to the relatively low wind speed, especially in the areas close to load centers or transmission grids. So far, the wind has reached only 7 percent of the 3,002 MW target set in the AEDP 2015.[202]

Biomass. The theoretical annual biomass energy potential of agricultural residues in Thailand is estimated to be over 200,000 GWh. Rice, sugarcane, and oil palm account for 85 percent of this potential. Biomass has developed faster than other renewable resources, with 44 percent of the 5,570 MW target set in the AEDP 2015 achieved.[203]

Geothermal. Thailand has very modest geothermal potential in northern Thailand. In 1989, it built the first geothermal power-generation facility with a capacity of only 300 kW in the Fang District. However, the development of geothermal has since then been stagnant due to little resource availability.

3. Environmental concerns

Reliance on fossil fuels for energy has led to increasing air pollution in Thailand. According to the World Health Organization, 68 deaths per 100,000 inhabitants are attributed to either indoor or outdoor air pollution (32 indoor and 36 outdoor). The total number of deaths attributed to indoor and outdoor air pollution is estimated to be about 30,000 and 33,000, respectively, in 2016.[204] The power sector contribution to air pollution–related mortality is significant. In 2011 air pollution from coal-fired power plants was responsible for more than 1,500 premature deaths. Other health impacts include strokes, ischemic heart disease, lung cancer, other cardiovascular diseases, and respiratory diseases to both adults and children.

The International Renewable Energy Agency (IRENA) projected a 70 percent increase in energy-related CO_2 (in particular fossil fuels) from 2015 to 2026 in Thailand, raising the air pollution–related external costs by 21 percent on average of US$68 billion. In 2013, carbon emissions in the power sector were 0.506 kg CO_2/kWh. After facing massive public opposition and delays in projects, PDP 2015 was developed to reduce carbon emissions more aggressively than the previous PDPs by promoting RE and fuel diversification. The PDP aimed for an emission reduction of 37 percent compared to 2013 levels (0.319 kg CO_2/kWh).[205] Thailand has revised its projections for coal power generation in its PDP 2018

[200] IRENA 2017, Renewable Energy Outlook Thailand.
[201] 2015, Renewable energy developments and potential in the GMS, ADB.
[202] IRENA 2017, Renewable Energy Outlook Thailand.
[203] IRENA 2017, Renewable Energy Outlook Thailand.
[204] Climate Analytics 2019, Country Profile Thailand, Decarbonising South and South East Asia.
[205] MOE 2015, Thailand Power Development Plan 2016–2036 (PDP2015).

downwards.[206] The annual CO_2 emission from PDP 2018 is estimated to be less than that in 2015 because the proportion of electricity production using natural gas would increase instead of generating electricity produced from coal. However, through its PDP, Thailand would still emit approximately 103,845 thousand tonnes of CO_2 by 2037, contributing significantly to global climate change.

Thailand has constructed several major hydro dams for power generation; however, opposition among rural communities has significantly increased. Communities and civil societies' resistance to projects such as the Pak Mun and Rasi Salai Dams have virtually halted new dam construction in Thailand. To meet Thailand's energy needs, Thailand plans to import hydropower from neighboring Laos and Myanmar, shifting the ecological and environmental impacts of hydropower development to the neighboring countries.

Renewable energy is perceived to have relatively less environmental impact. However, in the absence of a comprehensive study, its overall impact is less understood, particularly in waste management and land footprint.

6.1.2 Current Approach

PDPs have been established as the primary form of strategic planning in Thailand's power sector for many years. It determines what type and what quantity of power plants get built, where, and when. There is no legal framework covering the commissioning or approval of PDPs. The government does not follow a regular timetable for PDPs' preparation but instead prepares them on an "as needed" basis. The PDP is updated whenever the government considers that changing circumstances require a new plan.

There is no legal framework covering the commissioning or approval of PDPs. The approval follows standard government procedures and is ultimately given by the Cabinet after reviewing by relevant ministries and other bodies, including the National Energy Policy Council that provides formal endorsement before the PDP is submitted to the Council. Preparing PDP's responsibility lies with the Energy Policy and Planning Office (EPPO) of the Ministry of Energy (MOE). Other organizations such as the electricity utilities, the regulator, the RE body, the National Economic and Social Development Committee (NESDC) are also involved through several working groups established for PDP preparation. The EGAT is mainly involved, providing extensive expertise and undertaking detailed modeling and cost analysis in the PDP. All the organizations, except NESDB, are within the energy sector. Some Thai consultants are used for specialized inputs, if needed, but the PDP is prepared with minimal or no overseas support.

The PDP sets out a significant structural change to power generation in Thailand for over 20 years. This includes a significant progressive increase in RE, strengthened EE, a reduced dependency on gas, and a substantial increase in regional interconnection for higher levels of power imports from adjacent countries. The PDP is part of a broader TIEB, the last version of which was updated for 2015–2036. At present, the TIEB serves de facto as the national energy policy and energy-sector development plan combined and consists of the PDP, the EEP, the AEDP, the Oil Plan, and the Gas Plan. All the plans are being revised and updated to reflect changes in the economic-growth projections. The PDP in Thailand is linked to several more detailed thematic plans and Nationally Determined Contribution (NDC) for GHG reduction. The targets under these plans are integrated into the PDP through active interministries coordination.

[206] Climate Analytics 2019, Country Profile Thailand, Decarbonising South and South East Asia.

The Thailand PDP 2018–2037 continued to focus on (i) energy security (supply reliability and fuel diversification), (ii) economy (cost of power generation and EE measures), and (iii) ecology (environmental impacts, particularly CO_2 emission).

The PDP 2018 plan's preparation has given priority to the reliability of power systems in each region. The emphasis of PDP 2018 preparation was on (i) balancing power system (generation, transmission, and distribution), (ii) increasing grid flexibility, (iii) lowering the cost of energy generation, (iv) improving competition on energy generation to improve production efficiency and reduce cost, (v) reducing environmental impact (CO_2 emission), (vi) increasing penetration of RE and EE, (vii) developing a smart grid, and (viii) encouraging stakeholders' participation.

The following sections benchmark and evaluate current power system planning in Thailand against the international best practice of IRP under the seven broad topics. The assessment is based on PDP 2018 with some comparison with PDP 2015, wherever applicable.

1. Load forecasting

Load demand forecasting in Thailand is done using an End-Use and Econometrics model developed by the Faculty of Economics at Thammasat University. The data was disaggregated by the seven regions and types of electricity users: housing groups, business groups, industrial groups, and others. Load demand forecasting was based on the average long-term GDP growth during the year 2017–2037, estimated by the NESDC of 3.8 percent and the average population growth of 0.2 percent. Both GDP and population growths were revised downward compared to PDP 2015 (GDP and population growths of 3.94 and 0.3 percent, respectively).

In PDP 2015 the load demand forecasting had already been strengthened by adding additional parameters such as EVs, high-speed trains, economic corridors, and VSPP, which is being continued in PDP 2018.

EGAT commissioned the International Energy Agency (IEA) to undertake Thailand Grid Renewable Integration Assessment in early 2017, which also assessed the PDP 2015. The study concluded that the set of variables used to forecast demand does not seem to have missed any relevant information, and the method is a reasonable one. However, a comparison of the energy consumption and the peak demand forecast with the observed values shows that both electricity consumption and peak demand forecast tend to be systematically optimistic. The main reasons cited were due to the former planning exercise, a "policy statement" following official economic-growth expectations. Furthermore, there is an idea that overestimating demand is less costly than the opposite, given that underinvestment can result in shortages. Given that assessment, the recommendation is to check the inputs' quality, for instance, the methodology for the GDP forecast. GDP was revised downwards in PDP 2018 demand forecast.

PDP 2018 is expected to significantly reduce reserve margin by applying reliable supply to meet the demand. By 2027, the difference between demand and reliable supply will likely be net "zero." The inherent reserve margin thereafter will, on average, be 17 percent.

Assessment: Thailand uses a combination of top-bottom and bottom-up demand forecasting, and significant progress has been achieved in reducing overestimation. The PDP process in Thailand has been rated "achieved" compared to international practices on IRP.

2. Demand-side management and energy efficiency

Energy efficiency is an integral part of the current PDP and reflects the EEP prepared by EPPO. The energy savings target of EEP (30 percent reduction of energy intensity by 2036 compared to that in 2010 or 89,672 GWh for the power sector) was considered and integrated into PDP 2015 and 2018 of the parameters for demand forecasting. However, the exact methodology of integrating EE in demand forecasting was not explained in the PDP reports.

DEDE provides technical input to EPPO to conduct load forecasting to integrate EE target. Nevertheless, EE's realistic target setting remains a challenge due to relatively current analytical capacity and available information. There is a need to strengthen the monitoring and evaluation of EE targets.

Assessment: Energy efficiency targets set as part of the Energy Efficiency Development Plan (EEDP) is fully integrated into the demand forecasting. The PDP process in Thailand is rated "achieved" for EE compared to international practices on IRP.

3. Scenarios

In PDP 2015, the long-term power demand forecast was developed into two cases as the following:

Business-as-Usual Case: the statistical data of 2013 was used in the model where the energy conservation measures were already implemented. Therefore, by 2036, the estimated energy saving would be 27,282 GWh. As a result, the maximum power demand would reach 59,300 MW or grow at an average rate of 3.5 percent.

Base Case: the measures of energy conservation from the EEP were integrated into the model. Therefore, by 2036, the energy intensity would be reduced from 2010 by 24 percent, accounting for 89,672 GWh of energy saving. The maximum power demand would reach 49,655 MW or grow at an average rate of 2.7 percent, with the power demand saving of 9,543 MW.

Details of scenario assessment are not provided in the PDP 2018; however, it appears PDP 2018 has taken a more deterministic approach, where the above-mentioned energy savings target of EEP was integrated into the model. However, a scenario-based method was applied when formulating EEP. The approach is in-built into the EEP targets and carried over into PDP 2018.

PDP 2018 mentioned the assumptions for RE integration, but it did not provide the details of the scenarios used. PDP 2018 seems to have taken a deterministic approach of integrating the AEDP target to increase the portion of renewable generation from 8 percent at present to 20 percent of the country's electricity requirement by 2036. However, the scenario-based approach was applied when formulating EEDP; hence the approach is in-built in the AEDP targets and carried over into PDP 2018. However, in-depth analysis is needed, and capacity needs to be built to conduct scenario analysis of displacement of a traditional energy source with electricity (e.g., electrification of transport).

The IEA study commissioned by the EGAT conducted a simplified approximation of the capacity credit of wind and solar and an estimate of RE system costs to inform the PDP 2018. However, at that time, 2036 generation scenarios were not available. The analysis was hence based on principles outlined in the PDP 2015, with additional scenarios, where the share of wind and solar capacity was increased compared to 2015. It is understood that IEA 2018, Thailand Grid Renewable Integration Assessment (Preliminary Report) has only been partially used and is expected to be fully integrated into the next iteration of PDP.

Assessment: PDP 2018 applies a deterministic approach. However, a scenario-based method was used when formulating EEDP and AEDP while setting the targets. The targets have been integrated into PDP 2018. However, the analytical capacity to define and analyze scenarios based on the right set of policy

questions needs to be strengthened. The PDP process is rated "moderately achieved" compared to international practices on IRP.

4. Generation expansion plan

The formulation of Thailand PDP 2018 used a multicriteria approach under the three priority areas of energy security, economy, and environment (ecology). Frameworks for new generating capacity allocation and fuel diversification of the PDP 2018 include the following:

i) Balancing power system.

ii) Improving grid stability and flexibility.

iii) Lowering cost energy generation.

iv) Improving competition on energy generation to improve efficiency and reduce cost.

v) Reducing environmental impact (CO_2 emission).

vi) Increasing RE and EE.

vii) Developing a smart grid.

viii) Encouraging stakeholders' participation.

Thailand uses the technology company ABB's STRATEGIST model for generation optimization and uses in-house spreadsheet-based software for short-term planning. STRATEGIST is not suited for short-term analysis and studies requiring a high resolution of operational detail. Because integrating large shares of renewables into the system requires planners to consider the capabilities of the system to ramp up and down and take into account the start-up cost of the plants, a different type of software is recommended to make assessments more suited for the intermittent generation.

Thailand uses LCOE to screen generation expansion candidates, followed by additional analysis to determine the least-cost generation options. System costs for Variable Renewable Energy (VRE) generation must be considered in addition to LCOE to account for the when, where, and how of power generation and the interaction with the electric system. The IEA study indicated VRE deployment results in system savings entailing the avoided fuel cost and a portion of generation capacity and operating & maintenance cost of the reference technologies. They are higher for 'gas turbine combined cycle' than for supercritical coal due to the higher fuel cost per MWh of electricity. However, the system savings reduce in higher RE deployment scenarios due to decreasing capacity credits and increasing overproduction of VRE.

Assessment: Thailand PDP applies multicriteria analysis to prioritize candidate plants based on advanced methodology. The methodology could be further strengthened by using more advanced optimization software suitable for an intermittent generation. The PDP process in Thailand is rated "moderately achieved" for the generation plan.

5. Transmission expansion plan

The transmission plan is built into PDP 2018. However, the cost of transmission is not considered when optimizing the generation mix. IEA study indicates that the existing power system appears to be very

flexible, given that the grid is relatively stable, with advanced transmission equipment and protection schemes. RE generation in Thailand varies by month, but overall it is relatively stable due to different weather patterns in various regions throughout the year. More ambitious solar and wind levels are possible.

System assessment should also include energy storage and EVs as a flexible load. IEA study considered EV and energy storage. IEA study on Grid Renewable Integration Assessment has been only partially used and is expected to be fully integrated into PDP's next iteration.

Assessment: PDP incorporates a transmission plan even though the cost of transmission is not considered when optimizing the generation mix. Separate studies have been conducted on assessing grid flexibility to accommodate RE; however, it has been only partially used and is expected to be fully integrated into PDP's next iteration. The PDP process in Thailand is rated "moderately achieved" for transmission.

6. **Externalities**

The integration of the externalities is probably the weakest link of PDP 2018. There is a strong emphasis on achieving NDC's target on GHG reduction. However, no consideration has been given to environmental issues such as public health and the impact on biodiversity and ecosystems. The social and environmental costs have been left out during the PDP planning process. The only issue being considered was CO_2 emissions concerning climate change.

There is no formal application of SEA and no detailed analysis of any social or environmental issues apart from a specific section on the analysis of and measures to reduce CO_2 levels in the PDP.

SEA pilot projects have been implemented in Thailand, including SEA of a Regional PDP for the Southern Region. However, there is a low level of understanding of SEA among line ministries. There is still a need to advocate for the acceptance and adoption of SEA among these agencies. This has affected the launching of SEA regulations in Thailand, as the government believes that there has to be necessary SEA capacity before launching regulations to yield compliance and satisfactory results.

Assessment: While there is a strong emphasis on GHG reduction, no consideration has been given to other environmental and social externalities while preparing the PDP. There has been no uptake of SEA in PDP yet. The PDP process in Thailand is rated "moderately achieved" for the externalities.

7. **Stakeholder consultations**

Thailand has appreciated the importance of stakeholder participation and seeks comments on the draft PDP 2018. Five rounds of consultations covering four regions were conducted to seek input and opinions from stakeholders. A total of 1,873 people participated in these consultations. PDP reports are disclosed on the EPPO website.

Assessment: PDP preparation in Thailand goes through a robust public consultation process; hence it is rated "achieved" for the consultations.

6.2 PEA

PDP plays a critical role in providing a guideline for the electricity infrastructure development decisions regarding what, where, and when. Overall, all national policies pertinent to power sector development determine the enabling conditions for such choices. Furthermore, institutions, coordination, and the

nature of involvement of relevant stakeholders play a crucial role in the decisions about the development of power infrastructure.

6.2.1 Policy

Thailand has a strong policy foundation for the uptake of the integrated power system planning. A major milestone arrived in 2015 when the five major energy plans were combined into one integrated energy document known as the TIEB 2015–2036. At present, the TIEB serves de facto as the national energy policy and energy sector development plan. The long-term perspective and systematic approach taken in the TIEB could change how energy policy is implemented in Thailand. It could yield the desired results, provided that an effective mechanism for interministerial coordination and an implementation monitoring system is put in place. The TIEB consists of the PDP, the EEP, the AEDP, the Oil Plan, and the Gas Plan, all integrated to systemize the country's energy management.

With the higher volatility of energy-commodity prices, the rising concern over energy security, and the increasingly compelling cases made for renewables, the dynamics shaping the energy policy landscape have rapidly evolved in Thailand. The primary objectives of national energy policies are to enhance the country's energy security by diversifying the energy mix and strengthening the supply of fossil fuels while keeping energy prices affordable and minimizing the adverse impacts of energy production and consumption on the environment and society.

Overall, Thailand's policy objectives for energy-sector development have remained consistent, with a central focus on enhancing the security of the energy supply, which is critically important to national economic and social development. The policies align with the government's Eleventh National Economic and Social Development Plan, 2012–2016, which includes energy security among its core strategies.[207] The policies are executed through the implementation of (i) the PDP, which sets out its plans to increase and diversify its sources of supply, ensuring the security of the supply situation; (ii) the Alternative Energy Development Plan, 2012–2021, which sets out plans to increase the proportion of renewable sources; and (iii) the Energy Efficiency Development Plan, 2011–2030.

The Office of Natural Resources and Environmental Policy and Planning (ONEP) of the MONRE published detailed SEA guidelines in 2006 and encouraged dissemination. Still, to date the implementation of the SEA in strategic planning has been voluntary, and the SEA has not been used in strategic planning except for a few pilot exercises that have had limited impact.

However, there is an ongoing "SEA reform" process led by the Office of the NESDC under the prime minister's directive. The reform process started with clarifying the guidelines and institutional responsibilities for aspects of SEA implementation. NESDC launched an SEA Guideline in January 2020. Similarly, Thailand established a Sub-Committee on SEA under the National Committee for Sustainability. NESDC is a Secretariat of the Sub-Committee. This is being followed by a public awareness and capacity development program and by implementation of an SEA pilot (the details of which have yet to be decided).

The laws and legislation on SEA are being designed to make it a compulsory requirement for strategic planning, with seven sectors identified as priorities for implementation: Energy, Transport, River Basin Development, Urban Planning, Special Development Area Planning, Industrial Real Estate Development,

[207] Government of Thailand. National Economic and Social Development Board. 2011. Eleventh National Economic and Social Development Plan, 2012–2016.

and the planning of Mega Projects.[208] NESDC is working on draft regulations on SEA together with the Prime Minister's Office. This regulation is expected to be submitted to the Committee for Sustainability in early 2021, and subsequently to the Cabinet and the Office of Council of State.

6.2.2 Regulation and Institution

The legal basis for the IRP requirement for power sector development is well established in Thailand through (i) the National Energy Policy Council Act, (ii) the Energy Development and Promotion Act, and (iii) the Energy Conservation Promotion Act. The policy targets established for IRP are also in place and harmonized primarily through TIEB, supported by other RE- and EE-specific plans. The detailed description and analysis of these laws and policies are provided below:[209]

The transition toward IRP in Thailand arose from the enactment of three critical pieces of energy legislation in 1992, namely, the National Energy Policy Council Act, B.E. 2535 (1992), amended by the National Energy Policy Council Act (No. 2), B.E. 2550 (2007) and the National Energy Policy Council Act (No. 3), B.E. 2551 (2008); the Energy Development and Promotion Act, B.E. 2535 (1992); and the Energy Conservation Promotion Act, B.E. 2535 (1992), amended by the Energy Conservation Promotion Act (No. 2), B.E. 2550 (2007). The energy conservation promotion policy and its measures and programs were designed and included in energy plans to coincide with national development plans. Still, implementation lags behind the RE and EE targets as stipulated in the PDP, EEP, and AEDP.[210]

The institutional setup pertinent to PDP is robust in Thailand, led by the high-level National Energy Policy Council (NEPC), chaired by the Prime Minister. Deputy Prime Minister is designated by the Prime Minister as Vice Chairman, giving continuity to centralized planning. The mandate for planning and the roles and responsibilities of different agencies are well defined. The section below outlines the mandate, roles, and responsibilities of agencies involved in power sector development in Thailand.[211]

NEPC is the ultimate authoritative body for reviewing and approving proposals about national energy policy and regulation, energy-sector management and development plans, and strategies. NEPC was established to overcome any institutional fragmentation and ensure smooth coordination among agencies involved in the policy-making and implementation. NEPC plays a central role in promoting integrated energy planning in Thailand.

The responsibility for preparing PDPs lies with the EPPO, but organizations such as the electricity utilities, the regulator, the RE body, and the NESDC are involved through several working groups established for PDP preparation. The EGAT is mainly involved, providing extensive expertise and undertaking much of the detailed modeling and cost analysis in the PDP development. All the organizations, except NESDC, are within the energy sector. Some Thai consultants are used for specialized inputs, if needed, but the PDP is prepared with minimal or no overseas support.

---

[208] ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS.
[209] Adopted from ADB 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS IRENA 2017, Renewable Energy Outlook Thailand.
[210] 2017, Energy Transition in Thailand, Friedrich Ebert Stiftung.
[211] Adopted from 2018, Integrated Resource Planning with Strategic Environmental Assessment in the GMS, ADB and IRENA 2017, Renewable Energy Outlook Thailand.

The EGAT is a primary stakeholder of PDP. It is an SOE managed by the Ministry of Energy, the sole owner of the national transmission grid, responsible for electricity generation, including IPPs and small power producers, transmission network operation, and bulk electricity sales in Thailand.

The DEDE has an increasingly significant role to play in shaping the PDP and its implementation in the context of the growing concerns over the security of energy supply, the climate targets set in the Paris Agreement, and the falling costs of RE technologies over the past five years.

The Energy Regulatory Commission (ERC), established on the foundation of the Energy Industry Act (2007), was designed to function as an independent regulatory agency overseeing energy-sector operations in both the power and natural gas sectors. One of its main tasks is to ensure tariffs are calculated appropriately and transparently, ensure the procurement process is followed, ensure fair competition in the energy marketplaces, and protect energy consumers' interests.

MNRE champions SEA use in strategic planning at both sectoral and provincial levels. The ONEP of MNRE published detailed SEA Guidelines in 2006 and is responsible for its implementation. However, the SEA has yet to be applied in the PDP process. Irrespective of MONRE's increasing interest in engaging at the strategic planning level, its regulatory role has been limited to reviewing project-level EIA. As of now, MONRE exerts no influence on PDP development.

6.2.3 Stakeholders

In addition to the institutions mentioned in the previous section (Regulation and Institution), more PDP stakeholders are summarized below:

Owner of electricity infrastructures. The EGAT is a state enterprise managed by the Ministry of Energy and responsible for electric power generation and transmission and bulk electric energy sales in Thailand. Other notable IPPs include Glow Energy, Energy Absolute, Solar Power Company Ltd., and Ratchaburi Electricity Generating Holding.[212]

EGAT is the primary owner of the electric power infrastructure in Thailand. It holds the most interest and influence in the PDP process and is heavily involved in its development.

Investor. Thai firms and banks have funded or are funding most of the power plants. The state investor includes electricity monopolies like EGAT. EGAT is also investing in the Xayabouri dam in Laos and will purchase 95 percent of its output.[213] Thailand has not turned to MDBs for much aid. However, the latter did finance 2,034 MW of coal-fired generation alongside a small solar, hydropower, and wind generation. The ADB was a primary lender for solar and wind projects. Other notable investors include Italian-Thai Development Company Ltd., a Thai contractor for two projects in Thailand. Also, Power China, a Chinese company that also operates in Cambodia and Laos, has contracted two floating solar power-generation stations.

[212] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Thailand Focus: Q2-2019.
[213] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Thailand Focus: Q2-2019.

Private sector actors also include banks, whose funding is crucial for large infrastructure projects. For instance, four Thai banks (Bangkok Bank, Kasikorn Bank, Krung Thai Bank, and Siam Commercial Bank) have invested in the Xayabouri dam in Laos.[214]

Thai firms and banks have funded most of the power plants in Thailand and exert a lot of influence on the development of PDP.

Development partners. Thailand is less dependent on development partners' support to prepare PDP. However, development partners are still playing a crucial role in shaping power sector development by providing investments and technical support. IRENA and IEA have provided valuable support to integrate RE in the preparation of PDP. The ADB has also provided technical support to promote IRP and SEA, supporting regional cooperation on power trade through GMS RPTCC and providing concessional load to the private sector to invest in RE projects.

Development partners are not involved in PDP development in Thailand except for providing occasional technical advice and inputs. Development partners do not have any influence on PDP preparation in Thailand.

Civil society. In Thailand, CSOs worked with policy research institutes and academics to engage with government agencies to develop RE policies and drew the PDP. In addition, they have requested more transparency from government agencies and use opportunities to provide input into national energy planning and decision-making processes. For example, Jairaj and Seeley found that Thai CSOs influenced the National Solar Policy Initiative. Collaboration between policy research organizations and CSOs succeeded in including very small power producers in the national PDP in 2007. The Thai CSO, namely Healthy Public Policy Foundation (HPPF), has worked with the Thailand Energy Research Institute to include community perspectives in the National Solar Photovoltaic Roadmap. WWF even supported the preparation of Power Development Vision; however, there has been no uptake in the PDP process.[215]

Collaboration between Thai academics, CSOs, private sector representatives, and civil servants helped set out the Thai Solar PV Roadmap Initiative (TSRI) with the objectives of providing the Thai government with recommendations on how to effectively and inclusively pursue more significant solar power development and implement solar policies in the country. The HPPF is involved in the TSRI and brings other CSOs, community leaders, local governments, and media together to discuss critical issues in the roadmap. The HPPF has been working with these stakeholders to conduct research on the development and use of solar energy at the local level and understand its costs and benefits to provide input into Thailand's Solar PV Roadmap.[216]

CSOs are very active in Thailand and have exerted influence in shaping national energy policy, particularly in promoting RE.

Consultancies, academia, and think tanks. EGAT and EPP have a strong in-house technical and modeling capacity, less dependent on external support for technical input. However, some technical inputs have been provided by Thammasat University in the development of the modeling tool. Thai consultants are used for specialized inputs, if needed. Thailand has received technical inputs from leading energy think tanks such as ERIA, IEA, and IRENA in the specialized areas.

---

[214] Wells-Dang 2016, A Political Economy of Environmental Impact Assessment in the Mekong Region.
[215] WWF 2016, GMS Power Sector Vision 2050.
[216] Friedrich Ebert Stiftung 2017, Energy Transition in Thailand.

PDP preparation in Thailand is done mostly in-house by EPPO and EGAT. Academia and think tanks are requested to provide input on specific issues. Consultancies, academia, and think tanks have a limited role in PDP preparation and exert no influence.

6.3 Recommendations for Future Engagement

Thailand probably has the best competence and capacity to apply IRP principles in the preparation of a power sector development plan. This is particularly true concerning the extent to which VRE and EE are integrated into PDP preparation and also the level of coherence between different national policies and development priorities, as reflected in the PDP. There are also gaps in the present situation, including the lack of a formal SEA in the PDP process.

6.3.1 Awareness Raising and Broader Stakeholder Engagement

The current SEA reform process will change this. It will mean that the preparation of the next PDP will, by legal requirement, include an SEA. The implications of the PDP preparation process will need to be worked out concerning the PDP methodology and the development of capacities in the PDP organizations to ensure that the new PDP approach can be implemented without significant delays and increases in costs.

The Activity can work with the stakeholders involved in PDP preparation to increase awareness of the nature and role of SEA in PDP preparation and to develop methodologies to strengthen IRP with SEA capabilities.

One of the clear messages from the review of good international practice is that the power sector's policy and regulatory framework need to be developed in an integrated manner. Issues such as RE, EE, and the transmission system's management should be linked together through a coherent and coordinated set of policies and regulations. While Thailand has adequate technical capacity on several IRP aspects, more integrated and formal uptake requires policy decisions. Several policies are partially in place, such as Decisions on EE and RE. This can lead to uncertainty and confusion for planners and investors, who may be uncertain which regulations apply to power generation and management options.

The key step is to ensure that such policies and regulations cover all aspects of power sector development and management, applying the IRP framework. Countries like the US have successfully adopted such a framework and could serve as a useful learning reference for Thailand. The Activity could help to facilitate learning programs (seminars, study visits) targeting high-level officials. If there is buy-in, the Activity could play a neutral facilitator's role to support such a policy framework's design and uptake.

6.3.2 Technical Capacity

Though a range of social and environmental impacts are taken into account in PDP preparation, there has been no attempt to quantify and, in particular, calculate an economic valuation of these impacts. As such, the core objective of IRP, which is to "internalize the externalities" and develop a full economic costing of different options in the PDP, still needs to be developed in Thailand. The capacities exist within the country but need to be brought into the PDP preparation in a structured and effective manner. Additional capacity needs to be developed in the PDP agencies to ensure that the new approach—PDP with a mandatory integrated SEA—can be implemented.

6.3.3 Data and Knowledge Management and Sharing

Thailand already has several acceptable practices when it comes to PDP. The Activity can help compile those acceptable practices and develop a knowledge product for broader dissemination for neighboring countries' benefits.

Thailand has shown a keen interest in learning from SEA application in Vietnam. The Activity could facilitate such learning by organizing seminars and study visits.

7. VIETNAM

Summary

The energy sector plays a significant role in the continued development of Vietnam, and the demand for modern energy sources like electricity is growing at a faster pace. Access to electricity has also made remarkable progress in Vietnam. The communities that are not yet connected to the grid are mainly in the less developed and sparsely populated mountainous areas of the northwest and isolated islands. Providing universal access to electricity is a top priority of the government.

While having been a net energy exporter for a long time, Vietnam became a net energy importer in 2015 due to a recent increase in domestic activities and a policy limiting coal exports.

Vietnam's energy intensity showed a decreasing trend. This was due to the high electrification growth, which significantly reduced biomass fuels in the residential sector. However, the energy requirement in the industry and the transport sectors increased in recent years.

Vietnam has rich indigenous energy resources, such as coal, oil, natural gas, and water for hydropower generation. Vietnam has substantial oil reserves, the second-largest oil reserves in East Asia, exceeded only by the PRC. Similarly, natural gas production has increased substantially over the past decade and has leveled off in recent years. Coal is Vietnam's largest indigenous resource. However, the country exports its high-quality coal, and lower-quality coal is used in domestic power generation and industries.

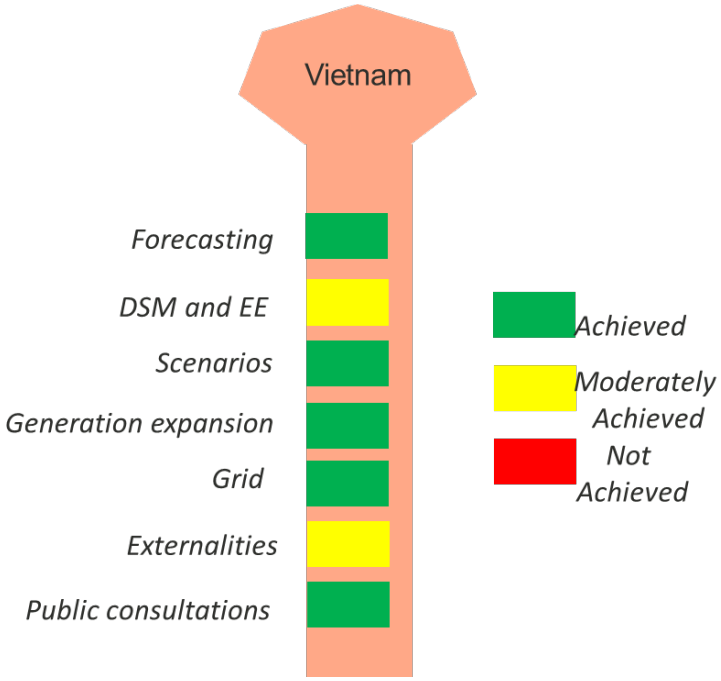
Vietnam has a high potential for RE, including solar, wind, biomass, and waste. Biomass and hydropower have been the main types of RE in Vietnam. Most hydropower resources have already been developed, forcing Vietnam to look for alternative power-generation sources during recent years.

The SEA of the Seventh Power Development Plan (PDP 7) in Vietnam identified thermal power as the primary source of potential social and environmental impacts. These impacts are mainly related to atmospheric pollution.

Vietnam has shown significant progress in the development of an IRP approach embedded in the PDP. The power sector in Vietnam is in the process of significant change, moving away from a traditional reliance on the expansion of power supplies through large-scale thermal or hydropower generation and toward a more diversified approach. Vietnam wants to take advantage of the opportunities that modern developments in EE, nonconventional RE, and cross-border power trade present. This represents a significant departure from the past, when the financial cost was the main determining factor in investment decisions.

The country's hydroelectric potential/reserves are nearly exhausted, coal-mining capacity is reaching the ceiling within the next ten years, and crude oil resources are declining. New gas fields are expected to be exploited only to compensate for existing rapidly declining fields. Therefore, in PDP 8, the expansion of the generation fuel mix will have fewer options, creating a selection problem. Renewable energy sources, imported coal, and imported liquified natural gas (LNG), development of nuclear power plants, and storage batteries must be studied more in depth to develop an optimum PDP.

The figure below summarizes Vietnam's PDP as demarcated and compared against seven constituent parts of IRP to identify each country's capability to achieve integrated PDPs fully.



Vietnam is using a combination of top-bottom and bottom-up approaches for load forecasting. The secondary drivers of demand growth, such as electricity sales by region and sector, have been included in the load forecasting. Furthermore, the country is now subdivided into six regions to improve granularity. There has been an attempt to include EE in load forecasting in Vietnam, which has resulted in a reduction in the demand forecast. The PDP process in Vietnam now applies a comprehensive scenario-based application employing multiple scenarios. The PDP in Vietnam is aggressively pursuing RE in the energy mix, particularly solar and wind, and LNG, with a no-coal option by 2026. It is using compatible models such as BALMOREL and PLEXOS to optimize generation expansion options. The PDP process in Vietnam has in-built measures to include environmental externalities. However, methodological and capacity issues persist in quantifying and monetizing environmental impacts. Extensive consultations support both PDP and SEA of PDP preparation.

Clear policy targets required for IRP are already in place, set by decisions pertinent to strategies and programs such as (i) Renewable Energy Strategy up to 2030, (ii) National Program on economical and efficient use of energy, (iii) Sustainable Development Strategy, (iv) National Target Program to Respond to Climate Change, (v) National Strategy on Climate Change, and (vi) NDC.

The legal basis for IRP for power development already exists to some degree through (i) the Law planning, and (ii) the Law on Electricity. The Law on Environment Protection further emphasizes the requirement for integrated planning.

The PDP process is fast evolving and is increasingly influenced by the growing role of new stakeholders such as private and environmental interest groups. The table below highlights key stakeholders relevant to power development in Thailand, their role/interest, and influence.

	Role/ Interest	***Influence***
Regulators		
Ministry of Industry and Trade	High	High
Ministry of Natural Resources and Environment	Medium	Medium
Owner		
State-owned enterprises (Vietnam Electricity)	High	High
Investors		
Government	High	High
FDI and private sector	High	Medium
Multilateral banks	Medium	Medium
Development partners	Medium	Low
Non-government organizations and civil society	Medium	Low
Consultancies, academia, and think tanks	Medium	Medium

Generally, Vietnamese institutions have a high degree of competence in most aspects of power development planning. Although substantial experience has been gained in applying SEA, which has laid a good foundation for fully integrated resource planning, Vietnam needs greater capacity on IRP and SEA. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Vietnam. Vietnam already has several acceptable practices when it comes to PDP. The Activity can help compile those acceptable practices and develop a knowledge product for broader dissemination in Vietnam and the neighboring countries.

7.1 Approach to Decision-Making

7.1.1 Background

1. <u>Power sector development needs and challenges</u>

The increasing population, a rising appetite for goods and services, rapid urbanization, and rapidly growing economic activities in industrial and service sectors exert increased pressure on Vietnam's energy supplies. For decades Vietnam has been one of the fastest-growing economies in Asia, with a GDP growth rate of above 6 percent per annum.[217] The energy sector plays a significant role in the continued development of Vietnam, and access to affordable and reliable energy will be critical for sustained economic growth.

Demand for modern energy sources like electricity is growing at a faster pace. From 2007 to 2017, Vietnamese total primary energy supply (TPES) grew at 4.7 percent, whereas the average annual growth rate in electricity demand was 12.1 percent during 2005–2014.[218]

Access to electricity has made remarkable progress in Vietnam. The percentage of households without electricity decreased from 50 percent in 1995 to 2 percent in 2014.[219] This has also been one of the drivers for rapid growth in electricity demand in the past. The communities that are not yet connected

[217] Danish Energy Agency 2017, Vietnam Energy Outlook Report 2017.
[218] ADB 2015, Vietnam Energy Sector Assessment.
[219] MOIT 2014. Report on Rural Electrification.

to the grid are mainly in the less developed and sparsely populated mountainous areas of the northwest and isolated islands. Providing universal access to electricity is a top priority of the government.

While having been a net energy exporter for a long time, Vietnam became a net energy importer in 2015 due to a recent increase in domestic activities and a policy limiting coal exports. This trend continued to proliferate, primarily driven by increased coal imports. Vietnam has some cross-border power transmission lines with neighboring countries, such as China, Lao PDR, and Cambodia.[220]

Electricity demand. The 2019 Vietnam Energy Outlook predicts that the required generation capacity would increase from just over 50 GW in 2020 to around 100 GW by 2030. Subsequently, it will rise to between 140 and 180 GW by 2040 and between 170 and 270 GW by 2050. The Outlook report states that "the total annual energy system costs are more than double from 2020 to 2030 as well as from 2030 to 2050." Meeting these investment needs efficiently and sustainably is seen as a core challenge to the government. Future investment will principally come from the private sector.

Electricity supply. The total installed and operating generation capacity in Vietnam was 34.1 GW in 2014. In 2014 the power-generation mix was constituted by hydropower (46.07 percent), gas (21.58 percent), coal (28.64 percent), oil (3.39 percent), and RE (0.32 percent).[221]

Vietnam has achieved excellent progress in its power sector, including a restructured sector, and implemented a competitive market, the private sector's active involvement in power plant development, low system losses, and reformed tariff. Notwithstanding considerable growth, the power sector still needs to continue its development. The critical challenge of Vietnam is the rapid expansion of power infrastructure to cope with increasing load demand and avoid any shortage that can negatively affect economic growth. Furthermore, the power sector also needs investments for upgrading and revamping of aging and congested transmission and distribution networks.

Meeting increasing load demand will require Vietnam to overcome several core issues in the power sector, including (i) poor energy resources management, (ii) lapses in environmental management, (iii) insufficient revenue for financial autonomy, (iv) enhancing EE, and (v) institutional gaps.

1. Energy intensity

From 1990 to 2015, Vietnam's energy intensity showed a decreasing trend. Both primary and final energy intensities of the country decreased from 1,006 toe/million and 905 toe/million 2010 US$ in 1990 to 453 toe/million and 364 toe/million 2010 US$ in 2015. This was due to the high electrification growth, which significantly reduced the use of biomass fuels in the residential sector. However, the energy requirement in the industry and the transport sectors increased in recent years. The final energy intensity under the business-as-usual scenario is estimated to continue to decrease from 364 toe/million to 228 toe/million 2010 US$ by 2040. This decreasing trend indicates that energy will be used more efficiently for economic development.[222]

With the issuance of the Law on Energy Efficiency and Conservation in 2010, many EE activities have been carried out throughout the country, covering different economic sectors, with good progress in applying EE measures for user appliances and partly also in industrial facilities. The effects of EE measures on the demand side will mainly reduce the consumption of fossil fuels like coal and oil products.

---

[220] 2015, ADB 2015, Vietnam Energy Sector Assessment.
[221] Renewable energy includes small hydropower plants below 30 megawatts (MW) of capacity.
[222] ERIA 2019, Energy Outlook and Energy Saving Potential.

The recent Energy Outlook report[223] estimates that there is a potential for a 17 percent reduction in electricity demand by 2030 if effective EE policies, regulations, and programs are put in place.

2. Energy resources

Vietnam has extensive reserves of energy resources such as coal, oil, natural gas, and water for hydropower generation. It has 3,390 million tonnes of proven recoverable reserves of coal, 600 million tonnes of crude oil reserves, and 610 billion cubic meters of gas reserves.[224]

In 2015, the total national primary energy supply was around 70.1 Mtoe. The share of total national primary energy by fuel type was coal (35.9 percent), oil (22.2 percent), gas (14 percent), hydropower (7.8 percent), and others (20.3 percent). Vietnam is a net exporter of crude oil and coal but is an importer of petroleum products because of limited capacity at the Dung Quat oil refinery (6.5 million tonnes a year) that could only meet around 45 percent of domestic demand.[225]

Oil. Vietnam has substantial oil reserves. The currently discovered oil reserves stand at 600 MT of crude oil at the end of 2018, the second-largest oil reserves in East Asia, exceeded only by the PRC.[226] Much of these reserves are located offshore. Domestic demand for petroleum products was 14.4 MT in 2013, catered to by 7.5 MT of imports and 6.6 MT domestic supply from the Dung Quat refinery.[227]

Natural Gas. The proven natural gas reserves of Vietnam are estimated at 610 billion cubic meters (bcm) at the end of 2018. Reserves are almost exclusively offshore. Production in 2018 was 9.6 bcm. Natural gas production has snowballed over the past decade and has leveled off in recent years at about 10 bcm.[228]

Since most of the gas fields in Vietnam are located offshore, an extensive pipeline system is in place to bring gas onshore. The Oil and Gas Master Plan, 2007–2015, with outlook to 2025, envisages gas for generation in southern Vietnam to increase from 8 bcm in 2010 to 21–24 bcm in 2025.[229]

Coal. Coal is Vietnam's largest indigenous resource, with proven reserves estimated to be of the order of 3.3 billion tonnes in 2018.[230] The bulk of this coal is anthracite, concentrated in the northern part of the country. The country exports its high-quality coal, while low-quality coal is used in domestic power generation and industries. The Vietnam National Coal and Mineral Industries Group (Vinacomin) solely owns coal mining, export, and domestic distribution.[231] The government's target is to rapidly increase coal production to 42.6 MT in 2013, 56 MT by 2020, and over 65 MT by 2030.[232]

Renewable energy. Vietnam has a high potential for RE, including solar, wind, biomass, and waste. The RE share in the TPES was 37 percent in 2007. However, this share was gradually reduced to 22 percent in 2017. Biomass and hydropower have been the main types of RE in Vietnam up to now. In 2017,

[223] Danish Energy Agency 2017, Vietnam Energy Outlook Report 2017.
[224] ERIA 2019, Energy Outlook and Energy Saving Potential.
[225] Danish Energy Agency 2017, Vietnam Energy Outlook Report 2017.
[226] BP 2019, BP Statistical Review of World Energy 2019, 68th edition.
[227] ADB 2015, Vietnam Energy Sector Assessment.
[228] BP 2019, BP Statistical Review of World Energy 2019, 68th edition.
[229] ADB 2015, Vietnam Energy Sector Assessment.
[230] BP 2019, BP Statistical Review of World Energy 2019, 68th edition.
[231] ADB 2015, Vietnam Energy Sector Assessment.
[232] Government of Vietnam. 2012. Coal Development Master Plan 2012–2020, with Outlook to 2030.

biomass and hydro accounted for 51 percent and 49 percent of the RE energy mix, respectively, while solar and wind accounted for minimal amounts in TPES.

Hydro. For a long time, the country has been reliant on hydropower and fossil fuels to generate electricity. However, up until 2019, the medium and large hydropower sources (about 20 GW capacity potential) have been almost fully utilized. The small hydropower resource has a total potential of about 6.7 GW, with more than 3 GW already in operation. This has led Vietnam to look for alternative power-generation sources during recent years.[233]

Solar. Vietnam's technical solar potential is about 18 TWh/yr, with more than 60 percent of this attributable to areas with the highest irradiation levels, which are in the country's southern half.[234]

With the Vietnam government pilot FIT rates for projects implemented between June 2017 and June 2019, solar power projects are booming. The country has risen as a regional (Southeast Asia) leader in solar PV power generation. There was only a small amount of solar and wind capacity in operation before 2018, but it was increased enormously in 2019. As of June 2019, 4.5 GW of new projects were connected to the grid. It is expected to increase by 630 MW by the end of 2019.[235] However, this rapid expansion has raised challenges due to grid issues.

The potential for floating solar PV (FPV) farms development on Vietnam's hydropower reservoirs is enormous. Vietnam has over 100 large hydropower schemes. The total area of these schemes' reservoirs is not known in detail for all schemes but can be estimated to be at least 100,000 ha. The most massive scheme is Son La, which alone has a reservoir of over 25,000 ha. Vietnam's first floating solar PV farm on Da Mi Reservoir was connected to the power grid in May 2019.[236]

Wind. Vietnam benefits from the optimal condition to generate wind power along the 3,300 kilometers of coastlines with consistent winds. Vietnam's theoretical wind potential is estimated to be about 26,763 MW, assuming 2,676 km^2 of suitable land area with sufficient wind speeds (> 6 m/s) and an installation density of 10 MW/km^2 (the average installation capacity per km^2).[237] However, technical wind potential is much less than the theoretical possibility, mainly because of system constraints.

There was only a small amount of wind power in operation before 2018, but it reached 0.45 GW in 2019.[238]

Biomass. The annual theoretical potential of biomass energy from the combustion of rice husks, rice straw, corn cobs, cassava stalk, bagasse, and sugarcane trash was estimated to be about 84,875 GWh in 2010. The technical level is much less than this, because of the difficulty in collecting the residues and their inclusion in the grid network.[239] The total technical potential of biomass resources is about 7 GW for power production, while solid waste power is 1.5 GW, of which currently only 0.3 GW is utilized. Lower installed generation capacity is mainly due to low FITs and significant competition for the intake material. The Vietnam government offers only 5.8 US cents per kWh for bagasse-fired plants and 7.4 US

[233] ADB 2015, Vietnam Energy Sector Assessment.
[234] ADB 2015, Renewable energy developments and potential in the GMS.
[235] https://asianinsiders.com/vietnam-bold-ambitions-for-a-greener-future-in-energy-production/
[236] Unpublished EU TAF technical paper.
[237] ADB 2015, Renewable energy developments and potential in the GMS.
[238] https://asianinsiders.com/vietnam-bold-ambitions-for-a-greener-future-in-energy-production/
[239] ADB 2015, Renewable energy developments and potential in the GMS.

cents per kWh for other fuel–fired power plants, making it hard for producers to reach the breakeven point.[240]

3. Environmental concerns

The SEA of the PDP 7 in Vietnam[241] identified thermal power as the primary source of potential social and environmental impacts. These impacts are mainly related to atmospheric pollution, with the emissions of CO_2 and particulate matter increasing more than tenfold during the PDP 7 period up to 2030, while those for SO_2 and NO_x will increase severalfold. The impacts of these atmospheric pollutants would be too high and would affect large sections of the population.

The SEA made a valuation of these impacts, with the cost for the base scenario estimated to be over $11 billion per year by 2030 unless concerted actions were taken to reduce the levels of atmospheric pollutant releases from, in particular, coal-fired power generation. The CO_2 emissions would be by far the highest in terms of the levels of economic externalities. They would represent a significant proportion of Vietnam's total GHG emissions in this period.

The SEA also identified a wide range of other potential impacts from each of the hydropower development proposals, summarized below.

Hydrological impacts. These arise from the dams affecting river flows in the river basins where they would be built. This has both positive and negative impacts, with concerns over sustaining minimum river flows and impacts on water availability for agriculture and other uses balanced by potential reduced flood risks and improved dry season river flows. The reservoirs' management regimes were identified as a key issue, with the potential for substantial positive impacts on agricultural production where a multipurpose management regime was used.

Resettlement. Thousands of families are likely to be resettled or otherwise impacted by dam construction. This would lead to potential impoverishment and substantial social and livelihood impacts. The 21 hydropower schemes would lead to the resettlement of 61,571 people, with this number varying from scheme to scheme. Over 90 percent of the resettled people would be ethnic minorities, among whom poverty incidence was more than double the national average. These communities are dependent on access to natural resources, especially forests, for their livelihoods.

Natural resource impacts. These impacts, especially on forests and on riverine aquatic ecosystems, were identified as high and potentially negative. This would be caused by changes to river flows, direct forest clearance, and the effects of opening up previously remote areas to outside exploitation. It is estimated that the value of the crops from the lost farmland would be around $2.9 million per year, while the total resource value of the forest lost, including environmental service functions, is estimated at $72.4 million.

Biodiversity impacts. These were assessed to be severe in some cases, with the risk of ecosystems fragmentation significant where a high proportion of sensitive biodiversity areas are located close to dam sites. In two cases, the risks of impacts on key ecological areas were assessed to be so severe that the SEA recommended that the development of these schemes should be reconsidered, and the introduction of environmental management plans for other sensitive areas was proposed.

---

[240] https://asianinsiders.com/vietnam-bold-ambitions-for-a-greener-future-in-energy-production/
[241] ADB 2018, Integrating SEA into PDP in Vietnam.

7.1.2 Current Approach

The PDPs are the national-level strategic development plans for power production and utilization in Vietnam. The current law requires PDPs to be prepared every five years, incorporating social and environmental issues.

Vietnam has shown significant progress in the development of an IRP approach embedded in the PDP. The power sector in Vietnam is in the process of significant change, moving away from a traditional reliance on the expansion of power supplies through large-scale thermal or hydropower generation. It is moving toward a more diversified approach that can take advantage of modern developments in EE, nonconventional RE, and cross-border power trade. This represents a significant departure from the past, when the financial cost was the main determining factor in investment decisions.

The final version of the revised PDP 7 included a significant expansion in the development of RE and also included assumptions that EE programs would be a significant factor in reducing future demand from the levels included in earlier predictions. The future expansion of power obtained through cross-border interconnections is less prominent, with the PDP reflecting assumptions that this trade's growth will be limited over the next 15 to 20 years.

The progressive development of the SEA as an integral part of PDP preparation has had significant impacts on the structure and content of the overall PDP process in Vietnam. This has been particularly true with the latest PDP, the PDP 7 revised in 2016. The original PDP 7, finalized in 2012, was not accepted by the Vietnamese government, with the impacts of air pollution from the proposed thermal (especially coal) power stations identified in the SEA, one of the main reasons for government requiring the PDP be revised.

The final approved Revised PDP 7 showed several essential changes from the original 2012 PDP 7. The first is a significant reduction in the overall projected load demand levels and, consequently, anticipated needs for increased generation capacity for 2030. The second is a substantial change to the mix of generation resources in the plan, with the proposed amount of new coal-fired power generation reduced by 30 percent and the amount of non-hydro renewable capacity increasing sevenfold, with this representing an increase from the 3.5 percent of total capacity in the original PDP to nearly 21 percent in the revised plan. These changes mean a reduction in forecast GHG emissions by 100 million tonnes of CO_2 equivalent a year by 2030. In economic value terms, this represents a saving of about $1 billion a year, based on the price of $10 per tonnes of CO_2 equivalent used in the revised PDP 7.

Recently the Electricity and Renewable Energy Agency (EREA) of the Ministry of Industry and Trade (MOIT) suggested fundamental changes to the PDP process that include (i) the PDP to be updated/prepared annually; (ii) the PDP to identify different types and quantities of generic projects necessary for system reliability; (iii) specific projects for development to be identified through an auction system rather than in the plan, and (iv) the acceptance of unsolicited generation projects. MOIT also suggested that the existing regulations (circular) for the PDP should be replaced by a new circular that defines the content, sequence, and procedures for the formulation, evaluation, approval, and adjustments to the PDPs and also a new circular to describe an auctioning process for new generation projects.

Vietnam is formulating the eighth Power Development Plan (PDP 8). Decision no. 1264/QDD-TTg was issued on October 1, 2019, approving the task of preparing the PDP 8. This PDP 8 is expected to differ radically from earlier PDPs, with one of its primary goals being to identify actions needed to create an attractive and stable investment environment for domestic and international private sectors interested in developing transmission lines. The priority is given to (i) development of renewable electricity sources, (ii) economic and efficient use of electricity, and (iii) development of modern and smart grid and interconnection with neighboring countries.

The country's hydroelectric potential/reserves are nearly exhausted, coal mining will reach the ceiling within the next 10 years, and crude oil resources and new gas fields are declining rapidly. The generation portfolio and fuel mix in PDP 8 will have fewer options, creating the selection problem. Renewable energy sources, coal and LNG import, nuclear power options, and storage batteries need more in-depth study.

The sections below benchmark and evaluate current power system planning in Vietnam against the international best practice of IRP under the seven broad topics. The assessment is done based on PDP 7, revised PDP 7, and any information available on the ongoing preparation of PDP 8 and their SEAs.[242]

1. Load forecasting

The load demand forecasts in PDP 7 were based on the analysis of current electric consumption data for each development sector, combined with assumptions on economic growth and savings from EE improvements during the planned period. In response to the criticism of the load demand forecasts of PDP 7 (growth rates, at around 15 percent, were seen as too high), new demand projections were prepared. The preparation of revised PDP 7 resulted in a significant reduction in forecasted load demand during the plan period. These new load demand forecasts included assumptions about enhanced EE measures combined with more realistic growth projections and reduced demand levels in the PDP by over 20 percent by 2030.

For PDP 8, an econometric model is being used in projecting load demand. Load demand projections are being made as a top-down approach, and the country is being subdivided into six regions. GDP and population growth are the key drivers, but secondary drivers are also used in the analysis. The secondary drivers include electricity sales by sector and region.

The main assumption for the load demand forecast includes:

- The growth rate of electricity price is 5 percent to 8 percent in the period 2021–2050.
- Electricity saving will reach 1.5 percent to 4.5 percent in 2021–2050:
    - Rooftop Solar PV: slow growth.
    - Demand response: effect of peak reduction is low.
    - EVs: the penetration is low (based on the scenario of the Ministry of Transportation).

The forecast is being done by developing a typical load curve for the whole country, divided into six areas and by month.

Assessment: The secondary drivers of demand growth, such as electricity sales by region and sector, have been included in the load forecasting. Furthermore, the country is now subdivided into six regions to improve granularity. In Vietnam, the PDP process is rated "achieved" for load forecasting compared to the good international practice of IRP.

2. Demand-side management and energy efficiency

Inadequate treatment of EE programs in load demand projections was one of the contentious issues in the past PDPs. National policies require a greater emphasis on EE.

[242] Unpublished EU Technical Assistance Facility for Sustainable Energy technical working papers.

PDP 8 is developing a systematic approach that incorporates EE in load demand forecasting, taking into consideration the government's EE policy targets (technical targets) and Institute of Energy's (IE's) methodology (econometric analysis) in forecasting electricity demand.

Assessment: There has been an attempt to include EE in load forecasting in Vietnam. Methodological and capacity issues persist when it comes to the full integration of EE in load forecasting. The PDP process in Vietnam is rated "moderately achieved" for EE.

3. Scenarios

The SEA for the original PDP 7 was based on three power supply scenarios (corresponding to low-, medium-, and high-load-demand cases) based on traditional "least cost" criteria, with social and environmental impacts (and, where possible, economic costs) calculated after their preparation. Two of the comments on the original PDP 7 were:

- Issues such as the potential of RE and the potential for more effective EE measures were not sufficiently integrated into the PDP.

- The implications of externalities associated with coal-fired generation were not adequately reflected in the scenarios presented.

The revision of PDP 7 reflected these concerns and included three scenarios: a business-as-usual scenario, an enhanced EE scenario, and an increased expansion of RE scenarios. These scenarios were identified through the original SEA analysis, and therefore the SEA of the revised PDP 7 was more fully integrated into the planning process.

The results of the SEA, including the two SEA scenarios on EE and RE expansion, were instrumental in informing the direction of change that the government would like to take in the revision of PDP 7. These scenarios showed that it was possible to reduce thermal power emissions without compromising the overall plan's viability and, particularly, without resulting in significant increases to the costs of power generation. The government consequently gave clear instructions that the PDP revision should include measures to strengthen EE and increase the proportion of RE in the power-generation mix.

Building on the experience, six scenarios have been identified for PDP 8:

- Base scenario 1: least financial cost assessment of generation options with no optimization of externality costs.
- Base scenario 2: least-cost full economic assessment of generation options that includes, wherever possible, the integration of externality costs into the calculation of the costs of different generation options.
- Renewable energy scenario: the RE-development scenario meets the goals of the national RE strategy (taking into account the cost of land and decommissioning at the end of the project).
- Scenario of increased biomass generation: this is the RE scenario, but the rate of electricity from biomass sources (rubbish, burning with bagasse, other biomass materials) is higher than the target in the RE strategy.
- The GHG scenario without externality costs: this would reduce GHG emissions by 25 percent compared to the normal development scenario as outlined in Vietnam's Nationally Determined Contributions commitment to the Paris climate change agreement.
- Scenario without any new coal-fired power plant: this would entail no new coal-fired thermal development after 2025.

Assessment: The PDP process in Vietnam is now applying comprehensive scenario-based applications employing multiple scenarios. The PDP process in Vietnam is assessed as "achieved" for scenarios.

4. Generation expansion plan

Vietnam's capacity reserve margin (the difference between the installed capacity and annual system peak load) is about 34 percent. However, there is a big difference between the North's reserve margin (more than 40 percent) and the tight situation in the South. This large surplus is probably due to the inflated load demand forecast in the past. This large surplus, coupled with the significant share of hydropower, means that the thermal contribution to peak demand (and variability in generation costs) is relatively small, except during the dry season when hydropower supplies are reduced.[243] PDP 8 is taking a reliability measure instead of a reserve margin. It aims for Loss of Load Expectation of less than 12h/year.

In PDP 7 and RPDP 7, the combination of two models was used for the optimization, which was STRATEGIST (US) and PDPAT II (TEPCO-Japan). The modeling was done by classifying the Vietnamese electricity system into three integrated subsystems.

STRATEGIST is not suited for short-term analysis and studies requiring a low level of operational detail. Since most variable VRE projects (wind and solar) could not be clearly defined in the models, they are inadequate in assessing the impact of variable RE projects on the electricity system's operation.

In PDP 8, IE plans to split the Vietnamese electricity system into six integrated subsystems, which consider the potential areas of high VRE sources, such as the South, Central Coast, and the Central Highlands. IE is also using the new planning model, BALMOREL, and EREA/MOIT to transfer them to the PLEXOS optimal planning model (Australian). These models will support power-generation expansion planning calculations with a high rate of integration of VRE sources.

This is particularly important because Vietnam is planning to scale up the uptake of new RE (FPV and offshore wind) and new storage technologies (pump storage and battery energy storage system). One of the strengths of the BALMOREL model is that it has a flexible spatial and temporal scope. The model's spatial resolution defines three layers of geographic entities: country, region, and area. The geographic distribution of variable RE is being captured at the area level, while the transmission requirements can be defined at the regional level. On the other hand, the temporal resolution defines three layers of time: year, seasons, and terms. The variability of RE production is being captured in both seasonal and term structuring in the model.

Costs considerations include fuel costs, CAPEX, OPEX & Generation Unit Start-up costs by fuel types. These also include land cost and treatment cost of solar panel and storage battery wastes.

Assessment: The PDP in Vietnam is aggressively pursuing RE in the energy mix, particularly solar and wind, and LNG; with the aim of a no-coal option by 2022. It is using compatible models such as BALMOREL and PLEXOS to optimize generation expansion options. The PDP process in Vietnam is assessed as "achieved" for generation expansion.

5. Transmission expansion plan

[243] World Bank. 2017. Pumped Storage Hydroelectric Power Right for Vietnam?

The grid-development program is an integral part of PDP 8. To determine the transmission grid required for high-scale integration of RE, PDP 8 has fragmented the power system into six subsystems, including North, North Central, Middle Central, South Central, Highlands, and the South.

Since the grid has not been able to allow the interconnection of more than 4,500 MW of solar power in 2019, with the largest concentration in the South-Central region, the government has allowed a series of grid projects to solve the congestion problems.

With the expectation that the capacity of variable RE sources will reach at least 10 GW of wind power and 20 GW of solar PV power by 2030, the transmission grid to evacuate VRE sources will undoubtedly be much larger than RPDP 7.

CAPEX, OPEX of transmission grid and loss costs of inter-areas are used as input parameters while optimizing generation-expansion options.

Assessment: The grid development program is an integral part of PDP 8. PDP cost considerations include transmission grid costs. The PDP process in Vietnam is assessed as "achieved" for transmission.

6. **Externalities**

Assessing potential social and environmental impacts of power sector development in a comprehensive but achievable manner has been the core purpose of the SEA of past PDPs. This SEA is a legal requirement in Vietnam.

The calculation of externalities as a part of the SEA of PDPs in Vietnam includes costs for:

- Hydropower
    - Hydrological impacts
    - Resettlement
    - Natural resource
    - Biodiversity
- Thermal power
    - GHG emissions
    - Atmospheric pollutants
    - Public health
- Transmission lines
    - Fragmentation of sensitive ecosystems

Costs and externalities will be estimated for the selected power scenarios.

- Taxes and fees required by the law and regulations:
    - Water resources related to environmental tax/fees/charges
    - Land tax
    - Environmental protection fees for wastewater discharge
    - Payment for forest environmental services
    - Payment for solid waste and hazardous waste collection and treatment
    - Transmission fees
- External costs
    - Cost of damage caused by air pollution (including NO_2, SO_2, $PM_{10/2.5}$)
    - Cost of CO_2 emission

- Costs of loss and reduction of biodiversity/ecosystems (calculated by ecosystem services)
- Cost of recycling and treatment of solar PV panel, if broken, power adapter, battery failure.

The goal of SEA of PDP 8 is to move to a full economic costing of generation options, with externalities integrated into cost calculations, though data and methodological constraints may limit the extent to which some externalities' valuation is possible. The valuation analysis will include an identification of externalities associated with wind and solar energy that were not included in past SEAs.

For more than 10 years, Vietnam has had environmental protection legislation requiring SEA (Vietnamese 2005 Law on Environmental Protection) to be undertaken by line ministries for effective development plans and requiring that these are reviewed and approved by MONRE and the Cabinet. The preparation of regular PDPs in Vietnam followed a well-defined process, and there has been an appropriate level of commitment to incorporating SEA into the more recent PDPs.

The SEA of the original PDP 7 consequently identified a range of potential social and environmental impacts. The likely effects of two primary strategies to reduce the significant impacts from air pollution: strengthened EE and expanded RE through the scenario analysis. The SEA results, particularly the economic assessment of the costs of atmospheric pollution, had an important impact on the debate over the original PDP 7.

The SEA process in the revision of PDP 7 influenced the preparation of the amended plan, leading to the more practical consideration of social and environmental issues in several important areas during plan preparation:

- The analysis in RPDP 7 was based on scenarios that emerged from consideration of issues such as improved EE and an increase in RE that were identified in the original PDP 7 SEA.

- The cost and benefit calculations, more effectively included in RPDP 7, internalizing the valuation of several social and environmental impacts, with these values assessed as part of the SEA process.

The PDP preparation process now fully integrates SEA elements into its structure. Economic valuations of potential impacts identified through the SEA are included in the cost calculations for different power-generation options. However, it is recognized that more needs to be done, with adjustments made to the planning framework and methodologies to ensure that full social and environmental costs, as well as "nontraditional" options such as DSM and RE, are fully integrated into PDP preparation. New national goals and targets in fields such as climate change mitigation, EE, and RE must be fully reflected in the PDP objectives and outcomes. MOIT and IE are fully aware of these challenges and are actively seeking to develop the PDP process to reflect these needs.

The focus of SEA of PDP 8 is (i) the full integration of externality costs into the analysis of power-generation options, which means that the valuation of social and environmental impacts is a central part of the SEA; and (ii) expanding RE throughout the scenarios, which means that the assessment of RE impacts on, in particular, land resources will be a core focus of the SEA and will require a methodology and data sources that are demonstrably credible and that reflect the highest standards of acceptable international practice.

Assessment: The PDP process in Vietnam has comprehensive measures to include environmental externalities. However, methodological and capacity issues persist in quantifying and monetizing environmental impacts. Nevertheless, the progress has been remarkable, particularly during the PDP 8.

The SEA process has evolved and is quite robust. The PDP process in Vietnam is rated "achieved" for the externalities.

7. Stakeholder consultations

In the past, PDP and SEA have been criticized for not having enough consultations built into the preparation process. SEA PDP 8 has been expanded in its scope to include several consultations:

1. During the scoping stage, to review the strategic issues and policy context of the SEA and the PDP, with this consultation in particular, including relevant government agencies and key experts at the national level.
2. During the scenarios and impact assessment, to review the scenarios and the impact assessment scope and methodology. In addition to the national-level stakeholders, this consultation will include representatives from different regions of Vietnam to ensure that these regions' perspectives and priorities are reflected in the analysis and conclusions of the SEA.
3. During the review of the impact assessment results, to include the valuation and internalization of impact externalities. This will be a comprehensive consultation to consider the implications of the SEA findings for the final preparation of the PDP options that are considered feasible for inclusion in the final PDP report.
4. Following the conclusion of PDP preparation, to review the overall SEA. The review will include recommendations on mitigation measures, policy/regulatory development, and the effectiveness of the SEA.

Assessment: Both PDP and SEA of PDP preparation is supported by extensive consultations. The PDP process in Vietnam is rated "achieved" for the consultations.

7.2 PEA

PDP plays a critical role in setting the guidelines/directions for the electricity infrastructure development decisions regarding what, where, and when. The national policies pertinent to power development determine the enabling conditions for such decisions. Furthermore, institutions, coordination, and the nature of relevant stakeholder involvement play a crucial role in the decisions about developing power infrastructure projects.

7.2.1 Policy

Clear policy targets required for IRP are already set by decisions pertinent to several strategies and programs, such as (i) Renewable Energy Strategy up to 2030, (ii) National Program on economic and efficient use of energy, (iii) Sustainable Development Strategy, (iv) National Target Program to Respond to Climate Change, (v) National Strategy on Climate Change, and (vi) NDC.

Furthermore, several decisions have been issued to support different elements of IRP for power sector development in Vietnam.

Vietnam's policy on RE is set out in Decision No. 2068/QD-TTg, approved on November 25, 2015. This sets the framework for the future, the Renewable Energy Strategy up to 2030 with an outlook to 2050. This strategy sets the framework for the future development of RE in Vietnam. It contains several provisions and targets related to both expansions of RE and RE industry development. It sets the target to increase the proportion of RE technologies produced in Vietnam to 30 percent in 2020, 60 percent in 2030, and 100 percent in 2050.

Decision No. 280/QD-TTg, on approval of the National Program on economic and efficient use of energy in the period of 2019–2030, sets the targets for a period up to 2025 and 2039. For the period up to 2025, its sets target to save 5.0 percent to 7.0 percent of the national energy consumption (2019–2025); to reduce power loss to less than 6.5 percent; to reduce the average energy consumption for the industrial sectors (targets were provided for steel, chemical, plastic, cement, textile, beverage, and paper industries), and other quantitative and qualitative targets for other sectors, programs, and EE measures. Similarly, for the period up to 2030, it sets a target to save 8.0 percent to 10.0 percent of the national energy consumption (2019–2030); to reduce power loss to less than 6.0 percent; further reduction targets for industrial subsectors; and other quantitative and qualitative targets for other sectors, programs, and EE measures.

Resolution No. 55-NQ/TW, on the orientation of the National Energy Development Strategy Vietnam to 2030, vision to 2045, sets the target for RE and EE as the following: (i) the proportion of RE sources in the TPES will reach about 15 percent to 20 percent by 2030; 25 percent to 30 percent by 2045, (ii) the rate of energy saving on the total final energy consumption compared to the typical development scenario will be around 7 percent by 2030 and about 14 percent by 2045, and (iii) reduce GHG emissions from energy activities compared to the normal development scenario at 15 percent by 2030, to 20 percent by 2045.

The national development planning framework also necessitates the uptake of an integrated planning approach. Overall national development approaches are defined in the national Socio-Economic Development Plans (SEDPs), which set the key goals and targets for a five-year period. The 2016–2020 SEDP, approved by the National Assembly of Vietnam under Resolution No. 142/2016/QH13 on April 12, 2016, emphasizes the need for modernization and economic restructuring to achieve more balanced and sustainable economic growth, with improved competitiveness, higher efficiency, and enhanced quality of life for all areas of the population. The SEDP also emphasizes the need to improve infrastructure planning quality, including for the power sector, to reflect the overall approach to national development set out in the plan. Reference is made to support improved EE and the development of RE sources "economically, efficiently, and environmentally friendly."

The reform and redirection of approaches to and priorities in the national development plan has resulted in several key policies and strategy documents in recent years, which demands an integrated approach. These include two important strategy documents approved in 2012: (i) Decision No. 432/QD-TTg, approved on April 12, 2012, on the Approval of the Sustainable Development Strategy of Vietnam for the period 2011–2020; and (ii) Decision No. 1393/QD-TTg, approved on the September 25, 2012, the Approval of the National Strategy on Green Growth. These two documents together are seen as defining the overall direction of development that the Government of Vietnam sees as essential for the country's sustainable future.

Several policies and regulatory provisions related to climate change are relevant to the development of an integrated power sector planning system in Vietnam. The government introduced the National Target Program to Respond to Climate Change on December 2, 2008 (Decision 158/2008). This recognized the importance of climate change as a strategic issue for Vietnam: "response to climate change is the responsibility of the whole political system, society, sectors, and organizations at all levels" (Article 1.1).

The National Strategy on Climate Change (Decision 2139/QD-TTg issued on December 5, 2011) recognizes climate change as "one of the biggest challenges" facing the modern world and identifies that Vietnam "is considered as one of the countries most affected by climate change" (Article 1). The Strategy sets out goals and targets that are linked to the overall approach to sustainable development and green growth, "to turn the low-carbon economy and green growth into main orientations for sustainable

development; lower emission and higher absorption of GHGs to become compulsory indicators of socio-economic development" (Article III), with this seen as essential for the development of a modern, high-productivity economy. This includes the power sector provisions on developing RE such as wind, solar, biofuels, and other technologies to constitute 5 percent of total primary energy (not just power output) by 2020 and 11 percent by 2050. The strategy also promotes EE measures and advocates steps to reduce the economy's energy intensity, actions that reflect the overall development strategies' provisions.

2015 NDC sets out GHG reduction targets for the period 2021–2030 that will, if they are realized, reduce GHG emissions by 8 percent by 2030 compared to the business-as-usual scenario based on national contributions, with this rising to 25 percent with international support. The NDC identifies 254 existing Clean Development Mechanism projects, 87.6 percent of which are in the energy sector. The energy sector, and in particular power generation, is also identified as a key sector (along with agriculture in relation to methane emissions) for future GHG mitigation activities in Vietnam. The NDC states that the emission intensity per unit of GDP will reduce by 20 percent over the 2010 level, increasing to 30 percent with international contributions, reflecting goals that have been central to sustainable development and green-growth initiatives of the government.

7.2.2 Regulation and Institution

The legal basis for the required for IRP for power development already exists to some degree through (i) the Law planning and (ii) the Law on Electricity. The Law on Environment Protection further emphasizes the requirement for integrated planning. The detailed description and analysis of these laws and policies are provided below[244]:

The Law on Planning (Law 2017/QH14, passed on December 6, 2017) introduces several fundamental changes to planning processes in Vietnam that will need to be reflected in future power sector planning processes, including those for RE, EE, and cross-border interconnections. It introduces a hierarchy of (i) the overall national master plan, (ii) national sectoral plans, (iii) regional plans, and (iv) provincial plans and requires that all plans "must follow and be instruments to implement the national master plan." This includes explicitly sectoral plans such as those in the energy sector, with these plans expected to reflect overall national development approaches and targets directly. The Law on Planning also stresses the need to ensure coordination between tiers and agencies and include consultations and plan formulation participation.

Sectoral plans are prepared by the designated agency (for power MOIT). They are submitted to the "Plan Appraisal Council" (established by the Prime Minister's Office) for review and, when finalized, to the Prime Minister for approval.

The 2004 Law on Electricity and the 2012 Law Amending and Supplementing Several Articles of the Electricity Law (Law No. 24/2012, approved on November 20, 2012) are the basis for the preparation of PDPs because these provisions set the regulatory framework for planning and operating power-generation and supporting infrastructure and activities. The laws define the scope of and responsibilities for the preparation of PDPs. The MOIT is assigned responsibility for the national plan, and People's Committees at different levels are responsible for implementation plans at decentralized levels. The 2012 law changed the PDP period to cover 10 years, with an orientation for a further 10 years and a revision after five years. It also specifies requirements concerning a range of social and environmental issues to which PDPs must

[244] Adopted from the unpublished EU technical discussion note on Strategic Environment of Power Development Plan 8.

conform. Within this context, the laws refer to the need to include and advance RE and EE, although they do not set specific targets in these areas or clarify how they should be considered. This is included in related legislation and regulations on these particular issues.

The 2014 Law on Environmental Protection, which follows and updates the 2005 law with the same name, includes several articles concerning the energy sector and an overall affirmation that environmental protection should be seen as an integral part of sustainable development. The law prioritizes EE and promotes the development of "green and renewable energy," both for the overall effectiveness of national development and as a means to respond to climate change and reduce GHG emissions. The 2005 Law on Environmental Protection also introduced the requirement that all strategic and sector plans, including PDPs, must include an SEA and is the basis for the development of SEA in the country. The 2014 Law on Environmental Protection reinforced and further detailed these requirements, with Chapter II, Section 2, setting out the principles and procedures for the implementation and review of SEAs within strategic plans.

The institutional setup pertinent to the PDP is quite advanced in Vietnam, given its centralized planning history. The mandate for planning and the roles and responsibilities of different agencies are well defined. The robust mechanism of the inter- and intra-agency is also in place. The section below outlines the mandate, roles, and responsibilities of agencies involved in PDP in Vietnam:[245]

The preparation of the PDP falls under the jurisdiction of the MOIT in Vietnam, which has been assigned by MOIT to the IE, a ministry agency. The management of the energy sector in Vietnam is mainly the responsibility of the MOIT, both as a line ministry and as a ministry with oversight responsibility of state-owned energy enterprises. The laws define the scope of and responsibilities for the preparation of PDPs. The MOIT is assigned responsibility for the national plan, and People's Committees at different levels are responsible for implementation plans at decentralized levels.

In 2012, the MOIT established the General Directorate of Energy (GDE) to better align the MOIT's departmental responsibilities in the energy sector. Its responsibilities include overall energy planning and policy formulation; appraisal of power and energy development plans and local and regional development plans; and management of BOT power projects.

The Electricity Regulatory Authority of Vietnam (ERAV) was set up in 2005 under the MOIT. The responsibilities of the ERAV include developing regulations and directions to implement and regulate competitive power markets; developing technical codes and performance standards for power distribution and transmission, and for monitoring/certifying compliance; monitoring electricity tariff review and tariff setting; issuing reliability criteria for power supply, guiding and monitoring compliance; reviewing load demand forecast, conducting system studies, and recommending measures to achieve supply-demand balance; and monitoring implementation of power projects.

The Energy Efficiency and Conservation Office is a dedicated unit in the MOIT leading the implementation of the Vietnam Energy Efficiency Programs and the EE and conservation laws, decrees, and regulations.

The IE is an energy research and planning institute set up under the MOIT 20 years ago. It conducts research on national energy strategies, policies, and development plans; forecasts future energy demand; prepares project feasibility studies; and identifies new technologies to improve EE and supply. It is also active in developing and promoting RE, and it established the Center for Renewable Energy and Clean Development Mechanisms in 2007. IE serves as a research organization and think tank for the government.

[245] Adopted from ADB 2015, Vietnam Energy Sector Assessment.

The three main state-owned energy enterprises that directly operate and manage the energy sector are the Vietnam Electricity (EVN), the Vietnam Oil and Gas Group (PetroVietnam), and Vinacomin.

In Vietnam, the MONRE combines environment, land, and energy and mining functions, although important aspects of natural resource policy are housed elsewhere. The SEA is to be undertaken by line ministries for significant development plans and reviewed and approved by the MONRE and the Cabinet, respectively. Even though MOIT is responsible for PDP and SEA of PDP, MONRE exerts significant influence in the preparation of SEA of PDP by regulating the preparation and the appraisal process.

7.2.3 Stakeholders

In addition to the institutions mentioned in the previous section (Regulation and Institution), more PDP stakeholders are summarized below:

Owner of electricity infrastructures. The Vietnamese government SOEs led by EVN are responsible for developing electricity projects in Vietnam. Vinacomin, a Vietnamese coal-mining company, owns eight coal-fired power plants. As EVN's self-financing and other sources of debt financing meet only about 66 percent of the total investment requirement, IPPs are expected to carry a large portion of the investment in the power-generation business, including those to be developed by foreign investors. Vietnam Electricity Development JSC is a notable IPP in Vietnam.[246]

The Vietnamese SOEs and EVN exert the most interest and influence in the PDP process. IPPs are also increasing their influence through their growing role in power generation in Vietnam.

Investors. Among bilateral investors, China is the largest financier of existing and planned power-generation projects, primarily through the Export-Import Bank of China. Other Asian bilateral investors include South Korea through its Export-Import Bank, and Japan through the Japan Bank for International Cooperation, and Vietnam self-finances. The EU and the United States have also invested in some coal-fired projects. The ADB is the most active MDB, while the World Bank is also involved in Vietnam.[247]

With the liberalization of the power sector as envisioned in the PDP 8, the bilateral and private sector investors' interest and influence in the PDP are growing, particularly in promoting RE such as wind and solar. It is also noteworthy that the role of the private sector is increasing in promoting LNG power plants.

Development partners. Development partners play a crucial role in shaping power sector development by providing investments and technical support. JICA has been directly supporting the preparation of PDP. The EU supported the preparation of Energy Outlook Report 2019, which will provide crucial input into PDP preparation by providing baseline information. EU is providing technical support for the preparation of the SEA of PDP 8. The ADB has also provided technical support to promote IRP and SEA in Vietnam. The ADB has also supported regional cooperation on power trade through the GMS RPTCC.

[246] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Vietnam Focus: Q2-2019.
[247] Mekong Safeguards 2019, Draft Mekong Safeguards Project Infrastructure Trends in CLMTV, Vietnam Focus: Q2-2019.

Development partners such as the EU and ADB have provided technical support to formulate PDPs and SEA of PDPs strengthening MOIT and IE capacity. With the increased national capacity, development partners' role is gradually decreasing.

Non-governmental organizations and civil society. In Vietnam, civil society is not directly involved in PDP preparation. WWF supported the preparation of the Power Development Vision. However, there has been no uptake in the PDP process. Regardless, several advocacy groups are promoting the sustainable energy agenda in Vietnam. Mekong Network, a leading advocate in the south, linked to Vietnam Rivers Network, has been active on water governance issues. Members of this network led the opposition to the Dong Nai 6/6A dams in 2011 (which would have affected a national park) and are now carrying out community consultations on the effects of the proposed Don Sahong dam. Among Vietnamese NGOs, PanNature (People and Nature Reconciliation) has taken an interest in regional EIA issues, initiating a Mekong Resource Forum on Vietnamese investment in Laos and Cambodia.[248]

The role of NGOs and civil society in PDP formulation is minimal except for attending a few consultation workshops.

Consultancies, academia, and think tanks. Perhaps the most distinctive feature of PDP and SEA in Vietnam has been professional associations and retired officials' roles. These technical experts are active members and are also involved in PDP, SEA, and EIA appraisal committees, set by MOIT or MONRE when required.

Retired technical experts and academic faculties are heavily involved in PDP formulation, mostly in advisory roles.

7.3 Recommendations for Future Engagement

Generally, Vietnamese institutions have a high degree of competence in most aspects of power system planning. For more than ten years, Vietnam has had environmental protection legislation requiring SEA to be undertaken by line ministries for major development plans, which further build their understanding about externalities, value them, and integrate them into the PDP. The production of regular PDPs in Vietnam followed a firm structure, and there has been an adequate level of commitment to incorporating SEA into the more recent PDPs. Although substantial experience has been gained in applying SEA, which has laid a good foundation for full IRP, Vietnam needs greater capacity on IRP and SEA. The Activity could play a vital role in developing the required technical capacity, knowledge base, and enabling policy environment in Vietnam.

One crucial issue that is apparent as PDP 8 is completed is that strategic planning in the power sector needs to develop as a continuous process with the regular updating of the overall PDP proposals. The appraisal of specific investment proposals as they emerge should ensure that they meet the standards and policy objectives set out in the PDP. This need for a continuous strategic planning process reflects the speed of change in power-generation technologies' economics and technical specifications (especially RE). It also demonstrates the evolution of the organization of Vietnam's power sector, with in the future private sector investments likely to dominate, in part based on auctioning or similar systems where the details of proposal sites and technical specifications are not known. The nature of the SEA needs to evolve to reflect this changing planning process. The methods and parameters developed during the assignment will play an essential role in this process.

[248] Wells-Dang 2016, A Political Economy of Environmental Impact Assessment in the Mekong Region.

7.3.1 Awareness Raising and Broader Stakeholder Engagement

While Vietnam has functional technical capacity on several IRP aspects, more integrated and formal uptake requires policy decisions. Several policies are partially in place, such as Decisions on EE and RE. This can lead to uncertainty and confusion for planners and investors who may be uncertain which regulations apply to power-generation and management options. Consequently, one key step is to ensure that such policies and regulations cover all aspects of power sector development and management, applying the IRP framework. Countries like the US have successfully adopted such a framework and could serve as a useful learning reference for Vietnam. The Activity could help to facilitate learning programs (seminars, study visits) targeting high-level officials. If there is buy-in, the Activity could play a neutral facilitator's role to support the design and uptake of such a policy framework. This will require constructive engagement with the government and building trust.

7.3.2 Technical Capacity

Vietnam is generally moving toward the direction of full IRP for the PDP. This is mainly due to a high level of technical capacity to understand and appreciate the principles, importance, and IRP methodologies. Capacity building is required for screening and to use suitable models for the expansion planning process. However, there are still several areas where the capacity building must fully include IRP for Vietnam's power system planning. National policies and the outcomes of the SEA point toward a greater emphasis on RE and EE. This is challenging, as experience, information, and models for planning RE and EE effectively need to be significantly strengthened, given their very different characteristics to the more traditional power-generation options that have been the main focus of PDPs. There is, in particular, a need to develop appropriate normative cost figures for (i) RE options such as wind and solar that reflect Vietnamese resource potentials and conditions; and (ii) the costs and likely effectiveness of EE programs and national targets in reducing future demand growth. There is also a need to ensure that the models used in the preparation of the PDP are ones that are effective in considering RE and EE options. There are some concerns over this, but the existing models used by Vietnam's IEMSP could support the following technical capacity-building activities by conducting in-depth training on specialized areas. The following are some of the identified areas:

- Bottom-up load forecasting integrating EE; however, this is dependent on the availability of disaggregated data. Generating and maintaining such data will require sustained support to develop a robust information management system.

- Power system planning–specific application of strategic environmental assessment, particularly in evaluating environmental and social externalities of different energy generation options.

7.3.3 Data and Knowledge Management and Sharing

Like Thailand, Vietnam already has several acceptable practices when it comes to PDP. The Activity can help compile those acceptable practices and develop a knowledge product for broader dissemination in Vietnam and the neighboring countries. Moreover, Vietnam can serve as a good SEA application practice, which could be shared with the other countries in the region. The Activity could help develop knowledge products based on good practices emerging from Vietnam practices and disseminate it widely in the Mekong countries. Similarly, the Activity could organize regional knowledge-sharing experience to share knowledge emerging from countries like Thailand and Vietnam.

8. REGIONAL OVERVIEW

Summary Results

8.1 Approach to Decision-Making

8.1.1 Background

1. <u>Power sector development needs</u>

CLMTV countries (Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam) share common energy security and environmental management concerns. While Lao PDR and Myanmar have extensive hydropower resources under development, the five countries continue to depend heavily on fossil fuels. Firewood and charcoal will continue to be primary energy sources in rural areas throughout the region for several years, which runs counter to sustainable and inclusive growth and the need to reduce GHGs and deforestation. In addition, the growing reliance on energy imports makes these countries more vulnerable to external supply shocks. Doubling or tripling in energy consumption is expected for these countries over the next 15 to 20 years, further compounding the problem. Governments will have to improve EE and diversify energy mix to meet increasing energy demand.

CLMTV countries have experienced dynamic economic growth over the past few decades and a substantial trade increase with the rest of the world. The key drivers of energy demand are visible: population growth, economic development, industrialization, urbanization, and lifestyle change. The share of industrial output in the GDP has grown remarkably since 1990.[249]

Reliable supply of affordable energy at adequate quality is fundamental to all the socio-economic achievements. Demand for power across the CLMTV countries has risen strongly for several decades, driven by increasing electricity use in all sectors.

The growth rates of energy production and consumption have been high in CLMTV countries compared with the world. However, the level of self-sufficiency of the CLMTV countries has not improved. There are variations among the nations: Cambodia is almost totally dependent on imports; Myanmar and Lao PDR have a high level of self-sufficiency; Vietnam is well placed, but the ratio is falling; self-sufficiency in Thailand is deteriorating rapidly.

In line with energy demand, electricity demand is also increasing across the CLMTV, and this trend will continue, requiring extensive expansion of the power systems. Behind this common characteristic of rapid and sustained growth lies a great deal of diversity. Cambodia has a relatively small electricity system. Electricity import, mainly from Lao PDR, Thailand, and Vietnam, is a significant contributor to electricity supply in the border areas. New hydro and coal-fired plants have been added in recent years, driving a rapid increase in electricity generation. In Lao PDR, hydropower is a dominant source of power generation. The power system in Myanmar is relatively underdeveloped, and only a small proportion of the population has access to electricity. The increasing future demand is expected to be met mainly by additional hydropower and coal, to a lesser extent. Until recently, Thailand's power system was the largest in the Lower Mekong Basin; the majority are gas-fired combined-cycle plants, substantial coal, and

[249] ADB 2016, GMS Energy Sector Assessment.

lignite-fired plants; and hydropower supply are in Lao PDR. Most future plants will be gas-fired, with large hydropower imports from neighboring countries. The installed capacity in Vietnam recently surpassed that of Thailand. The current system is composed mainly of hydropower plants along with coal-fired plants and gas combined-cycle plants. The current growth rate of demand has been high, and the government expects to meet this demand with natural gas and RE such as wind and solar.

The key sector issue is to ensure adequate and affordable supplies with negative impacts on the environment and society. The security of supply is a growing concern, particularly in Thailand, where there is widespread opposition to the greater use of coal and lignite. The development plan places a heavy emphasis on imported natural gas. Vietnam faces similar problems. Most countries are vulnerable to interruptions in crude oil and product supply and price because local production is minimal. They have little influence over producers and supply chains.

2. **Power trade**

The power systems in the CLMTV countries show certain common traits and considerable differences, which is thought to justify power trade in the region. Thailand expects to rely heavily on imported gas. Vietnam, too, seems to be committed to increasing the use of gas, displacing coal substantially. Lao PDR and Myanmar have relatively low demands and potential surpluses of hydropower. Therefore, there will be significant gains in interconnecting these national electricity systems to take advantage of this diversity. Interconnected systems can enable power exchange to achieve reduced system-wide cost by utilizing rich hydropower resources in the region and increased energy security to manage shortages during dry seasons and from interruptions to imported coal and gas supplies.

Before 1992, the region's only significant power transmission links were 115 kiloVolt (kV) lines. Double circuit and single circuit lines brought power to northeast Thailand from the Nam Ngum 1 Hydropower Plant commissioned in 1971. Another single circuit 115 kV line connected Lao PDR's southern grid to the Thai system to transfer power from the Xeset hydropower plant. Low-voltage lines connected parts of central Lao PDR with the Thai system and joined Lao PDR with contiguous Cambodia parts to distribute power to remote border regions. Over the past two decades, however, ten major high-voltage (220 kV and above) power interconnection lines have been built and operated.[250]

As a result, power trade in the region flows as follows:[251]

(i) Cambodia has been importing from Lao PDR (south) since 2010, Thailand since 2009, and Vietnam (south) since 2008.

(ii) Lao PDR (north) has been importing from Thailand since the late 1990s and the Yunnan Province since 2009.

(iii) Thailand has been importing from Lao PDR since 1971.

(iv) Vietnam (north) has been importing from the Yunnan Province since 2004.

[250] ADB 2016, GMS Energy Sector Assessment.
[251] ADB 2016, GMS Energy Sector Assessment.

(v) The Yunnan Province has been importing from Myanmar since 2008.

In 2010, the main trades were between the PRC and Vietnam and between Lao PDR and Thailand. However, there is a fall in the PRC–Vietnam trade, whereas the Lao PDR–Thailand trade has become dominant.

3. Environmental concerns

This significant expansion in the power sector in the CLMTV countries will bring added environmental and social pressures, resulting from the impacts of individual plants and the cumulative impacts of several power plants around major cities or along the river systems. For example, an SEA of mainstream dams on the Mekong River published in 2010 by the MRC concluded that the construction of one or more of the hydropower schemes could have profound implications for the sustainable development of the basin and irreversibly affect the lives and livelihoods of millions of people in all four Lower Mekong Basin countries.

While many impacts can be mitigated (e.g., reducing air pollutants), residual impacts cannot be managed so easily, such as losses to biodiversity. The scale of impacts and the management of the mitigation measures demand that greater attention should be paid to incorporating greater sustainability into the power planning process.

Increased use of RE can reduce dependence on imported fuels, lower carbon dioxide emissions, and increase distributed grid development options in remote areas (in contrast to a centralized, large-scale power system). Improved EE and DSM can lower power demand by shifting and flattening peak loads, thereby increasing energy savings. The SEA to assess the sustainability of the proposed regional power development and regional trade in electricity in the GMS illustrated that the RE and EE alternatives perform better from pollution, climate, food, and health and safety perspectives compared to business-as-usual PDP. This is expected because the RE and EE alternatives reduced the number of coal-fired plants, which all have lower performance in air and water pollution, GHG emissions, agricultural land take, and possible effects on people's health within the vicinity of coal-fired plants.

Despite the potential of RE and EE, however, their use in the CLMTV has been limited, due in part to the limitations of the conventional PDP process, the technical features of the modeling software, and lack of pertinent data to incorporate technical characteristics of distributed generation and DSM measures.

8.1.2 Current Approach

1. National approach

All CLMTV countries have power system development plans, but the detail and the quality are very variable. Myanmar has only recently started preparing PDP. Cambodia and Lao PDR published their PDPs with little indication of the underlying assumptions and power development planning process. Thailand has regularly updated a detailed PDP. Vietnam has a periodic power development planning process and includes a reasonably thorough assessment.

Energy efficiency. Performance across the CLMTV in EE is variable. Thailand has engaged with EE programs since 1992, supporting the law, fund, and voluntary standards. Similarly, Vietnam is now initiating a comprehensive approach with a new direction, demanding more aggressive EE targets and better implementation. In general, enforcement appears to remain a challenge; regulations on audits, reporting,

and standards require enforcement, which is administratively demanding. For the other countries, there is only minimal effort, with isolated projects primarily driven by donor engagement.

Renewable energy: In most countries, RE commitment is modest except in Thailand and Vietnam. There is a long history of promoting RE in Thailand, a substantial planning effort with stretch targets, and a series of interventions that partially support the intent. Vietnam is investing in grid-connected wind farms and planning to expand to solar power development. In Cambodia and Lao PDR, RE is mainly seen as a possible component of off-grid electrification, and there is little attempt to incorporate large volumes into the national grid supply. Myanmar is considering RE both for off-grid electrification and grid-connected power generation.

SEA: Over the past decade, SEA has emerged as an increasingly important planning tool in the CLMTV. With the Vietnamese 2005 Law on Environmental Protection, integrating an SEA as an integral part of national plans for all sectors— including PDPs—became a mandatory requirement. ADB supported the first SEA of power in Vietnam, the SEA of the Hydropower Master Plan, within PDP 6, which was prepared after PDP 6 was finalized and approved. This SEA was considered successful and, drawing from lessons learned, provided a basis for preparing the SEA for PDP 7, where it was included as part of the plan preparation. This SEA identified air pollution externalities from the proposed coal-fired generation as the most considerable possible impact. Vietnam is currently undertaking the SEA of PDP 8.

Other countries have also shown a great interest in promoting the uptake of SEA and are instituting required legal frameworks. Including an SEA in preparing strategic plans is a legal requirement, or soon will be, in all CLMTV countries.

- Cambodia. The draft Environment and Natural Resources Code 2017 makes SEA a requirement for strategic planning in many sectors, including the power sector.

- Lao People's Democratic Republic. The Environmental Protection Law (revised, 2013) requires that SEAs are conducted while policies, strategic plans, and programs are being developed, particularly for energy and mining.

- Myanmar. The Environmental Conservation Law 2012 refers to SEAs in strategic planning. The Environmental Impact Assessment Procedure 2015 states that an SEA may be required for strategic plans if deemed necessary.

- Thailand. In 2018, the Prime Minister initiated the development of new SEA guidelines and regulations under the National Economic and Social Development Board remit.

- Vietnam. The requirement to conduct an SEA in strategic planning was included in the Law on Environmental Protection 2005 and reaffirmed in the law's update in 2014.

2. Regional approach

ASEAN.[252] At the regional level, the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016–2025 Phase I: 2016–2020, with the theme of "Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All," serves as a blueprint and

[252] ASEAN Plan of Action for Energy Cooperation (APAEC) (aseanenergy.org)

pathways for ASEAN Energy Cooperation. The APAEC Phase I: 2016–2020 consists of seven program areas, namely (i) ASEAN Power Grid (APG), (ii) Trans ASEAN Gas Pipeline (TAGP), (iii) coal and clean coal technology , (iv) EEC, (v) RE, (vi) regional energy policy and planning, and (vii) civilian nuclear energy.

The APAEC is a series of guiding policy documents to support multilateral energy cooperation to advance regional interconnection and connectivity goals in ASEAN. It serves as a blueprint for better cooperation toward enhancing energy security, accessibility, affordability, and sustainability under the ASEAN Economic Community framework for the designated period.

The APAEC 2016–2025 has been developed by building on the progressive achievements of the previous plans. With the theme of "Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All," the plan will implement the outcome-based strategies and action plans through the seven program areas. Over ten years, the plan will be implemented in two phases. Phase I: 2016–2020 will focus on the short- to medium-term strategies required to achieve energy security cooperation and move toward greater connectivity and integration.

The APG, a component of APAEC, is an ambitious project that aims to interconnect the power systems in the region. It is a road to multilateral power trade that enables the integration of renewables. It aims to:

- Ensure regional security by promoting effective utilization and resource sharing for common regional benefit.
- Facilitate cross-border electricity trading (reliable, efficient, and economical operations) and effective utilization of resources across geographical locations.
- Enable the integration of a higher share of variable RE sources in the ASEAN power system, with a target of 23 percent RE share by 2025).

Heads of ASEAN Power Utilities/Authorities (HAPUA) has been conducting a systematic study titled "The ASEAN Interconnection Master Plan Study (AIMS)" as the basis for this regional planning and development on the APG. The first study (AIMS I) was completed in 2003, and the second study (AIMS II) was completed in 2010. These studies proposed a comprehensive plan of the regional transmission network that links ASEAN power systems. AIMS III is being developed for identifying new APG opportunities.

GMS.[253] Another relevant regional framework is the RPTCC. Since 2014, ADB has supported GMS power cooperation through two regional technical assistance projects: (i) Harmonizing the GMS Power Systems to Facilitate Regional Power Trade and (ii) Integrated Resource Planning with Strategic Environmental Assessment for Sustainable Power Sector Development in the GMS.

RPTCC, with the support of ADB, is preparing the GMS Grid Code and GMS Regional Master Plan Study. The GMS Regional Master Plan Study will develop a regional generation and transmission master plan for the GMS region for the period of 2022–2035.

- Determine the potential cross-border power transmission options based on generation and transmission master plan scenarios.

[253] https://www.greatermekong.org/rptcc

- Identify and rank most economically and technically feasible transmission upgrades and corresponding generation development.

The long-term generation plan will be developed based on load demand projections and availability of resources based on respective country PDPs. Hence, parameters (e.g., EE, RE, optimization of energy mix) pertinent to the preparation of national PDPs will be carried over to prepare the regional master plan. However, the plan will be prepared based on several scenarios of cross-border grid connectivity.

- Base case scenario: In this scenario all the existing and under construction cross-border transmission interconnections are considered. Different generation dispatch levels are considered to derive wet and dry seasons in each scenario.

- Scenario 2: All the planned and proposed cross-border transmission interconnections are included. Both dry and wet scenarios are considered.

- Scenario 3: After analyzing the results of Scenario 2, the capacities of the proposed transmission lines with low utilization factors are neglected.

    - China: Laos interconnection only 1,000 MW (out of 3,000 MW) is considered (only the first stage).

    - Vietnam Center (Pliek Ku): Laos South (Hat Xan) 880 MW interconnection is not considered.

    - China: Vietnam North 3,000 MW interconnection is not considered. Both dry and wet seasons are considered.

- Scenario 4: After analyzing the results of Scenarios 2 and 3, capacities of the highly utilized transmission interconnections are increased.

It should be noted that national PDPs continue to consider imports and exports, though reliance on imports is decreasing due to conflicting objectives and priorities. New bilateral contracts continue to be planned and negotiated:

- 2,400 MW hydro/thermal export from Lao PDR to Cambodia by 2024/25 and increased export from Vietnam to Cambodia from 200 MW to 250 MW this year.

- Exports from Lao PDR to Vietnam and an MOU to increase to 5,000 MW by 2030.

One of the entry points in the GMS to influence the infrastructure investment is the RIF. RIF 2022 is the medium-term pipeline of priority projects in the GMS. It is a consolidation and expansion of the earlier Regional Investment Framework 2013–2022 and the Revised Regional Investment Framework Implementation Plan 2014–2020. It continues to operationalize the GMS Program's strategic thrusts and priorities under the GMS Strategic Framework 2012–2022 and the Hanoi Action Plan 2018–2022, which reviewed and refined these strategies. The RIF's current investment is driven by the establishment of the Regional Power Coordination Committee, which could build on the ongoing work in the subregion on harmonization and standardization and move regional trade in the sector to the next level. In addition, three new projects that are proposed for addition to the pipeline are mainly driven by investments in hydropower in Lao PDR. There is a unique opportunity to ensure better environmental and social safeguards in the energy sector, engaging through the RIF process.

Externalities and SEA. While ADB is supporting capacity building on IRP, the approach is not being applied to updating the regional master plan, nor is there a plan to conduct an SEA. However, SEA has emerged as an increasingly important planning tool in the GMS over the past decade. One of the earliest SEAs focusing on the development of large energy developments—specifically for large hydropower projects and, coincidentally, in the GMS—was undertaken by the MRC, initiated in 2009, for the MRC Basin Development Plan. ADB has been promoting applying SEA to the preparation of PDPs. It did this in the GMS, where it was actively supporting regional energy cooperation.

Under the framework of Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the Greater Mekong Subregion, ADB supported the study, which focuses on sustainability and policy-making, into PDPs. Specifically, the study incorporates SEA into the PDPs in the GMS to arrive at an optimal power development trajectory for the GMS.

8.2 Regional Collaboration Framework and Stakeholders

ASEAN:[254] HAPUA is the most significant electricity organization in Southeast Asia. Its objective is to promote cooperation among its members to strengthen regional energy security through interconnection development, enhance private sector participation, encourage standardization of equipment, promote joint project development, cooperate in human resources, research and development, and improve quality and reliability of electricity supply system. HAPUA consists of several working groups:

- HAPUA Working Group No. 1 – Generation & Renewable Energy
- HAPUA Working Group No. 2 – Transmission / APG
- HAPUA Working Group No. 3 – Distribution and Power Reliability & Quality
- HAPUA Working Group No. 4 – Policy Studies & Commercial Development
- HAPUA Working Group No. 5 – Human Resources

Its current focus is to support the ASEAN Economic Community through ASEAN energy market integration by successfully implementing the APG as HAPUA is assigned, based on MOU of APG. APG is the essential element of energy connectivity.

ASEAN Power Grid Consultative Committee (APGCC) is an organized body under HAPUA. It was established in 2007 to strengthen and promote a broad framework for member countries to cooperate toward developing a common ASEAN policy on power interconnection and trade, and ultimately toward the realization of the APG to help ensure greater regional energy security and sustainability based on mutual benefit.

Its focus is to enhance cooperation to execute the development of 16 interconnection projects with 27 links. Thirteen links have been operating with a total capacity of 5.212 MW. The current activity of

[254] http://hapua.org/main/hapua/about/

APGCC is to prepare the ASEAN Electricity Exchange, where the Multilateral Electricity Trading happens among the ASEAN member countries.

APGCC consists of the chairman and vice chairman, members (governments and utility representatives), alternate members, and chairman of HAPUA Working Group No. 1, 2, 4, and 5.

Key dialogue partners of HAPUA include Japan, Korea, China, Australia, US, Russia, ASEAN Secretariat, ASEAN Center for Energy, IEA, ERIA, and ASEAN Energy Market Integration.

The USAID Clean Power Asia Programme is supporting AIMS III development.

GMS:[255] The RPTCC manages regional power trade in the Greater Mekong Subregion and provides recommendations on overall policy in this area. An intergovernmental agreement on Regional Power Trade in the GMS was signed at the First GMS Summit on December 3, 2002. The intergovernmental agreement confirmed the GMS member countries' commitment to advance power trade and harmonize the development of their power systems based on the principles of cooperation, gradualism, and environmental sustainability. It also established an RPTCC with the specific responsibility to elaborate on the rules that should govern regional trade in electricity. The RPTCC has since met one to two times a year. Organizing meetings rotates among the member states. It also facilitates the exchange of information on energy-sector plans and projects. RPTCC comprises officials from the energy departments and ministries of the six countries in the subregion. ADB has been providing technical, financial, and secretariate support to the RPTCC. Agence Française de Développement (AFD), JICA, and the World Bank are other key development partners of RPTCC.

A significant decision was made in December 2013 when all GMS countries signed the intergovernmental MOU for the establishment of the Regional Power Coordination Center (RPCC) to synchronize power system operation and harmonize the regulatory framework, which will be governed by RPTCC. However, RPCC has yet to be operationalized.

8.3 Recommendations for Future Engagement

Strengthening regional cooperation in the region has galvanized several new infrastructure investment vehicles such as the ASEAN Infrastructure Fund, GMS RIF, Belt and Road Initiative, the Lancang-Mekong Cooperation Mechanism, and the ACMECS Infrastructure Fund. Similarly, regional collaboration, strategic planning, and investment decision frameworks are also rapidly evolving in the region, associated with some of these financing vehicles. ASEAN and GMS are probably most advanced in charting the clear strategic framework, road map, and institutional and governance mechanism. Others are comparatively new and are still in the process of establishing the required institutional mechanism.

While initiatives were supported by several development partners to generate knowledge and information, the underlining institutional framework and capacity to govern the regional framework and intervention remains weak. Nevertheless, platforms like ASEAN and GMS provide an opportunity to raise awareness of high-level officials, engage in policy dialogue to harmonize standards and procedures, and facilitate knowledge exchange. GMS RIF also offers a chance to anticipate and engage in infrastructure-related investment decisions. The Activity should actively engage with these platforms

[255] https://www.greatermekong.org/rptcc

and facilitate development partners' coordination and collaboration on knowledge generation and sharing activities. The knowledge product generated from the Activity could be presented and showcased during the high-level official meetings of ASEAN and GMS.

ANNEXES

Meeting Notes

Meeting Notes	
Date	July 21, 2020
Subject	**Integrated resource planning and Power Development Plan Thailand**
Author	Sumit Pokhrel
Attendees	Dr. Veerapat Kiatfuengfoo, Director, Power Policy Division, Energy Policy and Planning Office, Ministry of Energy Piyachatr Pradubraj, Senior Program Officer, The Asia Foundation Sumit Pokhrel, External Consultant, The Asia Foundation
	The objective of the meeting was to seek input into the Activity's ongoing analysis on integrated planning and decision support in the energy sector in Thailand. This analysis will systematically analyze and evaluate the PDP. PDP 2018 has been submitted to the cabinet and is awaiting approval. PDP 2018 is significantly different than the previous PDP (2015), mainly in two aspects. • PDP 2018 has divided the grid system into several regions to improve planning granularity. • Potential for RE is considered for each region, which includes community power plants. • Reserve margin has been significantly reduced by applying the concept of reliable supply to meet the demand. By 2027, it is expected that the difference between demand and reliable supply will be net "zero." The inherent reserve margin thereafter will on average be 17 percent. • Import from Lao PDR and other neighboring countries are considered. • NDC target on CO_2 emission is integrated. • Targets from other five plans under TIEB are fully integrated. Load forecasting is based on econometric model. General consideration of energy use by EVs and use of battery. Demand-supply optimization is done using the STRATEGIST model. Some end-use models are being applied based on Excel sheets.

	Integration of social and environmental externalities (pollution, public health impact, loss of ecosystems and biodiversity) remains the area that needs improvement. IEA 2018, Thailand Grid Renewable Integration Assessment (Preliminary Report), has only been partially used and is expected to be fully integrated in the next iteration of PDP. New load forecasting is being considered for the next iteration of PDP.
Next Action Steps	The TAF will share the draft of the assessment report for EPPO's input once it is ready.

Meeting Notes	
Date	September 9, 2020
Subject	**IRP and Power Development Plan Thailand**
Author	Sumit Pokhrel
Attendees	Dr. Sarat Prakobchat, Director, Division of Energy Regulation and Conservation, DEDE, Ministry of Energy Dr. Pongpan Varasayan, Senior Professional Engineer, Division of Energy Regulation and Conservation, DEDE, Ministry of Energy Mr. Thiti Ratchadatikun, Plan and Policy Analyst, Division of Planning, DEDE, Ministry of Energy Several other participants (approximately 10 total) Sumit Pokhrel, External Consultant, The Asia Foundation
	The meeting's objective was to seek input into the Activity's ongoing analysis on integrated planning and decision support in the energy sector in Thailand. This analysis will systematically analyze and evaluate the PDP. Revision to Alternative Energy Development Plan (AEDP) is ongoing but yet to be submitted to the cabinet. All the plans under TIEB are being revised due to change in economic-growth projections due to COVID pandemic. The new minister has assumed the responsibility. Energy policies are likely to change, which will have implications on the planning. Several plans: TIEB is fragmenting planning, and there is a need to consolidate. Timing and sequencing of plans also needs to be revisited. As of now, PDP comes first, followed by others, whereas it should have been the other way around. Demonstration of economic and financial viability is the major constraint when it comes to promotion of RE and EE. Data and information are the key constrains to robust economic analysis of environmental externalities. Interested in learning from Vietnam experience. DEDE provides technical input to EPPO to conduct load forecasting to integrate EE. Realistic target setting is a challenge based on current analytical capacity and available information.

	There is a need for monitoring and evaluation of EE and RE targets. Scenario analysis is an integral part of AEDP. In-depth analysis is needed and capacity needs to be built to conduct scenario analysis of displacement of traditional source of energy with electricity (e.g., electrification of transport). Coordination among different agencies involved in planning is important. Other important stakeholders include: • Energy Regulatory Commission • Federation of Thai Industries, Institute of Industrial Energy
Next Action Steps	The Asia Foundation will share the draft of the assessment report for EPPO's input once it is ready.

Meeting Notes	
Date	August 25, 2020
Subject	**Integrated resource planning and Power Development Plan Thailand**
Author	Sumit Pokhrel
Attendees	Pradeep Tharakan, Principal Energy Specialist (Climate Change) and Unit Head, Sovereign Energy Operations (GMS) Asian Development Bank Sumit Pokhrel, External Consultant, The Asia Foundation
	The meeting's objective was to seek input into the Activity's ongoing analysis on integrated planning and decision support

	in the energy sector in the Mekong countries. This analysis will systematically analyze and evaluate the PDP. ADB promotes IRP in the GMS and is currently undertaking a diagnostic study. One of the most successful IRP models in PDP is Vietnam, where ADB has provided support since around 2006 through GMS Core Environment Program. ADB is supporting Cambodia to prepare its PDP. However, integration of principles of IRP has remained a challenge due to a lack of political willingness. ADB is planning to support Myanmar to develop its PDP in 2020. Myanmar is more receptive to innovation in planning and there are great opportunities to support IRP integration in the PDP jointly. The Activity could potentially develop pilot case studies on the application of IRP in one or two states.
Next Action Steps	The Asia Foundation will share its workplan with ADB once it is ready and explore opportunities to collaborate.