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Integrative Strategy and Policies for Promoting Appropriate Renewable Energy Technologies in Lower Mekong Basin Region

With Special Focus on Viet Nam

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Preface

Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam, which are located in the Lower Mekong Basin Region (LMBR) with great potential and opportunity for co-operation, have achieved remarkable achievements in economic development. Exploitation of renewable energy (RE) sources is seen as one of the best ways to facilitate economic growth in a low carbon way, ensure energy security with focus on indigenous resources and benefits to public health, and improve the economy of rural areas. This report assess strategy and policies for the RE development of LMBR countries and analyse the social, economic, and environmental benefits derived from RE development for Viet Nam. In the case of Viet Nam, five technologies–solar photovoltaic (PV), biogas, wind, small hydro, and biomass– were evaluated and found to meet 14.1 percent of power generation potential by 2040. Moreover, the RE technologies used for power generation is estimated to reduce GHG emissions ranging from 9.5 million to 175.2 million tonnes CO_2e, based on the level of technology deployment. To achieve the RE development target at national level, new market based instruments and a regional cooperation framework that facilitate cross-border projects are proposed.

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List of Abbreviations

AAGR	average annual growth rate
AEDP	Alternative Energy Development Plan
AHP	Analytic Hierarchy Process
APS	Alternative Policy Scenario
ASEAN	Association of Southeast Asian Nations
BAU	business as usual
CO_2	carbon dioxide
EdL	Electricité du Laos
ERC	Energy Regulatory Commission
ERIA	Economic Research Institute for ASEAN and East Asia
EU	European Union
EVN	Electricity of Viet Nam
FIP	feed-in premium
FIT	feed-in tariff
GDP	gross domestic product
GHG	greenhouse gas
GWh	gigawatt-hour
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
ktoe	kilotonne of oil equivalent
kW	kilowatt
kWh	kilowatt-hour
LEAP	Long-range Energy Alternatives Planning
LMBR	Lower Mekong Basin Region
MCA	multi-criteria analysis
MCF	maximum capacity factor
MOEP	Ministry of Electric Power
MONRE	Ministry of Natural Resources and Environment

MOIT	Ministry of Industry and Trade
Mtoe	million tonne of oil equivalent
MSW	municipal solid waste
MW	megawatt
MWp	megawatt peak
O&M	operations and maintenance
PDP	Power Development Plan
PV	solar photovoltaic
PVPS	Photovoltaoic Power Systems Programs
RE	renewable energy
RET	renewable energy tecnology
RESPPS	Renewable Energy Small Power Projects
RPS	Renewable Portfolio Standard
SHP	small hydropower
SHS	solar home system
toe	tonne of oil equivalent
T&D	Transmission and distribution
US$	United States dollar

Executive Summary

Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam, which are located in the Lower Mekong Basin Region (LMBR) with great potential and opportunity for co-operation, have achieved remarkable achievements in economic development in recent years. With their rapid economic growth and having implemented the rural electrification programme, their electricity demand also rapidly increased. Exploitation of renewable energy (RE) sources is seen as one of the best ways to facilitate economic growth in a less carbon-intensive way, ensure energy security with focus on indigenous resources and benefits to public health, and improve the economy of rural areas through electrification. Hence, the Energy Research Institute Network (ERIN) Research Project on 'Integrative Strategy and Policies for the Promotion of Appropriate Renewable Energy Technologies in Lower Mekong Basin Region' was implemented by a Working Group of the five represented countries in the region, with expertise and financial assistance from the Economic Research Institute for ASEAN and East Asia (ERIA).

This study aims to (i) set up the strategy and policies for the RE development of LMBR countries; (ii) assess and select the prioritised RE technologies; and (iii) identify the social, economic, and environmental benefits derived from RE development.

Among the five LMBR countries, Thailand is the most advanced in promoting private sector investment in RE resources. Experiences in policy application, success stories, weak points, and lessons learnt from Thailand were analysed and shared among the five countries. Cambodia, Lao PDR, Myanmar, and Viet Nam are still in their initial steps in RE deployment, therefore, these countries focused on the analysis, evaluation, and selection of suitable policy instruments for developing RE technologies in their respective countries. Effective RE policy instruments in advanced countries, such as some European countries, the United States, Japan, and other Association of Southeast Asian Nations (ASEAN) member countries were also evaluated and considered if these can be applied in the LMBR.

The prioritised RE technologies were selected based on the major criteria of their potential for greenhouse gas (GHG) reduction and their abatement costs, and each government's priorities and benefits to the economy, society, and environment. Calculations of the cost–benefit for each RE technology were undertaken and outputs of calculations were used as a base for the selection of prioritised RE technologies and appropriate future installed capacity of each RE technology in the region.

Due to the similarity in economic condition and the existing exploitation status of RE sources, yet with limited input data for modelling, cost–benefit calculations for each RE technology and the impacts of RE technologies on low-carbon and sustainable development were carried out for Viet Nam as a case study during the first year.

In this study, the Long-range Energy Alternatives Planning (LEAP) model was used to develop a baseline scenario or business as usual (BAU) scenario to outline future energy demand for the period 2013–2040 based on gross domestic product (GDP) and population projections, changes in technology, and existing policies. Emission factors for each technology and fuel type were selected based on the values identified by the IPCC (available in LEAP).

The Alternative Policy Scenarios (APSs) were further developed based on the accessible potential of all types of RE sources, assuming that additional action plans or policies would be developed or likely to be under consideration. The differences between the BAU and APSs represent the additional RE consumption and potential fossil energy savings as well as potential GHG reduction.

In the case of Viet Nam, five RE technologies–solar photovoltaic (PV), biogas, wind, small hydro, and biomass– were considered and evaluated in APSs for power generation, which achieved the share of RE at 12.7% of total power generation output by 2030 and 14.1% by 2040. Moreover, the RE technologies used for power generation lead to reduced GHG emissions ranging from 9.5 million to 175.2 million tonnes CO_2.eq. Similarly, the incremental costs vary from US$-1.73 trillion to US$1.61 trillion.

In this study, a Co-Benefits Approach based on Multi-Criteria Analysis (MCA) method was used to evaluate the prioritised technology options based on criteria that reflect the country's RE development priorities, GHG emission reduction potential, as well as environmental, social, and economic benefits. Selection results for prioritised RE technologies showed that wind power is the first prioritised range with the highest score, followed by solar PV. Both technologies could get high scores on environmental benefits and country's development priorities. Biomass and small hydropower are the third and fourth prioritised range because these technologies got high scores on GHG emission reduction potential. Biogas power got the lowest score due to its low potential on GHG emission reduction and low economic benefits.

The study used analytical framework to identify the barriers for RE deployment. The analysis showed that the main barriers for achieving the target of RE development of 14% by 2040 include (i) limited access to capital; (ii) limited attractiveness to financiers because of indirect subsidies to power production from natural gas and coal; (iii) limited and unattractive feed-in tariffs for RE power generation; (iv) limited understanding of RE technologies at the local level; (v) cumbersome requirements for establishing plans for RE development; (vi) weakly developed supply chains, and (vii) lack of energy service provision, operation, and maintenance of RE equipment.

To achieve the above RE development target, strategies and action plans were proposed to address existing barriers. The RE policy instruments applied effectively in other countries were reviewed and analysed in order to propose the appropriate effective policies for supporting these action plans.

Finally, the strengthened subregional cooperation was proposed by undertaking cross-border RE projects to reduce the costs of developing RE technologies and make the energy future of the subregion more stable and secure.

Chapter 1

Introduction

1.1. Introduction

Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam are neighbouring countries located in the Lower Mekong Basin Region (LMBR), an area with great potential and opportunity for co-operation and development of renewable energy (RE).

In recent years, LMBR countries have achieved remarkable progress in economic development. Together with rapid economic growth and implementation of rural electrification, electricity demand has rapidly increased. In the next decade, electricity demand in the region is expected to continue increasing at a high rate due to economic growth. The use of fossil fuels is not only associated with environmental and health impacts, but the consumption of petroleum and import dependence also greatly impact national budgets, trade balances, and household incomes. Exploitation of RE sources is one option for these countries to meet the expected increase in electricity demand, the desire to have energy security, and to enhance economic competitiveness. Although research and promotion of RE technologies occurred over the previous decades, these were not on a large scale.

Compared to other countries in the region, Thailand has made impressive progress with RE development. At present, alternative energy sources (solar, wind, biofuel, biogas, and mini hydropower) account for only 12% of Thailand's overall energy use, and the government is targeting an increase to 25% by 2021. The main policy and regulatory framework for reaching this target is the Alternative Energy Development Plan (AEDP), announced in 2012. The projected quadrupling of installed alternative energy capacity over the period up to 2021 is expected to derive from dramatic advances in solar and wind power, a doubling in biomass energy, and a multiple-fold increase in mini hydropower. The main support for renewable energies in Thailand is the feed-in tariff premium, differentiated according to technology, capacity, and location. Other mechanisms that support RE investment in Thailand are financial incentives in the form of grants and low-interest loans, fiscal incentives in the form of exemption from import duties, and personal income tax and corporate income tax provisions.

Viet Nam is endowed with RE resources such as hydropower, biomass, wind energy, geothermal energy, and solar energy. So far, these RE sources have not been widely used due to the lack of specific policy initiatives and the absence of a supportive institutional framework.

Viet Nam has ambitious targets for the development of RE technologies. These are described in the National Master Plan for Power Development, which covers the period 2011–2020, with the vision extended through 2030—also called the Power Development Plan VII. The share of RE in electricity generation is expected to grow from 3.5% in 2010 to 6.5% in 2020, 6.9% in 2025 and 10.7% in 2030. The targets are defined for four RE sources: wind, solar, biomass, and small hydropower.

A feed-in tariff (FIT) for wind power was approved by the Prime Minister's Decision No. 37/2011/QD-TTG in 2011. The fixed price of 7.8 US cents per kilowatt-hour (kWh) is offered for a grid-connected onshore wind project. However, compared to countries in the region and the world, the support price of wind power in Viet Nam is too low and is not attractive to national and international investors.

The other supporting mechanism for grid-connected biomass cogeneration and solid waste power projects were also approved in 2014, which regulated the fixed price at 5.8 US cents/kWh for biomass cogeneration, 10.05 US cents/kWh for incineration technology, and 7.28 US cents/kWh for burial of solid waste. Many additional incentives have been provided by the government to encourage investment in RE. These include, but are not limited to, import duty exemption, incentive rate for corporate income, exemption or reduction of land use fee/rental, and others.

The RE Development Strategy in the Lao PDR (approved in 2011) defined the required capacity to achieve 30% share of RE share in 2025. This is the most ambitious target in the Mekong region. However, large hydro is not included in this target; only installed capacity and generation for small hydropower are specified. In 2011, the total installed capacity of the Lao PDR is 2,566 megawatts (MW). This is installed and operational for both domestic consumption and export, of which 1,987 MW is used for the export market to Thailand and Viet Nam (ADB, 2013). The installed capacity of RE sources is around 28MW. To date, there are no action plans or support measures to achieve this target.

Myanmar has significant RE potential, however, to date, little of the country's solar, wind, and biomass energy potential has been exploited. The focus has been on hydropower investments. Total installed renewable capacity is about 150MW. The Ministry of Energy is targeting an additional 472MW of RE by 2015, which represents 15% of current installed capacity. At present, there are no specific RE incentives. However, the government has recently announced a new foreign investment law that offers foreign investment incentives that include tax exemption, income tax relief, and targeted customs duties for the importation of machinery and equipment, which could be applied for RE promotion.

The development of RE in Cambodia, compared to other countries, is still limited to a demonstration project. Financial incentives for RE development are not yet in place. Some investment incentives under the Investment Law (1994) are available, such as tax exemption and import duty exemption. Cambodia does not have a specific RE development target, but it has the 'Master Plan Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia' that is linked to the electrification programme to achieve the full electrification of villages by 2020, and 70% household electrification by 2030. One of the main components of this electrification programme is the development of RE (solar, wind, mini and micro hydro, biogas, and biomass) and financial resources are mainly from foreign countries in the form of donation or grant. Access to finance is considered one of the main barriers to the development and implementation of RE in Cambodia (ACE, 2013).

In summary, Thailand has achieved early success in RE power development, mainly by relying on important support measures that include subsidies and FITs. However, this measure of success is based on RE capacity expansion and does not necessarily capture other indicators, including energy security, innovation, job creation, and environmental impact mitigation (ICEM, 2014). Moreover, an integrated strategy with set priorities for RE technologies to be achieved is still lacking. In the case of Thailand, these additional considerations could be used as lessons learnt, to be shared and to help advance the development and use of green energy throughout the region.

1.2. Objectives of the Study

This study aims to set up the strategy and policies for RE development in LMBR countries; to assess and select the prioritised RE technologies; and to identify the social, economic, and environmental benefits from implementing RE development.

1.3. Scope of the Study

This study will focus on RE technologies for power generation in the countries of Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam. The assessment and selection of priority RE technologies was carried out for Viet Nam as a case study for application to other countries in the region later.

The assessment uses data from the energy sector with 2013 as the base year for business as usual (BAU) scenario; and projects energy demand and GHG emissions up to 2040 to establish a foundation for the selection of priority RE technologies, and for setting up the strategy and policies for RE development.

Chapter 2

Regional Context and Literature Review

1.4. Global and Regional Outlook for Renewable Energy

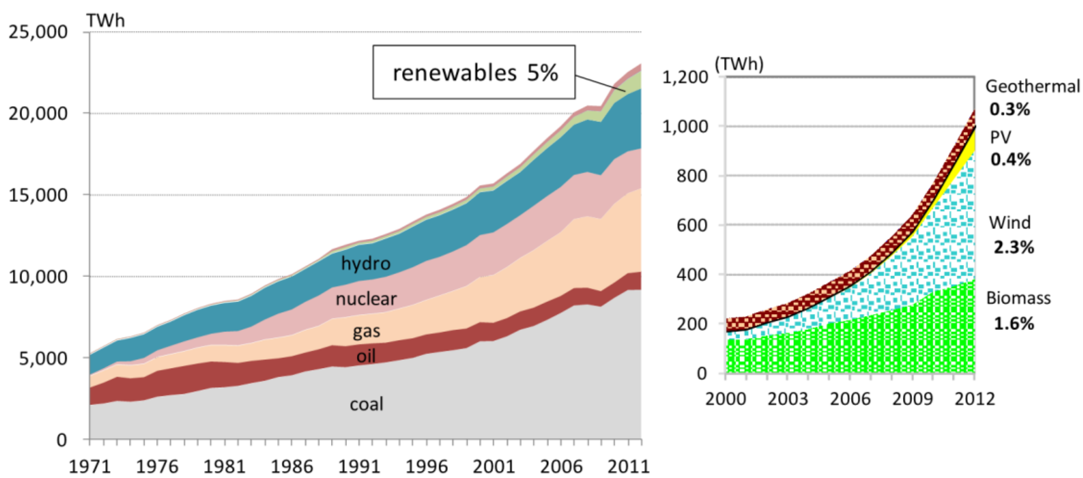
The deployment of renewable energy (RE) is widely considered as one of the major plank for increasing energy access, providing energy security, and reducing carbon emissions. The vast array of RE technologies that are being considered today includes (i) energy technologies using energy sources such as solar and wind, which have substantial variability within a day; (ii) mini hydropower options with storage capacity that are dispatchable but having seasonal variations in generation; (iii) biomass and waste-to-energy power generation operations that are typically available at the community level; and (iv) geothermal options that can be typically dispatched.

Significant progress has been made in the past two decades in improving the performance and efficiency and in reducing the cost of renewables. For example, among the developing countries in East Asia Summit region, China and India account for 2%–3% of renewables in overall electricity generation. In the Association of Southeast Asian Nations (ASEAN), if all types of hydros were included, the contribution of RE accounts for about 15%.

1.4.1. Current status and outlook of RE power generation

In recent years, the volume of wind and solar photovoltaic (PV) power generation is increasing. However, the share of RE (wind power, PV, biomass, and geothermal) in global electric power generation is still around 5% in 2012 (IEA, 2014).

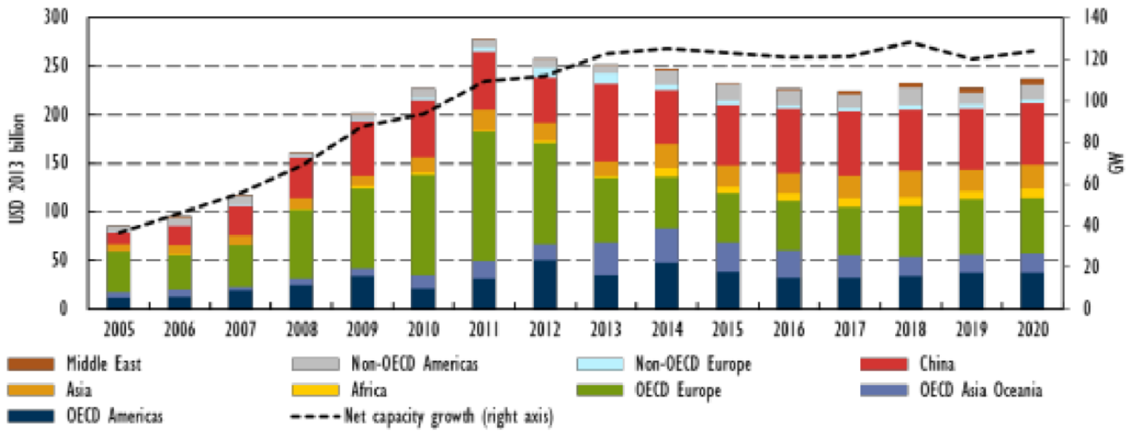
Figure 1: Global Transition in the Electric Power Generation



Source: International Energy Agency (2014).

According to the International Energy Agency (IEA), global investment in RE has declined after peaking in 2011. After leading the RE investment in the past, the decline is particularly prominent in Europe. Accordingly, various countries and regions, including Asia, may have a larger share of investment in RE in the future. However, the steady implementation of RE policies is critically important to maintain a high level of investment.

Figure 2: Record and Prospect of Investment in Renewable Energy



OECD = Organisation for Economic Co-operation and Development.
Source: International Energy Agency (2014), Medium-Term Renewable Energy Market Report.

1.4.2. Transition in promotion measures for RE

RE policies adopted can be roughly divided into FIT (in Europe) and Renewable Portfolio Standard (RPS) (in the United States [US]). In Europe, abolition or review of FIT is currently in progress. In Japan, RPS was introduced in 2003, which was then replaced by FIT in 2012. In the Republic of Korea, FIT was first adopted in 2003 and implemented through 2011, and then replaced by RPS in 2012. In California, US, the RPS has been implemented since 2002. To be described later, Europe is reviewing preferential treatment policies under the current FIT, and is in the process of pursuing a new direction for RE promotion aimed at enhancing the linkage with the power market.

Two methods are used to calculate the amount of RE electricity supplied. One is to include all the power generated from RE sources; the other measures only the excess amount after subtracting the self-consumed electric power. In Europe, the former method (all RE generation) is the main method while in the US, surplus feed-in or net metering has been implemented in 43 states.[1]

[1] Database of US Energy Administration, State Incentives for Renewables and Efficiency, as of September 2014.

Table 1: Transition in Renewable Energy Policy at Main Countries and Regions

	1998 1999 2000 2001 2002 2003 ~ 2010 2011 2012 2013 2014 2015	Current RE (%)	Target/Plan (%)
Japan	RPS → FIT	10.7	203,021+
Korea	FIT → RPS	3.7	202,210
California, US	RPS	20.9	202,033+
Spain	FIT/FIP → Retromeasure active	29.6	202,040
Germany	FIT → FIT/FIP	22.9	202,035
United Kingdom	RO → CfD	11.4	202,031
European Union	EU Directive (FIT driven) EU Guideline Competitive bidding		

CfD = Contract for Difference, FIT = feed-in tariff, FIP = feed-in premium, RE = renewable energy, RO = Renewable Obligation, RPS = renewable portfolio standard.

Source: The Institute of Energy Economics (IEEJ).

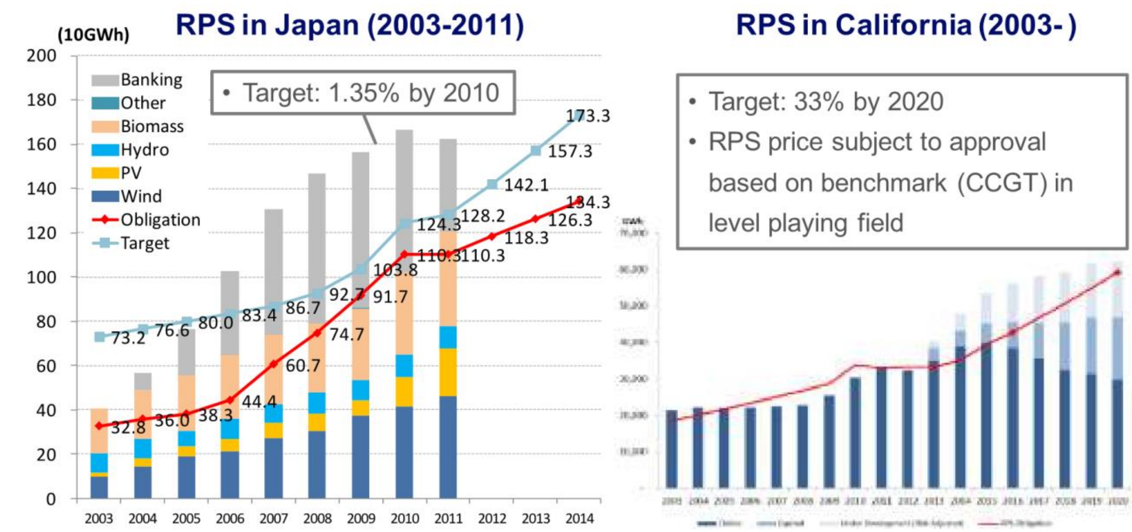
2.1.3. Implementation cases

Looking at the cases of actual implementation, the system and outcome of measures, such as RPS and FIT, vary broadly. For instance, on introducing RPS in Japan (2003–2012), the initial implementation target (overall target: ‘national usage target’) was specified to be 12.2 billion kWh in 2010 (approximately 1.35% of the electricity sales). However, in the second year after implementation, i.e. in FY2005, it was found that the procured amount, including banking (carry over) from the previous fiscal year exceeded the total of the obligatory amount (amount required to each company: ‘standard usage amount’)[2] by about 50%. Since then, the RPS power procured by the obliged companies have constantly surpassed the standard usage amount as well as the national usage target and the obliged companies kept carrying over the surplus from one year to another. Even with this continuous situation of oversupply, aspects of the RE power purchase agreement (such as price, purchase term, and others) were left for the market to decide; as a result, investment in RE was dampened. On the contrary, the state government of California established a target to supply 33% of the net system energy demand with RE by 2020, and specified an allocation per company accordingly to this target. The state government also adjusted the system by, for example, examining the procurement price of RPS and giving a certain level of advantage to RE by reflecting the global warming countermeasure cost.

[2] The RPS adopted in Japan stipulated that the obligatory amount (standard use) imposed onto the target business operators shall be adjusted based on the performance of each company to avoid sharp increase in burden. To that end, while the total of standard use did not match the implementation target, the gap between the two was to be filled gradually.

On FIT, the government, in some countries such as Japan, have set a fixed tariff each year. In other countries, such as Spain, generators are given the option to choose between a fixed tariff and a premium added to the market price of power. Despite the differences in the design of the FIT system, as with these examples, the introduction of RE or solar power in particular, rapidly progressed in countries that adopted FIT.

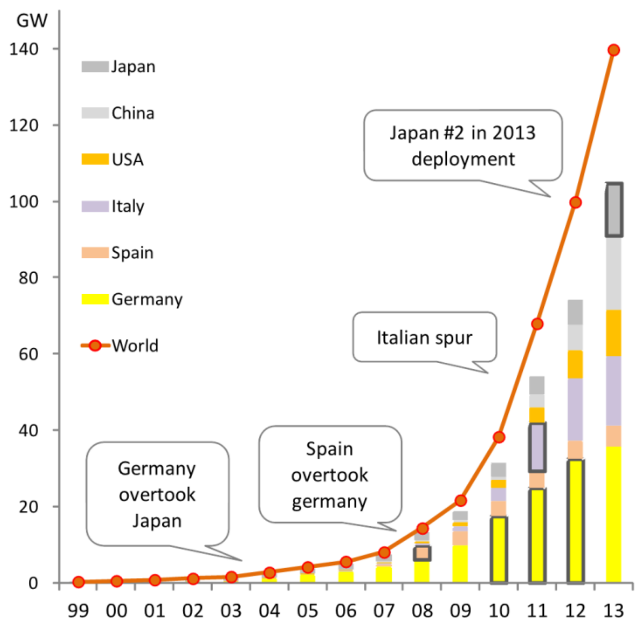
Figure 3: Renewable Portfolio Standard in Japan and California



CCGT = combined cycle gas turbine, GWh = gigawatt-hour, PV = solar photovoltaic, RPS = Renewable Portfolio Standard.

Source: The Institute of Energy Economics (IEEJ).

Figure 4: Development of the Solar Power Plant Capacity in the World



GW = gigawatts.

Source: The Institute of Energy Economics (IEEJ), based on the 2015 data of IEA PVPS (International Energy Agency-Photovoltaic Power Systems Programme).

2.1.4. Common issues

Some issues that surfaced for RE policies centred on RPS and FIT. For RPS, the key is to create demand that encourages the promotion of investment and market competition in RE (target setting). Political initiatives that enable such target setting are important. It is important to recognisethat the market price of power with a policy based onthe RPS is determined by negotiations among relevant parties or market trading, which can contribute to uncertainty over the return on investment and associated risk premiums. As a result, these increase the cost of implementation.

For FIT, where the priority is placed on the certainty of investment, there is a possibility that the subsidy level is too high. In situations where the cost of RE generation has fallen, it may be politically difficult to reduce the tariff to reflect the cost decline, due to vested interests. In the system of FIT, the purchase cost is often passed onto users. However, as has happened in Japan and Germany, passing on such cost (surcharge) sharply increases the electricity tariff along with the expansion of RE power generation purchased under the FIT.

The search for new methods of promoting the use of RE started mainly in Europe. Europe has long promoted the liberalisation of the power market, and, recently, there were criticisms that RE promotion measures based on FIT have distorted the market. For example, the profitability of conventional thermal power plants worsenedsignificantly due to the massive introduction of RE subsidised by FIT. In response to such situations, EU-wide guidelines were released by the European Commission, stating that measures to facilitate the use of RE shall be compatible with market structure and the power system operation.[3]

An example of specific measure is the Commission's guidelines that abolished the obligatory FIT for new, large-scale RE generation facilities (500 kilowatts [kW] or higher), and stipulated the transition to a feed-in premium (FIP) system where RE generators directly sell power at market price. The difference between the support level (hereinafter 'standard price') and market price is subsidised by a premium. The guidelines also specified that facilities with 1 MW or more should use competitive bidding from 2017 onward to apply the standard price and determine its level.

The United Kingdom has adopted the Contract for Difference system that, in principle, is similar to FIP in that RE generators pay the difference when the market price exceeds the standard price. For electric power from RE source with established technologies (e.g. onshore wind, PV), the standard price is determined by competitive bidding.

Such FIP and bidding systems aim to improve the efficiency of support measures by utilising the market mechanism and, from the viewpoint of encouraging investment in RE, also provide a basis for the long-term stability of the RE system. RPS and FIP both require direct sales of power in the market. However, with RPS, price is determined in the market, whereas the price in FIP is specified by the government or a premium determined through bidding as provided by the government or an organisation established by the government via a long-term contract.[4] As a result, these systems bring a level of certainty and long-term stability to the profitability of RE business. However, it can be politically difficult to raise the electricity tariff in countries where the power generation sector is not liberalised and the electricity tariff is regulated. In such cases, it will be necessary to secure funds to support the use of RE–via methods that are different from the FIT system in Europe or in Japan where the cost is recovered from the users through the electricity tariff. If the cost is to be covered by the national budget, the increase in the state expenditure on RE will require community acceptance. When subsidies are granted to the generation of fuel (especially fossil fuel), it may raise a question on the comparative costs of generation, and policy needs to be considered in view of climate change policies.

[3]See Guidelines on State Aid for Environmental Protection and Energy, 2014–2020 of the European Commission.

[4]For a case of onshore wind power generation, the Contract for Difference or CfD in the United Kingdom is for 15 years, and FIP in Germany or Italy is for 20 years.

2.1.5. Issues in policy support for RE uptake

The RPS, FIT, FIP, and bidding systems described above have the following advantages and disadvantages:

- The effectiveness of FIT is determined by the level of tariff set by the government. Clearly the incentive to introduce RE is high when the tariff is high. However, the burden on the consumers is also high. Thus, it might be necessary to adjust the tariff flexibly based on certain criteria, such as the capacity added.
- FIP that comes with obligatory direct marketing is similar to FIT in making a preferential treatment to RE in terms of providing financial aid, yet FIP is expected to promote power supply according to the demand and competition among RE generators, since the profitability of RE generators depends on market sales. FIP also helps reduce cost by adopting a bidding system to determine the level of premium through market competition. For sectors where the RE technologies and market are established to a certain degree, it may be desirable to recommend a shift to such a system based on market mechanism. Meanwhile, with FIP, project feasibility may be sacrificed because low-price bidding acts as a barrier for small-scale business operators to enter the market.
- RPS is a system where policymakers determine the volume or the share of RE electricity introduced and the market determines the procurement details (e.g. energy source, price, terms, and conditions). Setting the RPS target at an appropriate level is important. RPS also shifts the risk of profitability to RE generators. Adequate demand, investment options, and a relatively competitive electricity e-market are preconditions for the RPS system to achieve its intended effect.

2.2. Regional Literature Review of RE Current Policies and Lessons Learnt

2.2.1. Analysis of the impacts of policy and other support mechanisms in the region (Malaysia, Philippines, and Indonesia–ASEAN-3)

i. Renewable energy policies for power generation

All ASEAN-3 countries have implemented policies promoting RE separately for different RE technologies. FITs are becoming an important policy tool for RE promotion in the region as demonstrated in these three countries. RPS also plays an important role as a policy instrument for RE promotion.

Table 2: Status of Renewable Energy Policies and Targets

	2007–2009	2010–2012	Current RE (2012)(%)	Target (by year) (%)
Indonesia	FIT	FIT	12	26 (2025)
Malaysia		FIT	5	11 (2030)
Philippines	FIT, RPS	FIT, RPS	29	40 (2020)

FIT = feed-in tariff, RE = renewable energy, RPS = Renewable Portfolio Standard.
Source: REN 21 (2014).

Indonesia has used FIT since 2009, through Ministerial Regulation No. 31/2009, which obliges the state-owned company – Perusahaan Listrik Negara or PLN – to buy electricity from RE produced by independent power producers. The Indonesian government allocated FIT only for small hydropower sources. In 2012, Ministerial Regulation No. 04/2012 introduced a FIT for biomass, biogas, and municipal solid waste. Shortly afterward, discussions started about using FIT for geothermal energy generators. FIT payment is available only up to 10 MW for all these energy sources (IEA, 2015). In line with RE development policy, the government announced that wind and solar energy are the next sources that will be included in Indonesia's FIT list. FIT rates in Indonesia differ depending on geographic location, the level of generated voltage, and the time of a plant’s commercial operation.

In the Philippines, the FIT scheme was established by the Renewable Energy Act (2008) and implementation commenced in July 2012. As of 2012, tariff rates have been established for run-of-the-river hydroelectric, biomass, wind and solar power, guaranteed for a period of 12–20 years, denominated in Philippine pesos. The tariffs awarded are based on the actual levelised cost of generating electricity from the project (including connecting to the grid), and a set return on invested capital (Halstead et al., 2015). The tariffs were proposed by the National Renewable Energy Board and finally determined by the Philippine Energy Regulatory Commission. In this process, the tariff for ocean energy was not determined. Also, the hydropower reservoir and geothermal supplies were not included in the FIT due to market competitiveness. In addition, the RPS was also set up and applied to RE technologies, including biomass, waste, wind, solar, hydro, run-of-river hydropower, geothermal, ocean, or a hybrid system as determined by the ‘Renewable Energy Act (2008)’ and as authorised by the National Renewable Energy Board.

In Malaysia, the idea of a FIT mechanism was introduced by the government under the National Renewable Energy Policy and Action Plan (2010). Malaysia's Renewable Energy Act of 2011 introduced the use of a complex FIT system that covers four main technologies—biogas, biomass, small hydropower, and solar photovoltaic systems. Tariff rates distinguish between the type and size of installation, with a maximum installation size of 30 MW that can qualify for FITs. The maximum FIT period varies between 16 and 21 years for different technology categories, and annual degression rates are applicable, based on assessments of technology costs (Halstead et al., 2015).

In addition to the FIT and RPS, a number of incentives also aim to improve profitability by reducing investment and operation costs through subsidies and tax exemptions for certain RE technologies. These facilities are available to developers who are involved in exploration, construction, and operation activities.

Table 3: Status of Renewable Energy Policy Implementation

	Indonesia	Malaysia	Philippines
Renewable Energy Policies and Planning			
Renewable Energy Act		✓	✓
Renewable Energy Policy	✓	✓	✓
Implementation Programme			
Feed-in Tariff	✓	✓	✓
Renewable Portfolio Standard			✓
Biofuel Mandate	✓	✓	✓
Rural Electrification Programme	✓	✓	✓
Incentives			
Subsidies and taxations	✓	✓	✓

✓= Approved and implemented.

Source: Asia-Pacific Economic Cooperation (2012).

Despite having almost the same RE resources, Indonesia, Malaysia, and the Philippines have chosen different methods for implementing FIT. Their objectives are more or less the same – encouraging the private sector to be involved in generating energy from RE sources and developing electricity access throughout the country.

ii. Impact of RE promotional policies

In ASEAN-3 countries, FITs, together with fiscal and financial incentives contributed to the growth of the RE sector. In the Philippines, the Department of Energy is encouraging investors to submit applications for FIT eligibility. Developers who wish to avail of the tariff need to submit their proposals early given the 'first come, first served' policy of the government to make the market for RE very competitive. Between 2008 and 2014, the Department of Energy has approved 325 RE projects. By the end of 2014, the department has given approval to around 500 RE projects to generate 633.5 MW of electricity for the national power grid. The approved projects are under the FIT system, which is one way to provide incentives for more RE projects in the country. To accelerate investment in the sector, the government awards long-term contracts to RE producers at fixed, guaranteed rates. The FIT system guarantees all eligible RE plants the applicable rates for a period of 20 years. Given the guaranteed rate, the government intends to make RE power development a viable investment venture (Salazar, 2014).

In Malaysia, the enactment of Renewable Energy Act 2011, together with the establishment of the Sustainable Energy Development Authority, provided solutions to shortcomings identified during the period of the Small Renewable Energy Power (SREP) Program and greatly improved the prospect of RE development. Up to April 2013, RE projects that can generate a total of 345.35 MW have been approved and 102.43 MW are currently being exported to the grid from the operating facilities. The Malaysia Building Integrated Photovoltaic Technology Application Project, which was launched in July 2005, generated for Malaysia roughly 12.6 MW of the total PV installed at the end of 2010, of which 1.6 MW were connected to the grid (Wong et al., 2014).

On the contrary, incentivising the private sector to invest and increase the deployment of RE technologies – which is commercially more expensive than conventional energy resources – would increase electricity costs due to the implementation of the FIT allowance. In the Philippine case, the Energy Regulatory Commission is set to issue an order for the collection of FIT allowance by the state-owned National Transmission Corporation, amounting to PHP0.40 centavos per kWh covering 2014 and 2015. The FIT allowance will be used to pay RE developers who qualified under the scheme. This fund is expected to result in higher power rates for it will be reflected as a separate line item onthe electricity bills of consumers. The sensitivity of consumers and the business sector to electricity price increase is understandable given that they pay the highest rates in Asia (Salazar, 2014).

iii. Challenges and issues

Recent studies illustrate some of the significant issues associated with FIT, especially in the Philippines and Indonesia. The Philippines implemented FIT in 2008 and Indonesia in 2009 to encourage the green energy production, and to reduce carbon emissions. However, several issues have affected the effectiveness of this mechanism.

- A lack of coordination between central and regional governments often creates uncertainty for RE investment.
- Fuel and electricity subsidies have become a serious burden on Indonesia's state budget. In addition, energy subsidies hamper the development of RE.
- The lack of experience in private (long-term) financing of RE projects remains a significant challenge for RE project development.
- Aside from the fixed FIT price, the lack of built-in inflation adjustment is one of the weaknesses in both countries.
- Some of the most important criteria for attracting investors in the RE sector are the rate of FIT, the period of FIT payment, and the profitability of each project. The tariffs rates are still far too low in the opinion of most RE developers. The profit earned by the RE facilities through the sale of electricity is barely enough to maintain the operation of the facility. As a result, most facilities have to find other alternatives to support operation costs.

- As the field of RE is still new to the local market, most local banks do not have enough knowledges to assess the effectiveness of RE investment projects.Thus, RE developers are unable to get the financial support from banks. Nevertheless, no measures were identified to help project developers apply for finance or to help banks assess RE projects.
- The use of Standardized Power Purchase Agreements based on tariff designed as a function of avoided costs of power generation has been largely unsuccessful in Indonesia because the country's decision to switch from oil- to coal-based generation resulted in further lowering the avoided cost of generation. An uncertain regulatory regime coupled with lowering the tariff below the avoided costs of power generation, especially in the islands that have switched from oil- to coal-based generation, made the Indonesian FIT unsuccessful. Moreover, FITs that are denominated in Indonesian rupiah for biomass and city waste projects are affected by the rupiah inflation. Actually, many investors in RE projects in Indonesia are exposed to variable rate loans from local banks, therefore, the interest rate fluctuation is an additional risk faced by investors.

iv. Lessons learnt

Among the three countries in the region, Malaysia has advanced in terms of promoting RE development. The country has success stories or lessons learnt, especially on how to create and manage the RE fund to pay for the cost of FIT and guarantee payment for the whole FIT contract period.

Setting up a refund mechanism. A fixed-price tariff, which is a minimum payment based on the specific development cost of the technology along with a purchase guarantee, is believed to provide security to investors financing capital-intensive projects with high upfront costs and a high ratio of fixed to variable costs. Tariffs set too low may be ineffective at encouraging investment, while tariffs set too high may be lead to oversubscription and budgetary constraints.

However, in a regulated electricity market such as in Malaysia, the funding source for FIT is limited to a fixed percentage imposed on the Distribution Licensee's total electricity tariff invoices. The question that is often posed is 'who will pay for the FIT'? The most common method for funding the FIT involves sharing the costs among electricity consumers.

The FIT in Malaysia is not financed from tax revenue. Instead, the FIT will be financed by an REfund, which is derived by passing the FIT cost to final electricity consumers. This is essentially a polluter's pay concept – the ones who pollute the most, pay the most into the RE Fund. This form of fund collection has been proven to be an effective tool in overcoming current economic and financial crises as it does not utilise public funds. The spin-off from this RE Fund mechanism is greater acceptance as consumers tend to adopt energy efficiency measures to reduce their electricity consumption. Therefore, the issue of limited funding for subsidy in the form of tariff was also solved by setting up the RE Fund, as end users that used more than 300 kWh per month have to pay 1% of their bills into the RE fund.

Financial governance of the RE Fund. The management of the RE Fund will be under the supervision of the Sustainable Energy Development Authority (SEDA) Malaysia. The RE Fund can only be used to disburse FIT payment claims made by Distribution Licensees, and to cover any administrative expenses related to the implementation of FIT. Some measures that govern the RE Fund include transparency in disclosing and publishing the financial reports on funding receipts, funding disbursement to Distribution Licensees, and the administrative fees payable to the Distribution Licensees and SEDA Malaysia. The accounts of the RE Fund are presented to Parliament on annually, as mandated by the Renewable Energy Act.

2.2.1 Analysis of renewable energy policies in Viet Nam

Viet Nam is endowed with RE resources such as hydropower, biomass, wind energy, geothermal energy, and solar energy. So far, these RE sources have not been widely used due to the lack of specific policy measures and a supporting institutional framework.

Currently, Viet Nam has inadequate policies and mechanisms to support RE technologies, although there were existing plans or targets that were stipulated in other related documents (Table 4).

Table 4: Renewable Energy-Related Legal Documents in Viet Nam

Legal Document	Date of Approval	Title and Contents
Decision 428/QD-TTg	18/03/2016	**Title: Revised National Power Development Plan period 2011– 2020, with outlook to 2030 (Revised PDP VII)** *Objectives and targets:* - Increase the share of RE in power generation to 9.9% in 2020, 12.5% in 2025, and 21% in 2030 in terms of installed capacity. - Increase the share of electricity generated from renewable resources to 6.5% in 2020, 6.9% in 2025, and 10.7% in 2030 in terms of electricity generation.
Decision No. 2068/QD-TTg	25/11/2015	**Title: The Vietnam Renewable Energy Development Strategy to 2030, outlook up to 2050** *Objectives and targets:* - Wind power to reach 2.5 billion kWh in 2020, representing 1% of total electricity output, and further increase this to 16 billion kWh by 2030, and 53 billion kWh by 2050. - Solar power generation to rise from 10 million kWh in 2015 to 1.4 billion kWh in 2020, then to 35 billion kWh in 2030 and to 210 billion kWh (20% increase) in 2050. - Biomass power to reach 7.8 billion kWh in 2020, 37 billion kWh by 2030, and increase further to 85 billion kWh by 2050. - Hydropowerto provide nearly 90 billion kWh in 2020 and 96 billion kWh per year in 2030, from 56 billion kWh in 2015.
Decision of: 24/2014/QĐ-TTg	24/3/2014	**Title: Mechanisms to support the development of biomass power project in Vietnam** Electricity price of biomass power projects connected to the grid: - For heat cogeneration projects – Power: VND1,220/kWh (excluding value added tax, equivalent to 5.8 US cents/kWh).

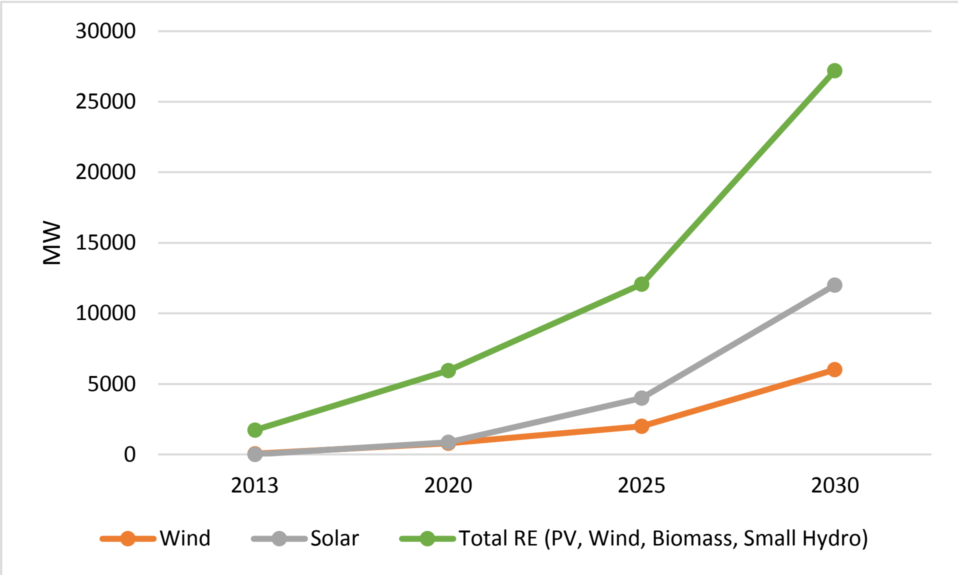
Legal Document	Date of Approval	Title and Contents
		Electricity selling prices are adjusted for exchange rate fluctuations/US$. - For other biomass power projects (not heat cogeneration projects – electricity), electricity price is applicable under the avoided cost tariff applicable for biomass power projects.
Decision of: 31/2014/QĐ-TTg	05/5/2014	**Title: Mechanisms to support the development of power generation projects using solid waste in Vietnam** Electricity price of solid waste power projects connected to the grid: - 10.05 US cents/kWh for incineration technology - 7.28 US cents/kWh for burial of solid waste
Decision 37/2011/QD -TTg	29/06/2011	**Title: Mechanisms to support wind power**(under revision) - 20-year power purchase agreement - Investment incentives, taxes, fees, land infrastructure - Support for electricity prices (grid): purchase price equivalent to 7.8 US cents/kWh
Decision 2149/QD-TTg by Prime Minister	17/12/2009	**Title: National strategy on comprehensive management of solid wastes for the period up to 2025, vision to 2050** *Objectives and targets concerning recycling, reuse, and energy recovery of solid wastes:* - By 2015: 60% - By 2020: 85% - By 2025: 90% - By 2050: 100%
Decision 18/QD-BCT	18/07/2008	**Title: Promulgation of regulation on avoided cost tariff and standardized power purchase agreement for small renewable energy power plants** *Objectives and targets:* Regulation on conditions, procedures, and construction of small RE power plants connected to the national power grid (Small Power Purchase Agreement)
Law 52/2005/QH 11	29/11/2005	**Title: Environmental protection law – 2005** *Related contents:* **- Article 6.** Environmental protection actions that encourage development, use of clean energy, renewable energy, GHG emission reduction, reduction of ozone layer destruction. **- Article 33.** Development of clean energy, renewable energy, and environment friendly products. - Organisations or individuals who invest in development, use of clean energy, renewable energy, and production of environment-friendly products get support from the state on tax, investment capital, and land for project construction.

Source: Authors, compiled from various sources.

i. Targets for RE development

The latest Revised National Power Development Plan, 2011–2020 (PDP VII), approved in March 2016, increased the targets for RE capacity from 1,700 MW in 2014 to 27,195 MW in 2030, and the respective RE share are targeted to increase to 9.9% by 2020 and 21% by 2030. Figure 5 illustrates the following three phases planned for RE deployment – inception, takeoff, and market consolidation. If the targets specified in PDP VII are reached by 2030, Viet Nam will come to the end of take off phase for RE deployment.

Figure 5: Renewable Energy Generation Target of Viet Nam



MW = megawatt.

Source: Revised National Power Development Plan, 2011–2020. Decision No.428/2016

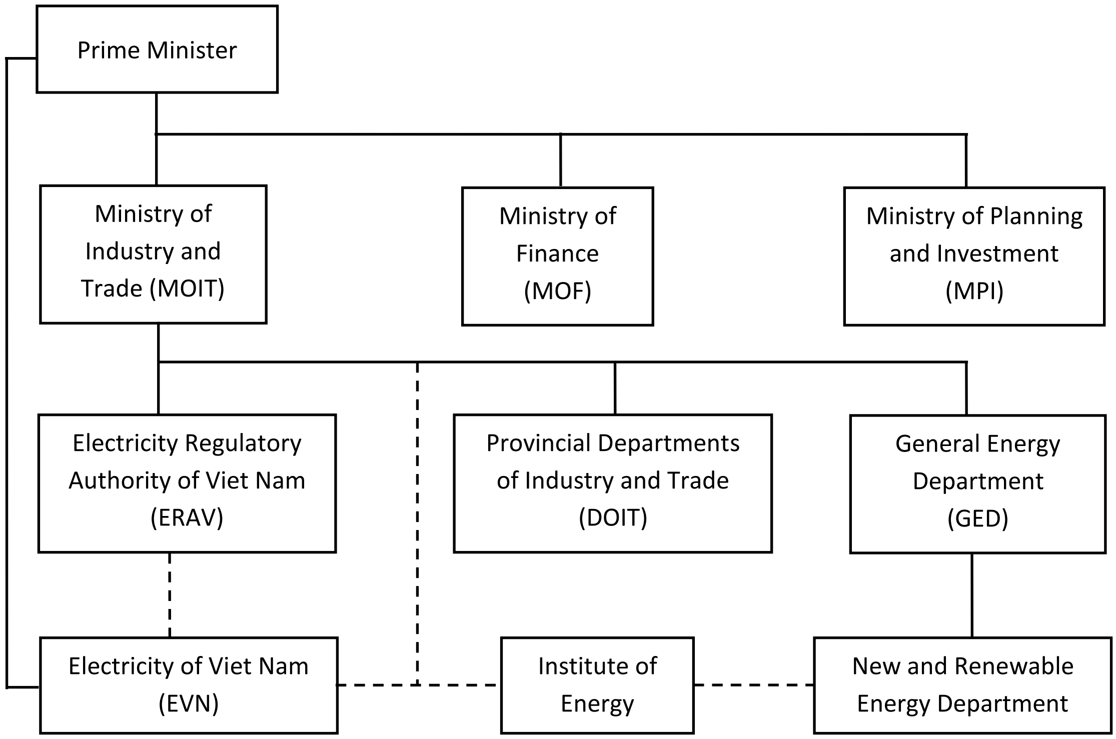
ii. Existing institutional framework for RE development

Viet Nam has a complex institutional structure in the energy sector. Some ministries are directly involved in formulating or implementing RE policy at the national level, while local governments and a number of other government agencies also have influence over either policy or its implementation, as described below and in Figure 6.

- The Government of Viet Nam and the Prime Minister are responsible for policies, regulations, strategies, and plans for the development of the RE sector.
- The Ministry of Industry and Trade (MOIT) manages all energy sectors, such as coal, oil, gas, electricity, nuclear energy, and REs. The ministry is responsible for policy design and national plans subject to the Prime Minister's approval.
- The Ministry of Planning and Investment takes the lead role in coordinating and allocating funds for energy projects submitted by line ministries and agencies, for consideration and approval by the Prime Minister.

- The Ministry of Finance is responsible for taxation and energy tariff policies applied to the energy sector.

Figure 6: Government Management Structure for Renewable Energy



Source: International Institute for Sustainable Development (2012).

- The Electricity of Vietnam (EVN) is the most important institution in implementing policies and regulations for RE development.
- The General Energy Department (GED) is under the control of the MOIT. This department helps MOIT to manage functions related to the energy sector.
- Under GED, the New and Renewable Energy Department is in charge of managing and designing plans for RE development.
- The Electricity Regulatory Authority of Viet Nam is a department under the MOIT. This department manages and regulates electricity market-related activities, including electricity from RE sources.
- At the provincial level, the provincial Departments of Industry and Trade are responsible for implementing state management directives for energy sector, including those for RE.
- The Institute of Energy conducts research on RE issues, such as RE planning and policymaking, and undertakes the preparation of investment reports.

iii. Existing legal documents

Over the years, the development of RE has received much attention from the state, as evidenced by policies, laws which were enacted. Table 4 summarises the legal documents related to RE development.

The legislations cited in Table 4 show the government's ambitious targets for RE development. However, some issues remain to be considered, including financial arrangements, detailed action plans, incentive mechanisms, and the assigning of responsibility to organisations that will need to implement the strategy on a mandatory basis.

The targets that were set up in the revised PDP VII appear realistic in terms of finance and implementation plans. Therefore, these will be considered in Alternative Policy Scenario (APS) with additional policies, measures, and action plans proposed.

Viet Nam has set RE targets in its various development planning, strategies, and decisions. However, to specify the targets, they need to be attainable, economically efficient, and sustainable and not simply quantities without any justification and/or elaboration. To have targets that are technically justifiable, economically verifiable, and financially sustainable is still a long way to go for Viet Nam stakeholders.

iv. Market price support and regulation

There is currently no standardised comprehensive legal framework for FITs for RE projects in general in Viet Nam. The main instrument currently used to promote renewables is the standardised (not negotiable) Special Power Purchase Agreement for power plants less than 30 MW and a standard tariff for small generators based on the avoided costs of the Electricity of Viet Nam (EVN). In addition, three FITs for grid-connected RE projects are in place – promulgated in 2011 for wind power and in 2014 for biomass cogeneration and solid waste to energy (Table 4). The FIT for solar energy is under consideration. Although these FITs are relatively modest compared with the return required by private sector investors, it does show the government's commitment to the clean energy development roadmap. The FIT for wind power generation offers a fixed purchase price and a variable additional subsidy from the environment protection fund paid through EVN. Some wind power projects are being implemented, and regulations for wind power integration are currently being revised to attract more private sector investment.

v. Fiscal incentives and other subsidies

Fiscal incentives are provided through tax provisions. These are typically intended to reduce costs related to investment and plant operation. Fiscal incentives also provide preferential treatment for RE enterprises as regulated by the Investment Law, including importation duties, corporate income tax and other tax exemptions as the following:

- Exemption from import duties for imported materials, equipment, and machinery that are not yet manufactured in Viet Nam.
- Corporate income tax exemption and/or reduction for RE enterprises.

- Tax exemption for the first years, 50% tax reduction for the next 9 years.
- Possibility of 10% tax rate being extended up to 30 years, if the RE projects are classified as using high or new technology and in special need of investment.

Other RE subsidies may be available to investors. For example, RE projects are exempt from land-use fees, environment protection fees and others include the following:

- Exemption and reduction of land use/rent for power plant area according to regulation, for transmission grid, and transmission substations.
- Exemption from environment protection fee.
- Soft loan and use of Clean Development Mechanism (CDM): Low-interest rate (according to the regulations of the Vietnam Development Bank).

vi. Policy effectiveness

To assess the effectiveness of the RE policy, the team has drawn the Table 5 showing the existing policy (effective policy), and the current status of the RE power plants in operation. It shows that the policy instrument on avoided cost tariff for small hydropower is very effective, while other FITs (for wind, biomass) are still under take-off phase and moderate.

Table 5: Existing Policies and Effectiveness

Area/Sub-area	Existing Policies	Effectiveness
Powers from Renewable Energy	FIT for wind power (Approved in 2011; under revision)	• 55 MW currently operating • 101 MW under construction • Many more undergoing application
	FIT for biomass power	250 MW under operation
	FIT for MSW	Not effective
	FIT for solar PV	Under consideration for approval, no assessment available. Many developers and investors have expressed interest.
	Avoided cost tariff for small hydropower	Increasing installed capacity 6 times (from 350 MW in 2009 to 1,984 MW in 2014)
Biofuels	Biofuel programme	6 ethanol plants are operating, providing 535 million litres of ethanol per year. However, many plants are having difficulties due to high production costs.

FIT = feed-in tariff, MSW = municipal solid waste, MW = megawatts, PV = photovoltaic.
Source: Authors, compiled from various sources.

vii. Comments on existing policy and institutional framework for RE development

From the status of policy implementation and institutional framework for RE development, some comments could be drawn, as follows:

- Viet Nam still does not have a clear legal framework to guide policies on RE projects. Policies are separately stipulated in different laws leading to confusion in their application.
- The EVN purchases electricity from RE projects at a price that is currently lower than electricity production costs for the wind or small hydropower. This is a major issue among investors and affects returns on investment. Also, it appears that investors in biogas and biomass power projects do not currently receive price support from the government.
- Procedures for establishing and operating RE projects often require the involvement of a number of authorities, resulting in high transaction costs as project developers must submit the same information to several government authorities at different points of time.
- Government officials often lack adequate experience in establishing and operating investment incentive policies supporting the RE sector.

- In many cases, the investors have encountered difficulties in seeking loans for their RE projects although legal documents confirm that they are eligible to access available soft loans.

New policy instruments were proposed in the document 'The Vietnam Renewable Energy Development Strategy to 2030, Outlook Up to 2050' issued in 2015 where it proposed several innovative measures, such as

- A Sustainable Energy Development Fund;
- Power purchase agreement of the type "Take or pay";
- Cost recovery through increasing electricity tariff;
- RPS for the generation of >1,000MW and for the distributor: The share of RE generation must be >3% by 2020 for generator, increased to>10% by 2030, and to >20% by 2050; and
- Net metering.

However, these measures will need to be elaborated for their practical implementation, by a concrete roadmap, and Government's degrees on application guides that will require a few years for preparation.

2.2.3. Myanmar's renewable energy status and policy

i. Renewable energy status in Myanmar

Myanmar has huge RE potential that could be leveraged to overcome the shortage in energy supply, improve energy security, and develop cost-effective access to energy in rural and remote areas. Investment in RE would also relieve budget pressure arising from fossil-fuel subsidies, which represent 9% of total government expenditure, and to foster foreign direct investment in Myanmar (OECD, 2014). Table 6 shows the resource potential and installed capacity of RE in Myanmar.

Table 6: Renewable Energy Resources Potential and Installed Capacity in Myanmar

Resources	Installed Capacity (MW)	Resource Potential (MW)
Solar	530 (ongoing)	52,000
Wind	5.4 kW	635
Small hydro	112.05	324
Biomass	18	600
Biogas	650MWh	3,600

kW = kilowatts, MW = megawatts, MWh = megawatt-hours.

Sources: World Bank/ESMAP and International Energy Agency (2013).

Myanmar has set an RE target to generate 15%–20% of its total electricity from RE sources by 2020. It is apparent that a large share of this would come from hydropower due to its enormous potential and availability, but the plan does not specify the shares of individual RE technologies. The Government of Myanmar and the New Energy and Industrial Technology Development Organisation of Japan signed an agreement in 2013 to support the process of introducing RE technologies in Myanmar. The government has signed a memorandum of understanding with a Thailand-based RE developer for the installation of a 210MW solar power plant in Minbu, Myanmar (OECD, 2014). In September 2015, a US$400 million loan was approved by the World Bank to support the National Electrification Plan, which aims for universal electricity access by 2030. The plan aims to extend electricity to over 1 million households, of which 60% will be connected to the grid network while the remaining 40% will obtain off-grid electricity by 2021 (Ross, 2015).

Large-scale solar projects are taking shape in Myanmar, as the government aims to connect the vast rural population to electricity sources. Green Earth Power, a Thailand-based RE company, plans to build a 220MW solar power plant in Magway Region at the cost of US$350 million, which is due for completion in 2017. ACO Investment Group, a US-based investment fund, have signed a memorandum in 2013 with the Government of Myanmar to build a 300MW solar facility at the cost ofUS$480 million in Mandalay Region in Central Myanmar. SPCG Public Company Limited, another Thai company, is considering building and operating a solar farm of several megawatts (Matsui, 2014). Currently, solar systems in the 1.5 W–500W range are being used throughout the country to assist local and rural communities. The government also formed a ministry-level committee of 'Rural Electrification & Water Supply' under the Rural Development and Poverty Alleviation Policy to increase households' electricity access through RE. Also, the current energy policy reform processes are planning to support the deployment of RE. Table 7 shows the proposed plan for 2015–2016 fiscal year.

Table 7: Proposed Plan for Electrification Using Renewable Energy, 2015–2016

FY Years	Total Villages	Electrification Systems				Budget	Impact	
		Grid Extension	Solar	Hydropower	Diesel Engine	(Million US$)	Households	Population
2014–2015	2,308	223	139	34	1	36,298	146,123	750,000

Source of data: Department of Rural Development, Myanmar, 2015.

viii. Renewable energy target

The government has not officially established RE targets although the Ministry of Electric Power aims to develop 472MW of installed capacity (about 15% of total generation capacity) from small hydropower generation plants by 2016. According to reports, the government also plans to use domestically produced biodiesel and bioethanol as substitutes for 10% of imported oil and gasoline by 2020.

At present, Myanmar has no specific RE incentives but investors can draw on the incentives provided in the new Foreign Investment Law (2012). These include the following:

- Income tax holiday for foreign investors;
- Exemption from a tax on profits if the profits are maintained in a reserve fund and reinvested in Myanmar within one year;
- For RE exported goods, income tax relief of up to 50% of the profit;
- Allocation for research and development expenses; and
- Exemptions from customs duties for the importation of machinery, equipment, instruments, machinery components, spare parts, and materials required for the enterprise.

The new law also assures investors that their investments will not be nationalised during the contract period, their permits will not be terminated without good reason, and their foreign currency can be repatriated in the same foreign currency.

ix. Analysis of effectiveness of current policies

A number of publications provide a list of barriers to the development and uptake of RE in general (Beck and Martinot, 2004; Painuly, 2001), and in ASEAN countries (Beck and Martinot, 2004; Painuly, 2001; Lidula et al., 2007; Luthra et al., 2015). According to international investors in wind energy and solar PV generation, the risk factors to implement projects are (i) legal security, (ii) negative policy changes affecting renewables, and (iii) the main financial support scheme and total revenues received (ESMAP, 2015). The main barriers to increase the uptake and development of RE in ASEAN countries include the following: (Beck and Martinot, 2004; Lidula et al., 2007; Painuly, 2001; Luthra et al., 2015; Das and Ahlgren, 2010; Umar et al., 2013; Umar et al., 2014a; Umar et al., 2014b; Urmee et al., 2009).

- Technological and/or infrastructure barriers,
- Economic and financial barriers,
- Administrative and/or regulatory barriers (usually at take-off stage),
- Market-relatedbarriers,
- Political and institutional barriers, and
- Social and cultural barriers.

To overcome these barriers, appropriate policy instruments need to be developed to facilitate the development of RE technologies in Myanmar. These policies should aim to increase the competitiveness of RE technologies with conventional energy technologies, create a business-enabling environment so that there are interests in RE investment, and increase energy security by reducing dependence on external and conventional energy resources. A few of these issues are discussed below.

x. Ramping up renewable energy technologies

With only 13% of the population being connected to the national grid (UNDP, 2013), and such electricity access being available mostly in urban areas, off-grid electrification using RE is not an option but is a must for Myanmar. In addition, RE would offer a multitude of other benefits, including ensuring energy security, reducing expenditure on fossil fuel subsidies, and increasing economic development in rural areas. Tapping the country's extensive RE resource potential (hydro, solar, and wind) could provide the much-needed source of electricity both for the grid and for the off-grid areas. It is recognised that the lack of affordability is a key hindrance to offeringRE technologies, such as solar home systems, in rural areas. Carefully developing microfinancing mechanisms for the promotion of rural energy systems can address this issue. Bangladesh has demonstrated true leadership in developing and implementing affordable financing mechanisms for RE-based rural electrification using microfinance (IDCOL, 2015). Lessons from Bangladesh could lead to implementing affordable and sustainable financing options for the poor.

xi. Mobilising private investment

Myanmar needs to foster private investment to hasten the introduction and deployment of RE technologies in Myanmar and improve the country's energy security. For this to happen, the government needs to create an enabling environment that would help private investors thrive in RE business. Some developments are already happening along this line; however, improvement in the domestic economic, legal, and regulatory regime can further strengthen private investment. Several things can be done to create and strengthen an investment-enabling environment in Myanmar and these include the following:

- Develop long-term, practical, and credible targets for RE. These targets will need to be broken down into technologies to create a trusting platform for private investors. In 2011, at the third ASEAN Energy Outlook, Myanmar set a target to generate 15%–20% of its total energy from RE sources by 2020. This target, by itself, is insufficient for the investors to make any commitments, as it does not indicate the shares of the different technologies.
- Develop and implement appropriate incentive mechanisms for RE and energy-efficient technologies to send a clear market signal to investors. This can include FIT, fiscal incentives, tax breaks, and others.
- It is also important to create a sound and unbiased market that allows fair competition among the operators, such as between independent power producers and state-owned enterprises. Sound and competitive policies, such as electricity market structure and removal of discrimination in accessing finance, can support innovation and develop an environment that is conducive to private investment in the energy sector, particularly to promoting new and alternative energy technologies.

xii. Regional cooperation

Regional cooperation can greatly improve energy security in a sustainable way, and enhance economic return by optimising the infrastructure and resources. There are examples of effective regional cooperation in the ASEAN, including those in the energy sector. An example is the existing cross-border power trade among Lao PDR, Thailand, and Viet Nam. Myanmar is also in cooperation with China and Thailand in terms of power trade. Broader cooperation among member states in the energy sector is currently being discussed. These include adopting a uniform technical standard, such as synchronising frequency, village control, and transient stability for the interconnected power grid (ADB, 2015).

Being a GMS country, Myanmar has a lot to gain from regional economic cooperation to develop its immature RE sector. Many other GMS countries, such as Thailand, have progressed far in developing their RE portfolios. Through regional cooperation, Myanmar can access already developed technical skills, technologies, and other benefits that are imperative for the development of RE projects.

xiii. The way forward

Development of effective policies requires in-depth research, as solutions are not often obvious. Most of the existing research in Myanmar often focuses on mapping potential hydrocarbon reserves. The issues that need to be addressed are (i) accessing electricity, (ii) pricing electricity, (iii) making it cleaner, and (iv) structuring the market. These issues need to be studied further, along with the implementation of new policies. The research can be prioritised and categorised as short-term priorities and longer-term objectives. Short-term policy priorities are those that require action within the next 3 years. These are focused on providing affordable and reliable electricity to all with the view of having immediate positive impact. Policy changes over the next 5–10 years will decide the path the energy sector will take as it matures. These are all fundamental for the long-term sustainability of the sector. From the above analysis, the following researches are recommended:

- What are the best options for increasing installed generation capacity in a short period? How can cross-border trading of electricity help in enhancing electricity access in Myanmar?
- What financial incentives can the government provide for the adoption of off-grid technologies, such as small-scale hydro and solar PV?
- What institutional structure is appropriate for Myanmar to provide electricity access using RE? Can these policies encourage more foreign direct investment into the energy sector?

2.2.4 Lao PDR's renewable energy status and policy

i. Review of the current status of RE utilisation and targets

Lao PDR has large hydro projects aimed at meeting the country's export electricity targets and increasing the number of consumers connected to the domestic grid. The country is also developing other RE sources, such as small hydropower (SHP), solar, wind, biomass, biogas, and municipal solid waste (MSW) to supplement supply to on-grid users as well as to satisfy electricity demands in rural areas (off grid). Despite the huge potential of these RE sources, their current utilisation (as of 2013) is rather low as shown in Table 8.

Table 8: Renewable Energy Potential and Current Utilisation, Lao PDR (MW)

	Small Hydro	Solar	Wind	Biomass	Biogas	Solid Waste	Total
Potential	2,000	511	40	938	313	216	4,070
2011	28	0.2	0.0	0.0	0.0	**0.0**	28.2

Sources: UNDP (2013).

The RE development strategy target specifies that 30% of the total domestic energy consumption will be generated by RE by 2025 as illustrated in Table 9.

Table 9: Renewable Energy Potential, Past and Projected Utilisation until 2025 (MW)

	Small Hydro	Solar	Wind	Biomass	Biogas	Solid waste	Total
Potential	2,000	511	40	938	313	216	4,018
2011	28	0.2					28.2
2020	134	36	12	24	19	17	242
2025	400	33	73	58	51	36	651

Source: ADB (2013).

xiv. Existing RE laws, regulations, policies, strategies, and development plans

The Government of Lao PDR has passed legislation and issued policies, strategies, and plans for the development of the power sector – including large hydro, and RE resources. The current strategy and planning approach is essentially concentrated on the country's potential hydroelectric power development to meet domestic and export demands. RE use and technology development, on the other hand, are explicitly covered in the national RE development strategies.

The existing laws, regulations, policies, strategies, and development plans are summarised as follows:

- ***Law on Electricity.*** The Law on Electricity dated 8 December 2008 was amended in 2011 and enacted on 20 December 2011. The Law on Electricity specifies the principles, rules, and measures on the organisation, operation, management, and inspection of electrical activities to ensure the effectiveness of electricity generation and business operation. The law specifies the principles and guidelines for conducting electricity generation, transmission, and distribution business in the Lao PDR; and recommends strategies for developing the rural electrification network and methodologies for the pricing of electricity.
- ***Water and Water Resources Law.*** The law recognises eight different categories of water sources according to purpose, including water sources allocated for the production of electric power. The Water and Water Resources Law has features that help ensure sustainable hydropower development. One of these is the requirement to undertake environmental and social impact assessments for large-scale hydropower reservoirs, and approval for small-scale hydropower reservoirs.
- ***Law on Investment Promotion***. Issued and enacted in 2004, the Law on Promotion on Foreign Investment was renamed and enacted in 2009 as Law Investment Promotion. It recognises the concession issued by the state for using ownership rights and other rights of the state that is according to regulations, for the purpose of developing and undertaking various business operations, particularly the concession right relating to land, minerals, electric power, and others (Article 15).
- ***National Socio-Economic Development Plan, 2011–2015***. The main objectives include rapid economic growth and poverty eradication; achievement of the Millennium Development Goals by 2015; and sustainable economic, social, and environmental development. The plan also identifies the energy sector as a strategic development sector, both for the short and longer terms. Its performance is vital in meeting the country's energy requirements, notably for the still-elusive goal of nationwide electrification. Developing the energy sector is central to the modernisation and industrialisation of the country, which is the primary platform for raising the living standards and eradicating poverty.
- ***Renewable Energy Development Strategy.*** The National Renewable Energy Development Strategy issued in October 2011 is the main policy framework for the development of RE in the country. The strategy sets a target of increasing the share of RE in total energy consumption to 30% by 2025. The government also aims to replace 10% of transport fuels by biofuels during the same period. Target details for each RE are illustrated in Table 9.
- ***Policy on Sustainable Hydropower Development in Lao PDR.*** The policy applies to all hydropower projects larger than 15 MW throughout the project development process (planning, construction, operation, and transfer/closure stages) and incorporates technical, engineering, economic and finance, and environment and social impacts aspects. At present, this is undergoing revision conducted by the Ministry of Energy and Mines.

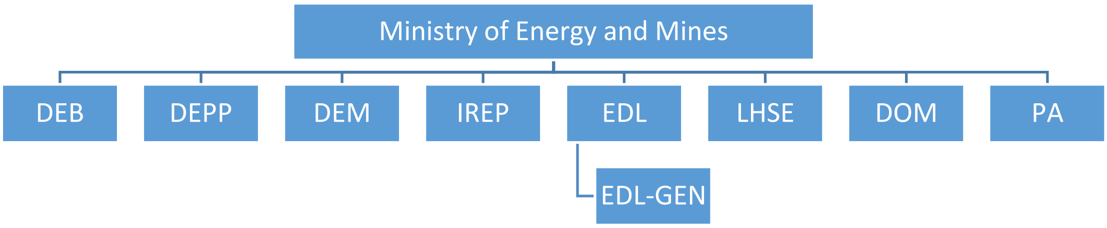
- ***National Policy on the Environmental and Social Sustainability of the Hydropower Sector.*** Issued by the government in 2005, the policy encourages the sustainable development of the hydropower sector (based on the principles of economic sustainability), maintenance of the renewable resource base, social sustainability (based on the principles of mutual understanding and consensus), and ecological sustainability (avoidance of irreversible environmental impacts).
- ***Power Development Plan (PDP).*** Article 9 of the Electricity Law states that the electricity enterprise shall prepare the electricity development plan. The Electricité du Laos (EdL) has been preparing the PDP every 3 to 5 years. EdL formulated the PDP 2010–2020 in August 2010, revising the former PDP 2007–2017. In August 2011, EdL updated PDP 2010–2020 by reflecting the latest electricity demand forecast and prospective project developments in the generation and transmission sector.
- ***Development of Regulation/Law on Biofuels.*** Lao PDR is developing a national programme for biofuel development with a vision to introduce 10% biofuel in the transport sector by 2025. The (draft) Decree for Regulation and Utilisation of Biofuels in Lao PDR, dated 11 September 2013, classified the size of biofuel production and level in accordance with the level of business purpose – family business, small to medium-sized, business, and large-scale business.

The various policies, strategies, and development plans listed above can only be put in place by means of policy instruments.

xv. Organisation of the energy sector

The Electricity Law of Lao PDR, amended in 2011, prescribes that the Ministry of Energy and Mines is responsible for making the policy and strategy for the country's electricity sector, supported by various ministries, e.g. Ministry of Finance, Ministry of Planning and Investment, and Ministry of Natural Resources and Environment. Various departments under the Ministry of Energy and Mines as well as at provincial level undertaking tasks and responsibilities of policy development and implementation are shown in Figure 7.

Figure 7: Organisational Chart of the Ministry of Energy and Mines



DEB = Department of Energy Business, DEPP = Department of Energy Policy and Planning, DEM = Department of Energy Management, IREP = Institute of Renewable Energy Promotion, EDL = Electricité du Laos, EDL-GEN= EDL Generation Public Company, LHSE = Lao Holding State Enterprise, DOM = Department of Mining, PA = Provincial Authority.
Source: ADB (2013).

Department of Energy Business. This department oversees private sector investments in the power sector. While it is involved in planning, development, and appraisal of project proposals, its main role is in negotiating project development agreements, concession agreements, and power purchase agreements.

Department of Energy Policy and Planning. This department is in charge of policymaking and planning, and is responsible for energy policymaking and energy/electricity supply planning.

Department of Energy Management. This department is in charge of drafting energy-related laws, regulations, guidelines, and technical and safety standards. It also monitors government agencies, state-owned enterprises, and private operators to ensure their compliance with the rules and regulations.

Institute of Renewable Energy Promotion. The institute is mainly responsible for promoting RE and conservation by implementing the Renewable Energy Policy and Strategy prepared in 2011. In support of RE, it is tasked with developing small-scale hydro, biodiesel, and biogas projects, and is responsible for preparing a manual on RE production and use. The institute also formulates and implements a rural electrification master plan.

Electricité du Laos (EdL). The EdL is a state-owned electric power utility, supplying electricity to domestic consumers through its transmission and distribution lines. EdL also manages the import and export of electricity.

EdL-Generation Public Company. The main objectives of EdL-Gen are to (i) generate energy for EdL for wholesale, and in the future,for export (this includes development of transmission lines and substations, as necessary); (ii) invest in or set up joint ventures with other electricity generation projects; and (iii) provide management and maintenance services for other electricity projects.

Lao Holding State Enterprise. This state-owned stock-holding enterprise is tasked to hold and manage the shares of the projects of independent power producers.

In addition to these departments and companies, the Government of the Lao PDR has also set up provincial departments of energy and mines and district energy and mines offices, which all work under the Ministry of Energy and Minesat the provincial and district levels.

xvi. Financial incentives and mechanism[5]

Investments in RE projects – whether on grid-connected or isolated systems, off-grid projects, and individual systems – are entitled to investment incentives under the Investment Law of the Lao PDR. The financial incentives include the following:

- Import duty free on production machinery, equipment, and raw materials;
- Profit tax exemption for a certain period depending on activities, investment areas, and size investment; and

[5] See the Renewable Energy Development Strategy in the Lao PDR.

- Subsidies on unit product price depending on energy type and times period.

In addition, investors can also obtain non-fiscal incentives, such as

- Up to 75 years leasing term (for enterprise construction land),
- Permission to expatriate earnings to home or third countries, and
- Right to employ foreign workforce (not more that 10% of the enterprise's total labour).

As to the financial mechanism, the government will seek assistance from international organisations, commercial banks, and sources of low-interest loans to fund RE projects. The government will also seek to improve the understanding of RE projects among private commercial banks to encourage investment in RE projects.

Retail tariff determination of electricity is guided by the socio-economic conditions of consumers, their sector, and type of use. The electricity tariff is set in nine categories for low voltage supply, and in four categories for medium voltage supply. The tariff for residential use and irrigation are set at a lower level than those for other categories of consumers. The residential tariff and agricultural tariff are cross-subsidised to some extent by the industrial and commercial consumers.

The incentive mechanism, such as FIT, is not practised[6] in determining the generation tariff for the RE sources of energy. Currently, the tariff for selling and buying electricity from RE power projects are agreed based solely on the negotiations between investors and the EdL.

xvii. Public–private partnership

To date, some forms of the public–private partnership are currently operating in the Lao PDR. The Pro-Poor Public–Private Partnership (5P) approach promoted by the Economic and Social Commission for Asia and the Pacific (ESCAP) aims to leverage the strengths of the government, the technical and financial advantages of the private sector, and the socio-economic development interests of rural communities. In partnership with the Institute of Renewable Energy Promotion, ESCAP implemented the 5P pilot project and widened the access of rural communities to modern energy services during 2011–2015.

Another form of public–private partnership is the work carried out by Sunlabob. Established in 2001, Sunlabob is a Lao PDR-based company dedicated to off-grid energy and clean water solutions. The company offers a range of products and services, providing rural electrification solutions to governments, multinational development agencies and companies, nongovernment organizations, and individuals. For the 5P project, Sunlabob serves as a technical advisor, providing advisory services to support technical system designs and implementation of the pilot project.

Another one is the off-grid rural electrification programme, which is supported by the World Bank. The SHS (Solar Home System) pilot programme was implemented by small private

[6] See the Lao PDR National Sustainable Energy Strategy Report on Enabling Environment and Technology Innovation Ecosystem for Affordable Sustainable Energy Options by APCTT and UNESCAP, 2014.

companies based in the respective provincial capitals. Under the model adopted by the village off-grid promotion service, these private companies – or PESCOs – work in cooperation with the Provincial Department of Energy and Mines offices that are responsible for rural electrification. PESCOs have a participatory planning process designed by the village off-grid promotion service, which identifies villages that meet the off-grid criteria, procures equipment, and employs village energy managers who are responsible for installing and maintaining the systems and collecting bill payments. Payments to the PESCOs and village energy managers are linked to their actual achievement (rebate based) in planning, installation, payment collection, and reporting.[7]

xviii. Effectiveness of current policies

The Renewable Energy Development Strategies aim to increase the use of RE potential in the Lao PDR and to supplement supply to meet domestic electricity demand. The proposed RE target is shared by three energy types – electricity (28%), biofuel (44%), and heat energy (28%). Table 10 illustrates the plan, together with the past achievements in 2011 and 2013.

Table 10: Renewable Energy Potential and Development Status in the Lao PDR (MW)

	Small Hydro	Solar	Wind	Biomass	Biogas	Solid Waste	Total
Potential	2,000	511	40	938	313	216	4,070
2011	28	0.2					28.2
2013[a]	30	0.9					30.9
2015	80	22	6	13	10	9	140
2020	134	36	12	24	19	17	242
2025	400	33	73	58	51	36	651

[a] Scaling-up off-grid rural electrification in the Lao PDR.
Source: ADB (2013).

As seen in Table 10, when compared to the target stated in the development strategies, the overall RE utilisation of around fivefold will be augmented from 2011 to 2015. However, from 2011 to 2013, the increase was less than 10% (from 28.2 MW to 30.9 MW). Moreover, when compared to the available potential, the RE target for 2020 accounts only for 6.0% and in 2025 for 16.2%.

Domestic consumption of electricity was estimated to grow to 2,863MW[8] by 2025, attaining 820 MW in 2011, 1,200 MW in 2013, 1,950 MW in 2015, and 2,670MW by 2020 (ADB,

[7] See the Report on the National Assessment Framework of Enabling Environment and Technology Innovation Ecosystem for Making Sustainable Energy Options Affordable and Accessible (2014).
[8] See the Renewable Energy Development Strategy in the Lao PDR.

2013).Projecting the RE contribution in 2011, 2013, 2015, 2020, and 2025 to the electricity demand forecast by 205 yields the results illustrated in Table 11.

Table 11: RE Contribution to Domestic Electricity Demands Forecast

Year	Demands (MW)	RE Contribution (%)						
		Small Hydro	Solar	Wind	Biomass	Biogas	Solid waste	Total
2011	820	3.41	0.02					3.44
2013	1,200	2.50	0.08					2.58
2015	1,950	4.10	1.13	0.31	0.67	0.51	0.46	7.18
2020	2,670	5.02	1.35	0.45	0.90	0.71	0.64	9.06
2025	2,863	13.97	1.15	2.55	2.03	1.78	1.26	22.74

RE = renewable energy.
Source: ADB (2013).

It can be observed from Table 11 that for 2013, the RE contribution to the domestic electricity demand is increasing from 2011 to 2025. However, by 2025, the total RE contribution accounted only for 23%, which is less than the anticipated figure (28%). This discrepancy is due to an unsystematic planning and lack of supporting assessment.

The existing policies and policy instruments used are, in general, less effective due to the followings reasons:

- Although several laws, regulations, policies, and plans have been issued and in use, the Lao PDR does not have a comprehensive national energy policy that sets out a systematic approach to energy planning, policy formulation, and sector development.
- There is no independent regulatory authority for tariff determination purpose. The incentive mechanism, such as FIT, is not practiced in determining the generation tariff for the RE sources of energy. Currently, the tariff for selling and buying electricity from RE power projects are solely based on agreements between investors and the EdL.
- There is no tangible and integrated national policy, strategy, and plan for using RE as part of the country's power development plans. A nationwide approach to systematically assess area-specific RE potential has yet to be put in place. Similarly, various RE appropriate technologies, e.g. distributed generation and micro-grids, are still at their infancy stage and not well known among implementing organisations and agencies.
- Most of RE development have been carried out following the needs of respective provinces without cooperation among them. No clearly described and well-coordinated approach exists for allocating responsibilities among agencies and ministries undertaking energy production-related activities.

- A workforce with knowledge, know-how, experiences, and skills in strategic planning and implementation is lacking and is considered a serious constraint.
- Most of the public–private partnerships on the renewable energy target (RET) development in the Lao PDR are based on the cooperation among donors, ministerial and provincial agencies, and private companies with some involvement from educational and research institutions.

vii. Recommendations

A comprehensive national energy policy should set out a systematic approach to energy planning, policy formulation, and sector development. There is a need to have clear RE policies stating the periodic targets for grid-connected and off-grid RE projects. In line with this, RE development must be integrated yet considered as a separate sector and its associated budget to be allocated in the Five-Year National Socio Economic Development Plan.

An independent regulatory authority needs to be established to look after financial incentives and issues such as FIT for the RE sources of energy.

There is a need for a systematic assessment of area-specific RE potential throughout the country. There is also a need to prepare distributed generation and various micro-grid configurations used in accordance with specific areas and needs.

RE development in provinces should be carried out in line with the area-specific RE potential and use of appropriate forms of distributed generation. Well-defined roles and responsibilities must be established and implemented among government organisation and agencies implementing RE and RE technology development.

It is also important to include knowledge on strategic planning, implementation know-how, experiences, and related skills at all levels of education – from technical schools to the universities.

Public–private partnerships should be encouraged to promote RE technology development through cooperation with research and educational institutions. This will enhance and improve the operation and maintenance of RE projects, which include micro-grids that supply rural areas with electricity, and/or connect them to national grids for the marketing of energy surplus.

2.2.5. Cambodia's renewable energy status and policies

i. Review on potential and current status of RE utilisation

Cambodia is lagging other Southeast Asian countries in the development of RE resources, partly because of a lack of experience, funds, and data. RE initiatives mainly take the form of research and demonstration projects. While RE is strongly encouraged by the government, appropriate policies and financial support are still evolving.

Electricity prices in Cambodia are very high, thereby opening opportunities for the development of small hydro, solar, wind, and biogas technologies for power generation.

Cambodia has an estimated hydro potential of 10,000 MW, with less than 10% currently developed. Approximately 50% of these resources are in the Mekong River Basin, 40% on tributaries of the Mekong River, and the remaining 10% in the southwestern coastal areas. By the end of 2014, approximately 830 MW of installed hydropower capacity had been in operation, approximately 800 MW was under construction, and another 198 MW being considered for feasibility.

Cambodia is considered to have high solar energy potential, which has been estimated to be at least 8,074 MW according to the latest ADB study on the GMS RE development opportunities in 2015 (ADB, 2015). Solar development in Cambodia is at the pilot stage. As of 2012, the country had about 2 megawatt peak (MWp) of solar PV installed (Poch, 2013).

Cambodia does not have vast wind resources. On average, wind speeds across the country are under 3 metres per second (m/s). The technical potential represents an upper limit and shows 1,380 MW categorised at or above good wind speeds (WWF, 2016).The development of wind resource is in the early stages. A few projects have been piloted in the northeastern and southwestern provinces. The first wind turbine, costing roughly US$1.74 million, is in Preah Sihanouk province. It is co-funded by Cambodia’s Sihanoukville Port Authority (48%), Belgium (28%), the EU (24%), and was inaugurated in January 2010 (Poch, 2013).

Cambodia has significant biomass resources from forests, plantation forests, rice husks, and palm trees. Biomass can be used for power requirements or converted into other fuels. The 2015 ADB study estimated Cambodia’s theoretical biomass energy generation potential at 15,025 gigawatt-hour (GWh) per year while technical biogas potential from livestock manure is estimated at 13,590,766 kWh per day. Several large- scale projects are planned at various sugarcane and palm oil plantations. There are also smaller biomass pilot projects at rice mills, ice factories, brick factories, and garment factories – around 40 projects – with capacities between 150 kW and 700 kW.

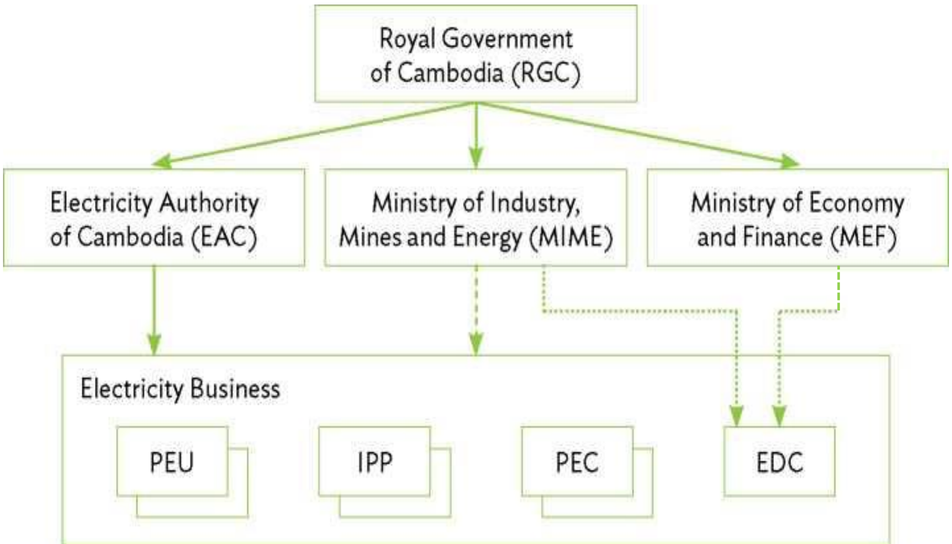
ii. Existing laws, regulations, policies, strategies, and development plans

Institutional Framework

The General Department of Energy of the Ministry of Industry, Mines and Energy is the main agency responsible for energy policies, plans, development strategies, and technical standards in Cambodia.

The Electricite du Cambodge is a state-owned utility responsible for power generation, transmission, and distribution. It is owned jointly by the Ministry of Industry, Mines and Energy and the Ministry of Economy and Finance. The Electricite du Cambodge accounts for more than 50% of installed generating capacity, but its coverage is largely limited to the country’s major centres. It serves 16% of households in Cambodia, mostly in Phnom Penh. About 600 rural electricity enterprises provide electricity to off-grid customers. These enterprises are usually small, locally owned enterprises serving local households and businesses with diesel-powered low-voltage distribution systems. In addition, a number of rural electricity enterprises provide battery-charging services to local households and businesses. Figure 8 shows the institutional framework for the power sector in Cambodia.

Figure 8: Power Sector Institutional Framework: Cambodia



EDC = Electricite du Cambodge, IPP = independent power producer, PEC = Private Electricity Company, PEU = provincial (or joint with private) electricity utility.

Source: Ministry of Industry, Mines and Energy.

Renewable Energy Development and Rural Electrification Policies and Targets

Cambodia's RE development and rural electrification policies are linked. The government's energy policy is aimed at (i) supplying adequate energy at affordable rates, (ii) ensuring the reliability and security of electricity supply to facilitate investments and advance national economic development, (iii) encouraging the socially acceptable development of energy resources, and (iv) promoting the efficient use of energy and minimising detrimental environmental effects resulting from energy supply and consumption.

The goals of the government's rural electrification programme are as follows:

- Provides safe, reliable, and affordable electricity to rural communities in a way that minimises negative impact on the environment;
- Provides a legal framework that encourages the development of RE sources by the private sector to supply electricity to rural communities;
- Supports RE initiatives;
- Promotes the adoption of RE technologies by setting electricity rates in accordance with the Electricity Law (2001);
- Promotes the use of least-cost forms of RE in rural communities through research and testing of grid and off-grid options; and
- Supports electrification in disadvantaged rural communities through funding assistance, training, and other means.

The government is targeting to achieving full electrification of villages by 2020, and 70% household electrification by 2030. The village electrification target involves about 14,000 villages (with almost 2.5 million households). The main components of rural electrification are (i) an expanded power grid; (ii) diesel stand-alone, mini-utility systems; (iii) cross-border power supply from neighbouring countries; and (iii) RE (solar, wind, mini and micro hydro, biogas, and biomass). In the short- and medium-terms, small village hybrid grid systems will also have an important role (ADB, 2015).

Incentive Framework

To help meet its rural electrification targets, the government has established the Rural Electrification Fund with the help of a loan from the World Bank and a grant from the Global Environment Facility. The fund administers grants in support of rural electrification, using both conventional technology and RE technologies, such as solar, mini and micro hydro, and biomass. Since 2008, the Rural Electrification Fund was created and then integrated with the Electricite du Cambodgein 2012 and they are now implementing three joint programmes:

- Solar home system programme, retaining the above incentive mechanism;
- Power to the Poor Program, which provides interest-free loans of $120 per household to cover the expenses for connection, deposit, meter installation, and wiring, to be repaid in 36 monthly instalments; and
- Assistance for the improvement of existing electricity infrastructure in rural areas or the development of new infrastructure, involving loan guarantees, interest-free loans of up to US$100,000, or a combination of grants and interest-free loans.

2.2.6. Thailand's renewable energy status and policy: Lessons learnt

i. Renewable Energy Resources in Thailand

Hydro and biomass are the two main sources currently used at a greater extent. The country has already exploited almost all economically viable hydro for electricity generation. The maximum potential of solar is estimated at 6,000 MW and wind at 3,000 MW (DEDE, 2015). Maximum exploitable potential of agricultural residues is estimated to be 15 million tonnes of oil equivalent (Mtoe). Plantation-based biomass is also estimated to supply an installed capacity of up to 10,000 MW. The total availability of municipal solid waste (MSW) is estimated at 2,064 kilotonnes of oil equivalent (ktoe) and biogas is estimated at 570 ktoe. The use of solar, wind, plantation-based biomass, MSW, and biogas are considered for power generation while agricultural residues are considered for cogeneration and residential cooking in the future. It is assumed that biomass-based energy resources used for power generation will be supplied by energy plantations grown on a sustainable basis, hence, the CO_2 emissions for biomass is assumed zero.

Table 12: Composition of the Thailand Power System (as of December 2014)

Classified by technology	(MW)	(%)
- Combined cycle	21,145	56.2
- Thermal	7,538	20.0
- Renewable	8,476	22.5
- Gas turbine/Diesel generator	153	0.5
- EGAT-TNB linkage	300	0.8
Total	**37,612**	
Classified by power producer		
- EGAT	15,482	41.2
- Independent power producers (IPPs)	13,167	35.0
- Small power producers (SPPs)	4,530	12.0
- Very small power producers (VSPPs)	2,029	5.4
- Power imports	2,404	6.4
Total	**37,612**	

EGAT-TNB: Electricity Generating Authority of Thailand – Tenga National Berhad
Source: PDP 2015 (EGAT, 2015).

ii. Thailand's Alternative Energy Development Plan

The Government of Thailand has been trying to push forward the Alternative Energy Development Plan (AEDP) as part of a strategy to be a low-carbon society. In the past, to attract investors, the Adder System was used to encourage renewable power generation. Currently, a FIT system is planned to be implemented to reflect the real cost of renewable power generation and specify the timeframe of purchasing. Previously, the timeframe of RE promotion – according to the PDP2010 revision 3 and the previous AEDP – was during 2012–2021. Called the AEDP-25% the target was to substitute fossil fuel consumption by 25% in 10 years. In the AEDP2015, the RE promotion schemes were designed to strengthen the community, lessen the dependence on fossil fuels, and address social problems such as MSW and agricultural waste. Thus, the 2015 plan intended to encourage waste, biomass, and biogas power generation as the first priority. This is in line with the policies of Thailand's Ministry of Agriculture and Cooperatives to increase the plantation areas of sugarcane and palm and raise the productivity of cassava from 3.5 to 7.0 tonnes per rai per year – increasing the potential by 1,500 MW. In addition, area by area zoning and power generation capacity-limitation measures were adopted to avoid the constraints from the previous plan.

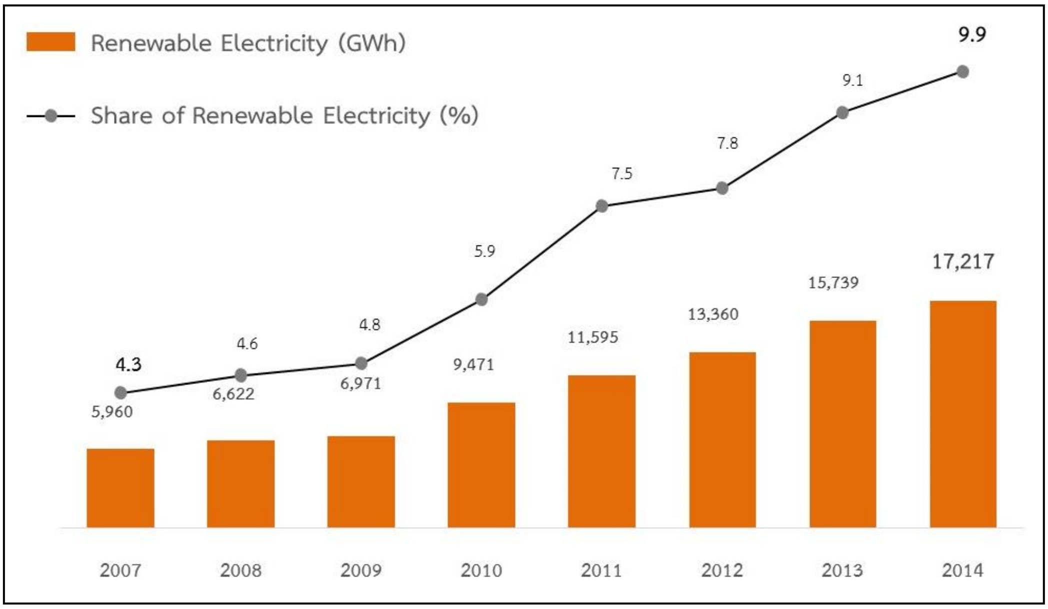
The main target of the AEDP2015 is to increase the portion of RE generation from the current 8% (in 2014) to 20% (by 2036) of the total power requirement, which accounts for 19,634.4

MW as shown in Table 13. In 2014, the share of natural gas in the fuel mix was 64%, which had decreased due to energy security concerns over imported gas. The AEDP2015 and PDP2015 aim to diversify fuels in power generation. By the end of the PDP2015, the aim of AEDP2015 is to cut natural gas to a share of 30%–40% from the current level of 64%. The proportion of RE is expected to rise to 15%–20% from the current 8%. An unspecified amount of coal capacity is supposed to be delivered as 'clean coal' by carbon capture and storage technology (which is currently at 0%. Hydropower should deliver 15%–20%. Consequently, shares of imported hydropower, clean coal/lignite, RE, and natural gas will be balanced in the long term.

iii. Renewable energy utilisation in Thailand

It is expected that technology improvement would build up the competitiveness of RE technology. Consequently, the nationwide RE electricity generation in Thailand has been increasing its share from 4.3% (5,960 GWh) in 2007 to 9.87% (17,217 GWh) in 2014 (Figure 9).

Figure 9: Progress of Renewable Energy Electricity Generation in Thailand



Source: PDP 2015 (EGAT, 2015).

The RE generation capacity of 17,217 GWh in 2014 included 1,298.51 MW solar PV, 2,451.82 MW biomass, 311.50 MW biogas from waste water, 224.47 MW wind power, 142.01 MW small hydro, and 65.72 MW MSW (Table 13). The Thailand's RE learning curve in Figure 9implies that the target of 20% RE generation in 2036 will be achieved. This RET achievement mainly comes from private investment.

In the AEDP2015, the high capacity target of 6,000 MW solar PV and 3,000 MW is due to a private proposal under consideration. It is advisable for the government to limit the ceiling capacity before launching RET policy. In Thailand, the capacity factor of solar is about 15% while wind power has a capacity factor of 20%. However, both solar and wind power have low capacity factors when compared to 40% for hydro and 80% for biomass. These figures also imply that incentives or subsidies are needed to make these RETs competitive with conventional power generation.

Table 13: RE Generation in 2014 and the AEDP2015 Target

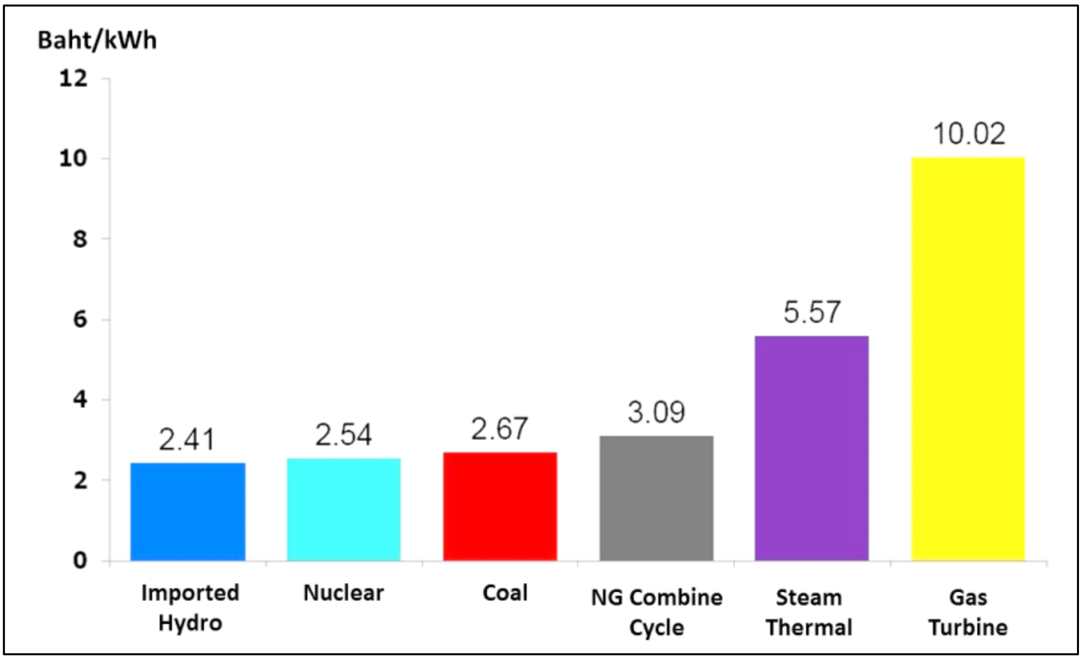
Type	Situation in 2014 (MW)	Target in 2036 (MW)
1. MSW	65.72	500
2. Industrial waste	-	50
3. Biomass	2,451.82	5,57
4. Biogas from waste water	311.50	600
5. Small hydro	142.01	376
6. Biogas from biomass	-	680
7. Wind	224.47	3
8. Solar photovoltaic	1,298.51	6
9. Hydro (storage)	-	2,906
Total(MW)	**4,494.03**	**19,684**
Electricity (GWh)	**17,217**	**65,588**
National Electricity Demand (GWh)	**174,467**	**326,119**
Share of RE (%)	**9.87**	**20.11**

AEDP = Alternative Energy Development Plan, GWh = gigawatt-hour, MSW = municipal solid waste, MW = megawatts, RE = renewable energy.
Source: MOEN, 2015.

iv. Policies and Instrument Promoting RET Deployment in Thailand

Power generation costs from RE resources in Thailand are higher than those of conventional energy resources such as coal, natural gas, and hydro (Figure 3). RE has been promoted to address global warming and climate change issues linked to greenhouse gas (GHG) emissions. The most well-known GHG is carbon dioxide (CO_2), mostly emitted from the combustion of fossil fuels in industrial sectors and electricity power generation. RE generation is competitive only at system peak generation for few hours. Therefore, to promote the fast growth of RET deployment, incentives are needed.

Figure 10: Levelised Generation Cost in Thailand (PDP2015)



Note: Exchange rate, 32 Baht = US$ 1
Source: EGAT, 2015.

Thailand is the first country in the ASEAN that promoted RET deployment through RPS, Adder tariff, and FIT mechanisms. Thailand introduced the RPS scheme in 2004, and then changed the policy by introducing the Adder tariff scheme in 2007 that provided a direct incentive to RET investors. As earlier noted, solar PV in Thailand has a very low plant capacity factor and is not economically and financially feasible. Therefore, Adder for solar PV was first set at B8.0 per kWh in 2007. Analyses of the Adder scheme show that all RETs are financially viable under an internal rate of return of 10% (Table 14). These internal rates of return confirm that RE generation, with Adders, will be financially competitive with conventional power generation from fossil-based plants.

The 'Adder' added a premium to the wholesale electricity price. Though the wholesale price is volatile and the premium was guaranteed for periods of only 7–10 years, on the RE learning curve of Thailand, Adder tariffs for all RETs are adjusted over time since 2007 to reflect the competitiveness of such RET. Solar PV shows a drastic decrease in its Adder over time (Table 15).

Table 14: Economics of Renewable Energy Generation in Thailand, With and Without Incentives

RET	IRR, without Adders (%)	IRR, with Adders (%)
Biogas	9	14
Small hydro	5	12
Biomass	4	11
Wind	2	11
Solar	NA	9

IRR = internal rate of return, NA = not applicable, RET = renewable energy target.
Source: Estimated by the Study Team

Table15: Thailand’s Renewable Energy Electricity Adders

RET	2007 (B/kWh)	2009 (B/kWh)	2010 (B/kWh)	Diesel Substitute (B/kWh)	3 South Provinces (B/kWh)	Years
Biomass						
< 1 MW	0.30	0.50	0.5	1.00	1.00	7
> 1 MW	0.30	0.30	0.3	1.00	1.00	7
Biogas						
< 1 MW	0.30	0.50	0.5	1.00	1.00	7
> 1 MW	0.30	0.30	0.3	1.00	1.00	7
MSW						
Landfill	2.50	2.50	2.5	1.00	1.00	7
Thermal Process	2.50	3.50	3.5	1.00	1.00	7
Wind						
< 50 MW	3.50	4.50	4.5	1.50	1.50	10
> 50 MW	3.50	3.50	3.5	1.50	1.50	10
Small hydro						
50 kW–200 kW	0.40	0.80	0.8	1.00	1.00	7
< 50 MW	0.80	1.50	1.5	1.00	1.00	7
Solar PV	8.00	8.00	6.5	1.50	1.50	10

B = baht, kW = kilowatts, MSW = municipal solid waste, MW = megawatts, PV = photovoltaic, RET = renewable energy target.
Source: DED, 2013.

In addition to the revised Adder tariffs for all RETs since 2007, Thailand also increased the RET deployment target, step by step. Table 14 presents the 1st Renewable Energy Development Plan (REDP20%) launched in 2009, changed to AEDP25% in 2012, and finally changed to AEDP30% in 2015 in AEDP2015. Please note that the share of RE in final energy consumption as set in REDP or AEDP includes RE electricity generation and biofuels in transport sector, and others.

Table 16: Development of RET in the AEDP

RET	REDP-20% in 2022 (ver. 2009)		AEDP-25% in 2021 (ver. 2012)		AEDP-25% in 2021 (ver. 2013)	
	MW	ktoe	MW	ktoe	MW	ktoe
Wind	800	89	1,200	134.36	1,800	201.54
Solar PV	500	56	2,000	223.93	3,000	335.90
Small hydro	324	85	84.65	84.65	324	84.65
Pump storage			670.90	670.90	-	-
Biomass	3,700	1,933	1,896.70	1,896.70	4,800	2,508.04
Biogas	120	54	268.72	268.72	600	268.72
Napier			-	-	3,000	1,791.46
Waste to energy	160	72	71.66	71.66	400	179.15
New RE	3.5	1	0.90	0.90	3	0.90
TOTAL	**5,608**	**2,290**	**3,351.81**	**3,351.81**	**13,927**	**5,370.33**

AEDP = Alternative Energy Development Plan, ktoe = kilotonnes of oil equivalent, MW = megawatts, PV = solar photo voltaic, RE = renewable energy, REDP = Renewable Energy Development Plan, RET = renewable energy target.
Source: AEDP2015 (DEDE, 2015)

In 2014, Thailand acknowledged the principle for employing a new FIT developed by the Ministry of Energy, which replaced the former Adder programme that had been in place for several years. The full policy for the FIT for very small power producers of less than 10 MW installed capacity was approved in 2014. The Ministry of Energy explained the introduction of the FIT for very small power producers as a first step because of the limited capacity of the transmission system.

The new FIT will be granted for 20 years, but landfill gas will receive support for 10 years only. The FIT rates differ greatly depending on power plant size and fuel types; different bonuses are granted for certain systems.

The Adder tariff mechanism expired on 31 December 2015 and was substituted by a FIT plus a premium model, which was especially supportive of projects up to 10 MW, especially for PV projects of up to 50 MW. Table 17 shows the 2016 FIT scheme of Thailand.

Table 17: New FIT for RET Deployment in Thailand

Capacity (MW)	FIT (B/kWh)			Duration (Years)	FIT Premium (B/kWh)	
	FIT_F	FIT v. 2017	FIT[(a)]		Biofuel projects (first 8 years)	Project in Southern Border Province [(b)] (lifetime project)
1. Waste (integrated waste management)						
Installed capacity ≤ 1 megawatt	3.13	3.21	6.34	20	0.70	0.50
Installed capacity > 1 – 3 MW	2.61	3.21	5.82	20	0.70	0.50
Installed capacity >3 MW	2.39	2.69	5.08	20	0.70	0.50
2. Waste (landfill)	5.60	-	5.60	10	-	0.50
3. Biomass						
Installed capacity ≤ 1 MW	3.13	2.21	5.34	20	0.50	0.50
Installed capacity > 1 – 3 MW	2.61	2.21	4.82	20	0.40	0.50
Installed capacity > 3 MW	2.39	1.85	4.24	20	0.30	0.50
4. Biogas (waste water/ waste material)	3.76	-	3.76	20	0.50	0.50
5. Biogas (energy plants)	2.79	2.55	5.34	20	0.50	0.50
6. Hydro						
Installed capacity ≤ 200 kW	4.90	-	4.90	20		0.50
7. Wind	6.06	-	6.06	20	-	0.50

B = baht, FIT = feed-in tariff, kW = kilowatts, kWh = kilowatt-hours, MW = megawatts.
Notes:
[a] This FIT rate applies to a project that delivers power into the grid in 2017, the FITv rate will be increased based on the core inflation rate. This only applies to waste (integrated waste management), biomass and biogas (energy plants) projects.
[b] Projects located in Yala, Pattani, Narathiwat and four sub-districts in Songkla (Kana Sub-district, Tapha Sub-district, Sabayoi Sub-district, and Natawee Sub-district only.
Source: AEDP, 2015.

The new FIT is composed of three components: FIT = FIT(F) + FIT(V) + FIT Premium.

FIT(F) is a portion of remuneration that is fixed throughout the whole period, while FIT(V) is a portion that varies according to the inflation rate. Variable portions are applicable only for certain technologies for which the feedstock price is considered to be volatile, such as for biomass and biogas from energy crops, and for waste-to-energy projects (excluding landfill gas projects). The FIT(V) rates were fixed for projects that dispatch electricity to the grid in 2017 FIT(V2017); after that, FIT(V) will be revised on an annual basis in accordance with the core inflation to reflect actual feedstock costs. The last component is the FIT Premium, which again is split into two categories: (i) additional FIT granted to promote the use of the certain renewable fuels and granted for the first 8 years of project lifetime, and (ii) a premium that is granted for the whole project duration for very small power producers located in three southern border provinces and four districts of Songkla province (i.e. Chana, Thepa, Saba Yoi, and Na Thawi).

v. Review on Barriers Incentive and Disincentive Mechanisms

Renewable Portfolio Standard (RPS)

In 2004, Thailand launched the RPS to encourage fossil-based power producers to increase their investment in renewable power plants by 3%–5%. Unfortunately, the RPS failed. It did not encourage RE deployment nor stimulate investment in RE. Thus, in 2009, the Government of Thailand changed the RPS policy to Renewable Energy Development Plant (REDP) and introduced strong subsidies in the form of Adders to most RET. Solar power received the largest subsidy of B 8.50 per kWh resulting in fast investment in RE.

Barriers on Limited T&D (Transmission and Distribution) Capacity

The AEDP would be integrated with the power demand forecasting to formulate the PDP2015. However, many limitations should be considered, for instance, the RE potential and power demand of each region. The transmission and distribution system has not been planned for the large amount of power generated from very small power producers, therefore, there is a possibility of reverse power flow problems, which would increase losses in the power system. This problem has occurred in the northeast part of Thailand where many solar and wind farms are located.

Role of the Energy Regulatory Commission

Currently, the Energy Regulatory Commission (ERC) of Thailand plays very small role in the AEDP, which was set by the implementing agencies. Consequently, the cost of subsidies in the form of Adders and FITs has been embedded in total national generation cost, which represents a burden to electric customers nationwide. In the future, the renewable purchase schemes would play a vital role in implementing the AEDP, thus, ERC will be responsible for monitoring the country's RE status, and revising the AEDP depending on the situation. As a result, private investors would have a clear picture of the country's RE development.

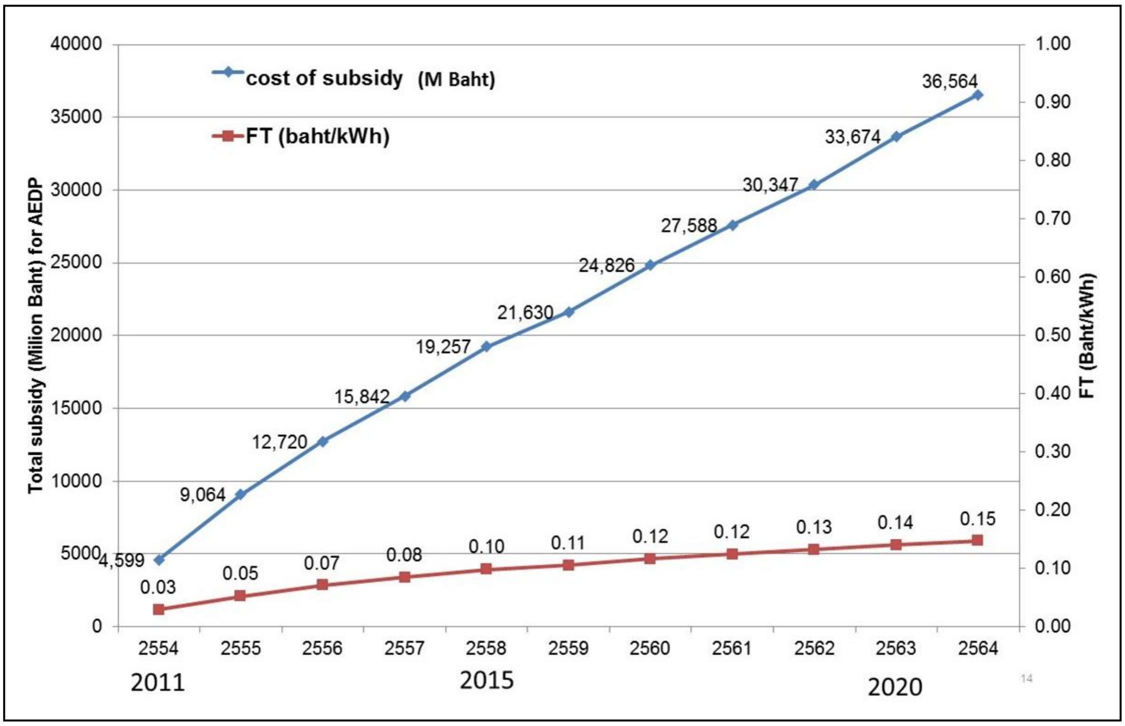
Benefits of RET Deployment in Nationwide CO_2 Reduction

The PDP2015 is inline and complies with AEDP2015, and if the new FIT is implemented successfully, the RE electricity generation will shift Thailand towards the so-called low-carbon society. CO_2 intensity in power generation is expected to decrease from 0.506 kg-CO_2/kWh in 2014 to 0.319 kg-CO_2/kWh in 2036. This target is quite ambitious for Thailand when compared with the previous power development plan. In terms of kt-CO_2 from the power sector, it will slightly increase from 89,678 kt-CO_2 in 2014 to 104,075 kt-CO_2 in 2036. The amount of CO_2 emissions from the power sector is almost stable due to the benefits of RET deployment in Thailand. This lesson in RET deployment is expected to help Thailand decouple economic growth from CO_2 emissions in the near future.

Impact of RET Deployment on Electricity Generation Cost

Both Adder and FIT schemes result in increasing electricity generation cost to the power producers and then this incurred cost is passed on to all electric customers in Thailand. With the 2013 Adder tariff, it is expected that the cost of subsidy to RET will be B36,564 million per year in 2021, resulting in increasing the retail tariff to customers at B0.15 per kWh when compared to the retail tariff of B3.50 per kWh in 2013. This burden cost will mainly come from subsidy to solar PV at higher Adder tariff. It is recommended that such impacts should be analysed before introducing Adder or FIT.

Figure 11: Impact of RET Deployment on Electricity Generation Cost

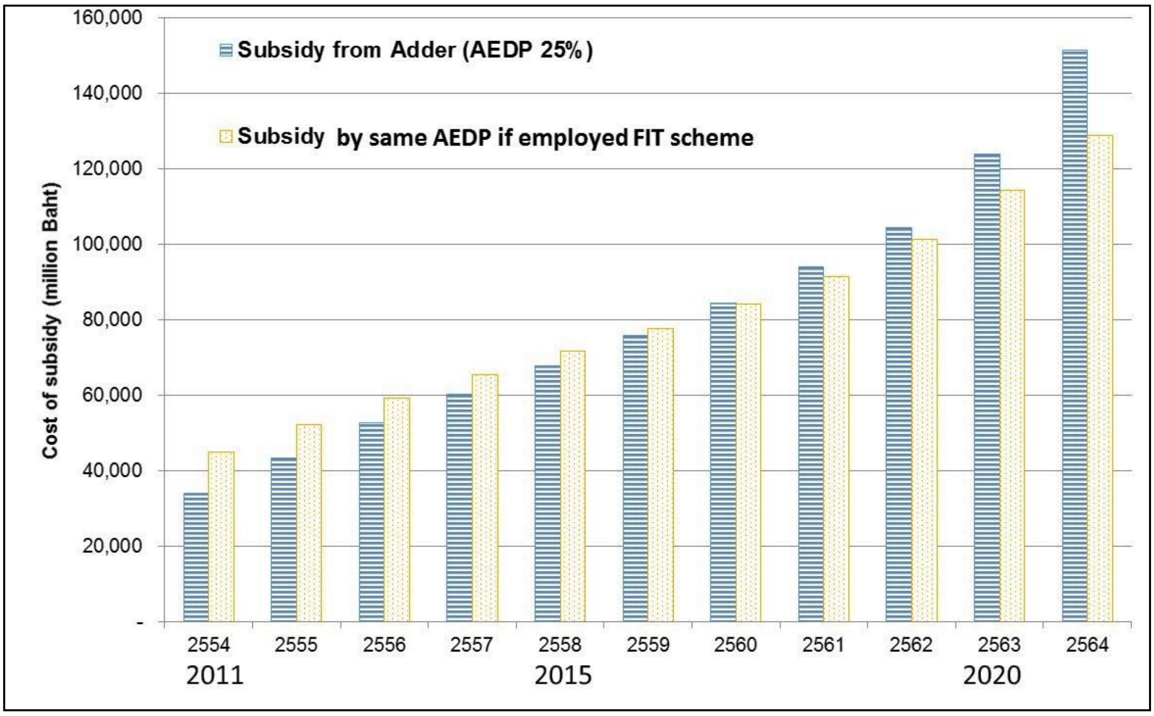


RET = renewable energy target.
Source: Estimated by the Study Team.

Adders vs. FIT – Which is better?

Thailand has employed Adder tariff for all RETs since 2007, and it was found that this subsidy cost will be go higher in the near future. Several studies have examined this mechanism. It was found that under the same target of RET capacity in the AEDP, the subsidy will be go lower when the FIT scheme is used to promote RET deployment (Figure 12). Finally, Thailand stopped the Adder scheme by the end of 2015, and started the FIT scheme for all RETs in 2016.

Figure 12: Impact of Renewable Energy Deployment under Adder vs. FIT Schemes



AEDP = Alternative Energy Development Plan, FIT = feed-in tariff.
Source: Estimated by the Study Team

2.2.7. Interregional cooperation for RE development

The region as a whole generally has a high potential for RE development. Some countries have high potential and relatively high penetration of RE capacity. However, the cooperation and harmonisation for RE development was very limited. Certainly, there is room to increase cooperation and harmonisation for both individual countries and the region. Expansion of renewables such as wind, solar, biomass, and geothermal would lead to an increase in diversity, assuming these do not completely displace another fuel source. However, increased RE share in power generation may have alternative impacts. For example, it could result in a higher cost of electricity or less jobs. Expansion into thermal is likewise not as clear-cut from a general perspective.

There are few initiatives in renewable energy regional cooperation, including joint studies on Renewable Energy Support Mechanism for Bankable Projects, Off-grid Rural Electrification Approaches, Renewable Energy Technical Standards in ASEAN, and the establishment of Energy Research Institutes Network. The online ASEAN Renewable Energy Information was established to provide key ASEAN information on RE studies, country profiles, and reports. The RE Business Directory and RE Permit Procedures were also completed and published. To help shape influential RE policies and increase deployment of RE projects in the region, several focus group discussions were organised, such as (i) on CO_2 reduction – Greater Role of RE in ASEAN Power Generation Sector, (ii) Impacts of Renewable Energy Integration through Grid Connection, (iii) RE Lending Guidelines, (iv) Business Models for Rural Electrification, (v) Technical Standards for PV Hybrid System, and (vi) Recommendation on RE Permit Procedures.

Since countries in the region were at different levels of RE policy regulation framework, interregional cooperation on RE standards, on exchange of information and lessons learnt, and on pilot and demonstration projects, it was seen that best practices and benchmarking would facilitate rapid RE deployment. There is a good opportunity for Cambodia, Lao PDR, and Myanmar to benefit from the experiences of Thailand, Malaysia, and Viet Nam in successfully implementing RE policy through interregional cooperation.

RE policy and planning in the region has developed individually given that these are at different stages of development. Hence, the level of integration in RE policy and planning in the region is still nascent among the countries and much need to be done to raise the expertise in this area.

From the review above, it appears that the most applicable instruments for the development of RE projects are (i) FIT with relevant level of tariff, (ii) simplified procedures for RE development permission, (iii) economic incentives, and (iv) financial support schemes. These instruments have been applied in the Greater Mekong Subregion countries with various levels of incentive. The interregional power exchange and cooperation in policy experiences may push further the improvement and refinement of these instruments for RE deployment in the region.

Chapter 3

Development of Alternative Policy Scenarios for Renewable Energy Power Generation in Viet Nam

This chapter covers the outlook of business-as-usual (BAU) and alternative policy scenarios (APSs) of renewable energy (RE) technologies for power generation, which are based on the assumption of gross domestic product (GDP) and population growth, changes in technology, oil price trends, and additional policies. The APSs assess the impact of RE policies on energy saving, energy security, and greenhouse gas (GHG) emission reductions, and calculate the costs and benefits of the different RE technology options. They also act as the basis for the evaluation and selection of mitigation technologies, which contribute to set up the strategies and policies for promoting appropriate RE technologies in Viet Nam and the region.

1. Background

In 2013, Viet Nam achieved GDP of US$92.28 billion in 2005 US$ terms. The commercial sector contributes the most to Viet Nam's GDP (43.86%), followed by the industrial sector (38.57%) and agriculture (17.57%). The population of Viet Nam in 2013 was 89.71 million, while GDP per capita was US$1,029 per person (at constant 2005 US$ values).

Although Viet Nam is well endowed with a wide variety of energy resources, the capacity for energy extraction, production, and distribution is limited, especially in the electricity sector, which has a negative effect on production and in improving the standard of living and augmenting income.

Although Viet Nam exports crude oil, production is limited by the capacity of the oil refinery. Viet Nam still imports oil products and will depend on outside supplies of oil until 2020, negatively impacting the economy, society, and the development objectives of Viet Nam.

In 2013, oil products reached 17,457 kilotonnes of oil equivalent (ktoe), of which 10,086 ktoe is exported; coal production reached 22,980 ktoe, of which 7,169 ktoe is exported.

At the end of 2013, the total installed capacity of all power plants was 30,597 MW. Commercial electricity consumption per capita is estimated to be 1,272 kWh/year per capita, considered high in the region.

The rural electrification programme has been implemented over the past few years. According to reports by the Electricity of Viet Nam (EVN), by the end of 2013, 99.6% of communes and 97.9% of households have access to electricity from the national grid, higher than most countries with the same GDP in the region and in the world.

Viet Nam has a high potential for developing RE, such as small-scale hydropower, biomass energy, wind energy, solar energy, and others, which can be utilised to meet energy demand especially in areas far from the grid. However, due to limited budgets and lack of technology, most of the population must rely on biomass, a non-commercial energy. As a result, Viet Nam has low commercial energy consumption per capita compared to other Asian countries.

Fast-paced economic development and GDP growth led to high energy demand, especially the demand for natural gas, electricity, and coal for the manufacturing industries and residential activities and this trend is expected to be maintained in the future. Thus, energy generation and consumption is going to be the main source of GHG emissions in the coming decades.

2. Data and Methodology

2.1. Data and assumption

For consistency, the energy demand in Viet Nam for the next 25 years was estimated using the econometric approach with the historical energy data taken from the Energy Balances for Non-OECD Countries compiled by the International Energy Agency (IEA). Socio-economic data, such as GDP and industrial GDP used in the modelling work, were taken from the *Statistics Year Book of Viet Nam* and the *World Development Indicators* published by the World Bank. Other data, such as population and population growth rates, were obtained from national sources. Where official data were not available, estimates were obtained from other sources or the Institute of Energy.

In projecting future energy demand and GHG emissions, the assumptions used were based on population, GDP, crude oil price, changes in technology, and the context of existing energy-related policies as well as RE source potentials.

i. Population

In 2013, the total population in Viet Nam was 89.71 million and is projected to increase at an average annual rate of 0.66%, reaching 107.24 million in 2040. The urban population is expected to increase from 28.98 million in 2013 to 55.67 million in 2040, which accounts for 52.03% of the total population (see Viet Nam Population Forecasts, 2009–2049, GSO, 2011). It is assumed that there is no difference in population between the BAU scenario and the APS.

ii. GDP

GDP grew at an average annual rate of 7.01% during 2005–2010, slightly down to 5.91% during 2010–2015 due to the global economic crisis. GDP projection is around 7.0% for 2016–2020[3] and is estimated to be 6.5% for the period 2021–2025, 6.0% during 2026–2030, 5.5% during 2031–2035 and 5.0% during 2036–2040.[4] These projections are used for the development of both scenarios – BAU and APSs.

iii. Crude oil price

Future changes in crude oil prices remain highly uncertain. In this study, the crude oil price, as measured by Japan's average import price (nominal dollars per barrel), is assumed to decrease

[3] See the socio-economic development plan for 2016-2020 (March 2016).
[4] See the ERIA-Working Group estimation in 2016.

from US$105 a barrel in 2013 to US$84 in 2020 and then increase to US$137 a barrel in 2030 and US$209 a barrel in 2040 (IEEJ, 2015).

iv. Technology development

Technology development is an important factor to impact on energy demand. Along with GHG emissions, these have been included in BAU.

On the demand side, technology substitutions and changes in energy efficiencies were considered based on existing technologies and the trend of changes in the past.

In power generation, thermal efficiencies by fuel (coal, gas, and oil) were projected based on future power plant technologies as forecast by the US Department of Energy's *Annual Energy Outlook, 2008.* Thermal efficiency is expected to improve considerably over time in the BAU scenario as more advanced generation technologies, such as natural gas combined cycle and supercritical coal plants become available.

v. Electricity generation fuel mix

The share of electricity generated at coal-fired power plants is projected to increase considerably, at the expense of other energy types (thermal and hydro). Viet Nam is expected to increase its imports of coal for power generation and electricity, particularly from the Lao PDR and China. The use of nuclear energy is assumed to start in 2028 in line with Viet Nam's nuclear power development plan. In the BAU scenario, it is assumed that the first unit of nuclear power, with a capacity of 1,200 MW, will be installed in 2028 and the following units of nuclear power with capacity of 1,100 MW will be installed in 2029 and 1,200 MW in 2030.

vi. Costs of power generation

Data on capacity, efficiency, capital, operation and maintenance (O&M) costs, and maximum availability (or maximum capacity factor) were obtained from the PDP VII and other published documents, as listed in Table 18.

Table18: Existing Power Sources and Costs of Power Generation, 2013

	Capacity (MW)	Capital Cost (US$/kW)	Fixed O&M Cost (US$/kW)	Variable O&M Cost (US$/MWh)**	Efficiency (%)	Maximum Availability (%)
Thermal coal	7,058	1,300	45.5	4.5	35	80
Hydro	13,336	1,700	13.6	2.5	100	60
Thermal gas	93	1,200	42	3.0	37	80
CCGT	7,074	1,020	45.9	3.0	49.5	80
Nuclear	0	4,000	130*	0.5	33	80
DO fired GT	264	900	31.5	4.4	49.5	80
FO	1,050	1,200	42	1.48	30	80
Small hydro	1,589	1,700	42*	2.5	100	45
Biomass	81	1,800	70*	6.7	32	60
Wind	52	2,000	40*	5.0	100	25

CGT = combined cycle gas turbine, GT = gas turbine, DO = diesel oil, FO = fuel oil.

Sources: Power Development Plan VII; *International Energy Agency (2014); **National Renewable Energy Laboratory (2010).

vii. Fuel costs

Table 19 presents the cost of fuel energy by type, which was derived from the 2012 energy statistics of Viet Nam.

Table 19: Cost of Fuel Energy

	Unit	Indigenous Cost	Import Cost	Export Cost
Anthracite coal	US$/tonne	45		
Bituminous coal*	US$/tonne	96		
Crude oil	US$/tonne			887.6
Electricity	US$/kWh		0.06	
Diesel oil	US$/tonne		958.4	991.4
Gasoline	US$/tonne		1,058	1,103
Kerosene	US$/tonne		1,035	1,071
Fuel oil	US$/tonne		7,13.4	749.2
Jet kerosene	US$/tonne		1,023	1,045
Liquid petroleum gas	US$/tonne		939	942
Natural gas	US$/million British thermal unit	4.75		

* With an average calorific value of 6,500 kcal/kg, compared to anthracite coal with 5,500 kcal/kg.
Source: Vietnam-National Energy Efficiency Program (2013).

Changes in these fuel prices over time are based on changes in the international crude oil price. The crude oil price is assumed to increase to US$137 a barrel in 2030 and US$209 a barrel in 2040 (IEEJ, 2015).

3. Methodology

Currently, there are many types of models such as optimisation models (e.g. MARKAL), simulation models (e.g. ENPEP), and accounting frameworks (e.g. Long-range Energy Alternatives Planning or LEAP). These models were accepted for integrated energy planning as well as mitigation analysis in the context of the United Nations Framework Convention on Climate Change (UNFCCC).

Unlike complex tools such as ENPEP or MARKAL, LEAP is a simple tool that does not require a great number of data and this makes it easy for users to develop different policy scenarios and to select the best solutions based on cost–benefit analysis.

LEAP is also flexible and can be used to create models of different energy systems based on available data, ranging from bottom–up, end-use techniques, to top–down approaches.

Moreover, LEAP has been widely applied in more than 190 countries worldwide and 10 member ASEAN countries also are using the LEAP model to analyse the energy saving potential in East Asia under the energy project of the Economic Research Institute for ASEAN and East Asia (ERIA). Hence, this study uses LEAP as a tool for this analysis.

In this study, LEAP was used to develop a baseline scenario (or BAU) to outline future energy demand during 2013–2040 based on GDP and population projections, changes in technology, and existing policies regarding the LEAP files from existing studies[5] by ERIA. Emission factors for each technology and fuel type are selected based on the values identified by the Intergovernmental Panel on Climate Change or IPCC (available in LEAP).

The APSs were based on the accessible potential of all types of RE sources, assuming that additional action plans or policies would be developed or likely to be considered. The differences between the BAU and APSs represent the additional RE consumption and potential fossil energy savings as well as potential GHG reduction. In estimating the primary energy requirements, an accounting model is used in which the future choice for technology and fuels are based on the programmes of the country and the most likely available supply in the future.

The assessment and selection of the prioritised RE technologies were carried out based on multiple criteria, including social, economic, and environmental aspects, which need to be evaluated for decision-making for setting up the strategy and action plans for RE development. The difficulty here is that not all criteria can be valued in monetary terms. In this case, the technique of multi-criteria analysis (MCA) was used – an approach widely used for decision-making that requires making choices between and examining trade-offs across multiple objectives of policy, such as growth, inclusion, and environment.

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[5] See LEAP file of Viet Nam, 2016.

Analytic Hierarchy Process (AHP) is one of the more widely applied MCA methods, which is a method for converting subjective assessments of relative importance to a set of overall scores or weights. The fundamental input to the AHP is the decision maker's answers to a series of questions of general form, such as 'How important is criterion A relative to criterion B?'. Although AHP has been used in many applications in both the public and private sectors, AHP still has several limitations. First, AHP was criticised for not providing sufficient guidance on structuring the problem to be solved, forming the levels of the hierarchy for criteria and alternatives. Second, the critique of AHP is the 'rank reversal' problem, i.e. changes in the importance ratings whenever criteria or alternatives are added to or deleted from the initial set of alternatives compared (Alexander, 2012).

Other use of MCA is a 'co-benefits approach' that was developed and applied by the National Action Plan on Climate Change for India's climate policy challenge. The co-benefits approach is a useful way for developing countries to address the issue of climate mitigation, but in a manner consistent with development objectives. The co-benefits analysis is intended to provide a framework for analysing the impacts of any policy objective under consideration on the full range of outcomes across economic, social, and environmental goals. Therefore, MCA with co-benefits approach was chosen as the tool for this study to prioritise RE technologies.

To support these strategies and action plans, the RE policy instruments applied effectively in other countries were reviewed and analysed based on the country-specific financial conditions to get the effective policies that could reduce the project costs of RE technologies.

4. Potentials on Renewable Energy Sources and Assumptions

Viet Nam has achieved a remarkable progress in economic development in recent decades. Together with rapid economic growth and implementation of rural electrification programme, electricity demand in recent years during 2001–2010 increased at a higher rate of 14.5%, and 10.3% during 2011–2015. Higher GDP growth over the same period caused the difficulties in the development of power generator sources. Due to increasing electricity demand, Viet Nam is expected to become an importer of electricity and coal for power generation in the coming years.

Though Viet Nam possesses significant natural resources, including RE such as biomass, solar energy, small hydropower, and reserves of crude oil, coal, and natural gas, its energy resources, as forecast, are unlikely to sustain economic growth at previous levels without imports and/or new sources of energy.

To meet such rapidly increasing electricity demand, the revised PDP VII envisages increasing the share of renewables in the energy mix to 6.5% of the total power generation in 2020, 6.9% in 2025, and 10.2% in2030. The bulk of this renewable capacity will come from small hydropower, solar PV, and wind power generation. In particular, the total solar PV power capacity is expected to increase from the current level, which is negligible, to around 850 MW by 2020, 4,000 MW in 2025, and 12,000 MW by 2030. Wind power capacity is estimated to increase to around 800 MW by 2020, 2,000 MW by 2025, and to 6,000 MW by 2030.

As noted earlier, the revised PDP VII and the Strategy for RE Development in Viet Nam are aimed at realising these targets for RE development. Currently, however, there are no concrete measures that include technical and financial support, no specific action plans, nor are there indications of institutional reform (including regulation or legislation) to support the achievement of these targets.

This section assumes that the proposed RE development under APS scenarios are based on the accessible potential and maximum ability of exploitation for all types of RE and from additional action plans or policies to be developed, which will ensure that the targets are met.

5. Small hydropower

The potential for small hydropower (SHP) (with a capacity of less than 30 MW per site) is estimated to be about 7,000 MW. By 2012, 157 SHP projects with total capacity of 1,269.4 MW will be in operation and an additional 163 SHP projects with total capacity of 1,683.0 MW are under construction. Moreover, over387 SHP projects with total capacity of 2,688.9 MW are being planned for the period. Thus, the total capacity of SHP that could be exploited is around 5,640 MW.

By 2013, the total installed capacity of SHP was 1,589 MW and is expected to reach 3,100 MW by 2020, 4,600 MW by 2030, and 5,640 MW by 2040.

To support SHP development, the Minister of Industry and Trade has released a decision on the 'Regulation on avoided cost electricity tariff and power purchase agreement' for SHP plants. However, almost all profitable feasible sites had been developed. The existing regulation on avoided cost for SHP is not likely to attract investors. Therefore, in BAU only 2,000 MW is assumed to be installed in 2020.

For APS, it is assumed that additional policy measures will support SHP development while almost all the potential capacity of SHP is exploited, as shown in Table 20.

Table 20: Installed Capacity of SHP in BAU and APS

	Installed Capacity (MW)			
Scenarios	**2013**	**2020**	**2030**	**2040**
BAU	1,589	2,200	2,200	2,200
APS	1,589	3,100	4,600	5,600

APS = Alternative Policy Scenario, BAU = business-as-usual, SHP = small hydropower.
Source: Government of Viet Nam (2016).

6. Biomass power plant

The main biomass sources that can be used to generate electricity are sugarcane trash, rice husks, and rice straws. Based on the production of bagasse and paddy in 2010, this study estimates that 4.8 million tonnes of bagasse, 8.0 million tonnes of rice husks, and 48.0 million tonnes of rice straws are available.

Due to abundant bagasse resources, the Revised PDP VII has set up a plan to develop biomass power generation in sugar mills with capacity estimated at around 500 MW by 2020 and 2,000 MW by 2030.

At present, bagasse is used for combined heat and power production in 40 sugar mills. The total installed power capacity of all such system is around 150 megawatt electric (MWe), with factory capacities ranging from 1.5 MWe to 24 MWe. Produced heat and power from these factories are mainly used for their own demand for pressing and producing sugarcane. Currently, only six power plants sell their surplus power 81 MW) to the national power network with 70 million kWh at a selling price ranging from US$3.0 to US$4.8per kWh. The opportunity to sell surplus from sugarcane factories is quite big due to expanding capacity that is also increasing. However, currently, the selling price is still low and proves to be a big constraint to further expansion.

So far, no biomass power plant is installed in Viet Nam due to high investment and production costs and the low selling price of electricity. However, 10 rice husk power plants with an average capacity of 10 MW per site are preparing investment reports. Almost all sites are in Mekong River Delta, where the rice husk resource accounts for 55% of total sources in the country.

So far, the current support mechanisms are not strong enough to encourage investment in biomass power plants. Therefore, in the BAU, it assumed that the installed capacity would increase from 81 MW in 2013 to 100 MW in 2020.

For APS, it is assumed that there would be additional policy measures to support biomass power plants; therefore, the total installed capacity is estimated to increase to 500 MW in 2020, 1,600 MW in 2030, and 4,000 MW in 2040.

Table 21: Installed Capacity of Biomass Power Plants in BAU and APS

	Installed Capacity (MW)			
Scenarios	2013	2020	2030	2030
BAU	81	100	100	100
APS	81	500	1,600	4,000

APS = Alternative Policy Scenario, BAU = business-as-usual, MW = megawatts.
Source: Government of Viet Nam (2016).

7. Wind power plants

With more than 3,000 kilometres of coastline and plenty of islands, the total potential wind energy in Viet Nam is estimated to be as high as 26,700 MW at speeds of over 6 metres per second (World Bank, 2001).

Currently, 48 projects on wind power development are registered in the whole of Viet Nam, concentrated in the central and southern provinces with a total registered capacity of 5,000 MW. Capacity per project ranges 6–250 MW.[6]

The first phase of a project located in Binh Thanh commune, Tuy Phong district, Binh Thuan province has just been completed with an installed capacity of 30 MW, including 20 wind turbines, each at 1.5 MW. The second phase was initially planned for construction in 2011–2015, and there were plans to increase its capacity to 120 MW. The first phase of the wind mill project was connected to the national grid in March 2011.

The second wind power project was implemented in the Mekong Delta, Bac Lieu Province. The first phase of 10 turbines of 16 MW was completed and connected to the national grid in September 2013. The second phase, completed during 2012–2015 increased its capacity to 99.2 MW.

Wind energy for power generation is one prioritised area as planned in the Revised PDP VII with the aim to achieve installed capacity of 800 MW in 2020 and 6,000 MW by 2030. The PDP VII is very ambitious and the target will be difficult to achieve because wind power is still not attractive to national and international investors. Investment is high and the price of electricity is too low at 7.8 US cents/kWh.

The low purchasing price at 7.8 US cents/kWh is considered the biggest obstacle facing investors. Hence, the second phase of wind power plant in Binh Thuan Province as mentioned above has not yet started.

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[6] Based on data from the Provincial Department of Industry and Trade where documents were updated until May 2011) (in Vietnamese).

Due to these reasons, in BAU, the installed capacity was assumed to increase from 52 MW in 2013 to 130 MW in 2015 if the purchase price of electricity from wind power did not change.

For APS, it is assumed that the total installed capacity would increase to 800 MW in 2020 and 5,000 MW in 2030, and 10,000 MW in 2040 – provided additional policy measures would support the wind power plants.

Table 22: Installed Capacity of Wind Power Plants in BAU and APS

	Installed Capacity (MW)				
Scenarios	**2013**	**2015**	**2020**	**2030**	**2040**
BAU	52	130	130	130	130
APS	52	130	800	5,000	10,000

APS = Alternative Policy Scenario, BAU = business-as-usual, MW = megawatts.
Source: Government of Viet Nam (2016).

8. Biogas energy

At present, biogas technology has developed in two directions – family size biogas plants and large-scale plants. Large-scale plants often use in big farms and foodstuff processing plants for replacing a part of on-grid power.

In Viet Nam, biogas has been used for electricity generation, contributing to saving energy and improving people's livelihood. Electric generators run by biogas have been installed in several provinces, such as Thai Binh, Bac Giang, Phu Tho, Da Nang, and Tien Giang, with good results. Almost all these power generation projects are small-scale and are connected to the grid.

In 2009, a biogas power generation project was installed at the pig farm of San Miguel Food Company in Ben Cat district, Binh Duong province. The project's total capacity is 17,000 cubic metres (m^3) and its power generation is 3.5 MW. Currently, four units with a total capacity of 2.0 MW (at 500 kW per unit) were put into operation in April 2011 but only for internal use.

Another grid-connected project with a capacity of 9 MW is being operated by the TH-True Milk Company. The plan is to install the plant in 2020 to deal with cow's waste in Nghia Dan district, Nghe An province.

To date, no biogas power plants are connected to the national grid due to high investment. There are also no support mechanisms for the development of biogas power plants.

For the BAU case, it assumed that there is no electricity from biogas while for APS case, it is assumed that the total installed capacity of biogas is30 MW in 2020, 150 MW in 2030, and

200 MW in 2040 provided there are policy support measures to incentivise the generation of biogas power.

Table 23: Installed Capacity of Biogas Power Plants in BAU and APS

	Installed Capacity (MW)			
Scenarios	**2013**	**2020**	**2030**	**2040**
BAU	0	0	0	0
APS	0	30	150	200

APS =Alternative Policy Scenario, BAU = business-as-usual, MW = megawatts.
Source: Government of Viet Nam (2016).

9. Solar energy

Viet Nam has a stable high solar radiation in the southern and central regions but it fluctuates by season in the northern region. Average solar in the south and central is about 5 kWh per square metre per day, fluctuating from 4.0 to 5.9 kWh per square metre per day. The solar radiation in the North fluctuates from 2.4 to 5.6 kWh per square metre per day.

Solar photovoltaic (PV) has been studied in Viet Nam since the start of the 1990s. The telecommunication and marine assurance sectors are pioneers in this field. Since 1992, solar PV has supplied electricity to households in rural remote mountainous areas.

Currently, the total capacity of solar PV units installed in Viet Nam is1.6 megawatt peak (MWp) and is mainly used for telecommunications, rural health services, population centres, battery-charging stations, and household systems. Only a small number are connected to the grid projects. The biggest grid-connected PV system was installed at the National Convention Center in Ha Noi in 2006 with a capacity of 154 kilowatt peak. Another 12 kilowatt peak was installed at the building of the Ministry of Industry & Trade (MOIT) in 2010. These projects are operated as demonstration projects (not commercial) – mainly for their own use.

So far, no large ground-mounted PV systems are in operation. However, there have been some announced investments in utility-sized PV power plants. Based on media reports in January 2015, a 30 MWp PV plant with an investment of US$60 million is being developed and planned to be grid-connected in the Quang Ngai province. Another announcement was a planned 100 MWp PV plant in central Viet Nam Quang Nam province. In March 2015, a Russian energy company with Singaporean and Vietnamese investment partners was planning to invest US$140 million but negotiations with EVN about 'market prices' are still ongoing.

The current costs of small PV systems in Germany fell to just US$2,200/kW in the second quarter of 2012 from an average of US$3,800/kW in 2010. The European Photovoltaic Industry Association forecasts that cost for small-scale rooftop PV system in the most competitive markets could decline between US$1,750 and US$2,400/kW by 2020. Large utility-scale PV projects could see their average costs decline to between US$1,300 and US$1,900/kW by 2020 (IRENA, 2013).

In this study, the average price of PV systems in Viet Nam is estimated to be US$3,500/kW in 2013 and projected to reduce to US$2,000/kW by 2020, and to US$1,000/kW by 2040. This trend of cost reduction could make PV systems competitive in the future.

An average total solar radiation of 5 kWh/m^2/day in most of the middle and the southern provinces of Viet Nam, could be exploited to meet increasing electricity demand and market for power generation.

As noted earlier, it is assumed that there are no solar PV power plants in the BAU scenario.

In an APS scenario, based on the Revised PDP VII, it is estimated that grid- connected PV could achieve 800 MWp in 2020, 10,000 MWp in 2030, and 16,000 MWp in 2040 – provided there are support polices.

Table 24: Installed Capacity of Solar Power Plants in BAU and APS

	Installed Capacity (MW)			
Scenarios	2013	2020	2030	2040
BAU	0	0	0	0
APS	0	800	10,000	16,000

APS =Alternative Policy Scenario, BAU = business-as-usual, MW = megawatts.
Source: Government of Viet Nam (2016).

10. Outlook Results: Business-as-Usual

The BAU scenario was developed based on assumptions that Viet Nam's demand for energy will continue to increase based on historical trends where GDP will continue to increase, and there will be lack of additional policies to promote RE development.

In view of a changing energy mix, the use of RE technologies will be considered based on previous trends in the absence of additional policies to encourage and support investors.

10.1. Final energy demand

Based on the input data and key drivers, such as GDP, population, and historical trends in energy consumption, the energy demand per sector and fuel type is projected as follows:

Final energy demand by sector

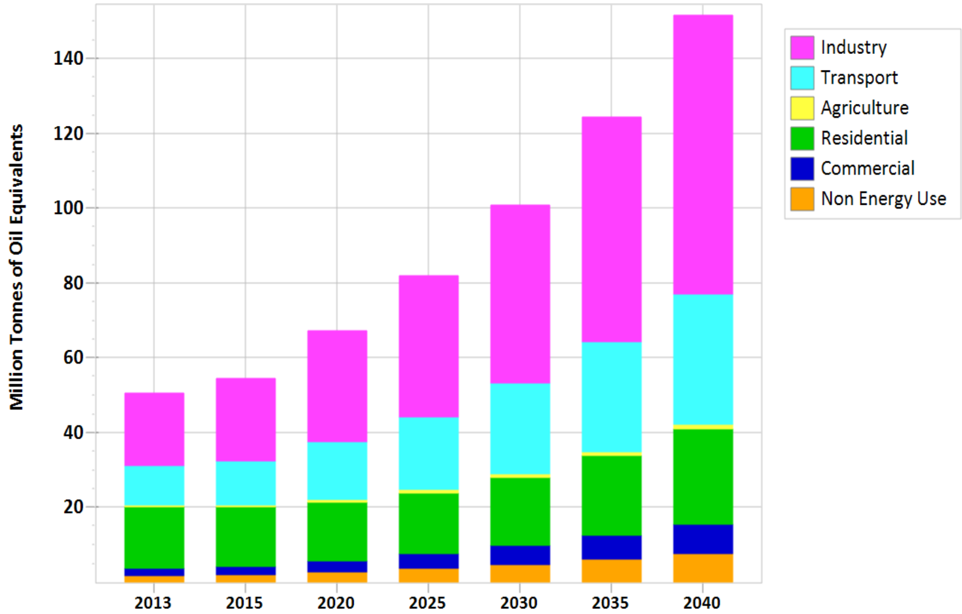
Under the BAU scenario, driven by assumed economic growth and a growing population, final energy consumption is projected to increase at an average rate of 4.2% per year between 2013 and 2040, with strong differences between sectors. On a per sector basis, the strongest growth in consumption is projected to occur in the commercial sector, increasing by 5.5% per year. This is followed by the industrial sector (5.1% per year), the transport sector (4.6% per year), the agricultural sector (2.0% per year), and the residential sector (1.7% per year). The non-energy use is expected to increase at growth rate of 5.7% per year.

Table 25: Final Energy Demand by Sector (Mtoe)

Sector	2013	2015	2020	2025	2030	2035	2040	AAGR (2013–2040) (%)
Industry	19.4	22.1	29.6	37.7	47.8	60.1	74.4	5.1
Transport	10.5	11.6	15.5	19.5	24.1	29.3	34.9	4.6
Agriculture	0.6	0.7	0.8	0.9	1.0	1.1	1.1	2.0
Residential	16.4	16.0	15.6	16.3	18.3	21.5	25.6	1.7
Commercial	1.9	2.1	3.0	3.9	5.0	6.4	7.9	5.5
Non-energy use	1.7	1.9	2.7	3.6	4.7	6.0	7.5	5.7
Total	**50.5**	**54.4**	**67.3**	**81.9**	**100.9**	**124.3**	**151.5**	**4.2**

Source: Calculation results derived from LEAP model.

Figure 13: Final Energy Demand by Sector



Mtoe = million tonne of oil equivalent.

Source: Calculation results derived from LEAP model.

Based on fuel types, under the BAU scenario, natural gas in final energy consumption is projected to grow rapidly, increasing by 7.4% per year between 2013 and 2040. Electricity demand is projected to exhibit the second highest growth, increasing by 6.1% per year between 2013 and 2040. Oil products are projected to grow at 5.0% per year, followed by coal at 4.5%.

Meanwhile, biomass fuels, such as wood, are projected to decline by 6.7% per year between 2013 and 2040 due to the impact of economic growth, which will translate into improved standards of living. As a result, energy consumers are expected to switch from biomass fuels with a low level of efficiency to alternative fuels (such as liquefied petroleum gas and electricity) with higher efficiency.

Table 26: Final Energy Demand Fuel Type (Mtoe)

Fuels	2013	2015	2020	2025	2030	2035	2040	AAGR (2013–2040) (%)
Coal	9.6	11.0	14.6	18.0	22.0	26.5	31.4	4.5
Natural Gas	1.3	1.6	2.5	3.6	5.1	6.9	9.2	7.4
Biomass	13.8	12.1	8.4	5.7	4.0	2.8	2.1	-6.7
Electricity	9.8	11.8	17.4	23.3	30.3	38.9	48.8	6.1
Oil Products	15.9	17.9	24.3	31.3	39.5	49.1	59.9	5.0
Total	**50.5**	**54.4**	**67.3**	**81.9**	**100.9**	**124.3**	**151.5**	**4.2**

AAGR = average annual growth rate, MTOE = million tonne of oil equivalent.
Source: Calculation results derived from LEAP model.

On the relation between GDP growth and energy demand, Viet Nam's energy intensity is projected to decrease during 2013–2040. Energy intensity of the country is to decrease from 547 tonnes of oil equivalent (toe)/million in 2005 US$ in 2013, to 338 toe/million in 2005 US$ in 2040. This is a good indication that energy will be used efficiently in the future for economic development.

Table 27: Energy Intensity

	2013	2015	2020	2025	2030	2035	2040
GDP (in 2005US$ billion	92.3	104.3	146.3	200.5	268.3	350.6	447.5
Total energy consumption (Mtoe)	50.5	54.4	67.3	81.9	100.9	124.3	151.5
Energy intensity (TOE/million in 2005US$)	547.0	522.0	460.0	409.0	376.0	354.0	338.0

GDP = gross domestic product, Mtoe = million tonne of oil equivalent.
Source: Calculation results derived from LEAP model.

10.2. Primary energy supply

Under the BAU scenario, Viet Nam's primary energy demand is projected to increase at an annual rate of 4.8% from 60.1 Mtoe in 2013 to 212.9 Mtoe in 2040, which is higher than the growth rate of the total final energy demand (4.2%). The reason is that the share of gas and hydro-based power generation up to 2040 is expected to decline due to the limitation of supply. These reductions are supplemented by coal fuel-based generation, which has lower than natural gas and hydropower plants.

Natural gas is expected to grow rapidly, increasing at an annual average rate of 6.5% between 2013 and 2040, followed by coal (at 6.3%), oil (at 5.1%) and hydropower (at 3.1%). Other supply sources (mostly biomass fuel) are projected to decline at an annual rate of 4.2% during 2013–2040 due to demand shifting towards commercial energy.

Table 28: Primary Energy Supply, BAU (Mtoe)

Fuels	2013	2015	2020	2025	2030	2035	2040	AAGR (2013–2040) (%)
Coal	16.2	17.7	30.3	38.4	48.9	64.9	83.6	6.3
Oil	16.4	18.3	25.4	33.0	41.8	51.2	62.8	5.1
Natural gas	9.0	9.5	10.9	18.6	26.4	37.1	49.2	6.5
Nuclear	0.0	0.0	0.0	0.0	2.8	2.9	2.9	-
Hydro	4.5	5.9	8.1	9.1	9.9	10.0	10.1	3.1
Others	14.1	13.0	9.8	7.3	5.8	4.9	4.4	-4.2
Total	**60.1**	**64.4**	**84.5**	**106.4**	**135.5**	**171.0**	**212.9**	**4.8**

AAGR = average annual growth rate, BAU = business-as-usual, Mtoe = million tonne of oil equivalent.
Source: Calculation results derived from LEAP model.

10.3. Power generation

Under the BAU, fuel inputs for power generation are projected to increase at an average rate of 6.5% per year between 2013 and 2040. The fastest growth will be in coal power generation (8.0% per year) followed by natural gas (6.4% per year), hydro (3.1% per year), and RE (2.2% per year).

Table 29: Power Generation Inputs by Type of Fuel, BAU (Mtoe)

Fuels	2013	2015	2020	2025	2030	2035	2040	AAGR (2013–2040) (%)
Coal	6.6	6.7	15.7	20.4	26.9	38.5	52.2	8.0
Oil	0.1	-	0.0	0.1	0.2	-	-	0.0
Natural gas	7.5	7.7	8.2	14.7	20.9	29.8	39.5	6.4
Nuclear	-	-	-	-	2.8	2.9	2.9	-
Hydro	4.5	5.9	8.1	9.1	9.9	10.0	10.1	3.1
Renewables	0.5	0.6	0.8	0.8	0.8	0.8	0.8	2.2
Total	**19.1**	**20.9**	**32.9**	**45.1**	**61.6**	**82.0**	**105.5**	**6.5**

AAGR = average annual growth rate, BAU = business-as-usual, Mtoe = million tonne of oil equivalent.
Source: Calculation results derived from LEAP model.

11. Evaluation of APS Scenarios for RE

As noted earlier, the APSs are designed based on the potential of RE sources under the assumption that additional action plans or policies are developed or considered. The outputs of the APSs will be used as the basis for assessing the impact of RE policies on energy saving, energy security, and GHG emission.

11.1. Input fuels demand for power generation

Under the APSs, new policies to encourage the exploitation of RE sources for power generation have significantly reduced fossil fuels as input fuels for power generation. RE sources are expected to grow at 12.6% per year, which is higher than 10.4% per year compared with BAU (2.2% per year). The increase in RE sources resulted in the reduction of other fossil fuels. Coal is expected to grow at 7.3% per year, which is lower than 0.7% per year compared with BAU (8.0% per year). Natural gas is expected to grow at 5.4% per year, which is lower than 1.0% per year compared with BAU (6.4% per year).

Table 30: Power Generation Inputs by Type of Fuel, APSs (Mtoe)

Fuels	2013	2015	2020	2025	2030	2035	2040	AAGR (2013–2040) (%)
Coal	6.6	6.7	14.4	17.4	21.5	31.2	43.8	7.3
Oil	0.1	0.0	0.0	0.1	0.2	0.3	0.3	2.8
Natural gas	7.5	7.7	8.1	14.4	18.4	24.5	31.0	5.4
Nuclear	-	0.0	0.0	0.0	2.8	3.0	3.2	-
Hydro	4.5	5.9	8.0	8.9	9.6	9.8	10.0	3.0
Renewables	0.5	0.6	1.8	3.0	5.6	8.4	11.2	12.6
Total	**19.1**	**20.9**	**32.4**	**43.7**	**58.2**	**77.3**	**99.5**	**6.3**

AAGR = average annual growth rate, APSs = alternative policy scenarios, Mtoe = million tonne of oil equivalent.
Source: Calculation results derived from LEAP model.

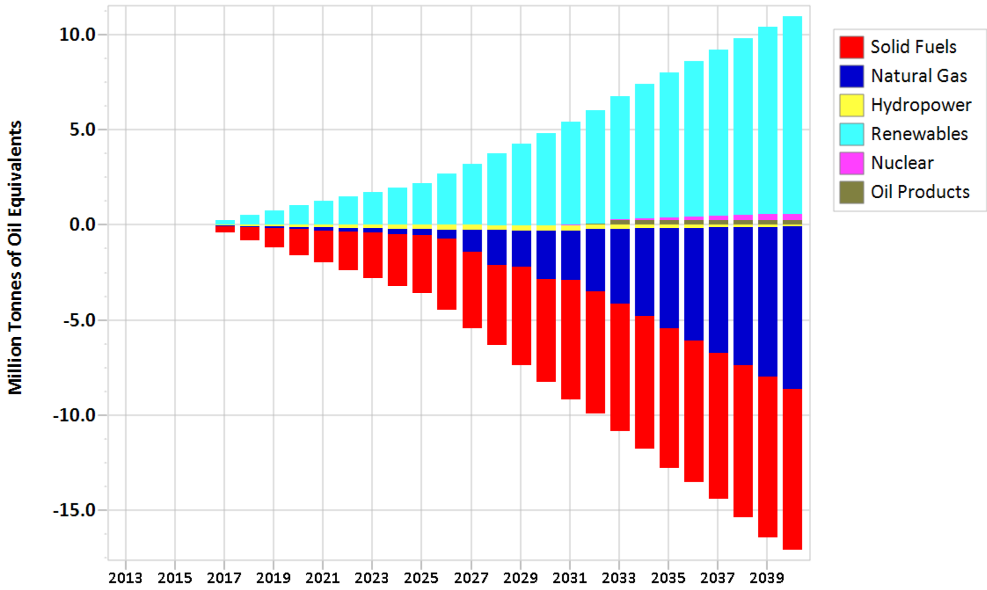
By 2040, power generation inputs of RE sources are expected to increase at an additional amount of 10.3 Mtoe, which corresponds to the reduction of inputs of traditional fuel energy types, mostly from coal (8.4 Mtoe) and natural gas (8.6 Mtoe).

Table 31: Power Generation Input by Technologies, APS vs BAU (in Mtoe)

Fuels	2013	2015	2020	2025	2030	2035	2040
Coal	0.0	0.0	-1.3	-3.0	-5.4	-7.3	-8.4
Oil	0.0	0.0	0.0	0.0	0.0	0.3	0.3
Natural gas	0.0	0.0	-0.1	-0.3	-2.6	-5.3	-8.6
Nuclear	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Hydro	0.0	0.0	-0.1	-0.2	-0.3	-0.2	-0.1
Renewables	0.0	0.0	1.0	2.2	4.8	7.6	10.3
Total	**0.0**	**0.0**	**-0.5**	**-1.4**	**-3.4**	**-4.7**	**-6.1**

Source: Calculation results derived from LEAP model.

Figure 14: Power Generation Input by Technologies, APS vs BAU



Source: Calculation results derived from LEAP model.

11.2. Power generation output

Moreover, RE-based power generation technologies such as small hydropower, wind power, solar PV, biomass, and biogas power plants were promoted to substitute for traditional power generation technologies, which resulted in significant increases in the share of RE power generation.

Table 32: Power Generation Output by Technologies, APS (billion kWh)

	2013	2015	2020	2025	2030	2035	2040
Coal	26.9	27.4	59.5	72.6	90.9	132.8	188.5
Natural gas	42.8	44.6	47.3	84.4	109.2	147.0	187.4
Hydropower	52.0	68.7	92.9	103.5	112.2	114.4	115.9
Nuclear	-	-	-	-	10.7	11.5	12.4
Oil products	0.5	-	0.1	0.5	0.6	1.3	1.3
Renewables	5.1	6.1	15.6	25.2	46.9	64.9	83.1
- Small Hydro	5.0	5.5	10.3	11.8	15.3	17.4	19.3
- Wind	0.1	0.2	1.7	4.1	10.4	15.9	21.5
- Solar	-	-	1.0	4.9	12.5	16.6	20.7
- Biomass	0.1	0.4	2.5	3.9	8.0	14.3	20.7
- Biogas	-	-	0.1	0.4	0.6	0.7	0.9
Total	**127.3**	**146.8**	**215.4**	**286.2**	**370.4**	**472.0**	**588.4**
Share of RE (%)	**4.0**	**4.2**	**7.2**	**8.8**	**12.7**	**13.8**	**14.1**

APSs = alternative policy scenarios, kWh = kilowatt-hour.
Source: Calculation results derived from LEAP model.

By 2040, the share of RE increases from the negligible rate (1.4%) in BAU to 14.1% in APSs. Wind contributes the highest share at 3.7%, followed by solar and biomass (3.5%), small hydro (3.3%), and biogas (0.1%).

Table 33: Share of Renewable Energy by Types of Technology (%)

	2013	2015	2020	2025	2030	2035	2040
Small hydro	3.9	3.8	4.8	4.1	4.1	3.7	3.3
Wind	0.0	0.1	0.8	1.4	2.8	3.4	3.7
Solar	0.0	0.0	0.5	1.7	3.4	3.5	3.5
Biomass	0.1	0.3	1.2	1.4	2.2	3.0	3.5
Biogas	0.0	0.0	0.1	0.1	0.2	0.2	0.1
Total	**4.0**	**4.2**	**7.2**	**8.8**	**12.7**	**13.8**	**14.1**

Source: Calculation results derived from LEAP model.

The above study results have been implemented based on the accessible potential of each type of RE with the assumption that there will be additional support policies for promoting RE. However, priority in the selections will be given to RE technologies, which have lower energy production cost and high potential on GHG emission reduction.

11.3. GHG reduction potential

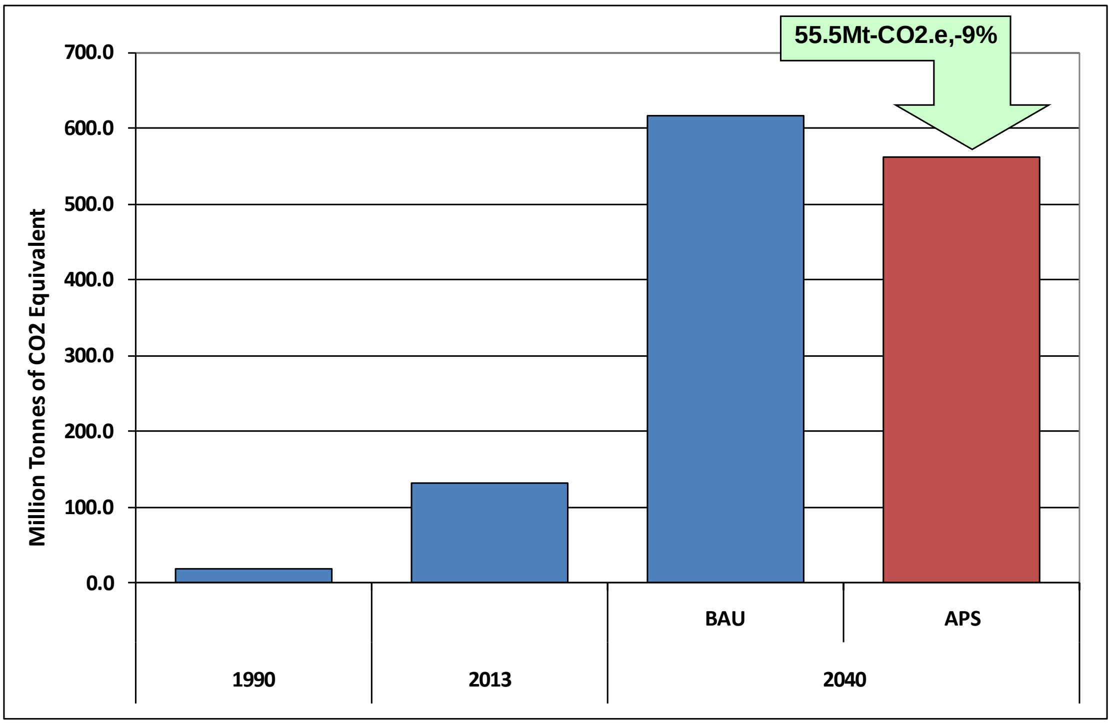
GHG emissions under the BAU scenario are projected to increase by 5.9% per year from 131.6 million tonnes of CO_2 equivalent in 2013 to 616.8 million tonnes of CO_2 equivalent in 2040. Under APS, the annual increase in GHG emissions between 2013 and 2040 is projected to be 5.5% yearly, which is 0.4 percentage points lower than the BAU scenario. Improvement in reducing GHG emissions under the APS will be 55.5 million tonnes of CO_2 equivalent (or 9 % reduction) in 2040, indicating that the goal to promote RE development in Viet Nam is very effective in reducing GHG emissions (Figure 15).

Table 34: CO_2e Emissions by Scenarios Up to 2030
(in million tonnes of CO_2 e equivalent)

Scenarios	2013	2015	2020	2025	2030	2035	2040	AAGR 2013–2040 (%)
APS	131.6	144.1	209.0	272.3	340.1	441.7	561.3	5.5
BAU	131.6	144.1	214.5	285.2	368.4	483.9	616.8	5.9
Reduction	-	-	-5.5	-12.9	-28.3	-42.3	-55.5	

AAGR = average annual growth rate, APS = alternative policy scenario, BAU = business-as-usual.
Source: Calculation results derived from LEAP model.

Figure 15: Evolution of CO_2e Emissions, BAU and APS



APS = alternative policy scenario, BAU = business-as-usual.
Source: Calculation results derived from LEAP model.

Chapter 4

Strategy Proposals for Renewable Energy Development

The Alternative Policy Scenarios (APSs), as noted earlier, were developed based on the accessible potential and ability of exploiting all types of RE for power generation with the assumption that additional policies will be implemented. Results show that the renewable energy (RE) resources could be exploited to contribute 14.1% of the total power production in 2040.

These outputs also depend on prioritised least-cost RE technology options. The strategy for RE development aimed at achieving the RE target and plan of action for Viet Nam is based on these assumptions – accessible RE resources, the adoption of least-cost technology, and the presence of supporting policies.

1. Prioritised Renewable Energy Technology Options

A total of five RE technologies are proposed in APSs for power generation, which will achieve the share of RE at 12.7% of total power generation output by 2030, and 14.1% by 2040. However, not all five RE technologies could be feasible because of low economic return and high greenhouse gas (GHG) abatement costs. The prioritised RE technology options are selected to achieve the targets of RE development based on co-benefit analysis to ensure balancing between the costs of GHG abatement and benefits of sustainable development of the country.

In this study, a Co-Benefits Based Approach (Dubash, et al., 2013), based on Multi-Criteria Analysis (MCA) will be used to evaluate the prioritised technology options when there are multiple important objectives. This method provides a clear and transparent process to guide decision-making based on criteria balanced for GHG abatement costs and benefits for sustainable development, as specified in each option.

1.1. Cost–benefit analysis

Investment for RE development will bring benefits to society, environment, and economy. This section focuses on the cost–benefit of RE technologies for power generation based on basic assumptions and input data.

i. Basic assumptions

Data on economic and technical specifications of each RE technology option were taken from published data, research results, and implemented relevant projects.

In the electricity generation module, data on power capacity, process efficiencies, capital cost, and operations and maintenance (O&M) costs were taken from the PDP VII of Viet Nam.

In other modules (such as natural gas production, oil refining, crude oil production, and coal production), the capacity data and other data on process efficiencies, capital costs, O&M costs, and others were referred to the PDP VII and other studies or overseas data.

The data on economic and technical specifications of each RE were referred from Vietnam's Intended Nationally Determined Contributions for Energy and Transport Sectors (Bao et al., 2015).

It is assumed that all RE technologies could replace coal-fired power thermal plants. The fuels used for these power plants include both domestic and imported coals. The cost of domestic coal is US$45 per tonne while the cost of imported coal is US$96/tonne.

Coal-fired thermal power plant's efficiency is 35% and maximum capacity factor (MCF) is 80%.[7]The investment costs for coal power plants are US$1,300/kW and the O&M costs are US$45.5/kW, with additional variable O&M costs of US$4.5/MWh. The lifespan of coal-fired thermal power plants is expected to be 30 years.

The environmental externality costs are also included in each scenario. Estimation of external costs of electricity generation requires complex databases and integration of simulated models, and externality-related studies.

Viet Nam so far has not officially carried out any study on the external costs associated with electricity generation. Due to a lack of sufficient data and evaluations to calculate externality costs in the power sector, external costs factors are extrapolated from other relevant studies in China, including nitrogen oxides (NO_x), sulphur dioxide (SO_2), and particulate matter (PM10), in which the cost of NOx is US$1,328/tonne, SO_2 is US$2,047/tonne, and PM10 is US$1,460/tonne (Nguyen-Trinh and Ha-Duong, 2015).

There are several estimates of the external costs of carbon dioxide (CO_2) emissions. The average cost of CO_2 control used by the European Commission is US$19/tonne). Some studies on these issues in China estimate the costs of CO_2 at US$50/tonne. Clean Development Mechanism projects use damage costs of US$7/tonne, which are based on the monetary benefits that power producers could earn if they reduced CO_2 emission during electricity-generating activities. For historical and near-term calculations, this value is acceptable and quite useful for both power producers and energy policymakers. In long-term projections, the average CO_2 control cost of US$20/tonne would be used (Nguyen-Trinh and Ha-Duong, 2015).

ii. Specific input data and results

Based on the assumptions above and the following input data for specific RE technology and the application of a 5% discount rate, the cost–benefit of each RE technology compared to BAU were calculated as follows:

Small hydropower plants

[7] MCF referred to as the maximum availability of a process is the ratio of the maximum energy produced to what would have been produced if the process ran at full capacity for a given period (expressed as a percentage).

It is assumed that the capacity of small hydropower plants (SHP) could reach 4,600 MW by 2030 and 5,600 MW by 2040, replacing coal power plants.

The MCF of SHPs is 40%. The investment cost for SHP is US$1,700/kW and the O&M cost is estimated at US$42.0/kW with additional variable O&M costs of US$2.5/MWh. The lifespan of SHP is 25 years.

Coal-fired thermal power plant's efficiency is 35% and MCF is 80%. The investment cost for coal power plants is US$1,300/kW and the O&M cost is US$45.5/kW, with additional variable O&M cost of US$4.5/MWh. The fuel cost for coal-fired thermal power is US$45/tonne. The lifespan of coal-fired thermal power plants is expected to be 30 years.

Based on the input data above, the cost–benefit of SHP compared to the BAU is calculated. All incremental costs relative to the BAU are shown as positive values, while benefits are shown as negative values.

Results show that the total social costs (including investment cost and O&M costs) for developing SHP plants are approximately US$2.04 billion, resulting in social benefits[8] of US$3.25 billion, with the majority accounted for by reduced fuel imports (US$1.75 billion) and environmental externalities (US$1.31 billion). Therefore, the net social benefits amount toUS$1.21 billion.

Table 35: Social Costs – Small Hydro Scenario Differences vs. BAU

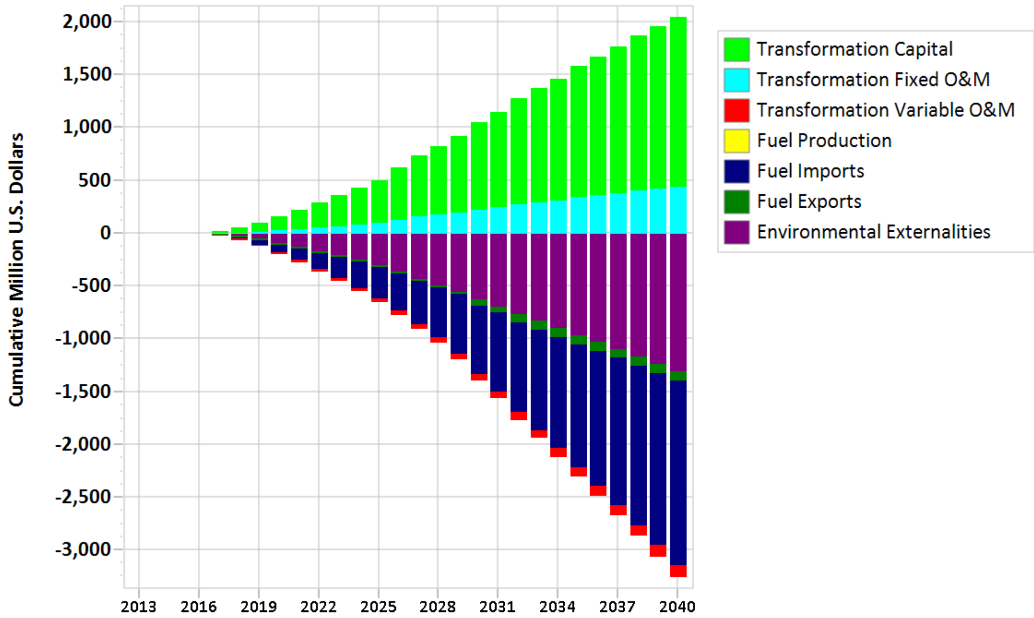
Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	157.0	499.0	1,048.3	1,578.2	2,041.3
Transformation capital	125.4	398.6	818.8	1,233.5	1,600.1
Transformation fixed O&M	31.6	100.4	229.5	344.6	441.2
Benefits	-191.3	-644.9	-1,392.3	-2,299.7	-3,250.0
Fuel production	-0.0	-0.1	-0.2	-0.2	-0.2
Fuel exports	-17.4	-17.4	-56.6	-84.1	-84.1
Fuel imports	-72.2	-297.8	-653.3	-1,167.1	-1,749.8
Transformation variable O&M	-8.0	-25.9	-51.1	-77.3	-104.2
Environmental externalities	-93.6	-303.7	-631.1	-970.9	-1,311.7
Total	**-34.3**	**-145.8**	**-344.0**	**-721.5**	**-1,208.8**

Source: Calculation results derived from LEAP model.

[8] Benefits are shown as negative values, while costs are shown as positive values.

Figure 16: Social Costs – Small Hydropower Scenario Differences vs. BAU



BAU = business-as-usual.
Source: Calculation results derived from LEAP model.

Biomass power plants

The assumption is that Viet Nam's biomass power capacity could reach 1,600 MW by 2030 and 4,000 MW by 2040 to replace coal power plants.

The efficiency of biomass power is 31.5% and MCF is 60%. The investment cost for biomass power plants is US$1,800/kW and the O&M cost is US$70/kW, with additional variable O&M costs of US$6.7/MWh. The fuel cost for biomass thermal power is US$25/toe. The lifespan of biomass power plants is assumed to be 30 years.

Results show that the total social costs (including investment cost, O&M costs, fuel production, and export) for developing biomass power plants are approximately US$1.68 billion, resulting in social benefits of US$3.41 million, with the majority accounted for by reduced fuel imports (US$2.23 billion) and environmental externalities (US$1.19 billion). Therefore, the net social benefits amount to US$1.73 billion.

This biomass power scenario requires more fuels, such as diesel and residual oil for power generation, to meet the peak power requirement resulting in the reduction of the amount of oil products for export of US$85.4 million compared with BAU scenario in terms of costs.

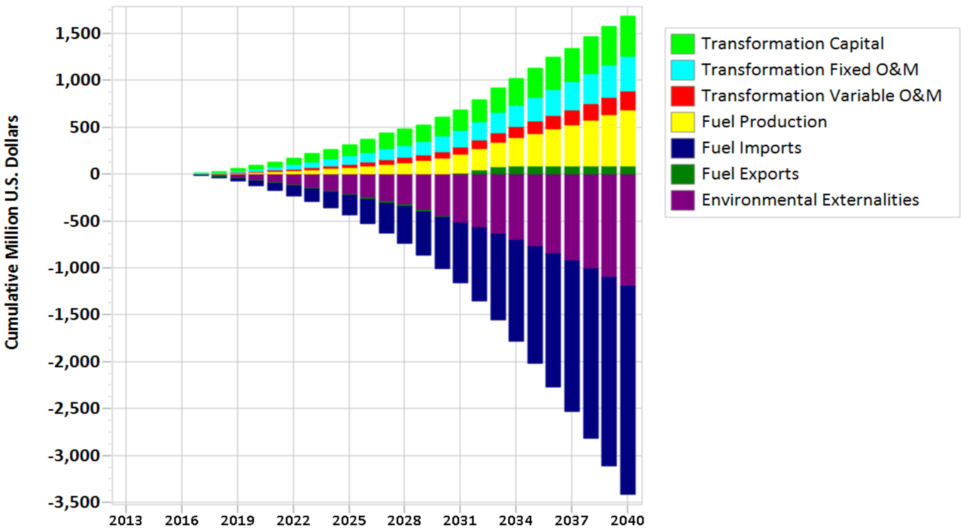
Table 36: Social Costs – Biomass Power Scenario Differences vs. BAU

Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	81.2	302.7	600.6	1,132.3	1,683.7
Transformation capital	36.5	121.4	209.7	314.2	429.0
Transformation fixed O&M	26.2	88.0	161.2	255.7	369.1
Transformation variable O&M	9.9	33.4	70.2	128.8	198.9
Fuel production	19.4	70.7	170.3	348.1	601.3
Fuel exports	-10.8	-10.8	-10.8	85.4	85.4
Benefits	-111.4	-427.0	-999.5	-2,017.0	-3,414.9
Fuel imports	-49.0	-212.7	-548.6	-1,244.2	-2,225.1
Environmental externalities	-62.4	-214.3	-450.9	-772.8	-1,189.8
Total	**-30.1**	**-124.3**	**-398.9**	**-884.7**	**-1,731.2**

BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Figure 17: Social Costs – Biomass Power Scenario Differences vs BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Wind power plants

It is assumed that wind power plants could reach 5,000 MW by 2030 and 10,000 MW by 2040 to replace imported coal power plants.

Wind power farms have an average load factor of approximately 25%. The investment costs for wind power farms are US$2,000 per kW and the O&M costs are US$ 40 per kW, with additional variable O&M costs of US$5.0 per MWh. The lifespan of wind power plants is 20 years.

Results show that the total social costs (including investment cost and O&M costs) for developing wind power plants are approximately US$5.57 billion, resulting in social benefits of US$3.96 million, with the majority accounted for by reduced fuel imports (US$2.36 billion) and environmental externalities (US$-1.59 billion). Therefore, the net social cost is US$1.61 billion.

Table 37: Social Costs – Wind Power Scenario Differences vs. BAU

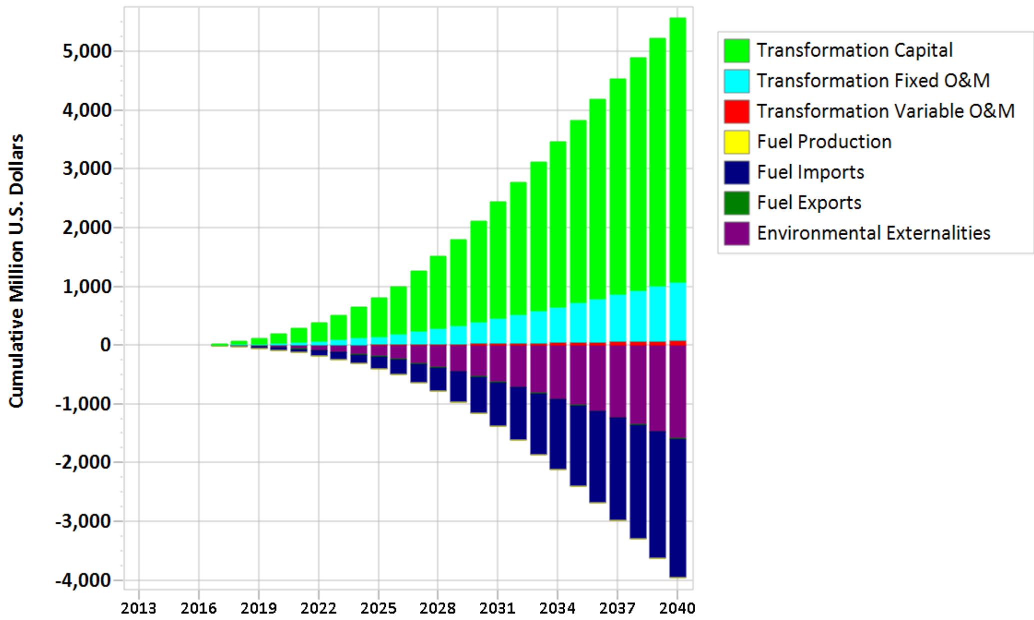
Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	186.8	802.7	2,111.8	3,821.2	5,565.8
Transformation capital	152.7	654.2	1,714.0	3,100.1	4,493.3
Transformation fixed O&M	31.5	137.3	369.9	670.3	998.8
Transformation variable O&M	2.6	11.3	27.9	50.7	73.7
Benefits	-85.3	-399.5	-1,164.7	-2,399.1	-3,957.7
Fuel production	0.0	-0.1	-0.1	-0.2	-0.3
Fuel exports	-6.7	-6.7	-6.7	-6.7	-6.7
Fuel imports	-35.0	-198.5	-619.3	-1,368.1	-2,361.1
Environmental externalities	-43.5	-194.2	-538.5	-1,024.0	-1,589.7
Total	**101.6**	**403.2**	**947.1**	**1,422.1**	**1,608.1**

BAU = business-as-usual, O&M = operations and maintenance.

Source: Calculation results derived from LEAP model.

Figure 18: Social Costs– Wind Power Scenario Differences vs BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Solar photovoltaic power plants

It is assumed that the total installed capacity of grid-connected PV power plants will reach 10,000 MW in 2030 and 16,000 MW in 2040 to replace imported coal power plants.

The MCF of PV power plants is 15%. PV power plants require capital investments of US$3,500/kW in 2013 (which is expected to decline to US$1,000/kW in 2040), and O&M costs of US$35/MW. The lifespan of grid-connected PV systems is around 25 years.

Results show that the total social costs (including investment cost, O&M costs, and fuel export) for developing solar PV power plants are approximately US$6,316.0 million, resulting in social benefits of US$5.28 billion, with the majority accounted for by reduced fuel imports (US$3,552.1 million) and environmental externalities (US$1.35 billion). Therefore, the net social cost is US$1.04 billion.

This solar PV scenario requires more fuel, such as diesel and residual oil, for power generation to meet the peak power requirement resulting in the reduction of oil products for export (or US$772.1 million in terms of money) compared with BAU scenario.

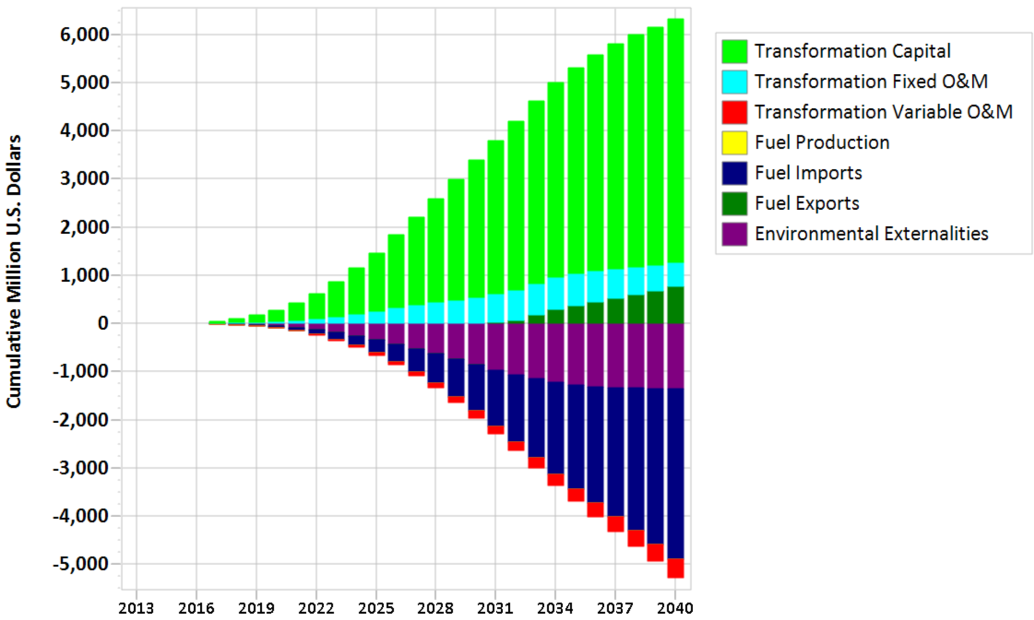
Table 38: Social Costs – Solar Photovoltaic Scenario Differences vs. BAU

Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	261.0	1,463.0	3,391.5	5,311.9	6,316.0
Transformation capital	223.2	1,214.0	2,849.6	4,281.4	5,058.9
Transformation fixed O&M	38.6	249.8	542.7	659.2	485.1
Fuel exports	-0.7	-0.7	-0.7	371.4	772.1
Benefits	-94.1	-658.0	-1,961.1	-3,695.3	-5,278.7
Transformation variable O&M	-7.2	-47.2	-138.0	-254.5	-372.8
Fuel production	0.0	-0.1	-0.1	-0.1	0.0
Fuel imports	-36.5	-274.9	-967.8	-2,158.3	-3,552.1
Environmental externalities	-50.5	-335.8	-855.2	-1,282.4	-1,353.9
Total	**166.9**	**805.1**	**1,430.4**	**1,616.6**	**1,037.3**

BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Figure 19: Social Costs– Solar Photovoltaic Scenario Differences vs. BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Biogas power plants

It is assumed that the total installed capacity of biogas power plants could reach 150 MW in 2030 and 200 MW in 2040 replacing imported coal power plants.

The energy efficiency for biogas power generation is 32% and the MCF of biogas power plants is 50%. These plants have an average investment cost of US$820/kW and O&M costs of US$115/kW, with an added variable O&M cost of US$0.1/MWh. The lifespan of biogas power plants is approximately 20 years.

The average cost of a biogas digester with a volume of 10m^3 is US$580 and the annual average production capacity is about 1,200m^3/year. The investment cost is approximately US$900/toe/year (with heat value of biogas of 5,380 kcal/m^3). The O&M costs are estimated at 3% of the investment cost, or US$27/toe/year. The lifespan of biogas digester is approximately 10 years.

Results show that the total social costs (including investment cost and fixed O&M cost) for developing biogas power plants are approximately US$254.0 million, resulting in social benefits of US$282.3 million, with the majority accounted for by reduced fuel imports (US$161.8 million) and environmental externalities (US$101.3 million). Therefore, the net social benefits amount to US$28.3 million.

Table 39: Social Costs – Biogas Power Scenario Differences vs BAU

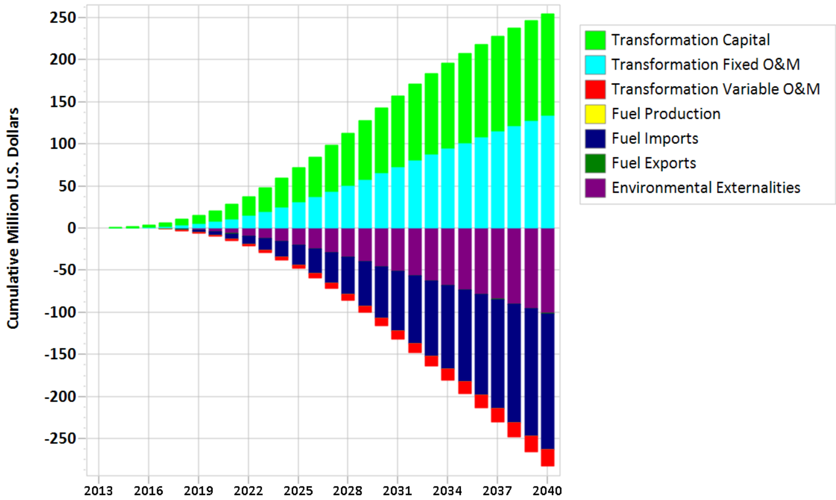
Unit: Discounted 2013 cumulative US$ million

	2015	2020	2025	2030	2035	2040
Costs	**1.92**	**20.68**	**71.30**	**142.56**	**206.93**	**253.99**
Transformation capital	1.55	13.02	40.60	77.09	105.56	120.21
Transformation fixed O&M	0.37	7.66	30.70	65.47	101.37	133.78
Benefits	**0.00**	**-9.84**	**-48.20**	**-116.06**	**-196.80**	**-282.30**
Transformation variable O&M	0.00	-0.88	-4.06	-9.00	-14.19	-19.10
Fuel production	0.00	0.00	-0.01	-0.01	-0.01	-0.02
Fuel imports	0.00	-4.56	-23.92	-61.25	-109.11	-161.78
Fuel exports	0.00	-0.09	-0.09	-0.09	-0.09	-0.09
Environmental externalities	0.00	-4.31	-20.12	-45.70	-73.39	-101.32
Total	**1.92**	**10.83**	**23.10**	**26.51**	**10.13**	**-28.32**

BAU = business-as-usual, O&M = operations and maintenance.

Source: Calculation results derived from LEAP model.

Figure 20: Social Costs – Biogas Power Scenario Differences vs. BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

1.2. GHG abatement costs of RE technologies

The overall cost of reducing GHG emissions and the total cumulative GHG emissions avoided by each RE scenario are summarised in Table 40.

Table 40: Mitigation Potentials and Costs

Units: 2013 US$ million

	Solar PV	Biogas	Wind	Small Hydro	Biomass
Transformation	5,171.2	234.9	5,565.8	1,937.0	997.0
- Electricity generation	5,171.2	90.7	5,565.8	1,937.0	997.0
- Biogas production	-	144.2	-	-	-
Resources	-2,780.0	-161.9	-2,368.1	-1,834.1	-1,538.4
- Production	-0.0	-0.0	-0.3	-0.2	601.3
- Imports	-3,552.1	-161.8	-2,361.1	-1,749.8	-2,225.1
- Exports	772.1	-0.1	-6.7	-84.1	85.4
Environmental externalities	-1,353.9	-101.3	-1,589.7	-1,311.7	-1,189.8
Net present value	1,037.3	-28.3	1,608.1	-1,208.8	-1,731.2
GHG savings (million tonnes CO_2e)	147.5	9.5	175.2	129.3	143.9
Cost of avoiding GHGs (US$/tonne CO_2e)	7.0	-3.0	9.2	-9.3	-12.0

CO_2e = carbon dioxide equivalent, GHG = greenhouse gas, PV = photovoltaic.
Source: Calculation results derived from LEAP model.

From the above results, some comments could be drawn, as follows:

- The RE technologies used for power generation lead to savings in GHG emissions ranging from 9.5 million to 175.2 million tonnes of CO_2 equivalent. Similarly, the incremental costs vary from -US$1.73 billion to US$ 1.61 billion.
- Environmental externalities or externality costs contributed significantly to making RE technologies feasible in terms of economics and costs of GHG reduction.
- Three of five technologies can be implemented at negative incremental costs. Biomass power technology replacing coal power plants is most cost-effective in reducing GHG emissions, followed by SHP and biogas power technologies. Solar PV power, followed by wind power plants, has the highest incremental cost due to high investment costs.

1.3. Selection of prioritised RE technologies

1.3.1. Methodology for selection

As noted earlier, the MCA method was used to evaluate the prioritised technology options based on criteria that reflect the objectives of RE development, GHG reduction, and sustainable development.

The process of selecting prioritised technology options was implemented with the following steps:

- Identify the criteria and sub-criteria for the selection of priority technologies based on the context and information available in Viet Nam.
- Prepare the information sheets for each RE technology option to support the selection.
- Describe the expected performance of each option and score the option against each criterion.
- Assign weights for each of the criteria to reflect their relative importance to the decision.
- Combine the weights and scores for each of the options to derive the overall value.
- Examine the results.

An effective approach to carry out the MCA method for the selection of prioritised technology options is to use a facilitated workshop with participants chosen to represent all the key perspectives on the issues.

First, the information sheets, including criteria and sub-criteria for the selection of prioritised RE technologies, were prepared by a technical group.

The rating scores through the MCA process is made by using the following rating scheme:

1 – Faintly desirable

2 – Fairly desirable

3 – Moderately desirable

4 – Very desirable

5 – Extremely desirable

The meeting was organised by the Institute of Energy (IE) to select the prioritised technology options, with 15 participants who are RE experts, economists, and managers from IE.

Participants were introduced to the purpose of the selection, information on RE technologies, and the method of scoring and weighting each criterion.

The scores were approved at a rate from 1 to 5 and assessed by the values associated with the consequences of each option for each criterion.

The weights were to be measured on a scale from 0 to 1. The rating weights were derived individually through a process of evaluating the important levels of each criterion and then compared in a group discussion to finally determine the weight for the criterion.

Criteria for selecting priority technologies

The following were the major criteria, which were discussed and adopted by the stakeholders:

Table 41: Criteria for Selecting Priority Technologies

<table>
<tr><th colspan="2">Multiple Benefits</th><th>Specifications</th><th>Weights</th></tr>
<tr><td rowspan="2">GHG emission reduction</td><td>GHG reduction potential</td><td>Options with large enough abatement potential to have a significant mitigation impact on the sector or at national levels.</td><td rowspan="2">0.25</td></tr>
<tr><td>Abatement cost</td><td>Options should have low abatement costs to attain feasibility in investment.</td></tr>
<tr><td colspan="2">Alignment with government priorities</td><td>Options should conform to the national strategies, sectoral development, priorities, and plans.</td><td>0.2</td></tr>
<tr><td rowspan="2">Economic benefits</td><td>Economic development</td><td>Contribute to economic development by developing new industries, creating investment environment, building and maintaining infrastructure, reducing costs, and opening more opportunities for business.</td><td rowspan="2">0.18</td></tr>
<tr><td>Increased energy security</td><td>Reduced energy imports (or dependence from the outside) will contribute to a stable and sustainable economic development.</td></tr>
<tr><td rowspan="2">Social benefits</td><td>Creation of new jobs</td><td>Create work opportunities and improve incomes.</td><td rowspan="2">0.17</td></tr>
<tr><td>Health conditions</td><td>Improve health conditions.</td></tr>
<tr><td rowspan="2">Local environmental benefits</td><td>Air quality</td><td>Reduce concentration of toxic gases and dust.</td><td rowspan="2">0.2</td></tr>
<tr><td>Other benefits (Biodiversity, land and water quality)</td><td>Ensure the quality of land and water.
Ensure the natural balance and ecosystem (such as river basins, forests, etc.)</td></tr>
</table>

GHG = greenhouse gas.

Source: Authors, compiled from various sources.

1.4. Result of the selection of prioritised RE technologies

The results of assessment and making scores for each technology by each criterion are presented in Table 42.

Table 42: Result of Selection for Prioritised RE Technologies

Option	GHG emission reduction	Alignment with government priorities	Economic benefits	Social benefits	Local Environ-mental benefits	Total
Small hydropower	1.25	0.60	0.72	0.51	0.40	3.48
Biomass power	1.25	0.80	0.72	0.51	0.40	3.68
Wind power	0.75	1.00	0.72	0.51	1.0	3.98
Solar PV	0.75	1.00	0.54	0.51	1.00	3.80
Biogas power	0.50	0.60	0.54	0.68	0.80	3.12

GHG = greenhouse gas, PV = photovoltaic, RE = renewable energy.

Source: Result from IE's group meeting.

From the above results of assessment for prioritising RE technology options, some comments could be drawn, as follows:

- Wind power is the first priority with its highest score of 3.98 point, followed by solar PV (3.8 point). Both technologies got high scores on environment benefits and in the country's development priorities (see Annex 2).
- Biomass and SHP are the third and fourth priorities with 3.68 and 3.48 points, respectively, because these technologies got high scores on GHG emission reduction potential.
- Biogas power got the lowest score at 3.12 point due to its low potential in GHG emission reduction and low economic benefits.
- All RE technologies were prioritised with different ranges for development to achieve the RE development targets, feasibility in investments, and in reducing GHG emissions.

2. Proposals on Strategy for RE Development

2.1. Targets of RE development

i. General target

The general target of RE development is to achieve 14% of RE in total power generation output by 2040.

ii. Specific targets

Specific targets are set for each RE technology based on assumptions made in the above APSs. The specific targets for each RE technology are arranged from higher to lower priority in the following:

Wind power technology

- By 2030: Installation capacity of wind power will reach 5,000 MW.
- By 2040: Installation capacity of wind power will reach 10,000 MW.

Solar PV power technology

- By 2030: Installation capacity of solar PV will reach 10,000 MW.
- By 2040: Installation capacity of solar PV will reach 16,000 MW.

Biomass power technology

- By 2030: Installation capacity of biomass power will reach 1,600 MW.
- By 2040: Installation capacity of biomass power will reach 4,000 MW.

Small hydropower technology

- By 2030: Installation capacity of SHP will reach 4,600 MW.
- By 2040: Installation capacity of SHP will reach 5,600 MW.

Biogas power technology

- By 2030: Installation capacity of biogas power will reach 150 MW.
- By 2040: Installation capacity of biogas power will reach 200 MW.

2.2. Proposed action plans to implement RE development targets

i. Identify the barriers to RE development

Although Viet Nam is endowed with RE resources, investment in RE technology is still insignificant. There are many barriers to large-scale development of RE technologies. These barriers were identified in several presentations and workshops, and interviews with stakeholders (IISD, 2012). The major barriers are summarised and presented as follows:

Economic barriers

- The investment cost of RE projects is higher than conventional energy projects.
- Longer payback period and lower rate of return.
- Low electricity tariffs exist due to the indirect subsidies available to power production from natural gas and coal, hence, making RE power difficult to compete with other conventional power plants.

Technical and human-capacity barriers

- Weakly developed supply chains and a lack of energy service provision, and O&M of RE equipment.
- Domestic technologies have not been developed and most of RE technologies are imported.
- Lack of specialised consultants, technical knowledge, and skills to implement RE projects.

Financial barriers

- Limited and unattractive feed-in tariffs (FIT) for RE in Viet Nam (currently available only for small hydro, wind power, and biomass, and these are considerably lower than in neighbouring countries).
- Limited finance is available from international financial institutions but depends on the project's feasibility.
- Lack of a sustainable mechanism to provide subsidy for RE projects.
- Difficulties in accessing financial resources from commercial banks due to a low rate of return.

Regulatory, legal, and institutional barriers

- Lack of regulation and clear procedures for planning, installing, connecting, and operating RE power projects.
- Inadequate policies and mechanisms to support RE projects.
- Cumbersome requirements for establishing plans for RE development.
- Information barriers.
- Lack of data on RE resources making it difficult for planning programs and projects.
- Lack of information on RE technologies and of service providers.

ii. Prepare roadmap action plans

To achieve the RE development target, a roadmap action plan is proposed to address the existing barriers. This requires the following actions for stakeholders:

- Government will act as a market enabler to encourage the economic organisations to participate in RE development and utilisation. Government will also protect the legal rights and interests of developers and users.
- The Ministry of Industry and Trade (MOIT) is to represent the state in elaborating the policies, regulations, and institutional arrangements to support and promote RE development.
- The Ministry of Planning and Investment will take the lead role in allocating funds for RE promotion and for research and development.
- The Ministry of Finance is responsible for fiscal incentives and energy tariff policies.
- The Ministry of Natural Resources and Environment is responsible for issues on environmental regulation and standards.
- The Ministry of Construction is responsible for national building standards and RE-related technologies.
- The Ministry of Education and Training is responsible for technical and capacity-building activities on RE technologies.
- The General Directorate of Energy under MOIT is responsible for implementing state management on RE. The Electricity of Viet Nam (EVN) implements policies and regulations in installing, connecting, and operating RE power projects.

The following action plans are proposed to remove the barriers and support RE development:

Table 43: Proposed Roadmap and Action Plan

Measures	Activity	Responsibility	Time Frame
Supportive policies	Set up effective policies on investment incentives.	MOIT (GED), MOF	2017–2025
	Set in place support systems to encourage no-regret and low abatement cost measures.	MOIT (GED), MPI	2017–2025
	Encourage and promote the development of a biomass fuel market.	MOIT (GED)	2017–2025
	Implement environmental regulation in the farms to encourage the use of biogas plants.	MONRE, MOIT	2017–2020
	Develop testing and standards of technology, such as biomass boilers, biogas systems etc. to improve the reliability of the technologies.	MOIT (GED)	2017–2020
Technical and human capacity building	Facilitate the training and education on the technology, form groups of technicians, and share experiences with international experts.	MOIT, MOET	2017–2025
	Develop business skills among appropriate groups to enable efficient preparation and implementation of RE projects.	MOIT, MOET	2017–2020
	Develop infrastructure and maintenance services.	MPI, MOIT	2017–2030
Regulation and institution	Develop regulations and clear procedures for planning, installing, connecting, and operating RE power projects.	MOIT (EVN)	2017–2020
	Develop institutional and legal framework to support RE projects.	MOIT (GED)	2017–2020
Information	Develop an information collection system on data of RE resources, technologies, and prices.	MOIT (GED)	2017–2030
	Build a communication system to provide sufficient and updated information to stakeholders.	MOIT (GED)	2017–2030

GED - General Energy Department, MOIT =Ministry of Industry and Trade, MPI = Ministry of Planning and Investment, MONRE = Ministry of Natural Resources and Environment, RE = renewable energy.
Source: Authors, compiled from various sources.

2.3. Proposals on policy and institutional framework for RE development

i. Proposals on policy and institutional framework

From the above analysis of the status of policies and of Viet Nam's institutional framework, this study suggests a move forward to implement an action plan through the following measures:

Develop comprehensive legal framework for RE development

- In the short term, it is necessary to revise the current legal system to ensure the preparation of investment incentives that are transparent and easy to understand. Revise also the current prices that EVN offers – notably FITs for wind power and SHP – and establish FITs for biomass and biogas power plants.
- In the long term, Viet Nam should consider revising the law on RE development. The revised law should provide adequate regulatory foundations for electricity market competition, product quality and standardisation, investment incentives, fiscal incentives, procedures for establishing and operating RE projects, power purchase tariffs, small power purchase agreements, and so on. The law should also provide for the establishment of a Renewable Energy Development Fund that supports all types of RE technologies including biogas, solar energy, and biofuels.

Initiate institutional arrangements

- The role and responsibility of ministries on state management of RE should be regulated by the law in which the MOIT has a decisive role in all RE issues with the support and assistance of other ministries.
- Under MOIT, the New and Renewable Energy Department should be assigned as focal point on national management of RE. This department will act on behalf of the government in RE promotion activities, such as setting up subsidy mechanisms, planning, arranging fund, and managing RE projects.
- The EVN should move forward quickly to enable the evolution of a competitive power market that treats all investors equally and allows investment incentives to work.

Establish a Renewable Energy Development Fund

- The aim of the Renewable Energy Development Fund is to support activities such as the conduct of surveys and assessments of RE resources and building data information systems; research and development and setting up standards; facilitate training and education; and offer subsidies to domestic manufacturers to improve the product quality.
- The fund's activity mechanism is not for profit and will be established by the MOIT and the Ministry of Finance.

- Contributions to the fund will come from royalties collected for the exploitation of natural resource, carbon taxation, or external costs of fossil fuel–based electricity generation outputs.

Chapter 5
Conclusions and Recommendations

1. General Comments on the Renewable Energy Policy

For the Lower Mekong Basin Region (LMBR) and other countries in the region, there is no magic policy instrument that fits all. The countries in the region have adopted various targets, incentives measures, and policy instruments. The different types of policy instruments are well known. These are explained in various articles and reports. Before looking at what new policy instruments could be applied to address the main barriers, policies that are already in place should first be identified. Policymakers could select based on what policy instruments could be applied.

Table 44: Proposed Instrument and Policy Types

Instruments	Policies
Legislative instruments	- Law and regulations - Standards - Codes of practice - Fiscal
Economic instruments	- Subsidies - Property and tradable rights - Bonds and deposit refunds - Liability systems
Voluntary instruments	- Voluntary agreements - Information and programmes - Research and development

Source: Authors, compiled from various sources.

Identified policy instruments should be assessed to determine which one is the most suitable to address the barrier and thus improve energy efficiency in the target industry. The following criteria can be used to evaluate instruments:

- Environmental effectiveness,
- Economic efficiency,
- Budgetary impact,

- Ability to implement and enforce, and
- Support from stakeholders.

The policy review report mentioned earlier describes these criteria and presents a general evaluation against these criteria.

Action areas need to be defined, including measurable and realistic targets, legislation on standards and labelling, systems of market-based incentives, knowledge and information programmers, and an institutional environment that is conducive. Effective policymaking requires effective mechanisms for regular evaluations to determine whether targets and policies need to be revised.

Following the evaluation of different policy instruments, the most appropriate instrument needs to be selected. In practice, this study recommends a *mix of policy instruments* because one instrument may not be enough to effectively address all the problems and issues.

2. Conclusions

Countries in the region are endowed with RE sources such as biofuels, biogas energy, SHP, wind power, and solar energy. With a growing demand for electricity, and faced with a reduction in the availability of fossil fuel resources, the government has developed an overarching policy framework for the RE sector. However, the current legal framework and incentive mechanisms were not adequately developed, and many barriers on policy and institutional framework still exist.

This study has evaluated the potential and ability of exploiting each RE technology that can contribute to the national targets for RE development, and has prioritised RE technology options and proposals on strategy for RE development to achieve the targets of RE development by 2030 and 2040.

The following conclusions could be drawn from the results of the study:

- Viet Nam can achieve an RE target of 14.1% total power generation in 2040. Wind contributes the highest share at 3.7%, followed by solar and biomass at 3.5%, small hydro at 3.3%, and biogas at 0.1%.
- The main barriers for achieving the target of RE development include (i) limited access to capital; (ii) limited attractiveness to financiers because of indirect subsidies to power production from natural gas and coal; (iii) limited and unattractive FITs for RE power generation; (iv) limited understanding of RE technologies at the local level; (v) cumbersome requirements for establishing plans for RE development; (vi) weakly developed supply chains; and (vii) a lack of energy service provision, operation, and maintenance of RE equipment.
- The results of RE technologies proposed for power generation show that there are several options with low or negative abatement costs, such as biomass, SHP, and biogas that could provide a pure win–win solution in implementation, getting economic benefits while reducing GHG emissions. In many cases, these options save

money overall, so with careful implementation, many sectors of the society could enjoy net economic benefits from these options, including reduced local and regional air pollutants, jobs creation, and other benefits.

- Based on the criteria on GHG emission reduction potential, the country's development priorities and benefits on the economy, the society, and the environment, wind power plant was selected as the first in the prioritised range, followed by solar PV, biomass, and biogas. All RE technologies could be prioritised at different ranges to achieve the target of 14% of RE by 2040.

3. Recommendations

3.1. Policy recommendations

Based on the landscape of RE policy discussed above, policy recommendations that should be considered are as follows:

- The assessment of policy options should include both the effectiveness and efficiency of alternatives. It is important to check whether policies achieve the desired outcomes, while meeting the demand for electricity, including those for the disadvantaged communities, at low cost
- Policy needs to be considered comprehensively. For example, integrating carbon pricing and resource pricing within the overall context is needed in achieving RE outcomes.
- While the East Asia Summit (EAS) region has abundant RE potential, the geographic distribution and exploitation status vary. If further promotion of RE is desired, further measures are needed.
- RE policy should be selected by taking into account the availability, maturity, market scale, and others of the RE generation technologies.
- Ways to share the cost of RE introduction should be well considered prior to the implementation of support scheme. To keep the support cost under control, support policy should include a system design that encourages market competition of RE supply, especially where the generation cost may fall rapidly.
- When the implementation cost of RE policy is to be recovered from the electricity users as FIT surcharge, considering its regressivity, it is necessary to consider measures that include the exemption of households below a certain level of power consumption.
- While cost measures are important, in order to expand the use of RE whose costs are currently high, it is essential to secure and maintain the stability of the policy to reduce investment risks. Long-term stability is particularly

important when investing in asset-specific developments. For this reason, policy uncertainty must be minimal and retroactive change in the system needs to be avoided. To ensure the stability of the investment environment, the measures adopted in Europe would be informative, where linkage between the RE power selling price and the market price was maintained at a high level and yet the long-term power purchase agreement is stipulated.

- At the same time, to avoid the over-subsidy of RE, it is best to share the vision of RE expansion in the long run, by clearly indicating in advance the conditions and schedule of reducing the support level based on certain criteria such as upper limit in the RE volume introduced at a certain period of time, and by setting the prospect of system change ('exit strategy', e.g. from FIT to FIP).
- When a subsidy is granted using the electricity tariff, there is a concern that the support to RE will distort power market (the market mechanism not functioning properly, or sending wrong price signals) and excessive support will put a cost burden on the government. Therefore, discussions to rationalise the subsidy are required.
- Initiatives must also be taken on obstacles other than financial incentives (e.g. lack of human resources, complicated regulations and procedures), with learning from best practices in other countries (e.g. acceleration of licensing procedures in Germany by specifying the development promotion zones [zoning] by local governments).
- Along with the increase in variable RE, measures to stabilise the electricity grid will become necessary, while maintaining the high degree of reliability demanded by consumers. It is important to consider how to bear those costs, including grid operation measures and/or expansion of grid infrastructure in line with the expansion of RE generation. It is also desirable to optimise system reinforcement and/or the construction of backup power sources. Thus, a comprehensive policy framework will be needed that would oversee the grid system and other related policy areas, such as smart communities, demand response, innovative storage technologies, and others with an aim to increase the supply of RE that would match the generation portfolio and electricity demand.
- A forward-looking technology think-tank specialising in trends in RE production technology and costs that is based in the East Asia Summit region can help drive an anticipatory RE policy. For example, the costs of solar PV production that have been bid by First Solar in the United States are for US$0.04/kWh in the 2nd quarter of 2015. Tracking the progress of President Obama's Sunshot initiative will also provide a sense of the future trend line in production costs. Trends in new RE technologies, such as wave power and

tidal power, can also be analysed, for example, tracking new patents issued, and new trial projects being implemented in different parts of the world.

- An information network among East Asia Summit countries should be established and maintained to enable the sharing of knowledge and findings on RE policies and the promotion of best practices.

3.2. Proposed supporting mechanisms for RE in Viet Nam

Viet Nam has already drawn some of these lessons. As already noted, a published avoided cost tariff, and a standardised power purchase agreement for qualifying Renewable Energy Small Power Projects [RESPPs] (no more than 30MW), under the supervision of a regulator, were adopted in December 2008, replacing the previous ad hoc system of confidential power purchase agreement negotiation, and a new FIT for selected RE technologies (wind, biomass, and MSW) in 2013. However, the question remains whether and how Viet Nam should implement more grid-connected RE then enable the new avoided cost tariff or FIT, which is expected to mainly benefit small hydro and possibly some biomass, wind, and waste-to-energy technologies. The first requirement is a clear articulation of the objective. If the objective is simply to meet some targets, then the rationale for that target should be sufficiently clear to enable the necessary political support. The mere existence of RE potential does not constitute a valid reason for its development, particularly in a relatively poor country such as Viet Nam.

Viet Nam is committed to market reforms, and indeed, the adoption of these principles has been a major factor in the successful economic development of the country over the past 20 years. These principles should be applied to RE development as well. The logical objective for Viet Nam is to develop RE resources to the point where the RE supply curve intersects the avoided social cost of thermal generation, which makes a logical target for RE development to bring most socio-economic benefits for the development of Viet Nam.

From the analyses presented, combined with international experiences on RE support and specific economic conditions in Viet Nam, the study team proposed the following supporting mechanisms:

- During the first stage (possibly a 5-year period), a FIT especially designed for selected RE technologies (wind, biomass, waste-to-energy, solar energy) and an Avoided Cost Tariff (ACT), which is currently applicable for small hydro, could greatly facilitate RE development in Viet Nam. In addition, supporting mechanisms should be based on quantity, i.e. competitive bidding, with differentiated objectives (targets) for each RE technology from the adopted government decree.

- In a competitive bidding mechanism as well as in a FIT, it is necessary to establish a supporting fund for RE development with stable and reliable financing sources (from the government, international donors, and levy on electricity and on fossil fuels).

3.3. Strengthened subregional cooperation

Given their geography, RE resources, and economic opportunities, the LMBR are well placed to undertake cross-border RE projects that can make the energy future of the subregion more stable and secure. The integration of significant shares of renewable resources is an important contribution for increasing electricity demand, diversifying the electricity generation mix, and decreasing import dependencies on conventional fuels. RE sources are abundant in the LMBR and remain an important – as in some countries and subregions – and dominant source of energy supply. Based on this, some recommendations could be suggested, as follows:

- ***Integrated regional renewable energy planning***

- LMBR member countries may recognise that renewable sources bring about multiple benefits, including direct reductions in GHG emissions. Although the upfront cost is generally higher than coal or gas turbines, these sources have no fuel cost. Harmonised policies and support schemes will benefit the utilities, grid operators, and investors.

- To encourage more investment, it is recommended that LMBR countries look beyond the widely implemented FIT. For example, individual or groups of countries could hold auctions for large-scale wind or solar projects to be built in one country but bought by one or more other countries. These could start as technology-specific auctions, but could evolve over time into those that are technology neutral – for example, location-specific auctions that allow all technologies to compete to see which one can provide the cleanest generation option at the lowest cost in a given location. Efforts to expand renewables should also be supported by working to improve power system flexibility, in order to integrate variable renewable resources while maintaining reliability.

- ***Capitalise on endogenous resources and technological capabilities for renewables***

  In some cases, the specific RE technology choice is clear. For example, Lao PDR has vast hydropower resources whereas Thailand and Viet Nam are rich in agricultural wastes and products that can be processed for energy purposes, such as biomass, biogas, and by-products from the processed food industry. Therefore, LMBR countries should also capitalise on their strong RE potential with their capabilities for commercial exchange, energy import–export, and sustainable supply and regional energy security.

Many PV module manufacturers are located in Thailand, therefore, demand for PV systems may potentially be met through intra-LMBR acquisition and development.

By cooperating, LMBR economies could also reduce the costs of developing RE technologies.

Suggested below are measures that can enable power utilities in LMBR to obtain RE at high levels. The LMBR economies can also explore opportunities to facilitate the demand response at the regional level and the complementation of the ASEAN Power Grid.

- Focus fiscal policy and regulatory support for both small-scale and large-scale RE power systems towards enabling power utilities to manage increased RE generation. LMBR countries can initiate policy dialogues to encourage among them utility-scale power storage, smart grid technologies and approaches, as well as demand response measures. Such policy dialogues must begin sufficiently early to avoid constraints that impede investments in RE or to curtail RE output.

- Support coordinated improvements of existing coal power plants at the subregional level, and increase RE offtake by enhancing cycling capabilities that can reduce system-wide costs and carbon emissions. The region can prepare the operational flexibility of fossil fuel–powered plants in the region. As necessary, it can initiate policy dialogue at the subregional or regional level to discuss regulatory and pricing matters, which will lead to integrating renewables into the grid and allow coal power plants to play a backup role.
- Enhance demand responses and complementation in major cities and/or towns, and in a coordinated way at the subregional level, in large power systems, towards increasing RE penetrations. LMRB economies could consider supporting selected utilities, to put in place programs that urge customers to time shift certain loads, and to explore possibilities for temporal and spatial complementation.

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ANNEXES

Annex 1: Status of Renewable Energy Uptake and Policies in Lower Mekong Basin Countries

Cambodia

a) Electric Power Industry ● Electricity tariff: Domestic sector = US$0.18/kWh, Industrial sector = US$0.1858/kWh
b) Subsidy for electricity tariff
c) Current status and challenges of RE policy System that is currently implemented: ● To promote power generation by RE, the Renewable Energy Action Plan 2002–2012 was formulated in May 2003, supported by the World Bank. The target was to raise the RE energy generation capacity to 6,000 kW. ● The introduction schedule or political measures were not specified for the target, and the implementation results were not disclosed. ● The government approved the Rural Electrification by Renewable Energy Policy in 2006 to expand access to electricity. This policy included the achievement of 100% electrification for rural areas by 2020, and supplying grid-quality electricity to 70% of households by 2030, among others.

Lao PDR

a) Electric Power Industry

Electricity tariff: Domestic sector = US$ 0.042/kWh, Industrial sector = US$ 0.092/kWh

b) Subsidy for electricity tariff

- Subsidy is for small consumers (residential), industries, and agriculture

c) Current status and challenges of RE policy

System that is currently implemented:

- None of the approaches has yet been implemented as RE policies are still in the process of being drafted.
- The 'Renewable Energy Development Strategy' announced in October 2011 specified 30% by 2025 as the ratio of introduced RE to the overall energy consumption, focusing on hydropower and biofuel (10% to reduce fossil fuel import).
- The policy is to promote the introduction of RE integrated with the local electrification policy. The construction of power systems and introduction of distributed RE power sources will be promoted simultaneously.
- In the local electrification policy, the target is to achieve a 90% national average electrification rate by 2020. To facilitate the introduction of distributed power sources, the Law on Electricity (effective since 1997) ensures the freedom of entry of small power generation business operators with 15,000 kW or less, based on the judgment of local governments.
- As Lao PDR does not have RE policies yet, the key domestic challenges and constraints on RE development will be as follows:
  - No specific policies or strategies on RE promotion.
  - Lack of coordination among stakeholders in RE.
  - RE policy has not yet been clearly stated in the National Socioeconomic Development Plan.
  - Lack of specific regulations and laws on RE.
  - It was not yet clear as to who is responsible for RE project approval.
  - Users have insufficient knowledge and understanding of RE.
  - Lack of public funding to support RE.
  - The absence of energy pricing regulation is a risk for investors.
  - Rural households prefer grid electricity rather than off-grid one.
  - Insufficient information on RE potential at the provincial level.
  - Electricity access rate in remote areas is still low.
- For further reference: http://www.edl.com.la/en/page.php?post_id=6

Myanmar

a) Electric Power Industry

Electricity tariff. Myanmar currently uses 'Capacity Basis Tariff'.

	Units	MK (kyats)
Household	Below 100	35
	101 to 200	40
	Over 201	50
Industrial	Below 500	75
	501 to 10,000	100
	10,001 to 50,000	125
	50,001 to 200,000	150
	200,001 to 300,000	125
	3200,001 and above	100

b) Subsidy for electricity tariff. The new tariff system helps the Ministry of Electric Power (MOEP) to remove the subsidy in the power sector. Currently, the subsidy is at break-even point.

c) Current status and challenges of RE policy

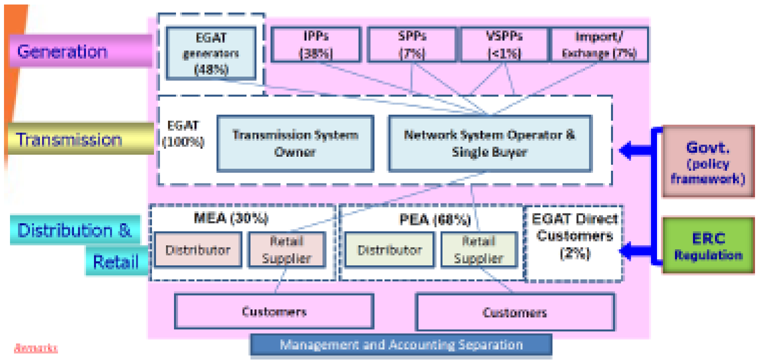
System that is currently implemented:

- To strengthen the rules and regulation in the power sector, the Ministry of Electric Power (MOEP) enacted the new Electricity Law and continues drafting the Electricity Regulation. After this stage, MOEP will proceed to formulate the necessary law, rules, and regulations (IPP, SPP, VSPP, FIT, etc.).
- MOEP has drafted the National Electricity Master Plan by coordinating with the Japan International Cooperation Agency (JICA). The MOEP is also getting the approval from the government. Based on the National Electricity Master Plan, the contribution of RE in power generation mix is 9% in 2030 and the capacity is at 2,000 MW.
- The Ministry of Energy considers hydropower as an important source of energy in its energy policy, and has policies to promote the development of small-scale hydropower. However, specific preferential treatment or measures to aid its achievement have not been implemented.
- To promote the development of small-scale hydropower, MOEP developed a new process. Under this scheme, the private sector can build and operate small and medium hydropower plants with the approval of regional governments.

Thailand

a) Electric Power Industry

- *Electricity tariff: Domestic sector = 3.4286 Baht/kWh, Industrial sector = 3.5570 Baht/kWh*
- Vertically integrated in generation and transmission.
- Single-buyer model



Source: Dr Romeo Pacudan, ERIN WS, 20 April 2015.

b) Subsidy for electricity tariff

Rural area customers are cross-subsidised by urban area customers.

c) Current status and challenges of RE policy

System currently implemented:

A target to raise the RE ratio in the final energy consumption to 25% by 2021 was established. The 'Alternative Energy Development Plan' (AEDP Master Plan, 2012–2021) was announced in July 2013. The target of RE electric power plant capacity was set at 13,927 MW.

A programme to purchase electricity from small power producers or SPPs (10 MW–90 MW) was started in 1994, while those from very small power producers or VSPPs (10 MW or less) started in 2002. Based on these, in April 2007, the Adder programme was introduced, where the purchase prices and the period were fixed by adding a premium on the purchase prices of SPP and VSPP programmes. Through revisions of the premium, the premium price and the purchase prices from SPP and VSPP were consolidated at the end of 2011, and the transition to the feed-in tariff system was announced. Specific system design is a pending issue.

Viet Nam

a) Electric Power Industry[1]

Electricity tariff

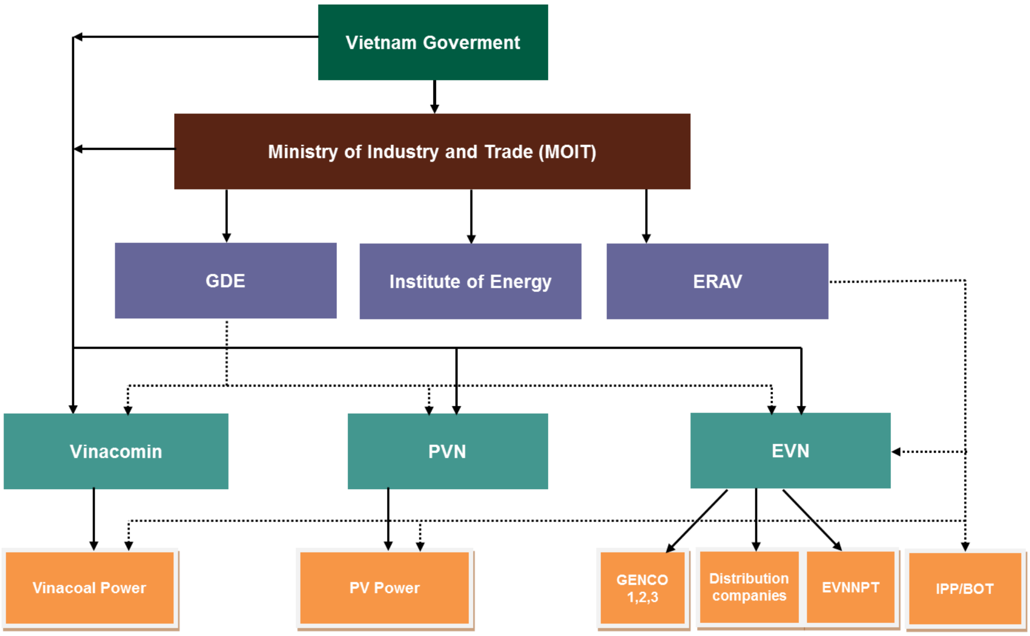
- The latest electricity tariff of Viet Nam was promulgated by the Ministry of Industry and Trade in Decision No. 2256/QD-BCT dated 12 March2015 and is applicable starting16 March 2015. According to this decision, the average retail tariff is VND 1,622.01 per kWh, or US$ 7.56 per kWh.
- The electricity tariff is divided into retail tariff and wholesale tariff, which are then further divided into groups of customers, voltage levels, consumption levels, and peak–off-peak hours. The following table presents a summary of the electricity tariff.

Electricity Tariff of Viet Nam *(from 16/03/2015)*		
No.	**Group of Customers**	**Tariff Range**
Retail Tariff		
1	Manufacturers	US$4.05–US$12.75 per kWh
2	Administrative and non-profit units	US$6.8–US$7.8 per kWh
3	Businesses	US$5.5–US$18.6 per kWh
4	Electricity for living	US$6.9–US$12.1 per kWh
Wholesale tariff		
1	Rural areas	US$5.7–US$ 9.5
2	Residential blocks or clusters	US$6.1–US$11.1 per kWh
3	Commercial – Service – Residential complexes	US$6.2–US$17.6 per kWh
4	Industrial zones	At 110 kilovolt busbar: US$3.8–US$11.2 per kWh At medium-voltage side of the substation: US$4.1–US$12.1 per kWh

- The Electricity of Viet Nam (EVN) group, established as a national company in 1995, owns and manages main power plants, load-dispatching offices, transmission companies, distribution companies, and others. A power development plan, reform proposal for electricity tariff, among others, were formulated and implemented.

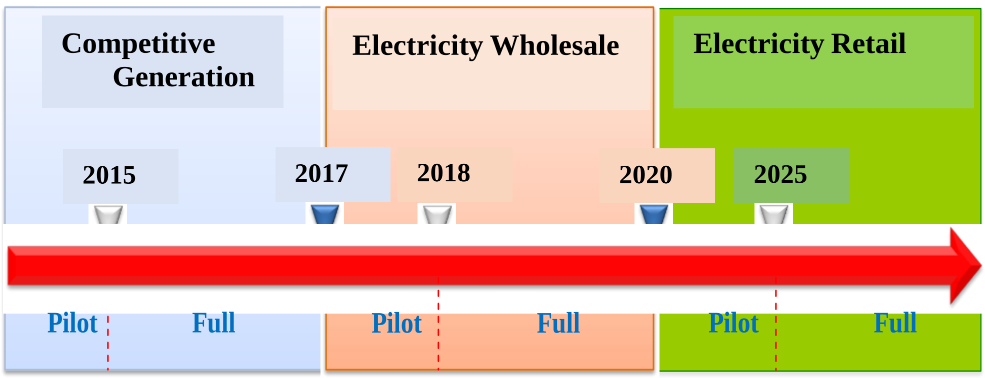
[1] The Electric Power Industry in the World, Japan Electric Power Information Center, Inc. (2014).

Figure A1: Organisational Structure of the Power Industry in Viet Nam



- The National Power Development Plan is developed every 5 years by the Institute of Energy and approved and promulgated by the Prime Minister. This is the plan for the next 10 years with outlook to the subsequent period of 10–20 years. It serves as the orientation document for the development of power industry in Viet Nam. The current plan is called PDP VII and a revised PDP VII is now being prepared for approval.
- The power market of Viet Nam is now at a competitive generation market stage, and is preparing for the pilot stage of electricity wholesale market.

Figure A2: Viet Nam's Power Market Development Roadmap



- Electricity tariff is regulated by Ministry of Industry and Trade. The current price is low and does not cover the actual cost, causing pressure to the EVN, which finances the development of the power system.

b) Subsidy for electricity tariff[2]

- Retail prices are the same throughout the country.
- Electricity prices are regulated, albeit less rigid than before. As of April 2011, EVN was allowed to adjust electricity prices by up to 5% every 3 months according to changes in production costs, while retail price adjustment over 5% require the approval of the Ministry of Finance (MOF) and the Ministry of Industry and Trade (MOIT). According to latest regulation, EVN is allowed to adjust electricity prices by 7%–10% every 6 months under a regulated pricing framework and in line with changes in production costs, with approval by the MOIT. Retail price adjustment over 10% or beyond the framework requires the approval of the MOF and the MOIT.

c) Current status and challenges of RE policy

System that is currently implemented:

To support RE projects, MOIT issued a regulation on the avoided cost-based tariff and standard power sale contract applicable to small power plants that use RE. The avoided cost-based tariff is set based on the avoidable cost on the national power system when 1 kWh is generated from the small power plant to the power distribution grid. The avoided cost tariff will be calculated by the seasons and is published annually.

For wind energy, the Government of Viet Nam has approved the fit-in tariff (FIT). The FIT is equal to US$7.8 per kWh and the EVN is responsible for purchasing all electricity from wind power plants with contract period of 20 years, with possible extension or renewal.

The supporting mechanism for biomass power projects is promulgated in 2014. According to this decision, EVN is responsible for purchasing all electricity generation from on-grid biomass power plants, has a contract period of 20 years, with potential extension or renewal. The FIT applied to power-thermal cogeneration biomass plants is US$5.8 per kWh. For on-grid biomass power plants other than power-thermal cogeneration plants, the power purchase price is according to the avoided cost-based tariff for biomass power projects promulgated by MOIT annually. All on-grid and off-grid biomass power plants also benefit from other incentives, such as investment credit incentives from the state, exemption from import tax for equipment and materials not yet produced locally, discount on corporate income tax, and exemption and reduction on land-use levy and fee.

- The supporting mechanism for on-grid power generation from solid waste projects is promulgated in 2014. Similar to the regulations on wind and biomass power projects, EVN is required to purchase all power generated from on-grid solid waste power plants, with a contract period of 20 years and with possible extension or renewal. Waste-to-power projects also benefit from other incentives on investment credit, import tax exemption, corporate income tax discount, and land-use levy and tax exemption and reduction that are similar to biomass power plants. The FIT applied for solid waste thermal power plants is US$10.05 per kWh, and the FIT applied for power plants burning gas recovered from solid waste landfill is US$7.28 per kWh.
- The supporting mechanism for on-grid biogas power projects has been proposed in a study implemented by the Institute of Energy with GIZ fund, but has not been approved yet by the Prime Minister.
- The revised PDP VII specified a target to raise the ratio of installed capacity of RE from 3.5% in 2010 to 6.3% by 2020, then to 8.1% by 2025 and to 10.1% by 2030.
- The amount and distribution of resources were not closely investigated and legal development and others are required. The use of RE is seen as an immediate measure to realising the objective of local electrification and for poverty alleviation; hence, commercial introduction is considered difficult.

Results*:*

- The mechanism on avoided cost tariff seems to have an effect on the development of SHP. Currently, 157 (SHP) projects with total capacity of 1,269.4 MW are in operation and 163 small hydropower (SHP) projects with total capacity of 1,683.0 MW are under construction. Over 260 SHP projects with total capacity of 2,028.2 MW are also preparing for investment report while 127 SHP projects with total capacity of 660.7 MW are being planned.[3]

[2] The Electric Power Industry in the World, Japan Electric Power Information Center, Inc. (2014).

[3] Statistics Data, General Directorate of Energy, MOIT, (2012).

- As of the end of July 2014, Viet Nam has 52 wind power projects with a total capacity of 4,452 MW, and all are located in the central and southern provinces. Three are already in operation with a total installed wind power capacity of 52 MW. The rest are in various stages of development, such as investment report preparation or construction stages.
- The support price for wind power is still low and benefits from wind power projects also do not compensate the investment costs and other operations and maintenance (O&M) costs. So far, the first wind power project, located in Tuy Phong District, Binh Thuan Province, has completed the first phase of building to become operational with an installed capacity of 30 MW. The second project, also located in Phu Quy Island has an installed capacity of 6 MW. The third wind power project with 16 MW capacity was implemented in the Mekong Delta, province of Bac Lieu. This has been completed and connected to the national grid in September 2013, as the first phase.
- The potential of biomass to power in Viet Nam is high, but now there is only 150MW of installed capacity using bagasse for power generation, mainly for the sugar plants' own consumption, with residual generation sold to EVN.

Cost-sharing method:

- The FIT for wind power is US$7.8 per kWh, of which US$6.8 is paid by EVN and US$1.0is subsidised by the state through the Environment Protection Fund.
- The FIT for cogeneration biomass power is US$5.8 per kWh and is paid by EVN
- The FIT for municipal solid waste power is US$10.05 per kWh for incineration and US$7.28 per kWh for landfill and is paid by EVN.

Annex 2: Assessment Results of the Prioritised Renewable Energy Technology Options

Table A1: Small Hydropower Plants

Co-benefits		Specifications	Grading (1 – 5)
GHG emission reduction	* GHG reduction potential	* Fourth highest with 129.3 million tonnes CO_2.equivalent	5
	* Abatement cost	* Second high benefit with –US$9.3 per tonne CO_2.equivalent	
Alignment with government priorities		Encourage investors to invest in small hydropower plants through avoided costs.	3
Economic benefits	* Economic development	Create opportunity for new business.	4
	* Increased energy security	Reduce electricity demand or reduce dependence on imported coal.	
Social benefits	* Creation of new jobs	Create work opportunities and improve incomes.	3
	* Health conditions	Improve health conditions.	
Local environmental benefits	* Air quality	Reduce the concentration of toxic gases and dust.	2
	* Biodiversity	Pressure on deforestation and flood prevention during construction and operation.	
Total (5–25)			17

Source: Result from IE's group meeting.

Table A2: Biomass Power Plants

Co-benefits		Specifications	Grading (1–5)
GHG emission reduction	* GHG reduction potential	* Third highest with 143.9 million tonnes CO_2.equivalent	5
	* Abatement cost	* Highest range of benefit with -US$ 12.0 per tonne CO_2.equivalent	
Alignment with government priorities		Encourage investors to invest in wind power plants through feed-in tariffs.	4
Economic benefits	* Economic development	Create opportunity for new business.	4
	* Increased energy security	Reduce electricity demand or reduce dependence on imported coal.	
Social benefits	* Creation of new jobs	Create work opportunities and improve incomes.	3
	* Health conditions	Improve health conditions.	
Local environmental benefits	* Air quality	Reduce the concentration of toxic gases and dust.	2
	* Biodiversity	Ensure the natural balance and protect the ecosystem.	
Total (5–25)			18

Source: Result from IE's group meeting.

Table A3: Wind Power Plants

Co-benefits		Specifications	Grading (1–5)
GHG emission reduction	* GHG reduction potential	* Highest with 175.2 million tonnes CO_2.equivalent	3
	* Abatement cost	* Last range of benefit with US$9.2 per tonne CO_2.equivalent	
Alignment with government priorities		Encourage investors to invest in wind power plants through feed-in tariffs.	5
Economic benefits	* Economic development	Create opportunity for new business.	4
	* Increased energy security	Reduce electricity demand or reduce dependence on imported coal.	
Social benefits	* Creation of new jobs	Create work opportunities and improve incomes.	3
	* Health conditions	Improve health conditions.	
Local environmental benefits	* Air quality	Reduce the concentration of toxic gases and dust.	5
	* Biodiversity	Ensure the natural balance and protect the ecosystem.	
Total (5–25)			20

Source: Result from IE's group meeting.

Table A4: Solar Photovoltaic

Co-benefits		Specifications	Grading (1–5)
GHG emission reduction	* GHG reduction potential	* Second highest with 147.5 milliontonneCO_2.equivalent	3
	* Abatement cost	* Fourth range of benefit with US$7.0 per tonne CO_2.equivalent	
Alignment with government priorities		Encourage investors to invest in solar PV power plants through feed-in tariffs.	5
Economic benefits	* Economic development	Create opportunity for new business.	3
	* Increased energy security	Reduce electricity demand or reduce dependence on imported coal.	
Social benefits	* Creation of new jobs	Create work opportunities and improve incomes.	3
	* Health conditions	Improve health conditions.	
Local environmental benefits	* Air quality	Reduce the concentration of toxic gases and dust.	5
	* Biodiversity	Ensure the natural balance and protect the ecosystem.	
Total (5–25)			19

Source: Result from IE's group meeting.

Table A5: Biogas Power Plants

Co-benefits		Specifications	Grading (1–5)
GHG emission reduction	* GHG reduction potential	* Lowest with 9.5 milliontonnesCO_2.equivalent	2
	* Abatement cost	* Third range of benefit with -US$ 3.0 per tonne CO_2.equivalent	
Alignment with government priorities		Feed-in tariffs mechanism is being prepared.	3
Economic benefits	* Economic development	Create opportunity for new business.	3
	* Increased energy security	Reduce electricity demand or reduce dependence on imported coal.	
Social benefits	* Creation of new jobs	Create work opportunities and improve incomes.	4
	* Health conditions	Improve health conditions.	
Local environmental benefits	* Air quality	Reduce the concentration of toxic gases and dust.	4
	* Biodiversity	Ensure the natural balance and protect the ecosystem.	
Total (5–25)			16

Source: Result from IE's group meeting.