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Peer Review on
Low Carbon Energy Policies in Viet Nam

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PREFACE

The APEC Peer Review on Low Carbon Energy Policies (PRLCE) was endorsed by the APEC Energy Ministers at the 2010 Energy Ministers Meeting. The review is an extension APEC's Peer Review on Energy Efficiency and follows its guidelines. The PRLCE seeks to achieve the following objectives:

- Share information on low carbon energy performance as well as on policies and measures for improving and promoting low carbon energy in respective economies;
- Provide opportunities for learning from the experiences of other economies and for broadening the network among low carbon policy experts;
- Explore how low carbon goals on an overall and/or sectoral basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstance of each economy;
- Monitor progress on attaining low carbon energy goals on an overall and/or sectoral basis and implementing action plans, if such goal and action plans have been already formulated at the time of the review;
- Provide recommendations for voluntary implementation on how implementation of action plans could be improved with a view to achieving low carbon energy goals.

Viet Nam volunteered to undertake the fifth peer review on low carbon energy supply policy, after Thailand, the Philippines, Indonesia and Malaysia. A Review Team of 12 experts (see Appendix A) visited Ha Noi, Viet Nam from 18 – 22 January 2016 to conduct the peer review. This report presents the peer review results in Viet Nam. Viet Nam and the Review Team share together the primary accountability of this review.

During the visit, the Review Team had open and constructive discussions on Viet Nam's low carbon energy policies and programs with representatives and experts from different lines of government ministries, energy and environment research institutions, and energy companies (see Appendix B). The Review Team wishes to thank all the presenters and others that spent time with the team for discussions, especially the representatives of the Ministry of Industry and Trade who co-organized the event.

EXECUTIVE SUMMARY

In Viet Nam, renewable energy activities as well as whole energy sector fall under the Ministry of Industry and Trade (MOIT)s' responsibility. There is however a strong leadership of the Prime Minister, the participation and contributions from different line ministries, provincial government agencies, and representatives of stakeholders in renewable policy formulation, planning and implementation process. Stronger efforts and continued improvement in staffing and cooperation mechanisms among governmental organizations and stakeholders are desirable for Viet Nam to build an effective regulatory environment for renewable energy growths.

In 2015, the Prime Minister has approved the first national strategy of renewable energy development in Viet Nam toward 2030 and with vision to 2050. It indicates clear targets and pathway for a commercial development at large scale of a wide range of renewable energy subsectors. It also shows the government's persistent determination and efforts to give a priority to renewable energy while building comprehensive supporting policies based mainly on market mechanisms.

The APEC Peer Review team finds targets set by the government of Viet Nam for wind (2.5 TWh), solar (1.5 TWh) and biomass energy (7.8 TWh) in 2020 particularly challenging to realize, given Viet Nam's context of current low start point in these renewable power subsectors as well as of general economic conditions, in addition, Viet Nam' annual electricity demand growth is anticipated to continue to grow rapid, at 10 percent per year on average over the next five years, and reform programs in power sector towards wholesale (from 2016) and retail (from 2021) competitive market are accelerated.

For long time, the development of renewable energy in Viet Nam has closely attached to the implementation of the government's objectives specific to energy sector policy and plans (in regard to accelerating rural electrification, enhancing energy supply security through fuel diversification and energy efficiency and savings, providing energy at affordable prices for citizens, etc.). Further more, renewables are also to serve the implementation of government objectves for the inclusive, sustainable development and modernisation of the general economy.

Viet Nam's most cost-effective renewable energy sources, including hydropower, solar thermal energy and biomass have been largely deployed for long time in its energy supply system. Hydropower always contributes the largest electricity source, accounting for roughly 41% of both total installed capacity and total generation in 2014. Various bioenergy sources are used by households and small industries in rural areas through applications of biogas technologies using livestock and poultry wastes, and thermal and power generating technologies using bagasse, rice husks and straw, and wood fuels. These competitive renewable energy sources together share almost one third of Viet Nam's current total primary energy consumption. This contributes significantly to Viet Nam's current achievements in acquiring an encouragingly high ratio of electrification (98% in 2014) with a relatively low cost compared to APEC and ASEAN averages, maintening its energy exporter position and low greenhouse gas (GHG) emissions (contributing only 0.5% globally in 2013).

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1994, Viet Nam has always followed and implemented with responsibility all UNFCCC agenda. In line with global trend towards enhancing measures to protect environment, respond to climate changes, the government of Viet Nam has initiated since 2007 the promotion of liquid biofuels (i.e bioethanol and biodiesel) production and use in road transport, development at commercial scale of modern higher-cost renewable energy technologies such as wind power, solar PV, municipal waste power. Viet Nam has actively exploited financial supporting opportunities provided by CDM and from international donors to implement renewable energy programs. Development situation of these new renewable energy sectors is diverse. Under the effect of FiT and various other supporting mechanisms and

policies as for preferential and special preferential investment projects, small-hydro and wind power sectors have recorded most encouraging growths over the last five years. Solar photovoltaic (PV), Municipal-Solid-Waste (MSW) power remain however at demonstration stage although Viet Nam has successfully attracted initial investment flows to build solar PV manufacture industry. Application of biofuels is limited to bioethanol (mainly E5) with an excess in production capacity compared to consuming market and E5 distribution available at roughly 41% of fuel retail stations in eight major cities and provinces by November 2015.

Difficulties in expansion of modern renewable energy applications in Viet Nam are deemed to attribute mostly to the economy's high dependency on these costly importing renewable energy technologies and foreign financial source in general for renewable energy investment projects; relatively low electricity prices in domestic consuming market; slow progress in improving the capacity and coordination among governmental agencies, in adjusting the regulatory framework for boosting renewable energy business, including the issuance of national and provincial master plans for the development of each type of renewable energy; lack of appropriate and reliable database on renewable resources as well as lack of effective biomass supply chain, technical infrastructure to support the construction of large-scale equipment and structures.

To improve the effectiveness in designing renewable energy policies and implementation programs in Viet Nam in order to achieve set goals, the APEC Peer Review Team made 66 recommendations to the government of Viet Nam for voluntary implementation in 8 focal issues, including general institutional organisation; low-carbon energy goals, targets and strategy; regulations and infrastructure; critical issues for the development of power supply system - FiT, smart-grid, private participation; specific renewable energy subsectors: wind power; solar PV, small-hydro power, geothermal energy, bioenergy (biomass energy, biofuels); and greenhouse gas management. The Peer Review team has also highlighted six recommendations on overarching issues at the end of the report.

Specifically, to further develop renewable energy in Viet Nam, the APEC Peer Review Team recommended setting a clearer near and long-term targets and adequately applying feed-in tariffs (FiT). A mechanism of timely revision of Fit rates and additional FiT premiums for renewable energy projects would be desirable, but careful management of interactions between FiT and other policies such as Renewable Portfolio Standard (RPS) would also be needed to avoid adverse interactions such as providing unreasonable advantages to incumbent market players and to introduce new investment.

Viet Nam submitted its Intended Nationally Determined Contribution (INDC) in 2015. The APEC Peer Review Team recommended preparing for the development and introduction of domestic Plan-Do-Check-Act (PDCA)-cyclic evolutionally process on climate strategy and developing a monitoring, evaluation and analysing framework on climate strategy.

RECOMMENDATIONS

1 INSTITUTIONAL CONTEXT

Recommendation 1: *It is desirable for the MOIT and related government organisations to continue close cooperation in implementing RE policies and plans under the leadership of the PMVN.*

Recommendation 2: *It is desirable for the MOIT to strengthen the functions, staffing of GDE as well as improve the coordination within the MOIT, and between the MOIT and related ministries in order to effectively implement RE policy and planning.*

Recommendation 3: *It is necessary to continue to strongly invest in capacity building activities, from government officers, researchers to people in industry generally.*

Recommendation 4: *It would be better to establish regular dialogue sessions between the MOIT and stakeholders on progress of RE planning and investment programs.*

2 LOW CARBON ENERGY GOALS, TARGETS AND STRATEGY

Recommendation 5: *Consider setting separate and clear targets for generation from small-hydro and run-of-river schemes; for solar farm and solar PV rooftop; and for biodiesel; also consider developing targets and policies for transport electrification.*

Recommendation 6: *Promptly invest in assessment of geothermal potential and in improving the quality of data for other renewable sources is another priority recommendation for Viet Nam*

Recommendation 7: *BAU/baseline in RE stratergy should be presented more clearly and in consistent with Viet Nam Green Growth Strategy (VGGS) as well as other subsequent national detailed RE subsectoral plans.*

Recommendation 8: *Viet Nam could actively promote its high proportion of renewable electricity to attract export manufacturers and investors with customers interested in carbon footprint*

Recommendation 9: *Promptly establish/designate a focal competent agency responsible for the national energy statistics and national GHG emission inventory's data collection, analysis, verification and update.*

Recommendation 10: *Establish evaluation frameworks to better identify the potential co-benefits (yet also possible conflicts) of particular renewable energy deployment options including regional and industry development outcomes, as well as broader environmental and social impacts.*

Recommendation 11: *Continue to study to establish clear indicators for improving monitoring and evaluation activities in the policy implementation cycle.*

3 REGULATION AND INFRASTRUCTURE

Recommendation 12: *Shorten time lag between issuance of a sectoral strategy/program with the issuance of detailed regulations, guidelines for its implementation.*

Recommendation 13: *Facilitate genuine stakeholder engagement by establishing a single one-stop destination website that details progress on planned activities, including promoted investment programs (especially for renewables), with time frames and on-going assessment.*

Recommendation 14: *Delivery of community service obligations including subsidised tariffs and FiT by stakeholders including generators and networks needs to be make more transparent to potential renewable energy project developers and the community more generally.*

Recommendation 15: *Provide greater transparency, information and campaigns to enhance societal trust and consensus on the need and opportunity for greater renewable energy deployment in Viet Nam.*

Recommendation 16: *Clearer regulations on access and use of available information and data in regard to Viet Nam's renewable energy resources, regional transmission and distribution network capacities to*

facilitate potential project developers to quickly assess the likely performance of their projects and any particular issues that may arise in network connection

Recommendation 17: *Improve investment environment with clearer, specific and more transparent guidelines including permitting and registration requirements, fiscal incentives within the FiT and RPS arrangements*

Recommendation 18: *Continue and strengthen 'polluter pays' principles for fossil fuel deployment to enhance the effectiveness of incentives for renewable energy deployment including greater use of environmental levies/fees on the use of fossil fuels and reductions in current subsidies to them.*

Recommendation 19: *Develop a more programmatic rather than project specific framework for isolated (off-grid) renewable hybrid systems in order to benefit from learnings and scale.*

Recommendation 20: *Better define the role of large/impounding hydropower generators in the national power development plan may facilitate the recognition of the need for the deployment of various renewables (particularly solar and wind)*

Recommendation 21: *Facilitate capacity building of key stakeholders in whole RE supply and deployment chain, including network operators, construction companies and the local renewable energy industry*

Recommendation 22: *Enhance planning capabilities and tools for better integration of transmission and distribution network planning with renewable energy deployment planning, as well as management of electricity market operation.*

Recommendation 23: *Regular, timely and transparent presentation of the planning framework and its key outputs to all relevant stakeholders, with opportunities for genuine stakeholder engagement in the process.*

4 BIOENERGY-BIOFUELS, BIOMASS

Recommendation 24: *Set clearer near and long term biofuel targets and strategies with more details on storage and distribution infrastructure and economic regulations in order to boost effectively the biofuel production and consumption market in Viet Nam.*

Recommendation 25: *Consider promoting stronger uptake of E10 through a sale obligation on fuel retail. Adoption of a bioethanol blending ratio E10 target might be a better option than an E5 target not only to close the oversupply production-demand gap, but also in the aspect that E10 usage could reduce the risk of phase separation.*

Recommendation 26: *Raise more public awareness on bioethanol usage via campaign program designed to match with different target groups.*

Recommendation 27: *Provide continuous support for research and development (R&D) in biofuel-related technologies in both upstream and downstream activities.*

Recommendation 28: *Establish clear programs to strengthen human resource capacity building in the biofuel area, both at government agencies and in enterprises.*

Recommendation 29: *Make more efforts to promote domestic biodiesel production and deployment, as well as to introduce clear targets and strategy for biodiesels development.*

Recommendation 30: *Consider diversified biomass sources while implementing the national strategy for renewable energy, especially in rural areas*

Recommendation 31: *Give more focus on establishing a biomass supply chain*

Recommendation 32: *Co-firing with biomass in existing or new coal-fired power plants is encouraged.*

Recommendation 33: *Increase the electricity capacity factor of the existing bagasse CHP*

Recommendation 34: *Municipal solid waste (MSW) to energy conversion processes should be considered in more detail.*

Recommendation 35: *Consider developing manure-based small power system; prioritizing the technology systems that produce both energy and fertilizer.*

Recommendation 36: *Study to promptly apply FiT as incentives for promoting biogas*

5 WIND ENERGY

Recommendation 37: *Invest to improve wind resource data reliability and consider to establish a specific agency responsible for unifying and managing wind resource data in an efficient way for wind power planning and development.*

Recommendation 38: *Consider adopting a concentrated development of wind farms along the southern coastal line for a better efficiency*

Recommendation 39: *Consider the introduction of graded tariffs when designing FiT for wind power*

Recommendation 40: *Establish a local certification scheme for wind turbine*

Recommendation 41: *Complete national power grid code with additional code for connected wind farms*

6 SOLAR PV, SMALL-HYDRO, GEOTHEMAL ENERGY

Recommendation 42: *Consider developing clear sub-targets for utility scale and rooftop installations with appropriate supporting data and analysis of daily electricity consumption by location.*

Recommendation 43: *Promptly establish the FiT system for solar power development to attract more private-sector participation.*

Recommendation 44: *The tariff rate scheme for net metering implementation should consider the levelized pricing of electricity consumers, to attract even small household consumers, and control appropriately large installations.*

Recommendation 45: *Continue to conduct capacity building activities. An information, education and communication campaign should be scaled down to household level.*

Recommendation 46: *In power sector planning and investment management, classification of hydropower development might be better emphasised on scheme of development rather than based on capacity scale; run-of-river hydropower should be further promoted.*

Recommendation 47: *Consider improving investment environment with clearer and more specific, transparent guidelines including potential sites, permitting and registration requirements, fiscal incentives under the FiT and RPS system*

Recommendation 48: *Geothermal resource potential inventory and assessment should be prioritized among any initiative toward this end.*

Recommendation 49: *Consider to set clear targets for geothermal energy development, including power, non-power and thermal applications of geothermal resources.*

7 POWER SUPPLY SYSTEM - FEED-IN TARIFF (FIT), SMART GRID, PRIVATE PARTICIPATION

Recommendation 50: *Develop a forward looking and proactive process around the queuing of renewable energy projects with a mechanism for timely revision of FiT rates and other arrangements subject to their performance.*

Recommendation 51: *Consider mechanisms such as additional FiT premiums for renewable energy projects that provide greater industry and Viet Nam benefits in terms of transmission costs, regional demand needs and the temporal value of the energy they provide.*

Recommendation 52: *Consider a specific FiT for co-firing of biomass in existing and proposed coal-fired generation*

Recommendation 53: *Need careful management of interactions between FiT and other policies such as RPS to avoid adverse interactions such as providing unreasonable advantages to incumbent market players*

Recommendation 54: *Better integration of smart grid within broader government ICT strategy and deployment given new low-cost energy monitoring and control technologies that energy consumers could usefully deploy, and which can utilise existing ICT infrastructure*

Recommendation 55: *Seek broader stakeholder engagement for development and implementation of the Government's smart grid strategy including membership of its smart grid steering committee.*

Recommendation 56: *Make good used of valuable smart-grid opportunities in Viet Nam's isolated power systems including opportunities to pilot smart renewable energy integration, storage and customer side applications.*

Recommendation 57: *Particular attention should be given to ensuring SOEs and other existing participants do not receive unfair advantages under the policies developed so that new private participants can compete on a level playing field*

8 GREENHOUSE GAS MANAGEMENT

Recommendation 58: *Viet Nam should actively prepare for the development and introduction of domestic PDCA (Plan-Do-Check-Act)-cyclic evolutionally process on climate strategy*

Recommendation 59: *Viet Nam should consider developing a monitoring, evaluation and analysing framework*

Recommendation 60: *Viet Nam needs to re-assess the current INDC targets and upgrade them to prepare NDC1 with new methodologies*

9 OVERARCHING ISSUES

Recommendation 61: *To clarify targets, roadmap, supporting measures, as they may not be clear in some specific areas (e.g., hydropower, solar power, biodiesel).*

Recommendation 62: *To improve energy statistics with more detailed data by subsectors (e.g., new and renewable power, transportation data, environmental impacts), renewable energy resource data quality, hence helping the formulation of policy to be more precise.*

Recommendation 63: *To improve cooperation and coordination among governmental ministries and agencies, cooperation between government and industry through establishing a regular dialogue mechanism.*

Recommendation 64: *To improve capacity building through bilateral and international cooperation, study tours, information sharing, and education and communication campaign.*

Recommendation 65: *To improve information and data in English provided on government and enterprise web portals to increase foreign investors' interest.*

Recommendation 66: *To continue and strengthen regional and international cooperation, including APEC.*

APEC PEER REVIEW
ON LOW-CARBON POLICIES (PRLCE)

PART 1: BACKGROUND INFORMATION

This part of the report shows basic information on renewable energy, including the current policy and objectives as well as renewable energy activities, and the main institution associated with energy and environment in Viet Nam. The data provided is the latest data available at the time of the Peer Review Team visit in January 2016.

The main purpose of this part is to provide the reader with the context within which the Peer Review Team based its recommendations.

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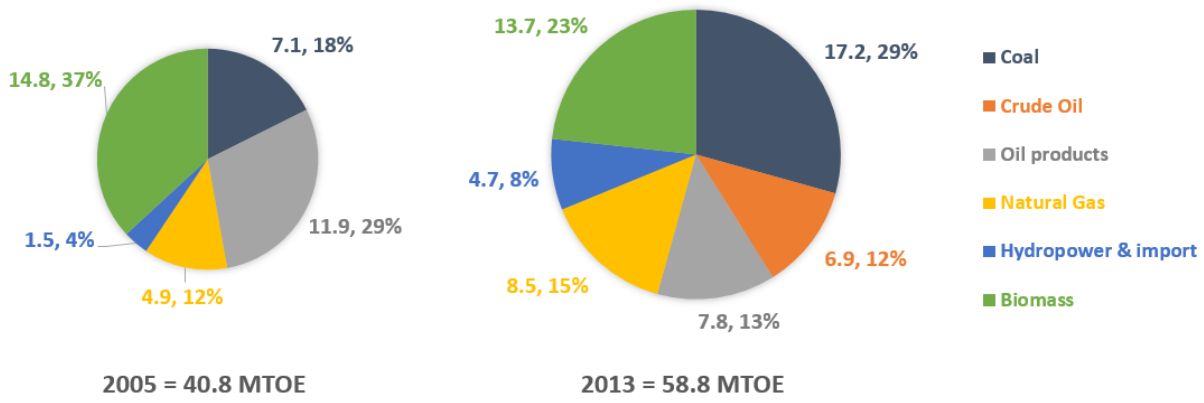
1 ENERGY SITUATION IN VIET NAM

1.1 Primary energy supply

Viet Nam total primary energy supply (TPES) in 2013 was 58.8 Mtoe, which is a slight increase of 1.3% from the 2012 level and 44% higher compared to the 2005 level according to government's energy statistics source. Energy source was diversified; 29% of the supply came from coal, 25% from oil, 15% from natural gas, 8% from hydropower and electricity import, and 23% from biomass in 2013 (Figure 1.1). Viet Nam has been a net energy exporter; however, trade surplus has significantly reduced over the last decade with implementation of the government's export restriction policy for natural resources together with the promotion of domestic capacity development in transformation and manufacturing sectors. Energy infrastructure extensions, encouraging economic growths rates (6.1% per year on average during 2005-2013 for gross domestic products (GDP)) along with structure change toward larger contributions from industry and services sectors, and households' income improvement over the last two decades have driven Viet Nam energy consumption. Per capita primary energy consumption and supply has steadily increased until 2010 then levelled off. It reached 0.65 toe per person in 2013, equal roughly 25% of the APEC average (APERC, 2016a).

Figure 1.1: Viet Nam total primary energy supply, 2005 vs 2013



Sources: Institute of Energy, 2006; National Energy Efficiency Program (VNEEP) - Ministry of Industry and Trade (MOIT), 2015

COAL

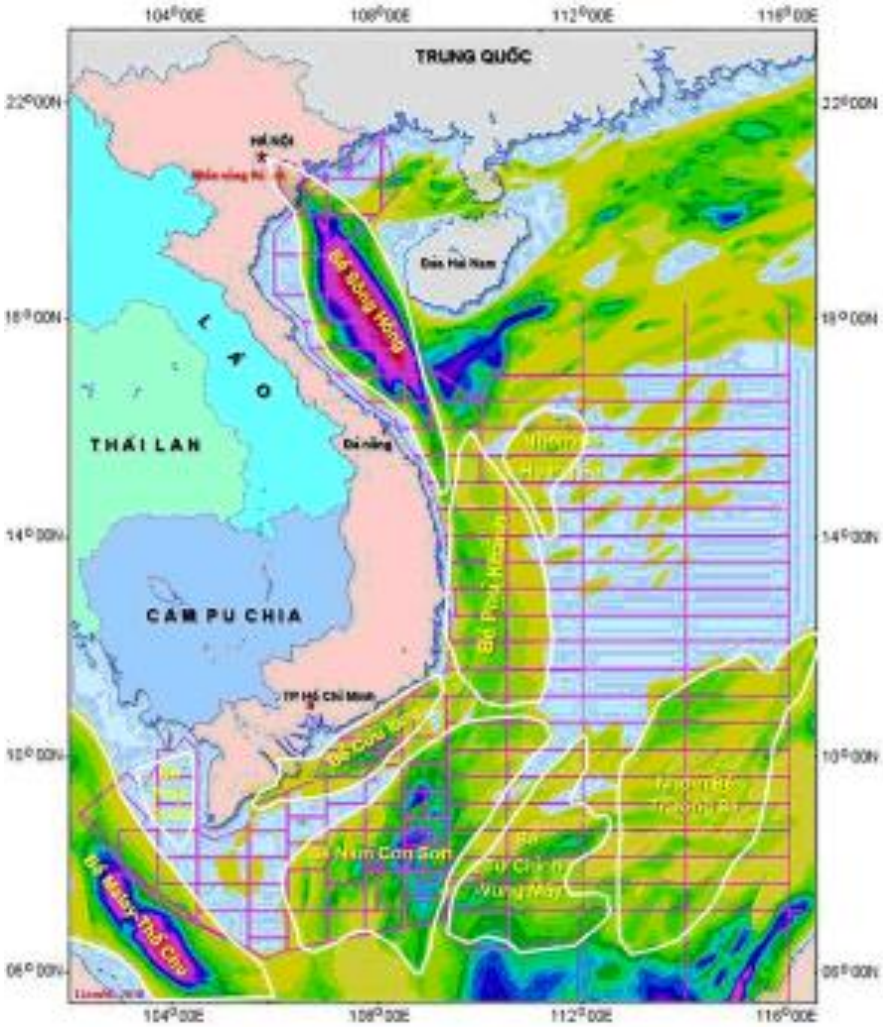
Viet Nam is a net coal exporter. In 2013, Viet Nam produced about 23 Mtoe of anthracite and semi-anthracite coals (3.2% lower than 2012 level), surpassing its primary coal demand at 17 Mtoe. About 7.2 Mtoe or 31% of the domestic coal production was exported; it was roughly 40% of the economy's export peak in 2007. About 1.3 Mtoe was imported. Coal production and exports recorded high growths at 21% and 39% per year, respectively, during 2000–2007, and then slowed down at rates of to –0.6% and –11.9% per year, respectively, during 2008–2013, resulting from changes in the government policy prioritising coal conservation for long term domestic use rather than boosting export for generating foreign currencies (VNEEP, 2015).

MOIT's data shows considerable coal potential at 48.7 billion tons in total as of 2010 (MOIT, 2015c). It concentrates mainly in two major basins in the north: the sub-bituminous-rich coal basin of Red River Delta (which accounts for 81% of total potential) and the North-East anthracite-rich coal basin (accounting for 18%). Only small reserves have been found in central and southern regions. Intensifying exploration and exploitation into deep layers of the North-East and Red River Delta coal basins is crucial for Viet Nam to avoid becoming a high coal import dependency in future. It remains however a challenge and is expected to take place beyond 2020 given characteristics of complex geological conditions and the environmental and economic sensitivity of these areas.

OIL

Viet Nam produced 17 Mtoe of crude oil in 2013, about 50% of which was exported (VNEEP, 2015). Oil resource potential is identified mainly offshore in eight (8) tertiary sedimentary basins, including Song Hong, Phu Khanh, Cuu Long, Nam Con Son, Malay – Tho Chu, Tu Chinh – Vung May, Truong Sa and Hoang Sa (Figure 1.2). BP statistics shows Viet Nam proven oil reserves of 4.4 billion barrels as of end 2013 (BP, 2015). The economy had 23 oil-producing fields in 2013 (Viet Nam Oil and Gas Group (PetroVietnam or PVN), 2014). The Cuu Long basin is the primary area for oil production; its major fields mature. According to PVN's forecast and planning, oil production is about 16–18 Mt/year through 2022 and then declines if no significant new discoveries happen.

Figure 1.2: Petroleum tertiary sedimentary basins in Viet Nam



Source: PVN, 2013

Viet Nam is a net crude oil exporter but a net importer of petroleum products. In 2013, net petroleum product import accounted for 52% of total primary oil supply. Petroleum product imports have shown a downward trend since 2009 as the first refinery in Viet Nam, the 140 000 barrels per day Dung Quat refinery, began operation during that period. According to the government's existing master plan for refinery development through 2025, five new refinery construction projects (the Dung Quat expansion, Nghi Son, Vung Ro, Long Son and Nhon Hoi) will be added. This expansion expects to increase domestic refining capacity to 25 Mt by 2020 and 45–58 Mt by 2025. Viet Nam is anticipated to become highly dependent on crude oil import then.

NATURAL GAS

Viet Nam is self-sufficient in terms of natural gas supply. There are three offshore gas pipeline systems built to deliver gas from oil and gas fields in the petroleum basins of Cuu Long, Nam Con Son and Malay-Tho Chu to shores in the southeast and southwest regions of Viet Nam. They are:

- Rang Dong-Bach Ho-Ba Ria with 1.5 billion cubic meter (bcm) per year capacity and in operation since 1995;
- Nam Con Son-Phu My with 7 bcm per year capacity and operating since 2003; and
- PM3 CAA-Ca Mau with 2 bcm per year capacity and operating since 2007.

In 2013, 13 oil and gas fields produced an annual natural gas supply of 9.8 bcm, a 4.2% increase over the 2012 level (PVN, 2014). Growths in the electricity and fertiliser have driven demand for natural gas.

Under the government's orientation, PVN and PetroVietnam Gas Joint Stock Corporation (PVGas) are preparing for the development of two major gas projects in order to have additional gas supply of about 7-10 bcm per year from Block B, Ca Voi Xanh field and adjacent sources to southern and central markets beyond 2020 (PVN, 2014). Viet Nam has also plans to develop beyond 2015 new infrastructure for importing LNG, firstly in the South to increase gas supply flexibility and ensure national energy supply security (PMVN, 2014; MOIT, 2015a).

BIOMASS

Biomass contribued 13.7 Mtoe or 23% in Viet Nam TPES in 2013 (VNEEP, 2015). Wood fuels, rice straw, rice husks, bagasse, agriculture wastes and animal manures are major traditional biomass sources, which have been used for long time in many rural and mountainous regions by both households and small industrial and handicraft establishments (such as sugar mills, some producers of ceramics, brick, tile, traditional bitscuits/sweets, etc) to produce heat, biogas energy and generate biomass power at low costs and mainly for their own use. (See Section 3.3 of Part I for more detail)

Forestry, agricultural production and animal husbandry activities provide annually abundant biomass sources. Current available sources are estimated about 58 Mtoe per year (GOV, 2015b). Viet Nam has tapped into only a quarter of this quantity. Various agricultural and crop residues (such as coffee husks, nut shells, cashew husks, coconut wastes, maizes, cassava, and so forth) as well as wood waste from wood processing plants, city waste, animal waste, basa fish fat, used-oil, or otherwise remain unexploited for energy production. Along with government's targets and plans to develop the economy sustainably, particularly to increase forest coverage rate from 41% in 2013 to 44%-45% in 2020 and continue to further modernize agriculture sector and rural areas, available biomass sources for energy are estimated to increase to 70 Mtoe in 2030, in which agricultural residues accounts for 30%, wood fuel 21%, animal and city waste 11%, organic waste 2% and energy crops 36% (GOV, 2015b).

HYDROPOWER

Hydropower is the earliest and most developed renewable energy sector in Viet Nam. In 2013, Viet Nam had 268 hydropower plants connected to the national grid or operating in isolated areas to supply electricity to local communes. Total hydropower installed capacity was more than 14 GW – the largest source in Viet Nam power system. With a generation of 57 TWh in 2013, hydropower contributed 8% (or 4.9 Mtoe) in TPES (MOIT, 2016c).

A hydropower plant with capacity from 30 MW and lower is classified as small-hydro power (SHP) in Viet Nam. In general, grid-connected SHPs have capacity scale from 1 MW and above. The typical capacity range of local off-grid hydropower is from 1 kW to 1 MW. There are also pico hydropowers with capacity ranging from 200W to below 1kW which belongs to the ownership of mountainous

households (Institute of Energy, 2014). In 2013, generation from grid-connected SHP was nearly 5 TWh, accounting for 8.8% of total hydropower source and less than 4% of total domestic power generation in Viet Nam (MOIT, 2016c).

Currently Viet Nam has deployed roughly 60% of the total techno-economical potential of hydropower which is estimated at about 95-100 TWh/year by the government. According to MOIT's planning, most of hydropower projects with capacity above 100 MW will be invested and built by 2020. That implies mainly SHP remains for construction in next periods.

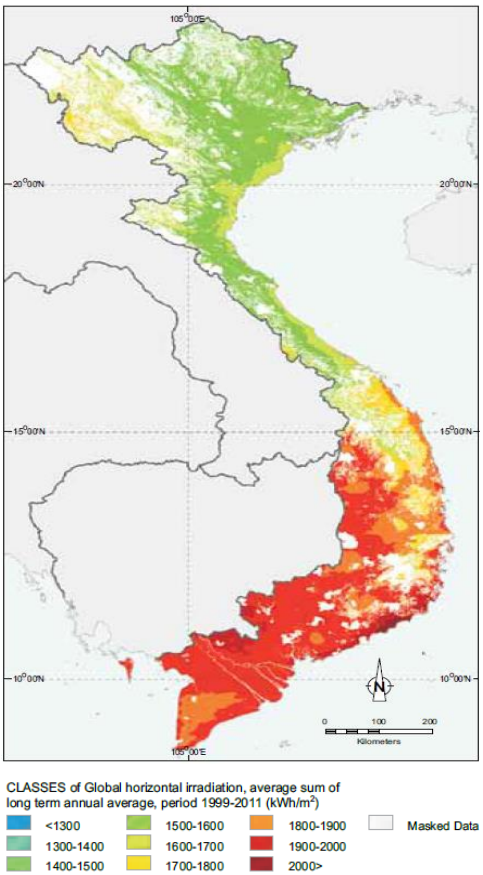
OTHER RENEWABLE ENERGY RESOURCES

Modern and high-cost renewable energies such as solar and wind power are at preliminary stage of development. By 2013, little capacity has been installed and most of systems are small scale and off-grid for local electricity supply. Only three recent wind power projects are connected to national grid. (See Section 3 of Part I for further details.) However, potential of these sources are estimated significantly in Viet Nam.

Solar power

The daily solar energy potential in Viet Nam is characteristically below 4 kWh/m^2 in the north to above 5 kWh/m^2 from central to southern part (IE, 2016). The Asian Development Bank (ADB) study on renewable energy development and potential of Viet Nam indicated that some 220,000 km^2 of land area (excluding island areas) is suitable for solar power generation installable capacity of 0.06 kWp/m^2, the average installed capacity per area based on current technologies. ADB likewise cited that the technical solar potential is about 18 TWh/year, with more than 60% coming from the southern half of Viet Nam (ADB, 2015).

Figure 1.3: Areas potentially suitable for solar photovoltaic development in Viet Nam (island areas excluded)



Sources: GeoModel Solar; Lahmeyemer International, 2012; ADB, 2015.

Wind power

According to a World Bank survey in 2001, wind energy potential in Viet Nam is estimated about 513,360 MW, surpassing the potential of all neighbouring Southeast Asian economies (World Bank, 2001). Viet Nam's wind potential is significant in the central coastal region (including Quang Binh, Quang Tri, Thua Thien Hue and Binh Dinh) and the south (including Ninh Thuan, Binh Thuan, Lam Dong, Tra Vinh and Soc Trang).

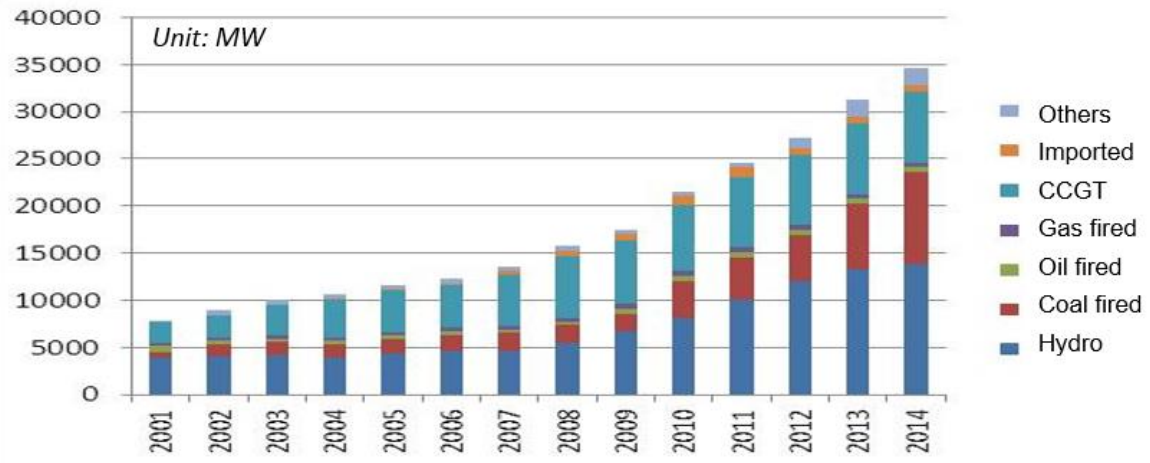
1.2 Electricity supply

In 2014, Viet Nam total electricity supply was 145.5 TWh, increasing over 11% from its 2013 level. Of this total electricity output, over 41% came from hydropower plants and other renewables, 57% from thermal power plants and less than 2% from import (MOIT, 2016a).

Viet Nam's power system is the third largest in ASEAN, with a total installed power capacity of over 34.5 GW in 2014. During 2005–2014, over 22.4 GW were newly built, that corresponded to an average growth of nearly 13% per year. Development of renewable power sources recorded the highest growth at 15.1% per year on average. The installed hydropower capacity tripled from 4.4 GW in 2005 to 13.6 GW in 2014, at an average annual growth rate (AAGR) of 13.4% and other renewable sources increased from a negligible level to 2 GW in 2014 (AAGR at 42.4% during 2010-2014). As a result, renewable's share of total installed capacity in Viet Nam increased from 38% in 2005 to 41.5% in 2014.

Among thermal power sources, coal-fired power plants recorded the fastest growth in development, averaging 23% per year from 2005–2014. With 8.3 GW newly added, the installed capacity of coal-fired power increased to 9.8 GW in 2014, expanding its share to 28.5% from 13% in 2005. It surpassed the capacity of gas-fired power plants, which remained stable at 7.7 GW since 2009. Contribution of gas power reduced from 45% in 2005 down to 22% in 2014. Growing deployment of renewbale and coal power also led to further reductions in the roles of oil power and import in Viet Nam's electricity system. The share of oil power capacity and import source remained small and continued to decrease to 1.6% each in 2014.

Figure 1.4: Viet Nam's evolution of the power capacity structure 2001-2014



Source: MOIT, 2015c

Table 1.1: Power installed capacity and generation in Viet Nam in 2013

Power Type	Capacity (MW)	Share (%)	Generation* (GWh)	Share (%)
Large Hydro (>30 MW)	**13,260**	**43.2**	**51,954**	**40.8**
Coal thermal	7,116	23.2	26,863	21.1
Gas turbine	7,446	24.3	42,745	33.6
Oil thermal	912	3.0	249	0.2
Diezel	70	0.2	7	0.01
Other renewables	**1,884**	**6.1**	**5,511**	**4.33**
Small-hydro	1670	5.4	4,989	3.92
Wind	56	0.2	62	0.05
Biomass	150	0.5	460	0.36
Biogas / MSW	4	0.01		
Solar power	4	0.01		
Total	**30,688**	**100%**	**127,329**	**100%**

Note (*): Including only grid connected power plants

Source: MOIT, 2014 and 2016c.

Since 2004, the government of Viet Nam has established a vision for a competitive power market. On 1 July 2011, Viet Nam's competitive generation power market (VCGM) launched its pilot operation and commenced full operation on 1 July 2012. The first pilot year of the competitive wholesale power market (VWEM) started January 2016. About 31-42 power plants (equivalent to an installed capacity of 16.3-20 GW, or 44%-49% of total national power system) eligible not to participate in VWEM in 2016 includes:

- Multi-purpose strategic hydropower plants,
- Small-hydro with capacity from 30MW and lower with inappropriate connection infrastructure,
- Other renewable power plants of all-size,
- Power plants invested based on the Build-Operate-Transfer (BOT) scheme and having PPA (Power Purchase Agreement) or HOA (Heads of Agreement) concluded before January 2016,
- Power plants invested based on the Independent Power Producer (IPP) scheme, built in industrial zones and not to supply their total production to the national power network,
- Gas-fired power plants using PM3-CAA gas source.

The government has plan to start the Competitive Retail Power Market by 2021.

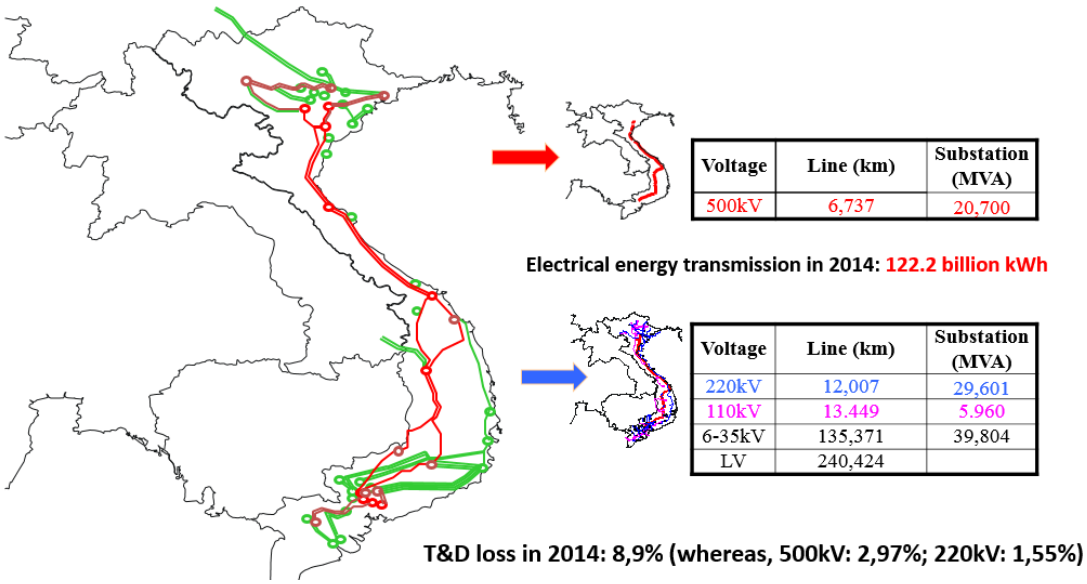
Viet Nam's electricity system is operated at high voltage levels 500 kV, 220 kV, 110 kV and medium voltage levels from 35 kV to 6 kV. The 500 kV and 220 kV transmission grids are managed by the

National Power Transmission Corporation while the 110 kV distribution grid and medium voltage power grids between 6 kV and 35 kV are under the regional Power Companies'management.

Viet Nam has had a 500 kV interconnected power grid since 1995. The 500 kV line is the backbone of the national power system, transmitting from the north to the south with a total length of 6737 kilometers in 2014 (Figures 1.5). The 500 kV grids play a vital role in balancing power for entire Viet Nam and have a major impact on power supply reliability of each region.

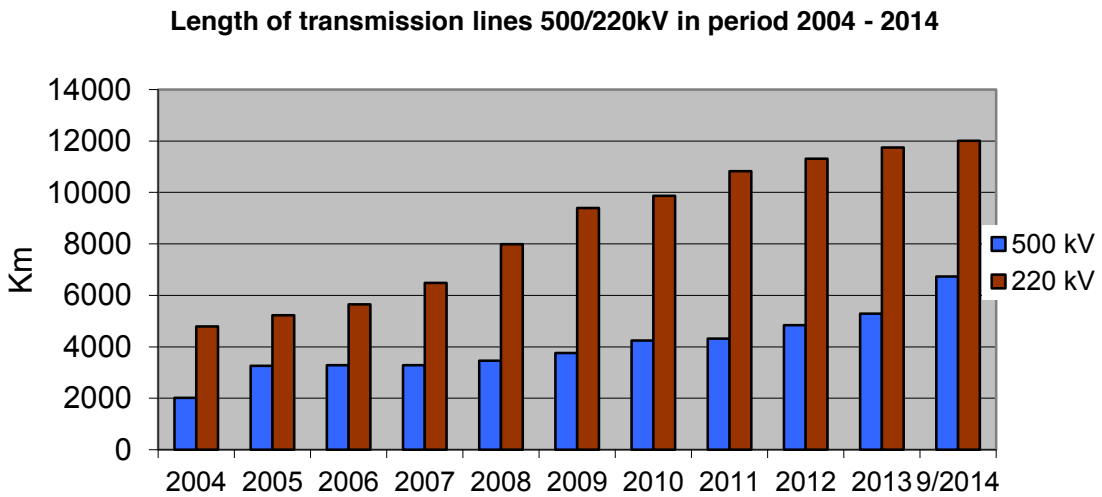
During 2004-2014, power transmission and distribution grid developed rapidly together with growths in power sources. Figure 1.6 shows annual expansions of line length and transformer capacity at 500 kV and 220 kV voltages over that period. Hence, electric energy transmission could increase 84% from 66 TWh/year in 2008 to 122 TWh/year in 2014. Currently, Viet Nam has electrified 99.6% of its communes and 98% of its rural households (EVN, 2015), an increase from about 50% of households by mid 1990s (ADB, 2011).

Figure 1.5: Viet Nam power transmission network by end 2014

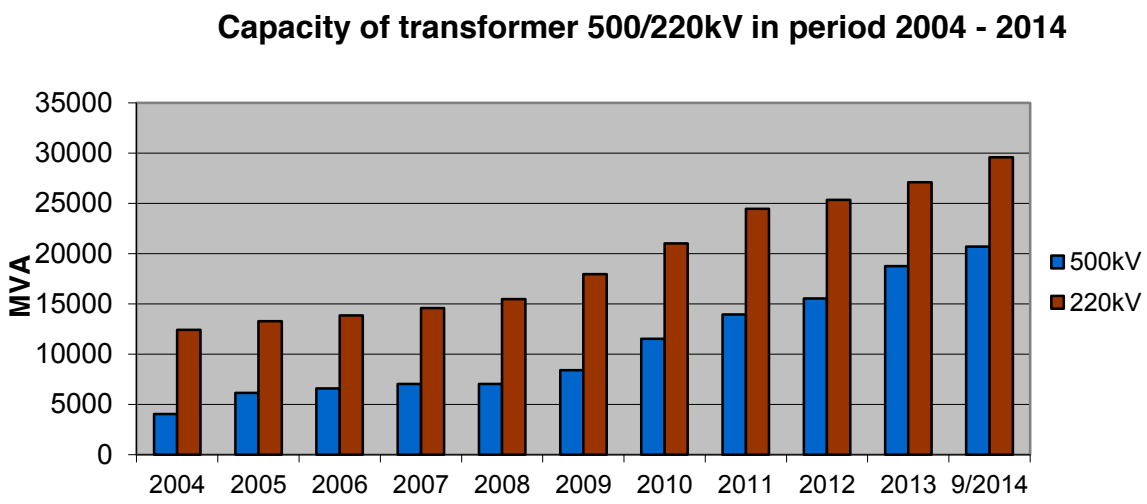


Source: MOIT, 2015c

Figure 1.6: Development of power transmission network in Viet Nam during 2004-2014

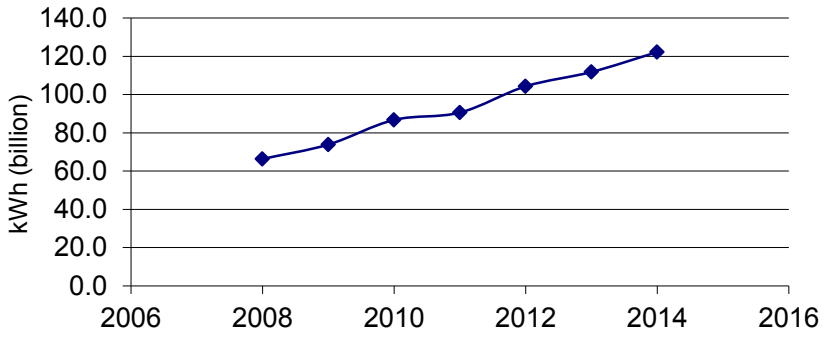


Source: MOIT, 2015c



Source: MOIT, 2015c

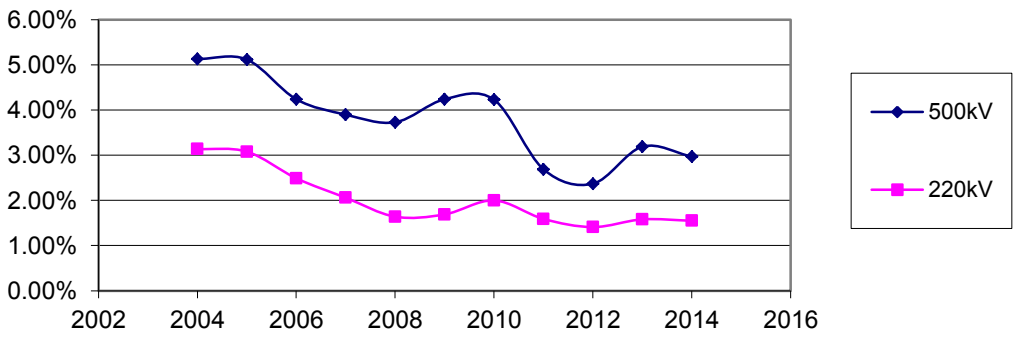
Figure 1.7: Electrical energy transmission in Viet Nam, 2008-2014



Source: MOIT, 2015c

Power system efficiency has improved significantly during 2004-2014. Losses reduced from 5% for 500kV grid and 3% for 220 kV grid in 2004 to about 3% and 1.5% respectively in 2014 (Figure 1.8), contributing to reductions of total loss of transmission and distribution system which was 10.3% in 2010 and 8.9% in 2014.

Figure 1.8: Losses of Transmission network in Viet Nam, 2004 - 2014

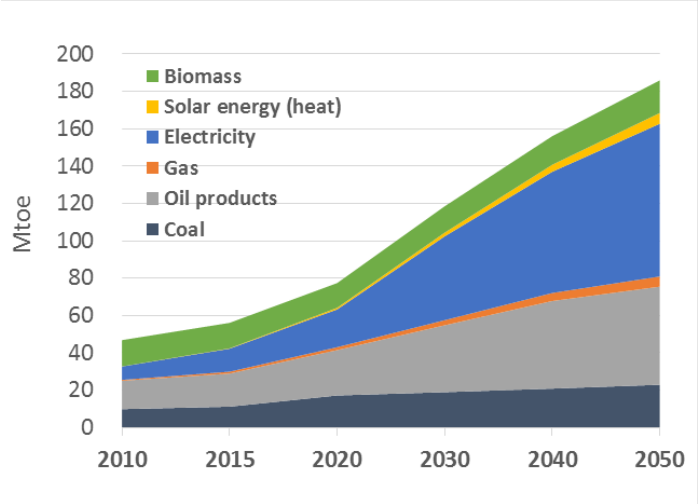


Source: MOIT, 2015c

1.3 Final energy demand

Viet Nam total final energy consumption (TFEC) in 2013 was 50.6 Mtoe, up 2.6% from 2012 and 36% higher than 2005 level (VNEEP, 2015). Demand structure by fuel has changed significantly, with a reduction in the share of biomass (non-commercial energy) and a rise in modern fuels, including oil, coal, gas and especially electricity. During 2005–2013, electricity demand grew over 13% per year on average, reflecting progress in industrialisation and modernization of the economy.

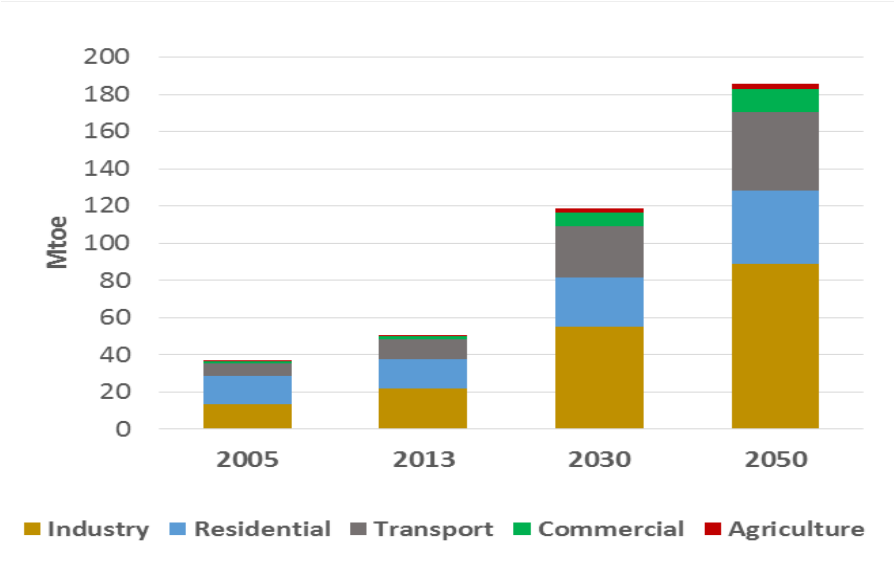
Figure 1.9: Viet Nam final energy demand by fuel, 2005-2050



Source: Institute of Energy, 2006; GOV, 2015b

Industry is an important sector in GDP growth and has represented the largest segment of TFEC at 43% (including also 4% petroleum products and gas demand for feedstocks) in 2013. This sector consumed mainly coal at 41%, electricity at 24%, renewable energy at 17%, petroleum products at 11% and natural gas at 7%. During 2005-2013, industrial energy demand growth ranks the second fastest, 6.0% per year average, after only transport. It contributed 60% of total additional demand over this period and increased 6-percentage points in its share from 37% in 2005.

Figure 1.10: Viet Nam final energy demand by sector, 2005-2050



Source: Institute of Energy, 2006; GOV, 2015b

The residential sector accounted for 31% in 2013. In this sector, traditional biomass accouted 64%, electricity 23%, coal 8% and oil 6%. Demand for electricity grew rapidly in the residential sector,

reflecting improvements in household income that creates an increase in electric appliance use, and improvements of power supply quality.

The transport sector was the third largest energy-consuming sector, accounting for 22% of TFEC in 2013 and remained the main consumer of petroleum products at 72% of the economy's total requirement. This sector's share increased rapidly from 18% in 2005, resulting from its highest demand growths (6.4% per year average) during 2005-2013.

Commercial and agricultural energy consumption represented 3% and 1% of TFEC respectively in 2013. Electricity (30% in commercial sector, 22% in agriculture) and oil (74% in agriculture, 44% in commercial) are the most-consumed fuels in these sectors.

Viet Nam is forecasting economic growth (GDP) between 6.5% - 7.6% per year over the period to 2030 (MOIT, 2015c). Under the Energy Efficiency Scenario, Viet Nam's final energy demand is projected to double to 119 Mtoe in 2030 and 186 Mtoe in 2050 (GOV, 2015b). It corresponds to an average growth rate at 5% per year during 2013-2030, then lower at 2% during 2030-2050. Industry remains the highest-consuming sector throughout the forecast period, with a share increase to 46% in 2030 and 48% in 2050. Transport demand continues to grow quickly and surpasses residential demand, with a share of 23% in 2030-2050. Share of residential demand reduces significantly to 22% in 2030 and 21% in 2050. Contributions from the commercial and agriculture sectors rise slightly from 4% in 2013 to about 8% in 2030 and 9% in 2050.

Final demand for electricity is forecasted to continue to increase strongly at over 10% per year to 2020 and then grow between 6-9% per year over the period 2020-2030. Meeting this demand will require an investment of around US$ 42 billion to 2030, with 58% of this required for generation and 42% for transmission and distribution (MOIT, 2015c). Oil demand increases faster than the past growth rate: 6.5% per year to 2020 and 4% per year over the period 2020-2030, compared to the rate of 3.5% per year during 2010-2015 (GOV, 2015b).

2 VIET NAM'S ENERGY SECTOR: STRUCTURES AND STAKEHOLDERS

2.1 Government agencies

Figure 1.11 shows the institutional organization of energy sector in Viet Nam.

- **Prime Minister**

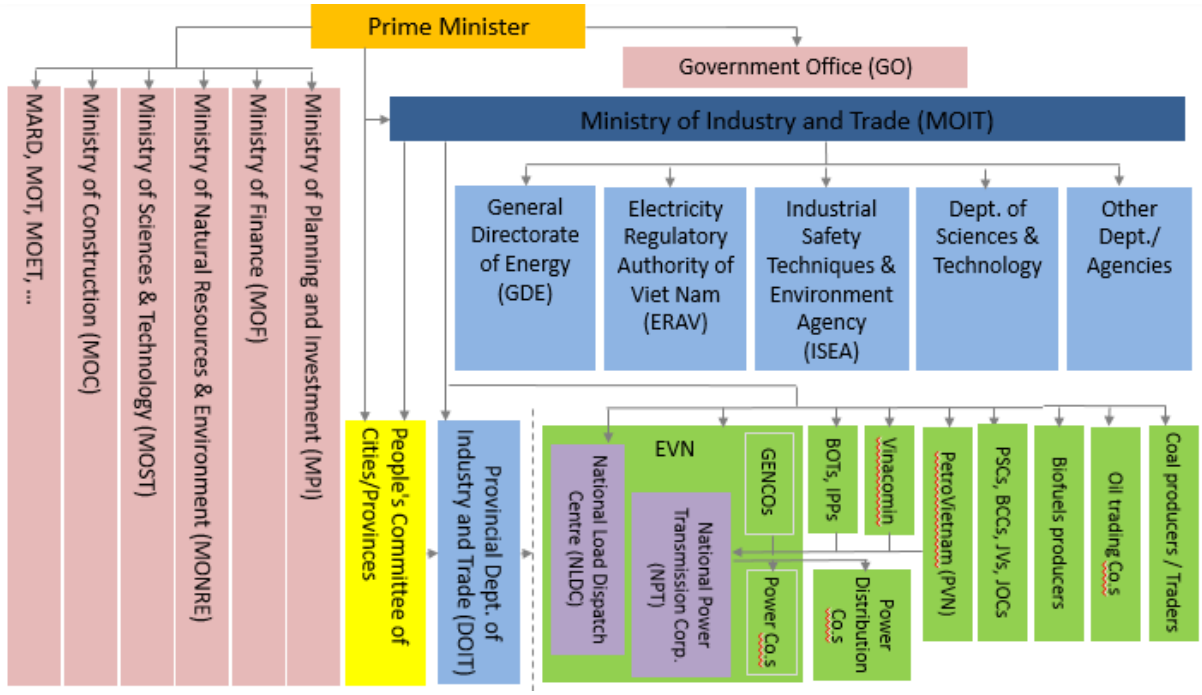
Prime Minister (PMVN) leads and takes responsibility for the work of the state administration system from the central to the local level, ensuring the consistency and continuity of the national administration system. Prime Minister has overall responsibility for policies, strategies, and plans concerning the development of energy sector. In turn, the Government Office and ministries involve in formulating or implementing energy policies within their tasks/field of responsibilities based on the principle that Ministers and Heads of ministerial-level agencies are personally responsible to the Prime Minister, Government and National Assembly for the sectors and fields under their charge and, together with other members of Government, assumes the collective responsibility for the work of the Government.

- **The Ministry of Industry and Trade (MOIT)**

The MOIT is the focal point for the state management and administration of coal, oil, gas, electricity, nuclear energy, renewable energy (RE) and energy efficiency activities. Formed in 2007 out of the merger of the Ministry of Industry and the Ministry of Trade, it operates currently in accordance with functions, tasks and powers as defined in the government's Decree 36/2012/ND-CP dated 18 April 2012 and the government's Decree 95/2012/ND-CP dated 12 November 2012. The MOIT takes the leading role to coordinate and cooperate with different lines of ministries, local government agencies, researchers and key stakeholders in drafting energy policies, national energy strategies

and plans to submit to PMVN or Government for approval. It is responsible for formulating detailed regulations and guidelines to implement government policies, administrating, examining the implementation and reporting aggregate results of energy activities.

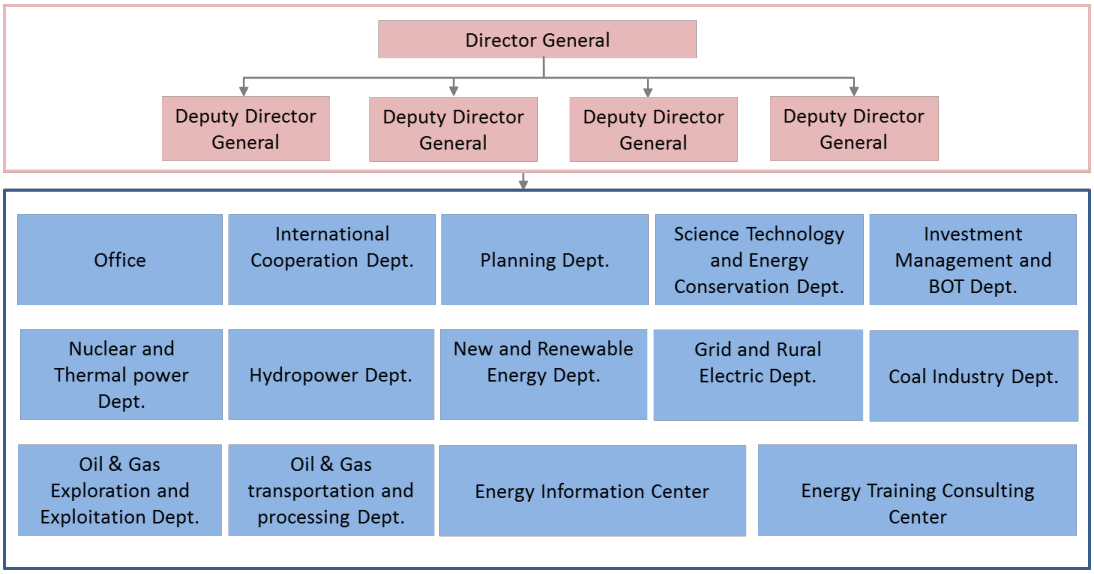
Figure 1.11: Simplified diagram of Institutional organization of energy sector in Viet Nam



Under the MOIT, key advisory and executive units assisting the MOIT's Minister with management of the energy sector are as followings:

- **The General Directorate of Energy (GDE):** On 25 October 2011, the Prime Minister's Decision 50/2011/QD-TTg established the GDE and it commenced operation (PMVN, 2011a). Its functions focus on formulating law, policy and planning, and generally managing whole energy sector. GDE is currently organized with 1 Director General, 4 Deputy Director Generals and 14 assisting units. Figure 1.12 shows the GDE's organization details.

Figure 1.12: Organization chart of the General Directorate of Energy (GDE)



- **The Energy Regulatory Authority of Viet Nam (ERAV):** The Prime Minister's Decision 258/QD-TTg, signed on 19 October 2005, and the Prime Minister's Decision 153/2008/QD-TTg, dated 28 November 2008, established the ERAV. The ERAV specialises in regulatory activities in the electricity sector in order to ensure a safe and high-quality supply of electricity for the economy. It also fosters the economical and efficient consumption of electricity and upholds the equity and transparency in the sector in compliance with the law. ERAV's concrete tasks include:
  - Implementing regulatory activities relating to the electricity market and tariffs (including approving the Termed Bilateral Power Purchase Agreements (PPA));
  - Reviewing provincial/city power development master plans and power development projects;
  - Monitoring and making the mid- and long-term forecasts for the electricity supply-demand balance;
  - Granting permits for power businesses; and
  - Overseeing the inspections of electricity activities.
- **Department of Science and Technology (DOST):** DOST assists MOIT's Minister in state management of sciences and technology, biotechnologies, standards- measurement and products qualities. It is responsible for formulating plans, guidelines and organizing the implementation, approval of national focused sciences and technology programs for the development of biofuel, environment industry…
- **Industrial Safety Techniques and Environment Agency (ISEA):** ISEA implements the functions of state management in the field of safety techniques and environmental protection in electricity sector, new energy, renewable energy, oil, gas and other mining industry. It assists MOIT's Minister to implement relevant programs, projects and tasks, and financial management of MOIT's National Target Program to Respond to Climate Changes.

In addition, different line ministries, local government agencies cooperate with MOIT to implement state management in energy sector. Some among them are:

- **The Ministry of Planning and Investment (MPI):** The MPI coordinates and allocates funds, especially in regard to state budget and ODA sources for energy proposals submitted by MOIT and localities.
- **The Ministry of Finance (MOF):** The MOF cooperates in formulating taxation and tariff policies in energy sector, as well as in managing, monitoring financial activities of national energy programs and projects.
- **The Ministry of Natural Resources and Environment (MONRE):** The MONRE involves in managing surveys and exploration of reserves of energy resources, supervises overall national environment-related issues. MONRE is the national Focal Point to coordinate the implementation of the UNFCCC (The United Nations Framework Convention on Climate Change) and its Kyoto Protocol; MONRE is also the designated agency for the implementation of the National Target Program on Responses to Climate Change (NTP-RCC). The Department of Meteorology, Hydrology and Climate Change (DMHCC) of MONRE is the Designated National Authority for the Clean Development Mechanism (CDM) in Viet Nam.
- **The Ministry of Science and Technology (MOST):** The MOST involves in supporting new renewable energy technology developments, appraisals of norms and standards.
- **The Ministry of Construction (MOC):** The MOC involves in establishing standards for all construction works of energy projects. The MOC is also responsible for regional planning (both urban and rural).

- **The Ministry of Agriculture and Rural Development (MARD):** The MARD responsible for planning and management of agricultural production activities that supply inputs to produce biofuels. It cooperates in implementing biogas, biomass power and hydropower development programs in rural areas.
- **The Ministry of Transport (MOT):** The MOT responsible for infrastructure development. It cooperates in implementing biofuel use programs.
- **The Ministry of Education and Trainning (MOET):** The MOET cooporates in preparing human resources for energy sector, participating in R&D programs on new energy technologies and products.
- **The People's Committee of Cities/Provinces, the provincial Departments of Industry and Trade (DOIT)** are responsible for implementing state management directives with respect to the energy sector, including directives for renewable energy, at the provincial level.

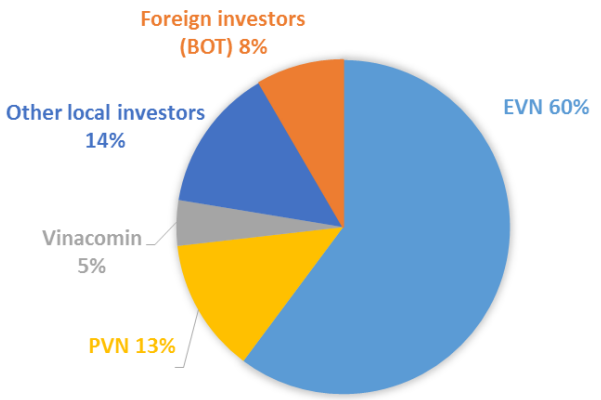
2.2 Other Related Organizations

- **Major/leading energy state-own enterprises:**

Viet Nam Oil and Gas Group (Petrovietnam, or PVN), Viet Nam National Petroleum Group (Petrolimex), Viet Nam Electricity (EVN), Viet Nam National Coal and Mineral Industries Holding Corporation Limited (Vinacomin) are the leading state-owned enterprises (SOEs) in energy industries in Viet Nam. They actively contribute to formulating and implementing development strategies, master plans and annual plans issued by the Government in energy sectors. The government restructured the SOEs gradually to operate on a commercial basis and with transparency in terms of their performance and financial information.

– **Viet Nam Electricity (EVN)** is leading SOE in electricity sector. The company is entrusted with investment and operation of major hydropower plants, especially strategic multi-purpose ones, nuclear plants, the national electricity transmission system and the rural grid-connected power development programs. EVN assumes also the operation of the national power system and power market. In 2014, EVN contributes 60% of 34-GW total power installed capacity.

Figure 1.13: Viet Nam installed power capacity structure by ownership in 2014



Source: EVN, 2015

– **PetroVietnam (also known as PVN)** is the leading SOE in oil and gas exploration, exploitation (E&P) and processing activities. PVN (including its subsidiary *PetroVietnam Exploration Production Corporation (PVEP)*) is a partner, representative of the Vietnamese government in commercial agreements and contracts signed with international investors in the field of oil and gas E&P in Viet Nam. PVN also participates actively in oil and gas trading and distribution, power

production through its subsidiaries, including PVGas, PVOil and PVPower. In power business, PVN's investment portfolio includes mainly gas-fired power, coal-fired power and renewable power. The company is also the leading investor in biofuel production and distribution in Viet Nam market; total capacity of three bioethanol plants invested by PVN is 300 million liters.

- **Vinacomin:** is the leading SOE in coal sector, operates in all fields of coal value chain in Viet Nam. The government entrusts Vinacomin with the task of a major coal supplier, ensuring sufficient thermal coal fuels for power generation. The company participates also in power generation, with a focus on coal-fired power.

- **Energy and environment research institutes:**

Research institutions most involve in energy policy consulting projects for the MOIT and Government (on contract basis) include:

- *Institute of Energy (IE):* undertakes and prepares energy sector plans, strategies, and policies. Under IE, the Renewable Energy and CDM Center specializes in new and renewable technical and policy studies.
- *Viet Nam Petroleum Institute (VPI)*: involve in study projects relating to national oil, gas and biofuel development strategies and plans
- *Industrial Policy and Strategy Institute (IPSI)*
- *Viet Nam Academy of Science and Technology (VAST)*

- **Academies:**

There are a number of universities involving in research projetcs on renewable energy issues, such as:

- *Universities of Technology* of provinces and citites
- *University of Agriculture*
- *Nha Trang University (Institute of Aquaculture)*
- *Can Tho University*

- **Professional associations:**

- *Viet Nam Energy Association (VEA)*: established in 2004, the VEA is the leading and active professional association in energy sector
- *Viet Nam Energy Conservation and Energy Efficiency Association (VECEA)*
- *Viet Nam Biogas Association (VBA)*: The VBA is an independent, market-driven, social-occupational organization which was initiated in 2009. It is an institutional platform that brings together actors, business and academia of the biogas sector in Viet Nam with the aim of improving the cooperation, connection and mutual support in developing and protecting legal rights of members in the Vietnamese biogas sector.
- *Viet Nam Biofuel Association (VBFA)*: The VBFA has operated since 2011. Its members include all bioethanol producers in Viet Nam.
- *Small & Medium Hydropower - Green Energy Association (SHPGEA)*: The SHPGEA was founded and operated in 2015. It is a professional social organization under the Viet Nam Energy Association, operates in the field of small and medium hydropower, green power economy-wide. SHPGEA aims to support investors in technology transfer, removing difficulties in investment and operation process, and at the same time, playing the bridge role between enterprises and state management agencies.

- *The Viet Nam Clean Energy Association (VCEA)*: VCEA was founded and operated in 2015 according to the Decision No. 637 QD/BNV on 29 July 2015 of the Ministry of Home Affairs, whose members comprise investors, owners and producers of renewable energy.

- **International organizations:**

Internation organisations, especially the World Bank (WB), the Asian Development Bank (ADB) and UNDP among others have been actively participated in energy policy formulation and implementation process by providing the Government of Viet Nam with technical and financial assistances.

Table 1.2: Selected energy policy-related programs in Viet Nam with the participation of international organizations and foreign donors

No.	Project/Program name	Main Objectives or Study Contents	Vietnamese Executive Unit	Donor/Foreign Partners	Duration time
CLIMATE CHANGE POLICY					
1	VNPT	Support the NTP-RCC with a focus on the transport and energy sectors	MOIT/ISEA	ADB	2011-2014
2	RESP	Improve the regulatory framework for renewable energy and increase the professional and organizational capacities of key institutions	MOIT/GDE	BMUB/GIZ	2012-2015
3	CCIT	Strengthen the capacity of policy makers and stakeholders in the industry sector to reduce GHG emissions, enhance climate resilience and exploit associated green trade opportunites	MOIT/ISEA/ DST/DOSTEE	UNDP	2013-2016
4	EEP	Support wider provision and use of renewable energy by facilitating renewable energy and energy efficiency-related cooperation, dialogue and experience sharing among stakeholders of different public and private sectors	MOIT/GDE/ RED	MFA Finland/ Nordic Development Fund (NDF)	2014-2016
5	PMR	Support for the elaboration of market-based instruments in Vietnamese climate policy and the additional reform of the selected state-owned sectors and introduction of regulatory incentives and pricing instruments	MONRE/MPI/ MOIT/MOC	World Bank	2015-2017
THE VIETNAM NATIONAL ENERGY EFFICIENCY PROGRAM					
6	BRESL	Barriers Removal to the Cost-Effective Development and Implementation of Energy	MOIT/MOST/ EVN	UNDP/GEF	2009-2015

No.	Project/Program name	Main Objectives or Study Contents	Vietnamese Executive Unit	Donor/Foreign Partners	Duration time
		Efficiency Standards and Labeling			
7	CPEE	Strengthen the capacity of Government and other key stakeholders in achieving the energy efficiency targets of the National Energy Efficiency Program	MOIT/DSTEE	WB	2011-2016
8	LCEE	Support VNEEP in promoting EE in the SMEs sector with a focus on key industrial sectors, and in implementing the new energy effificiency building code for new large buildings	MOIT/MOC	DANIDA	2013-2015
9	ASEAN SHINE	Harmonization of test methods and EE standards, adoption of common MEPS, and changing consumer purchasing attitudes in favor of energy efficient air-conditioners.	MOST/STAMEG	EC	2013-2016
10	VCEP	Support Viet Nam's sustainable growth by reducing GHG emissions through the more efficient usage of electricity in the building sector	MOC	USAID	2014-2018
11	VEEGB	Promote energy efficiency in building and reduce GHG emissions	MOC	IFC	2013-2017
THE VIET NAM POWER SECTOR REFORM PROGRAM					
12	DEP	Improve the performance of Viet Nam's PCs in providing quality and reliable electricy services, and to reduce GHGs through demand side response and efficiency gains	MOIT (ERAV)/EVN/ PCs	World Bank	2012-2018
13	TEP	Improve the capacity, efficiency, and reliability of electricity transmission services in key areas	MOIT/GDE/ ERAV/NPT	World Bank	2014-2019
14	PSRDPO3	To support the design and implementation of a competitive market for electricity generation; to restructure the power sector and reform of electricity tariff system	MOIT/ERAV	World Bank	2014-2015
15	VREDP	Increase the supply of electricity to the national grid from renewable energy sources on a commercially, environmentally, and socially sustainable basis	MOIT/GDE	World Bank	2009-2016

Source: CEGR, 2014.

3 RENEWABLE ENERGY DEVELOPMENT IN VIET NAM

3.1 Goals, Objectives, Targets and Roadmaps

The National Energy Development Strategy for the period 2020 with a vision to 2050 issued in 2007 (PMVN, 2007a) has indicated an aggregate target for renewable energy (RE) development. The targeted share of renewable energy (excluding large hydropower with capacity over 30 MW) in total commercial primary energy supply is 5% by 2025 and 11% by 2050.

The development and use of biogas technologies as well as high energy-efficient sanitary biomass-burning stoves have been promoted very early in Viet Nam and accelerated particularly since mid 2000s. Before 2015, biogas development targets and supporting programs were specified for short periods and integrated with the implementation of government's international cooperation programs and projects for emission mitigation from animal husbandry sector, energy savings, or for agriculture sector and rural development and modernisation in general. (See more details at section 3.3)

In 2007, government issued a specific biofuel program (PMVN, 2007b) with targets and roadmap details as shown in Table 1.3. Biofuels (biodiesel and bioethanol) are encouraged in Viet Nam as an alternative to partially replace conventional fossil fuels, contributing to assuring energy security and environmental protection. Biofuel use is focused on road transport vehicles.

Table 1.3: Summary of targets of the Biofuel development program for the period 2007-2015

Item	Up to 2010	2010–2015	Vision up to 2025
Legal framework	• Formulation of legal systems to promote industrial-scale production and use of biofuels • Campaign to raise public awareness of biofuels • Development of road map for use of biofuels to partially replace fossil fuels		
Technology	• R&D toward mastery of technologies for biofuel production, from biomass generation and blending, to increasing conversion efficiency	• Mastery of the production of materials and additives for biofuel production	
Human resources	• Ready for initial implementation	• Technical staff with in-depth knowledge and skills in major areas related to biofuel production • Technicians with general skills, ready for biofuel production	
Feedstock preparation	• Planning and development of raw material areas • Mastery of production of high-yield plant seeding	• Development of raw material areas now being planned • Large-scale production of high-yield plants	

Item	Up to 2010	2010–2015	Vision up to 2025
Expected output	• Pilot models for biofuel production and use • Annual capacity: 100,000 tons E5 and 50,000 tons B5 (equivalent to 0.4% of the economy's projected oil and gasoline demand)	• Wide use of biofuels to replace fossil fuels • Scaling up of production and distribution network • By 2015: 250,000 tons of ethanol and vegetable oil output (blendable to 5 million tons of E5 and B5), meeting 1% of the economy's oil and gasoline demand.	• Biofuel technology at world state-of the-art level • Up to 1.8 million tons of of ethanol and vegetable oil output

Sources: PMVN, 2007b; ADB, 2015

Prior to 2015, aggregate renewable power targets and implementation roadmaps were mentioned in the *National Power Development Plans (PDP*) for each ten-year period. As hydropower is a competitive power source, targets and programs were detailed in PDPs and small-hydro power master plans, which were established at national (issued by the MOIT) and provincial levels (issued by the People's Committee of Cities/provinces). Other renewable power subsectors, in general, had no specific economy-wide development targets nor clear implementation roadmaps. Renewable power projects used to be considered case by case and implemented in integration with the government's strategy or supporting programs of rural electricification, power savings, or for poverty alleviation in rural remote mountainous and islands areas.

In November 2015, the government issued for the first time a comprehensive national strategy of renewable energy for the period through 2030, with a vision to 2050 (PMVN, 2015b, hereafter mentioned as *RE Strategy* or *REDS* in brief), covering renewable power and bioenergy with diverse subsectors. Renewable energy development in Viet Nam continues to integrate with the implementation of broader objectives of general socio-economic development, industrial and sectoral deployment. In particular, it contributes to modernisation and new rural development, industry growth, fuel diversification, and implementation of Viet Nam's pledge to mitigate GHG emission increase.

The ambitious targets set include: commercial renewable energy to reach 37 Mtoe (31% of TPES) by 2020 and 62 Mtoe (over 32%) by 2030; renewable power (including large hydropower) to account for 38% of total generation by 2020 and 32% by 2030; biofuels to increase to about 5% of total transport fuel demand in 2020 (about 800 ktoe) and 13% (3.7 Mtoe) in 2030. The government expects that accelerated renewable energy growth will contribute to a mitigation of GHG emissions in energy activities of around 5% by 2020 and 25% by 2030, compared to the BAU (business as usual) plan. The targets will also result in a reduction of fossil fuel imports for energy purposes of about 40 million tons of coal (compared to the case established in the *National Power Development Plan for the period 2011-2020 and perspective to 2030 (PDP7*[1]*)*, approved by PMVN in 2011) and 3.7 million tons of oil products by 2030. A summary of the targets in the RE Strategy is given in Table 1.4.

Table 1.4: Summary of targets in the Renewable Energy Strategy of Viet Nam

Measure	2015 baseline	2020 target	2030 target	2050 target

[1] The PDP7 was under review for revisions by the time the Peer Review Team visited Viet Nam. The revised PDP7 was planned for release in 2016Q1 and it is subject to the PMVN's approval.

Measure	2015 baseline	2020 target	2030 target	2050 target
GHG mitigation in energy sector (vs BAU)	**-**	**5%**	**25%**	**45%**
Imported coal reduction (vs BAU scenario in PDP7 issued in 2011)	-	-	40 million tonnes	150 million tonnes
Imported oil reduction (vs BAU scenario in PDP7 issued in 2011)	-	-	3.7 million tonnes	10.5 million tonnes
RE in total primary energy supply	**25 Mtoe**	**37 Mtoe**	**62 Mtoe**	**138 Mtoe**
RE in total primary energy supply	31.8%	31%	32.3%	44%
Total electricity generation from RE	**58 TWh**	**101 TWh**	**186 TWh**	**452 TWh**
RE in total electricity generation	35%	38%	32%	43%
Electricity generation from hydropower	**56 TWh**	**90 TWh**	**96 TWh**	**96 TWh**
Installed capacity of pumped-storage hydropower	-	-	2,400 MW	8,000 MW
Electricity generation from wind	**0.18 TWh**	**2.5 TWh**	**16 TWh**	**53 TWh**
Wind power in total electricity generation	Negligible	1.0%	2.7%	5.0%
Electricity generation from solar	**0.01 TWh**	**1.4 TWh**	**35.4 TWh**	**210 TWh**
Solar power in total electricity generation	Negligible	0.5%	6%	20%
Electricity generation from biomass	**0.6 TWh**	**7.8 TWh**	**37 TWh**	**85 TWh**
Biomass power in total electricity generation	1.0%	3.0%	6.3%	8.1%
Solar water heating absorption area	3 million m^2	8 million m^2	22 million m^2	41 million m^2
Solar water heating energy supply	**-**	**1.1 Mtoe**	**3.1 Mtoe**	**6 Mtoe**
Households with solar equipment	4.3%	12%	26%	50%
Construction of biogas systems	4 million m^3	8 million m^3	60 million m^3	100 m m^3
Households with advanced biomass cookers	Negligible	30% by 2020 60% by 2025	Most rural households	Most rural households
Agricultural and forestry waste used for energy production	45%	50%	60%	70%
Livestock waste treatment for biogas	5%	10%	50%	Most treated

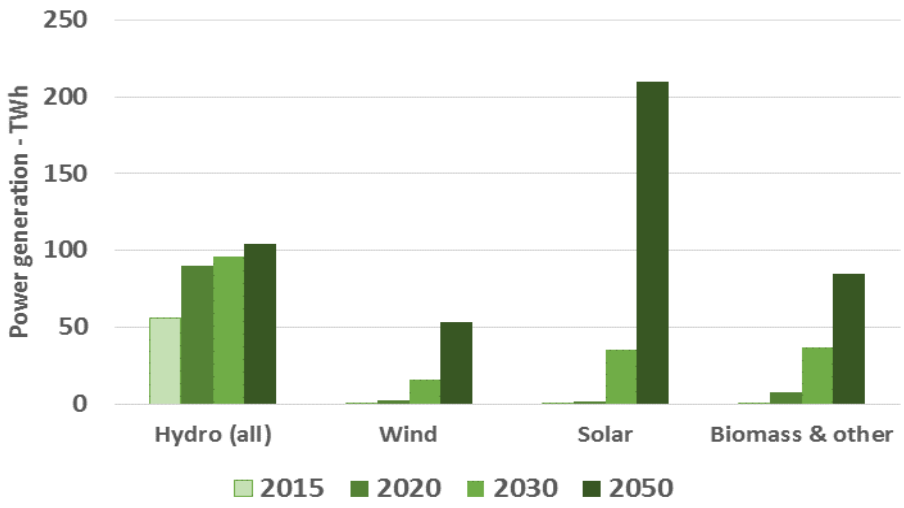
Measure	2015 baseline	2020 target	2030 target	2050 target
City waste treatment for energy	Negligible	30%	70%	Most used
Total deployed biomass sources for energy production	**14.4 Mtoe**	**16.2 Mtoe**	**32.2 Mtoe**	**62.5 Mtoe**
Biomass for biofuel production	0.2 Mtoe	0.8 Mtoe	6.4 Mtoe	19.5 Mtoe
Biomass for power generation	0.3 Mtoe	1.8 Mtoe	9.0 Mtoe	20 Mtoe
Biomass for thermal energy production	13.7 Mtoe	13.6 Mtoe	16.8 Mtoe	23 Mtoe
Biomass energy in total final energy demand	**25%**	**17%**	**14%**	**12%**
Biofuel production	**0.15 Mtoe**	**0.8 Mtoe**	**3.7 Mtoe**	**10.5 Mtoe**
Biofuel in total transport energy demand	-	5%	13%	25%
RE equipment manufactured domestically	**-**	**30%**	**60%**	**Domestic demand met, exporting**

Note: RE = renewable energy

Source: PMVN, 2015b

Figure 1.14 illustrates targeted changing profile of electricity generation by renewable power types in Viet Nam during 2015-2050 according to RE strategy.

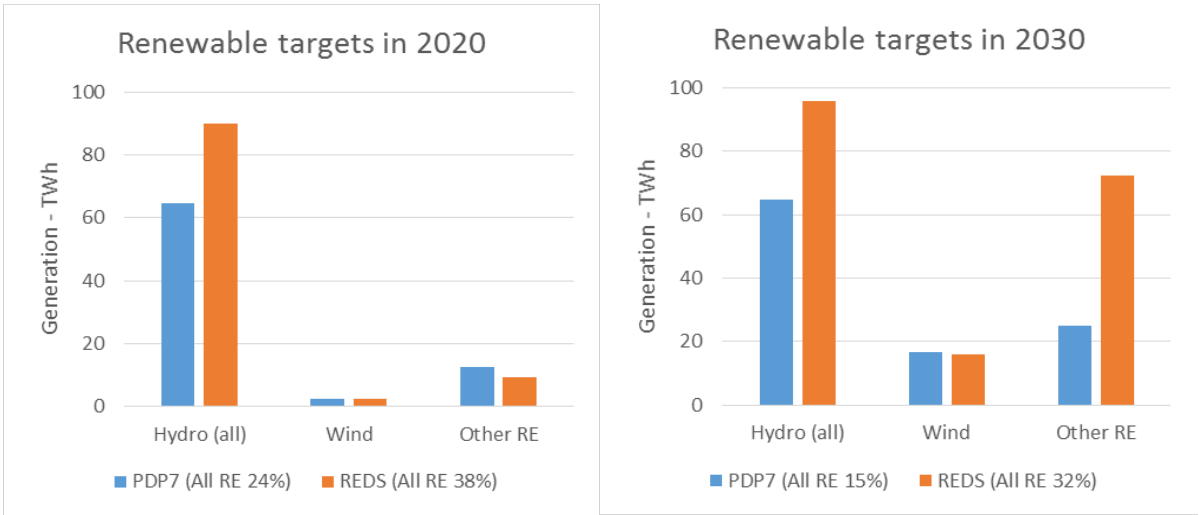
Figure 1.14: Renewbale power development orientations by subsector in Viet Nam, 2015-2050



Source: PMVN, 2015b

Changes of renewable power development targets set for 2020 and 2030 in RE strategy (2015) compared to PDP7 (PMVN, 2011c) are shown in Figure 1.15.

Figure 1.15 Renewbale power development targets by 2020 and 2030 in PDP7 (2011) vs in RE Strategy (2015)



Note: REDS = RE Strategy

Source: PMVN, 2011c and 2015b

3.2 Renewable Energy Policies and Regulations

Renewable energy has been subject to government investment incentives since its first introduction in Viet Nam. Support mechanisms and policies for renewable energy development include:

- Prioritising investment and use of renewable energy in the development of the energy industry with a focus on building Viet Nam's renewable energy market;
- Supporting all organisations and individuals with a variety of ownership structure to participate in the development and use of renewable energy;
- Applying various fiscal incentives within import tax, corporate income tax, land taxes and fees, depreciation policy, as well as credit incentives as specified in legislation, applicable to special preferential projects and preferential investment projects;

– Corporate income tax (CIT) rate of 10% for 15 years, 4 years for CIT exemption holiday, 50% reduction of CIT for 9 consecutive years after tax exemption period;

– Land use incentives, and reduction or exemption of land use tax for 20 years;

– Prioritizing the allocation of concessional credits from the development support fund, ODA (Official Development Assistance) sources and other foreign bilateral loans for energy projects such as those on the exploration and development of new and renewable energies and bio-energy (PMVN, 2007a);

– Central stage budget and ODA capital ensure 100% equipement purchasing and installation expenses of qualified rural off-grid renewable power projects; support maximum 85% of EVN's total investment in rural grid-connected power projects (PMVN, 2013);

– RE projects are eligible to apply state's preferiential credit loans according to Government's decree 75/2011/ND-CP dated 30 August 2011;

– Export credits covering up to 70% of the construction cost. The credit is for 12 years, benchmarked to government bond interest rates;

– Accelerated depreciation rates.

- Approved electricity prices (avoided-cost tariffs, Feed-in Tariff) for on-grid renewable energy consistent with the different locations and features of potential renewable energy projects to provide appropriate returns to investors;
- Standardized Power Purchase and Sale Contracts (20 years) for each renewable power type and an obligation for EVN/its regional electricity utilities to prioritise renewable energy in grid connection, dispatch and purchase electricity at approved tariffs;
- A Renewable Portfolio Standard (RPS) obligation upon major electricity generators and traders;

Table 1.5: Renewable Portfolio Standard (RPS) in Viet Nam

RPS obligation	2020	2030	2050
Electricity generation companies greater than 1,000 MW (excluding BOT projects)	RE not lower than 3%	RE not lower than 10%	RE not lower than 20%
Electricity distribution companies	RE not lower than 5%	RE not lower than 10%	RE not lower than 20%

Notes: RE = renewable power sources excluding large hydropower plants (>30 MW)

Source: PMVN, 2015b.

- Project specific arrangements for off-grid electricity systems;
- Net-metering for electricity consumers with simplified connection arrangements;
- Environmental fees for organisations utilising fossil fuels for energy production.

Policies of RPS and net-metering are newly mentioned in RE strategy but yet to be implemented by 2016.

The specific regulation system for renewable energy subsectors is as follows:

SMALL-HYDRO POWER

Capacity scales by potential locations for the investment of small-hydro power construction projects in Viet Nam until 2015 are stipulated within:

- The MOIT's Decision No. 3454/BCN dated 18 October 2005,
- The MOIT's Decion No. 2154/BCT dated 7 April 2008,
- The National Assembly's Resolution No. 62/2013/QH13 dated 27 November 2013, and
- Other related legal documents issued by relevant People's Committee of Cities/Provinces.

The MOIT issued the Circular No. 32/2014/TT-BCT on 9 October 2014 on regulation on avoided-cost tariff and power purchase agreement for small-hydro power plants (MOIT, 2014b), which replaced the previous MOIT's Decision No. 18/2008/QD-BCT dated 18 July 2008 on 'Regulation on avoided-cost tariff schedule and standard power purchase agreement'.

The MOIT annually approves and issues avoided-cost tariffs for small-hydro power. The avoided cost is defined as the production cost per kilowatt-hour of the most expensive power-generating unit in the national power grid. Tariff levels are detailed by regions and vary by seasons and daily dispatch periods.

WIND POWER

Enacted regulations include:

- The PMVN's Decision No. 37/2011/QD-TTg dated 29 June 2011 on "Mechanism for supporting wind power development" (PMVN, 2011d),
- The MOF's circular No. 96/2012/TT-BTC dated 8 June 2012 on "Financial mechanisms for grid-connecting wind power projects", and
- The MOIT's circular No.32/2012/TT-BCT dated 12 November 2012 on "Regulation on implementation of wind power project development, power purchase and sale contract form for wind power projects".

Current level of the Feed-in Tariff (FiT) for wind power is equal to 7.8 US cents/kWh. The government subsidises the power price for EVN by 1 US cent/kWh through the Viet Nam Environment Protection Fund. As of January 2016, the FiT level for wind power was under review by the MOIT for revision.

BIOMASS POWER

Enacted regulations include:

- The Prime Minister's Decision No. 24/2014/QD-TTg, dated 24 March 2014 on "Support mechanism for development of biomass power projects in Viet Nam",
- The MOIT's Circular No. 44/2015/TT-BCT dated 9 December 2015 on "Regulation on project development, avoided-cost tariff, and power purchase and sale contract form for biomass power projects".

The FiT for a biomass cogeneration (or CHP – combined heat and power) project is set equal to 5.8 US cents/kWh.

Avoided-cost tariffs apply for other biomass power projects. MOIT annually approves and issues these tariffs. Calculations are based on the generation cost of thermal coal power plants that use imported coal.

SOLID-WASTE POWER

The Prime Minister's Decision No. 31/2014/QD-TTg, dated 5 May 2014, on "Support mechanism for development of solid waste power projects in Viet Nam" indicates FiT levels applied for landfill gas and MSW direct combustion power projects equal to 7.28 and 10.05 US cents/kWh respectively.

SOLAR POWER

The MOIT is drafting specific regulations for solar power projects in Viet Nam. It plans to submit to the Prime Minister for approval by June 2016. The MOIT has proposed FiT as a support mechanism for solar PV farm and solar PV rooftop projects (MOIT, 2016a).

BIOFUELS

Applicable biofuels mixture and mandatory supply

The Prime Minister's Decision No. 53/2012/QD-TTg, dated 22 November 2012, on the Road map for mandatory application of biofuel in Viet Nam indicates applicable blending rates of biofuels with conventional fuels for road-motorised vehicles using gasoline and diesel in Viet Nam and the road map for the implementation. Biofuels produced and distributed include E5, E10, B5 and B10. Mandatory supply of E5 is required from 1 December 2014 in seven cities and provinces including Ha Noi, Ho Chi Minh City (HCMC), Hai Phong, Da Nang, Can Tho, Quang Ngai and Ba Ria-Vung Tau, then from 1 December 2015 for the whole economy. E10 will be mandatory in the abovementioned seven cities and provinces as of 1 December 2016 and will then expand to the whole economy on 1 December 2017.

To support the implementation of the PMVN's decision No.53/2012/QD-TTg, the Prime Minister issued Circular No.23/CT-TTg on 31 August 2015, requiring SOEs and encouraging private companies in oil trading business to ensure E5 supply in minimum 50% of their retail systems by end November 2015 in each of eight cities and provinces Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho, Quang Ngai, Quang Nam and Ba Ria-Vung Tau.

Approved master plan for fuel ethanol industry

MOIT's decision No. 3042/2013/QD-BCT dated 13 March 2013 approved the master plan for fuel ethanol industry to 2020 with perspective to 2030 to ensure a sustainable biofuel industry, based on a balance among transport fuel market need, potential of input material supply and investment in biofuel production projects. In 2014, the MOIT also directed VPI to complete a research study on the master plan for biofuel industry development in Viet Nam to 2020 with vision to 2030.

Technical and safety regulations:

The MOST issued national technical standards for mineral/conventional gasolines, diesels, E5, E10 and denatured and non-denatured fuel ethanol: QCVN 1:2015/BKHCN within the MOST's circular No. 22/2015/TT-BKHCN dated 11 November 2015 (effective from January 2016). This revised and replaced National technical standards for gasolines, diesels and biofuels previously issued by MOST in 2014 (QCVN 01:2014/BKHCN within the MOST's circular No. 30/2014/TT-BKHCN dated 15 October 2014), and in 2009 (QCVN 01:2009/BKHCN issued with MOST's circular No. 20/2009/TT-BKHCN dated 30 September 2009).

The MOIT issued QCVN 08:2012/BCT (MOIT's circular No.47/2012/TT-BCT dated 28 December 2012) and QCVN 09:2012/BCT (MOIT's circular No.48/2012/TT-BCT dated 28 December 2012) to stipulate national technical standards on blending, storage and distribution of E10.

- QCVN 08:2012/BCT: detailed technical requirements for equipement, auxiliary systems for storage and distribution of E10 in petroleum product retail stations,
- QCVN 09:2012/BCT: detailed technical requirements for equipement, auxiliary systems and facilities used for blending, storage and transportation of E10 in oil stockpiling terminals.

In 2015, MOIT issued Circular No.43/2015/TT-BCT dated 8 December 2015 on detailed regulations of overall fuel loss rate and by each business process of mineral petroleum products, E5, E10 and E100. This is also a preparation for formulating regulations on base price management for biofuels that the government plans to issue in 2016.

Investment incentives:

During 2007–2015, the government classified investment in biofuel production, biofuel technology research as areas eligible for special investment incentives (PMVN, 2007b). As a result, biofuel production enterprises became entitled to an income tax exemption or reduction for biofuel products according to legislation on Enterprise Income Tax. They became entitled to the highest land rent and land use incentives for 20 years. Raw materials, components, machinery and equipment for scientific research and technological development for biofuel production are exempt from import tax. Raw materials, components, machinery and equipment used for biofuel production are eligible for the lowest import tax rate.

Gvernment prioritizes the allocation of concessional credits from the development support fund, ODA capital and other foreign bilateral loans for energy projects such as those on the exploration and development of bio-energy (PMV, 2007a).

Incentives for biofuel trading:

Government decree No.83/2014/ND-CP dated 3 September 2014 and the MOIT's circular No. 38/2014/TT-BCT dated 24 October 2014 stipulates detailed regulations on conventional petroleum engine fuels (PEF) and biofuels businesses.

In 2015 through 2016Q1, E5 price regulation aimed at creating a price difference of 1.36-2.26 US cents/liter (i.e 300-500 VND/liter) compared to conventional gasolines.

- 0.7 US cent (i.e 150 VND) lower environment tax for a liter of E5 compared to conventional Mogas 92 (Environment tax 12.9 US cent/liter (~ 2850 VND/liter) for E5 vs 13.6 US cents/liter (3000 VND/liter) for Mogas 92),
- 2% lower excise tax for E5 compared to conventional gasolines (8% vs 10%) (As of 1 Jan 2016),
- Zero deduction in E5 price for the Petroleum Price Stabilisation Fund (vs deduction of 300 VND in price setting for conventional gasolines),
- Same import tax rate at 20% for E5 and conventional gasolines (As of 1 Jan 2016).

In addition, through adjustments of export tax of ethanol and raw cassava, the government tries to encourage domestic consumption, contributing to ensure input material supply for domestic biofuel production. Also, with issuance of the Prime Minister's Circular No.23/CT-TTg dated 31 August 2015, a mandatory use of E5 is required for road-motorising vehicle fleet of government agencies and establishments having investment from state budget in cities and provinces where biofuel supply is available. The MOIT in cooperation with the Ministry of Information and Communication, the MOST, People's Committee of cities/province and stakeholders intensifies the national communication program on promotion of biofuels (especially E5, E10) use.

3.3 Renewable Energy Programs

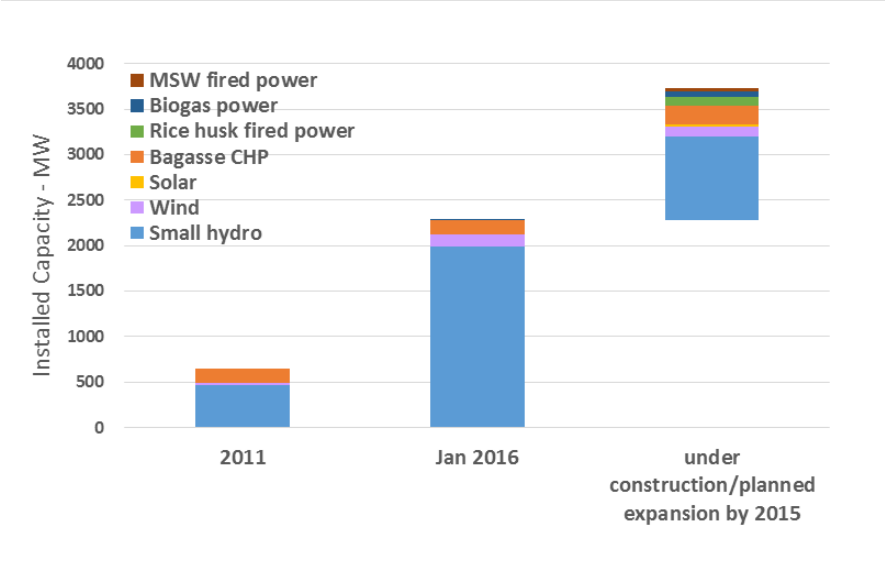
HYDROPOWER

The PDP7 (approved in 2011) specified economy-wide hydropower investment programs, in which capacity of the conventional large hydropower increases from 9.2 GW in 2011 to 17.4 GW by 2020; pumped storage hydropower plants will be introduced at 1.8 GW in 2020 and increase to 5.7GW by 2030. The development program of small-hydro power toward 2015 was established by provinces based on approved related master plans. The economy-wide target for small-hydro power capacity expansions was not mentioned separate as for wind power but lumped together with 'other renewables', and it was set to increase as a whole to 2.7 GW in 2020 and 5.8 GW in 2030. The PDP7 was under review for revisions by the time the Peer Review Team visited Viet Nam. The revised PDP7 was planned for release in 2016Q1 and it is subject to the PMVN's approval.

To promote small-hydro power development, avoided-cost tariffs have been applied to small-hydro power projects since 2008. Developments of off-grid small-hydro power within approved power master plans can be registered under the rural electrification program and as CDM projects, benefiting from credit and fiscal incentives as presented in Section 3.2. The MOIT has oversight for implementation of approved plans in regard to hydropower projects with capacity larger than 50 MW, while the People's Committee of Cities/provinces does for the lower scales developed in their administrative area. Investors from all economic sector has participated in hydropower developments based on BOT and IPP schemes. EVN has invested and will continue to be entrusted to invest in all large hydropower projects, especially strategic, multi-purpose hydropower projects.

At end 2014, total installed hydropower capacity in Viet Nam was over 15 GW, of which about 1.67 GW was small-hydro power (capacity from 30 MW and lower/site), accounting for the largest share at 44.3% in Viet Nam's power capacity mix (MOIT, 2016c). Electricity generation from hydropower was 59.8 TWh/year, accounting for over 41.1% of whole national power system in 2014. Figure 1.16 reflects the fast growth of small-hydro power capacity in Viet Nam over the last five years.

Figure 1.16: Renewbale power installed capacity in Viet Nam, 2011-2016 (excluding large hydropower > 30 MW)



Source: VNEEP, 2015; PMVN, 2015b; MOIT, 2016a; IE, 2016.

Currently, domestic enterprises can effectively manufacture and install various hydro-mechanical equipment, including spillway valve gate, water intake gate, powerhouse, penstock, crane of powerhouse and different kind of transformers.

WIND POWER

Since end 2000s, the MOIT has actively cooperated with Word Bank, governments of Germany, Finland and the United States (US) to establish programs of activities and projects supporting wind measurement and wind energy resource assessment programs, pre-feasibility and feasibility studies of wind farm construction investment, and financing wind power projects in Viet Nam. Recently, Viet Nam wind mapping has been completed (IE, 2016).

Figure 1.17: EVN's 7 kW wind-solar hybrid sytem in Kontum, Viet Nam

Source: IE, 2016

Prior to 2010, under the CDM and rural electrification programs, some small-scale wind systems were built. In 2004, EVN invested and operated Viet Nam's first wind power system. It is the on-grid 7 kW wind-solar hybrid system in Kontum province (Figure 1.17). Although the available data are limited, it is estimated that at least 1000 residential scaled small wind turbines (> 0.5kW and < 2kW) have been installed off-grid in several places in Viet Nam, including offshore islands (ADB, 2014; IE, 2016).

The PDP7 (2011) introduces the national wind power program during 2011-2020 with orientations toward 2030. It sets a target to increase wind power capacity from a negligible level in 2010 to 1 GW in 2020 and 6.2 GW by 2030 together with FiT scheme as a new incentive policy. Corresponding annual power generation levels are about 2 TWh in 2020 and 17 TWh by 2030. RE strategy issued in 2015 indicates basically the same wind power generation targets for 2020-2030.

During 2012-2015, the MOIT approved the master plans for wind power development toward 2020/2030 in 5 provinces, namely Binh Thuan, Ninh Thuan, Quang Tri, Ben Tre and Soc Trang. By January 2016, the national wind power master plan and several other provincial ones (such as Ca Mau, Bac Lieu, Thai Binh, Ba Ria-Vung Tau, Tra Vinh…) were in preparation for the approval (IE, 2016). In accordance with the government's approved master plans, most provinces with high wind energy potential are planning to accommodate wind farms composed of multi-MW wind turbines. By mid January 2016, 4 new commercial wind farms were invested and built by private investors and SOEs. They include:

- Wind Power 1 in Tuy Phong, Binh Thuan province. Phase I with capacity of 30 MW (1.5 MW x 20 turbines) was commissioned in 2011. Phase II with capacity of 90 MW is under construction. The Renewable Energy Joint Stock Company (REVN) is the onwner.
- Phu Quy wind farm in Phu Quy island, Binh Thuan province, commissioned in 2013 (6 MW, 2MW x 3 units). PVN has invested and completed the construction of the project, then transferred the ownership to EVN in 2014.
- Offshore Bac Lieu wind farm, commissioned in January 2016 (99.2 MW, 1.6 MW x 62 units). Cong Ly Construction-Trade-Tourism Company is the owner.
- Phu Lac wind farm in Binh Thuan province, started construction in July 2015 (24 MW, 2 MW x 12 units for phase I) and expected to be completed by September 2016. The Thuan Binh Wind Power JSC (TBW) is the owner.

Figure 1.18: Viet Nam 1st on-grid large scale wind farm – the Wind Power 1 in Tuy Phong district, Binh Thuan province

Source: REVN, 2012

Figure 1.19: PVN's 6 MW wind-diesel hybrid sytem in Phu Quy island, Viet Nam

Source: IE, 2016

Figure 1.20: Offshore 99.2 MW Bac Lieu wind farm, Viet Nam

Source: Song Da Investment and Trading Joint Stock Company (SODIC. JSC)

Installed wind capacity in Viet Nam has rapidly increased from only 8 MW in 2008 to about 135 MW by January 2016. In addition, there is another 114 MW wind capacity under construction (IE, 2016).

Wind turbines and wind tower manufacturing industry has gradually developed in Viet Nam with participation of foreign and domestic producers, such as GE (US), CS Wind Tower (Korea), VINA HALLA (Korea), UBI Tower (Viet Nam). Currently, these facilities serve primarily the international market (export) with a small quantity for domestic supply.

SOLAR ENERGY

Solar energy programs in Viet Nam include solar water heating and solar photovoltaic (PV) for power generation.

Solar water heating program

Solar water heating programs have been initiated and promoted within EVN's power saving and environment protection program since 2010. By cooporating with domestic producers of solar water

heating systems (such as Tan A, Hoan My, Son Ha, Bach Khoa Solar Energy North), EVN set up a 77-billion VND program to install 70 000 solar water heating systems during 2011-2015 (Son Ha, 2011). The program is implemented by phase and applied for households, hospital, kindergarten, school (including teacher/student dormitory), hotel, and restaurant. A financial support of 1 million VND (about 45 USD) is provided for each system installation registered by households, and for each 200-liters capacity of systems installed and registered by commercial clients (EVN, 2012).

Solar power development

The solar PV stand-alone systems are among renewable power technologies the government encourages to use to provide electricity services in remote and inaccessible areas, aimed at total household electrification by 2020. The grid-connected solar PV projects are primarily pilot projects and funded by developed countries/economies for research and development purposes or in accordance with the socio-economic policy of Viet Nam Government.

As of January 2016, total PV installed capacity was 5 MWe, representing 0.014% share of the capacity mix. It includes 4 MWe installed as stand-alone systems in off-grid, mountainous and remote rural areas and the remainder representing various installations in rooftops and hybrid systems (IE, 2016).

To further promote solar energy, the first large scale grid-connected solar PV power plant with a capacity of 19.2 MW was initiated in Quang Ngai Province, Central Viet Nam on 29 August 2015. The project covers a 24-hectare area with a total investment of VND 826 billion. It is aimed to export the generated electricity to the national grid and to be completed by mid-2016. According to the Institute of Energy, some aggregate targets for solar power developments at 0.9 GW by 2020 and 3.2 GW by 2050 have been under discussion.

In addition, government has provided attractive incentive packages to foreign investors and that led to the establishment of three solar PV assembly factories as following:

(1) Redsun at 12 MW/year capacity in Long An Province;

(2) IREX – Solar BK at 150 MW/year capacity in Da Nang City; and

(3) Bo Viet / Boway at 150 MW/year capacity in Bac Giang Province.

Currently, these facilities serve primarily the international market (export) with a small quantity for local/domestic supply.

BIOENERGY

Through energy efficiency promotion programs, especially the National Target Program of Energy Efficiency (VNEEP) implemented from 2005 under the coordination of the MOIT, and MARD's programs of agriculture low carbon, the government has been encouraging the investment in R&D and the dissemination of high energy-efficient sanitary biomass-buring stoves and biogas technologies in rural areas. Bioenergy development, particularly through applications of household and industrial scale biodigesters, is considered to offer a win–win outcome, both as a relatively clean fuel and as a response to the waste problem.

Biogas

Livestock and poultry in Viet Nam are distributed among industrial and households farms. In 2010, there were about 23,000 industrial farms and 8.5 million household farms. The government is projecting a yearly increase of 7.5% in the cow population up to 2020, 2.4% in the pig population, and 1.8% in the chicken population. These growths show potential for biogas production.

Through international cooperations, the MARD has coordinated and successfully implemented many programs on biogas promotion for households and industry use in different rural areas in Viet Nam. Major programs from early 2000s to today are summarized in Table 1.6.

Table 1.6: Major biogas technology promotion programs in Viet Nam

Programs	Implementation period & location/scope	Key features
Biogas Program for the Animal Husbandry Sector in Viet Nam	2003-2016, Economy-wide (58 provinces and cities)	A collaboration between the Department of Livestock Production - Ministry of Agriculture and Rural Development (MARD) and the SNV - Netherlands Development Organization Viet Nam Target: Construction of about 168000 household-scale biodigesters; support level: 1.2 million VND/biodisgester. Finance sources: ODA grant from Dutch government, Viet Nam State budget, advanced funds of provinces, and finance from households, voluntary credit. By end 2014, 145.000 biogas systems built for benefits of 725,000 people, provided training to 1,064 technicians of communes and rural districts, 1,668 biogas system builders, organizing thousands of seminars and workshops for promotion and training hundred thousands of biogas users.
Market Development of tubular biogas medium size in Viet Nam	2011-2013. In 5 provinces and cities: Quang Ninh, Bac Ninh, Ha Noi, Ha Nam, Thanh Hoa	Participants: The Institute of Energy in cooperation with its partners Stockholm Environment Institute Sweden, the Netherlands Development Organization, SNV and other partners. Construction of 10 demonstration models with industrial scale from 150- 500m3. Support level was 4000 - 6000 euro/unit. Finance source: Energy and Environment Partnership Program (EEP) in the Mekong Region (implemented by MOIT/GDE/RED in coopration with MFA Finland/NDF)
Livestock competitiveness and food safety (LIFSAP)	2010-2018. In 12 provinces	A cooperation between the Agriculture Project Management Board of MARD and the World Bank. Support 200 USD/biodigester + disinfection pit (for farms with minimum animal manures of 20kg/day). By end 2015, about 9000 biodigesters were built.
Improvement of quality, safety of agriculture production and Biogas plant development (QSEAP)	2010- 6/2015 In 16 provinces	A cooperation between MARD and ADB By 10/2011, 2 million biogas pool were installed, of which 1 millions of nilon pool type. The project has been merged with LCASP project then.

Programs	Implementation period & location/scope	Key features
Low Carbon Agricultural Support Project (LCASP)	2013-2018 In 10 provinces: Lao Cai, Son La, Phu Tho, Bac Giang, Nam Dinh, Ha Tinh and Binh Dinh, Tien Giang, Ben Tre and Soc Trang	A cooperation of the Agriculture Projects Management Board (APMB) of the MARD and ADB, with support of Korean EXIMBANK and JICA. By the end of 12/2015, there were more than 32,000 biodigesters (pool construction and composite types) builded/installed with support levels 3,000,000 VND/household scale biogas systems and 10-30 million/farm scale projects.

Sources: Apmb.gov.vn; biogas.org.vn; tietkiemnangluong.com.vn; IE, 2016.

In addition, biogas power projects have been initiated since 2006 with a 2.4-MW landfill Gò Cát project (at HCMC, 3 gas turbines installed). Also, a 2-MW biogas power project using livestock and poultry waste has been built at the sow farm of Animal Feed JSC San Miguel (17 000m3, 4 units x 500 kW) (Figure 1.21).

Figure 1.21: Biogas power project at the sow farm of Animal Feed JSC San Miguel

Source: IE, 2016.

Biomass power

By 2015, 40 bagasse CHPs with a combined capacity of 150 MW have been built and in operation across provinces in Viet Nam. Among these CHPs, only 6 plants (126.5 MW) have sold extra power to national grid and they are under expansion with target to have a combine additional capacity of 214.5 MW by 2017-2018. In most sugar mills, there is excess bagasse. Sugarcane tops and leaves haven't been exploited yet.

Since 2009-2011, about 10 feasibility studies (FS) on rice husks co-generator development in Mekong Delta region have been carried out. One plant has been built but currently operates not stably, neither cost-efficiently. It seems to result from inefficiency in feedstock supply, electricity tariff, and also technical issues.

Municipal solid waste power (direct combustion)

The first municipal solid waste (MSW)-fired power project is under investment in Soc Son – Ha Noi. Its operation is expected to start by end 2016. There are also some MSW power project proposals in HCMC, Da Nang and Thanh Hoa province (GOV, 2015b).

Biofuels

Since the 2007 deployment of the government's Decision No. 177/QD-TTg dated 20 November 2007 (PMVN, 2007b), investments in biofuel research and production have increased. Biofuel research focuses on biofuel technologies and applications in electricity generation and transportation use. About 58 R&D and pilot projects were implemented during 2007-15. The government has invested in domestic research capacity to advance the biofuel sector in accordance with the framework of *'Program 177'* as well as in other economy-wide and provincial funding programs available for the scientific and technological development in Viet Nam. Total state budget spent to support 'Program 117' was about 11.78 million USD (MOIT, 2016b).

Since 2009, investment in bioethanol production projects has increased among domestic enterprises including PetroVietnam. In 2014, there were five bioethanol plants (E99.5 and above) built in Quang Nam, Dong Nai, Quang Ngai (Dung Quat), Binh Phuoc and Phu Tho, with a total installed capacity of about 500 million litres per year, enough for mixing 10 billion litres of E5 (MOIT, 2016a).

Table 1.7: Number of fuel stations supplying E5 in Viet Nam by end November 2015

No.	Provinces	E5 filling stations	Share in total fuel stations (%)
1	Quang Ngai	150	100
2	Quang Nam	90	56.96
3	Da Nang	73	76.04
4	Hai Phong	32	14.1
5	Ha Noi	64	13.22
6	Ho Chi Minh City	262	50.58
7	Ba Ria - Vung Tau	61	28.37
8	Can Tho	87	51.18
	Total	**819**	**40.58**

Source: MOIT, 2016

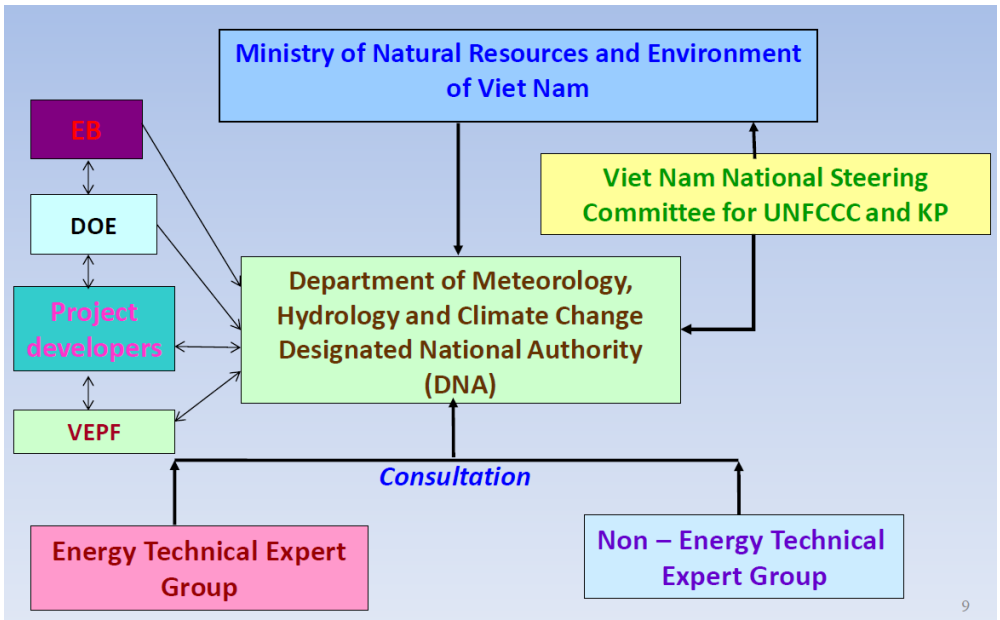
4 SUSTAINABLE DEVELOPMENT IN VIET NAM

In an early stage of industrialisation, and only recently recognised as a lower middle-income developing economy, Viet Nam contributes only 0.5% of global CO_2 emissions. In the past 50 years, however, extreme weather events such as storms, floods and droughts have increased both in frequency and intensity.

Since 1990s, the government of Viet Nam has been fully aware of serious impacts of climate change on the economy's sustainable development, and Viet Nam has been considered as one of the

economies most affected by climate change. Viet Nam signed the United Nations Framework Convention on Climate Change (UNFCCC) on 11 June 1992, ratified it on 16 November 1994, signed the Kyoto Protocol (KP) to the UNFCCC on 3 December 1998 and ratified it on 20 August 2002. Viet Nam has set up a National Steering Committee to implement the UNFCCC and KP, fulfiled all requirements to be a host economy for the development of clean development mechanisms (CDM) projects under the Protocol. On 22 June 2015, Viet Nam ratified Doha amendments and its supplement to KP.

Figure 1.22: Institutional arrangement for CDM in Viet Nam



Notes: EB = CDM Executive Board, DNA = Designated National Authority, DOE = Designated operational entity, VEPF = Vietnam Environment Protection Fund

Source: Viet Nam DNA, 2014

Every five years the Vietnamese government issues its "National Target Programme to Respond to Climate Change" (NTP-RCC) to assess the climate change impact on sectors and regions over specific periods, and to develop feasible action plans that can effectively respond to climate change in the short and long term in order to ensure the sustainable development of Viet Nam. In December 2008, the National Target Program to Respond to Climate Change for the period 2009 -2015 was approved by PMVN with a budget of about VND 1965 billion (equivalent to 84.75 million USD) (Decision 158/2008/QD-TTg).

The National Strategy on Climate Change was issued by Prime Minister on December 05, 2011 (Decision 2139/QD-TTg). This strategy with century-long visions is served as the foundation for all other ministerial, sectoral and local strategies, plans and programs. Accordingly, Viet Nam's response to climate change must be closely attached to sustainable development toward a low-carbon economy, and improve the competitiveness and strengths; the State will plays decisive role in management; enterprises' creativity and responsibility will be encouraged; socio-political and professional organizations and communities' participation and supervision will be brought into full play; internal forces and international cooperation will be made full use.

In 2012, the National Green Growth Strategy for the period 2011-2020 with a vision to 2050 (VGGS) was approved, which includes mitigation targets and measures; and regulations on linking with international carbon markets. The VGGS recognises that green growth - a path that prioritises long-term developmental and environmental sustainability - is essential for long-term economic development. The VGGS aims to develop the economy through investment in the preservation, development and efficient use of natural resources, the reduction of greenhouse gas (GHG)

emissions and environmental improvement, deploying advanced technologies on a sound scientific basis and considering Viet Nam-specific conditions (PMVN, 2012a). Economic sectors and provinces have developed Action Plans to implement green growth. In 2013, the Law on Natural Disaster Prevention and Control was enacted, aiming to address diverse natural hazards that affect Viet Nam, which are primarily climate change related. The 2014 Law on Environment includes a full chapter on climate change.

In the process to adopt the Paris Agreement, Viet Nam submitted its Intended Nationally Determined Contribution (INDC) in 2015 specifying its national contribution (target) for the period 2021–2030 covering its entire economy as:

- *Unconditional contribution*:

With domestic resources, by 2030 Viet Nam will reduce GHG emissions by 8% compared to BAU[2], in which:

- Emission intensity per unit of GDP will be reduced by 20% compared to the 2010 levels;
- Forest cover will increase to the level of 45%.

- *Conditional contribution:*

The above-mentioned 8% contribution could be increased to 25 % if international support is received through bilateral and multilateral cooperation, as well as through the implementation of new mechanisms under the Global Climate Agreement, in which emission intensity per unit of GDP will be reduced by 30% compared to 2010 levels.

According to Viet Nam's INDC report, the areas of energy (including transport and communications), agriculture (including land use and forestry) and waste can make the greatest contributions to emissions mitigation. Adaptation measures will focus on agriculture, water resources and forestry in delta, coastal, mountainous and urban areas. Protection from river flooding, storm surges, saline water intrusion and drought, which needs to be implemented in the 21st century, exceeds the domestic financial capacity. The cost of adaptation is estimated in excess of 3-5% of GDP by 2030, but state resources can only meet 30% of necessary financing. Investments from the private sector and international support are therefore required.

Implementation of Clean Development Mechanism (CDM) in Viet Nam

According to the report of Viet Nam DNA in 2014, as of 31 September 2014:

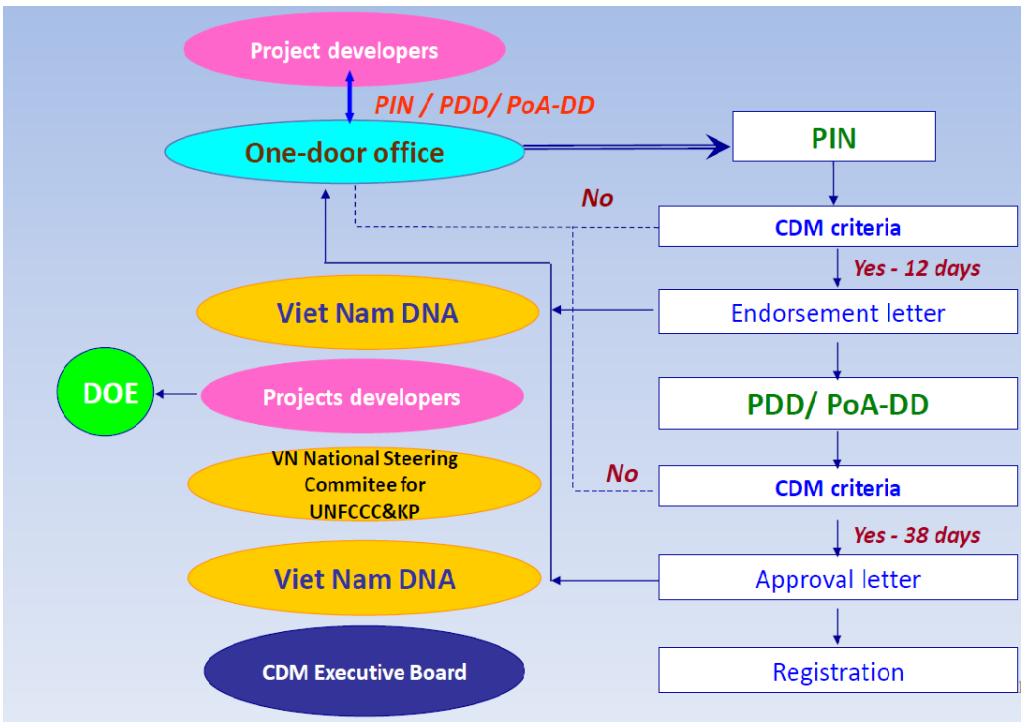
- The MONRE issued the Letter of Endorsement (LoE) to 25 Project Idea Notes (PIN), the Letter of Approval (LoA) to 287 Project Design Documents (PDD) and to 11 Programs of Activities (PoAs).
- 253 projects were registered by the CDM Executive Board (CDM EB) and that brought Viet Nam to 4th rank in the world with expected total GHG emission reductions of 137.4 million tCO_2e during the crediting period. Energy projects accounted for 88% of total registered projects, waste treatment at 10%, and afforestation and reforestation (A/R) 1.5%, and others 0.5%.
- 11 PoAs were registered by the CDM EB, Viet Nam ranked at 5th position in the world.

[2] *Viet Nam's Business-as-Usual (BAU)* scenario for GHG emissions was developed based on the assumption of economic growth in the absence of climate change policies. The BAU starts from 2010 (the latest year of the national GHG inventory) and includes the energy, agriculture, waste and LULUCF (land use, land-use change and forestry) sectors.

- GHG emissions in 2010: 246.8 million tCO_2e
- Projections for 2020 and 2030 (not included industrial processes):
  - 2020: 474.1 million tCO_2e
  - 2030: 787.4 million tCO_2e

– The CDM EB issued for Viet Nam 10,140,533 Certified Emission Reduction (CER) units, ranking Viet Nam at 11th position in the world.

Figure 1.23: Approval process for issuing a Letter of Approval (LoA) in Viet Nam



Note: PIN = CDM Project Idea Note, PoA-DD = Programme of activities design document, PDD = Project design document.

Source: Viet Nam DNA, 2014

Current challenges for implementation of CDM or other on-going (such as JCM) and forthcoming GHG crediting mechanisms in Viet Nam include:

– Limited awareness and knowledge of the scheme(s) among managers, policy markers, experts, enterprises, general public, private sector, Non-Government Organizations (NGOs);

– Limited financial sources for project activities in Viet Nam;

– Coping with the credit price level in the world (CER market has been virtually collapsed);

– Slow development of the domestic carbon trading market.

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APEC PEER REVIEW
ON LOW-CARBON POLICIES (PRLCE)

PART II: REVIEW TEAM REPORT

This part of the report presents the Peer Review Team's findings (both achievements and challenges) and recommendation about renewable energy policies, programs and measures in Viet Nam.

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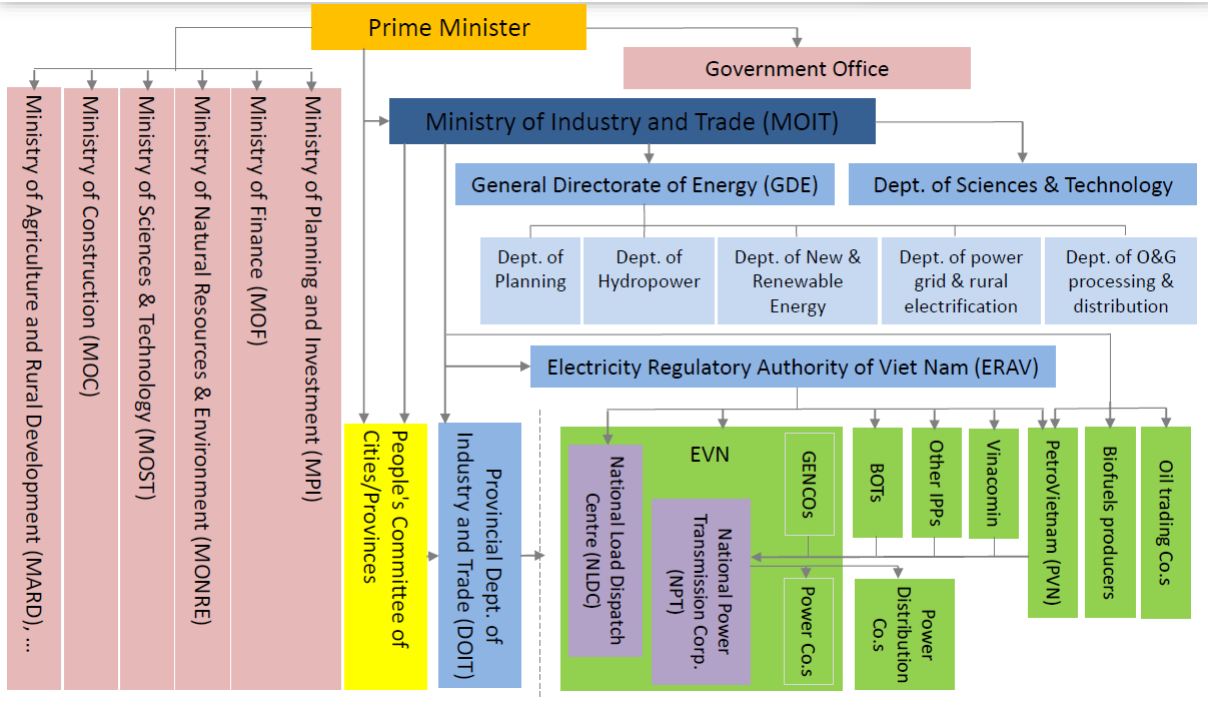
1 INSTITUTIONAL CONTEXT

ACHIEVEMENTS AND CHALLENGES

Achievement 1: The MOIT is the focal point for the state management and administration of renewable energy sector as well as whole energy activities. The MOIT plays the leading role in coordination of relevant governmental ministries and agencies and key stakeholders (producers, consumers, associations, academies, international donors) in the process of renewable energy policy formulation and implementation.

Achievement 2: There is a strong leadership of the Prime Minister, the participation and contributions from different line ministries, provincial government agencies, research institutions, business sector representatives as well as international development donors in renewable energy strategy and policy formulation process.

Figure 2.1: Diagram of Institutional organization for renewable energy development in Viet Nam



Achievement 3: Viet Nam has actively exploited opportunities for international technical assistances to enhance human and financial resources deployment in RE policy and strategy formulation activities

Achievement 4: Viet Nam has promoted and gradually implemented E-government since 2012. It improves information transparency, especially creates an easy access to update legal documents.

Challenge 1: Dispite of a clear allocation of tasks and responsibilities amongst related ministries and government agencies, coordination mechanisms between ministries, between different departments within ministries and at provincial level remain weak (CEGR, 2014).

Challenge 2: There is shortage of human resources in GDE and relevant agencies, research institutes, service enterprises to work on renewable energy projects.

Challenge 3: In Viet Nam, RE development is being promoted within the context of electricity market reform. Electricity market competition may make the government strategy to promote RE more complex.

Challenge 4: There is a number of RE professional associations established, but it's not clear if they are well resourced.

RECOMMENDATION

Recommendation 1: It is desirable for the MOIT and related government organisations to continue close cooperation in implementing RE policies and plans under the leadership of the PMVN.

Recommendation 2: It is desirable for the MOIT to strengthen the functions, staffing of GDE as well as improve the coordination within the MOIT, and between the MOIT and related ministries in order to effectively implement RE policy and planning.

In pursuing RE development and electricity market reform at the same time, the functions, especially staffing, of GDE, ERAV and other relevant departments under the MOIT will need to be strengthened. Also, a closer coordination of GDE with energy research institutions and RE professional associations will be necessary for better exchange of information and opinions.

Recommendation 3: It is necessary to continue to strongly invest in capacity building activities, from government officers, researchers to people in industry generally.

Changes in global energy and renewable energy landscape occur rapidly and most of renewable energy subsectors in Viet Nam are still at early stage of development. Innovations are required in the process of formulating and implementing policies. Investing in capacicy building is critical for Viet Nam to successfully formulate and implement policies in receiving technology transfers and deploying commercially available renewable energy technologies in the economy's circumstances.

Recommendation 4: It would be better to establish regular dialogue sessions between the MOIT and stakeholders on progress of RE planning and investment programs.

The MOIT has undertaken public consultation and hearings to obtain feedback from stakeholders in RE policy formation and planning. With the growth of RE industries, the number of stakeholders is increasing. It will be necessary to create an official platform/forum for private sector and other stakeholders on renewable energy to regularly discuss and exchange opinions on common problems and deliver a united voice during discussions with policy makers.

Coordinated feedback from industry stakeholders can help fine tune policies, identify and appropriately address unforeseen barriers. Professional associations on renewable energy, especially SHPGA/VEA and VCEA have the potential to provide this coordinated. Newly formed industry associations often need state financial and other assistance to help them grow to a size at which they become self-sustaining.

2 LOW CARBON ENERGY GOALS, TARGETS AND STRATEGY

ACHIEVEMENTS AND CHALLENGES

Achievement 5: By approving 'the Development Strategy of Renewable Energy of Viet Nam by 2030 with a vision to 2050' in 2015, the Vietnamese government has introduced clear viewpoint, targets and policy principles for RE development to 2030, with a consistency and development in more detail in issued legal documents over time. It corresponds and supports effectively to Viet Nam's commitments declared in international energy and environment/climate change fora.

Viet Nam has made considerable efforts to establish an extensive legislative and regulatory system to support the deployment of renewable energy over the past two decades. Relevant early regulatory frameworks include *the Prime Minister's Decision No2/1999/QD-TTg dated 13 February 1999 ratifying the Project on Rural Electricity*, the *Governmental Decree No. 45/2001/ND-CP on*

Electric Power Operation and the *Electricity Law* of 2004 and amendment in 2012, all of which included renewable energy provisions amongst their broader frameworks for electricity industry operation (IEA/IRENA, 2016). More recent key Laws and Decisions supporting and guiding renewable energy development include the *PMVN's Decision No. 1208/QD-TTg approving the PDP7* (2011), the PMVN's *Decision No. 1393/QD-TTg approving the National Green Growth Strategy* (2012) and *Law on Environmental Protection* (2014). In 2015, the Prime Minister approved *the Development Strategy of Renewable Energy of Viet Nam by 2030 with a vision to 2050*.

These have highlighted the importance of:

- Ensuring renewable energy deployment contributes towards broader electricity sector objectives of rural energy provision, general socio-economic development, improved power quality, a greater role for competitive market arrangements over time, and enhanced energy security including diversification of primary energy resources and fuel conservation,
- Renewable energy's potential role in facilitating Viet Nam's "green growth" strategy and the potentially adverse implications of fossil fuel subsidies and potential energy security advantages of greater use of domestic energy resources, and
- Integrating Viet Nam's climate change response, including renewable energy, with its broader socio-economic development strategy

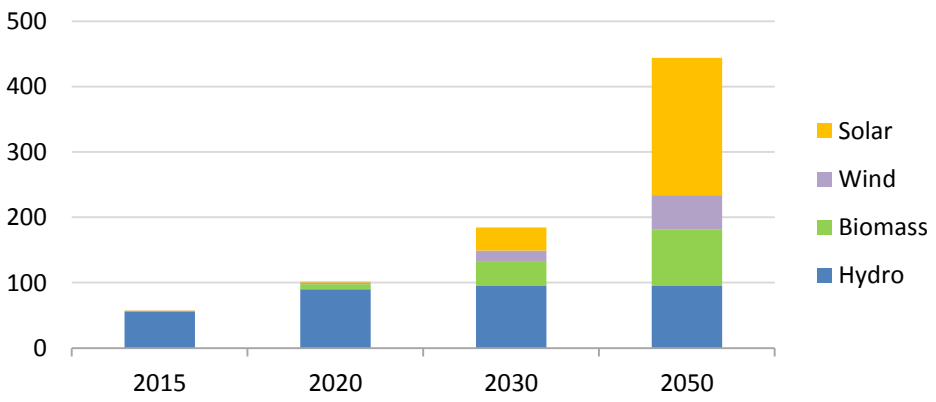
The RE Strategy includes high level targets for renewable energy increase and also associated targets for greenhouse gas (GHG) mitigation, imported fossil fuel reduction. Many specific/aggregate targets for different new RE resources and technologies, including hydro, solar, wind and biomass energy were set ambitious compared to all previous announcement in Viet Nam national energy stratergy (2007) and Power development plans. Most of the targets are in the form of a pathway by indicating progress required by 2020, 2030 and 2050.

These targets encourage diversification in energy sources. From 2015 to 2020, the proportion of renewable electricity generation keeps pace largely through additional hydro and the introduction of transport biofuels. Generation from biomass, wind and solar increases significantly from 2020 to 2030.

The target for generation from solar by 2050 is particularly ambitious but potentially reflects the ongoing reduction in the costs of solar generation. Solar is anticipated to become the predominant renewable electricity generation source by 2050. The integration of intermittent renewables into the electricity system is supported by allocating an increased proportion of hydro storage capacity as reserves.

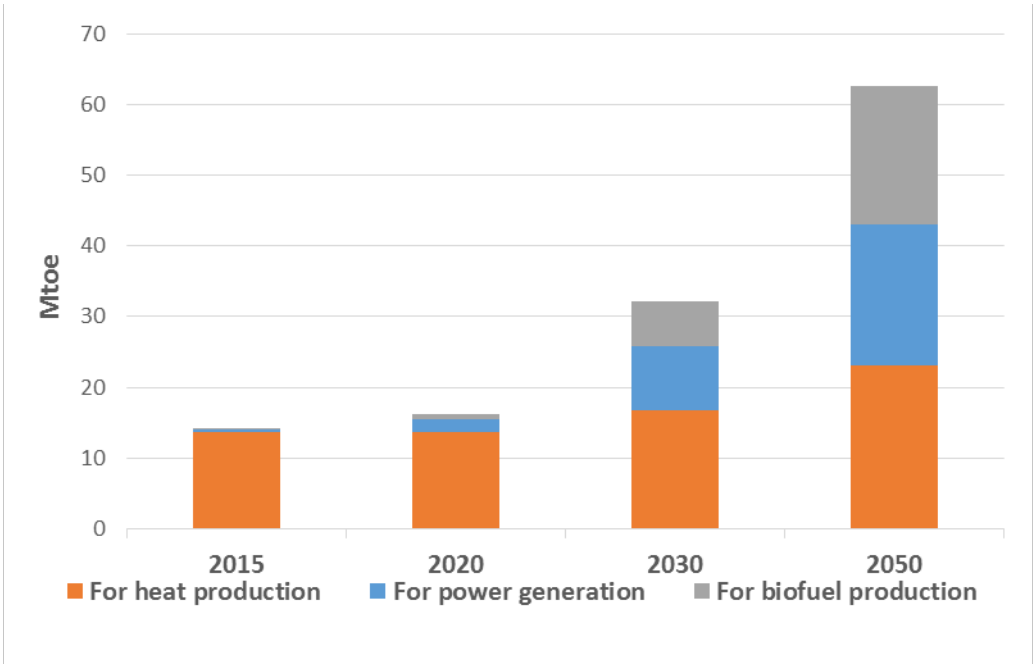
The targeted changing profile of electricity generation from renewables is illustrated in Figure 2.2. Biomass use and biofuel production targets are shown in Figure 2.3 and Figure 2.4

Figure 2.2: Targeted renewable electricity generation in Viet Nam, 2015-2050



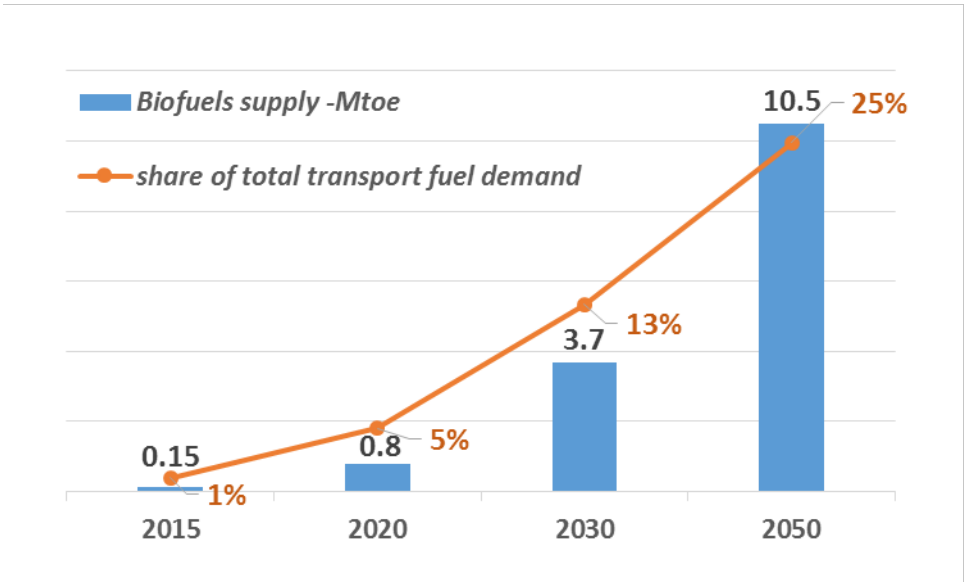
Source: PMVN, 2015b

Figure 2.3: Targeted biomass use in Viet Nam, 2015-2050



Source: PMVN, 2015b

Figure 2.4: Targeted biofuel production and consumption in Viet Nam, 2015-2050



Source: PMVN, 2015b

Achievement 6: Renewable energy development is closely integrated to the implementation of broader objectives of socio-economic and sectoral development, including rural electrification, energy efficiency and savings, technology and manufacture enhancement.

Challenge 5: All national strategy for important activities is approved by the Prime Minister in the forms of decisions, and thus have high enforceability but priorities among these for implementation are not clear.

There is a successful integration of renewable energy policy and regulation into broader policy and regulatory frameworks. However, this requires balancing priorities including short to longer-term, and local to national considerations, and managing the inevitable trade-offs arising between these.

RECOMMENDATIONS

Recommendation 5: Consider setting separate and clear targets for generation from small-hydro and run-of-river schemes; for solar farm and solar PV rooftop; and for biodiesel; also consider developing targets and policies for transport electrification.

In January 2016, no specific target for small-hydro was clearly mentioned in the enacted PDP7 and RE strategy. However, according to the RE strategy, renewable power types excluding large hydropower will be encouraged through the Renewable Portfolio Standard. Therefore, it's necessary to consider setting separate targets for generation from small-hydro (≤ 30 MW) and run of river schemes.

In regard to solar power, there should be a clear sub-target for solar power development on utility scale and rooftop installations. That will facilitate the coordination and collaboration between the MOIT and MOC in establishing sectoral action plans and detail incentive policies for each type of project.

Likewise, the government should consider setting a clear target and development strategy for biodiesels, separate from fuel ethanol in the national biofuel strategy.

Viet Nam does not yet appear to have any policies or targets for electric vehicles. Despite this, there are already an estimated 2 million electric motorbikes and other two wheelers in Viet Nam, out of a population of around 40 million two wheelers. The government should consider developing targets and supporting policies for fuel switching with electric vehicles, so that low carbon energy opportunities from transport electrification can be effectively and further exploited.

Electric vehicle technology, including electric bus, electric two wheelers, are a method by which fuel switching away from 100% non-renewable oil products (gasoline, diesel) to Viet Nam's 38% renewable electricity generation can be achieved. In addition, electric vehicles are around four times more energy efficient than their internal combustion engine counterparts and have significant air quality and noise reduction benefits. The energy running costs of electric vehicles are also much lower than for conventional vehicles.

Table 2.1: Comparison of emissions rates for two wheelers in Viet Nam

Emissions factor	Electric two wheelers			4-stroke gasoline two wheeler
	Class I Low power	Class II Mid Power	Clas III High Power	
CO2, g/km	16.1	20.5	27.7	55
CO mg/100 km	31.5	40.2	54.2	1,250,000
NOx, g/100 km	1.3	1.7	2.3	15
PM_{10}, g/100 km	0.3	0.4	0.6	10
VOC, g/100 km	0.0	0.1	0.1	225

Source: ADB, 2009.

Electric vehicles can deliver significant reductions in CO_2 emissions in the transport sector, depending on the local CO_2 emissions factor for electricity generation. In 2009, a study "Electric Two Wheelers in India and Viet Nam" was published which analysed the market for and environmental impacts of electric two wheelers. The study took into account the CO_2 emissions factor for

electricity specific to Viet Nam. The results show that electric two-wheelers can reduce CO_2 emissions by between one half and two thirds in Viet Nam. Table 2.1 takes data from this report and compares the CO_2 emissions from electric two wheelers with four-stroke two wheelers in Viet Nam.

Viet Nam has a challenge to meet high electricity demand growth by increasing generation capacity and electric vehicles could add to this challenge. However, experience in other economies/countries suggests that most charging of electric vehicles is done overnight when electricity demand is lower. Overnight charging can improve the off-peak utilisation of generation, transmission and distribution assets. Off-peak retail pricing structures can help reinforce this behaviour with benefits for the electricity system. Electric bus technology can substitute for diesel in urban buses, with particularly significant air quality benefits for urban airsheds.

Recommendation 6: Promptly invest in assessment of geothermal potential and in improving the quality of data for other renewable sources is another priority recommendation for Viet Nam

Lacking of quality data on geothermal potential by locations as well as for several other renewable energy subsectors seems a major impediment for the government to formulate clear targets and development strategy for renewable energy subsectors. It is necessary to prioritise the investment in energy resources assessment projects, for renewable as well as for fossil energy.

Recommendation 7: BAU/baseline in RE stratergy should be presented more clearly and in consistent with Viet Nam Green Growth Strategy (VGGS) as well as other subsequent national detailed RE subsectoral plans.

It is unclear for BAU/baseline in RE stratergy and if it is consistent with VGGS. BAU paths developed while establishing targets in RE strategy need to be clearly presented in detail and used consistenly in other subsequent national detailed plans to ensure an easy and appropriate comparison and progress/evolution assessment.

Recommendation 8: Viet Nam could actively promote its high proportion of renewable electricity to attract export manufacturers and investors with customers interested in carbon footprint

With increasing international emphasis on climate change, Viet Nam can leverage its low carbon electricity to gain a competitive advantage over other economies such as China for attracting export manufacturing. Some international companies, particularly with customers in Europe or the United States (US), are looking to reduce the carbon footprint of the goods they sell. They may consider the carbon intensity of the electricity system as part of their criteria for selecting which countries to set up manufacturing plants in. Large hydro should be included in the renewable electricity statistics when promoting the proportion of electricity coming from renewable resources.

Recommendation 9: Promptly establish/designate a focal competent agency responsible for the national energy statistics and national GHG emission inventory's data collection, analysis, verification and update.

To improve planning activities as well as monitoring and evaluation activities in the policy implementation cycle, it is necessary to establish/designate a focal agency with sufficient resources taking responsiblility for the national energy statistics and national GHG emission inventory's data collection, analysis, verification and update.

The MOT should better resource the development of more segmented energy and transport data to help inform policy development, implementation and monitor success. Data gaps appear to exist, notably for the direct use of renewables for process heat and for transport demand and energy use by mode and vehicle type. Mode share, km travelled and travel speed data collection can be done using smartphones (including GPS monitoring), either as part of surveys or potentially directly from

companies such as Google. While energy demand by vehicle type is harder to measure, it can be derived from vehicle distance and vehicle type information.

Recommendation 10: Establish evaluation frameworks to better identify the potential co-benefits (yet also possible conflicts) of particular renewable energy deployment options including regional and industry development outcomes, as well as broader environmental and social impacts.

The co-benefits of greater renewable energy deployment in terms of reduced air, water and solid waste pollution, and regional development opportunities including local employment and investment, are all playing a growing role in APEC members seeking to expand renewable energy deployment. At present, however, these co-benefits are not recognised, or appropriately accounted for, in project assessments despite the broader societal value they offer.

In Viet Nam, more attention should be paid to develop archiving system, not only in regard to a unified/consistent dataset, but also analysis method/approach used in formulating and evaluating the implementation of energy and GHG emissions reduction strategy. Putting in place/develop archiving and quality assurance/quality control (QA/QC) systems in all policy formulation and implementation stages is also required.

Recommendation 11: Continue to study to establish clear indicators for improving monitoring and evaluation activities in the policy implementation cycle.

3 REGULATION AND INFRASTRUCTURE

3.1 Regulation

ACHIEVEMENTS AND CHALLENGES

The regulatory framework for renewable energy deployment extends well beyond legislation and regulations specific to renewable energy, given the broader context within which it must occur, including energy sector, climate change, transport, regional development and land-use planning arrangements. Detailed review of this broader context is not possible given the constraints and scope of this peer review, and the focus of this section on 'Regulation and Infrastructure' for Viet Nam's electricity sector.

The *RE Strategy* recently issued in 2015 by PMVN contains a comprehensive range of policy proposals extending current regulatory frameworks to support the potential achievement of the targets. In summary, current regulatory arrangements demonstrate:

- The critical role that affordable and accessible energy plays in societal welfare and economic development, and the prioritisation that this has required. Viet Nam's achievements in economy-wide electrification are particularly notable, as are the relatively low costs of electricity by comparison with many other economies/countries,
- Clear recognition of the varied potential benefits of renewable energy in facilitating green growth, energy security and reduced environmental impacts beyond climate change,
- An appreciation of the need for integration of renewable energy strategy and policy within broader socio-economic and industrial and sectoral deployment, and
- A growing number of current and proposed regulatory and incentive mechanisms to facilitate appropriate renewable energy deployment.

Revised version of PDP7 and policy details for renewable power sources were not available at the time of this peer review. However, it clearly represents a valuable opportunity to further Viet Nam's

regulatory frameworks to facilitate the very rapid renewable energy deployment that is being sought under the *RE Strategy*.

Achievement 7: Viet Nam has made special and persistent attention to apply systematic approach and market-based mechanisms as key measures in designing RE suppoting policies and regulations.

Viet Nam is applying different policy measures and mechanisms to boost investment in RE sector, such as:

- *Diversified participants in RE markets:* The development of a renewable energy market with participation by organisations with a variety of ownership structures underpins the mechanisms by which the RE development targets will be met. Private participation is discussed further in Section 7.3.
- Development of renewable power projects must follow *government's approved power master plans at economy-wide and provincial levels.*
- *Environmental fees as a source to Sustainable Energy Development Fund:* The funding for many of the renewable electricity policies (such as the additional cost to fill the difference between EVN's purchase price and the project's approved FiT level) comes from a new *Sustainable Energy Development Fund*. The RE Strategy states that capital for this fund will come from State budget, environmental fees applied to fossil fuel use, and contributions from domestic and foreign organisations.
- *Standardised sale and purchase agreement by each type of RE power:*

Renewable electricity projects are to be given priority connection to the national grid and power purchase with the costs of investment, transmission and distribution included in the EVN's electricity purchase price. PPA signed between EVN and renewable power plant owner is standadised. A 20-year long term contract is guarantied for RE power projects.

Avoided-cost tariff is applied for EVN's electricity purchase price from hydropower, biomas power projects. Feed-in tariffs (FiT) have already been set or are under development for most categories of renewable resources. FiTs review is regular and revisions are subject to changes of actual market dynamics and government priority targets by each development stage. Further discussions are presented in Section 7.1.

Final customers for electricity who install stand-alone renewbale power system (such as individuals and companies installing solar generation at their own premises (eg rooftop solar) are allowed to use net metering to offset their own generation against their consumption.

- *Financial and fiscal incentives:*

Various fiscal incentives in regard to import tax, corporate income tax, land taxes and fees, depreciation policy, as well as credit incentives as specified in legislation for special preferential projects and preferential investment projects are applicable to renewable energy projects.

There are also links of CDM and international CO_2 prices with financial supports to renewable energy project developers in Viet Nam.

Achievement 8: Viet Nam has made efforts to expand regulatory and incentive mechanisms specific to each renewable energy type to facilitate its appropriate deployment

There are a growing number of current and proposed regulatory and incentive mechanisms to facilitate appropriate renewable energy deployment. So far, the MOIT has issued specific regulations for small-hydro power, wind power, biomass power, solid-waste power and biofuel. Regulations for other renewable energy, such as solar power, biogas, geothermal, or otherwise are under preparation.

Challenge 6: The key policy and regulatory framework challenge would seem to be appropriate investment mobilisation

Most of renewable subsectors remain currently at early stage of development while government set ambitious targets of RE deployment by 2020 and there is strong competition from neighbour ASEAN economies to attract investment flows for boosting domestic RE capacity and industry. Timely review incentives and complete the regulatory system is critical to an effective management of the speed and targeted scale of renewable energy deployment over the next five years. This is involving multiple regulations across diverse and complex deployment contexts including off-grid and behind-the-meter applications as well utility scale projects. This must be achieved within Viet Nam's changing electricity industry arrangements including moves towards greater competition and a growing number of existing and potential stakeholders. Finally, there is the need for broader community consensus, at local and provincial and national levels, on the importance of greater renewable energy deployment, and the benefits that it can deliver Viet Nam.

RECOMMENDATIONS

Recommendation 12: Shorten time lag between issuance of a sectoral strategy/program with the issuance of detailed regulations, guidelines for its implementation.

There has been time lag of a year or more between the issuance of several renewable power programs and the issuance of relevant regulations and guidelines for their implementation. Wind power has been seen as an example. Since 2011, the Prime Minister has approved the PDP7 with a clear promotion of large scale wind power deployment. However, detail planning at central/economy-wide and provincial levels was not promptly prepared; by end 2015, only 5 provincial wind power plans were approved by the MOIT to give clear guidelines and falicitate investment process of potential investors in these provinces. The first large scale wind power project was commissioned in 2011 but until end 2012 the MOIT issued regulations on contract model and FiT level for wind power development. Also in biomass power sector, it seems that government's delays in formulation of detail guidelines and incentives postponed the development of a number of proposed rice husk power projects in Mekong Delta region. Timely progress on the current review of the FiT rates and other detailed regulations is particularly important for successfully implementing new high renewable development targets for 2020.

Recommendation 13: Facilitate genuine stakeholder engagement by establishing a single one-stop destination website that details progress on planned activities, including promoted investment programs (especially for renewables), with time frames and on-going assessment.

The government should facilitate stakeholder engagement with the key activities and tasks identified in 'solutions' and 'implementation' sections for the RE Strategy by establishing a single one-stop destination website that details the ongoing status and progress on these activities. That would create a great transparency and effectiveness for sector information exchanges, this, in turn, facilitates timely coordination, enhances societal trust and consensus on the need and opportunity for greater investment for new energy types.

Such sites are seeing growing use in APEC members to assist key stakeholders – government, industry, non-governmental organization (NGO) and community – in understanding the objectives, overarching strategy, framework, specific policies and regulatory arrangements intended to deliver specific government objectives (As it was successfully demonstrated in CDM management in Viet Nam). This site will need to be regularly updated and include timelines, status and progress reports on the key activities and tasks identified in Viet Nam's renewable energy development strategy. It can also include links to associated government policy and regulatory activities such as those of the PDPs.

There are also opportunities for improving quality of information in English in web portal of many ministries and government agencies at central and provincial levels.

Recommendation 14: Delivery of community service obligations including subsidised tariffs and FiT by stakeholders including generators and networks needs to be make more transparent to potential renewable energy project developers and the community more generally.

Community service obligations (CSOs) associated with the delivery of energy services to the community exist in all APEC economies and reflect, of course, the important role that energy plays in societal welfare and progress. However, poor transparency in such CSOs – who is paying how much to whom – has proven problematic in terms of key stakeholders incentives (often disincentives) to facilitate renewable energy deployment.

Recommendation 15: Provide greater transparency, information and campaigns to enhance societal trust and consensus on the need and opportunity for greater renewable energy deployment in Viet Nam.

There are opportunities to enhance policy and regulatory frameworks to provide greater transparency and information on the outcomes of renewable deployment to enhance the public's understanding of the value such deployment provides to the community.

Information on the progress of other projects within the scheme can assist investors in determining the most appropriate timing for their projects in terms of supply chain players capabilities and resources, as well as potential future challenges should, for example, a large number of projects all propose to locate in the same region and connect to the same region of the grid.

Recommendation 16: Clearer regulations on access and use of available information and data in regard to Viet Nam's renewable energy resources, regional transmission and distribution network capacities to facilitate potential project developers to quickly assess the likely performance of their projects and any particular issues that may arise in network connection

Renewable energy investment mobilisation will benefit from more transparent, timely (rapid) planning and development processes including tax arrangements, network connection and environmental assessment, with details and preliminary assessments available at early stages of project development.

A common lesson from renewable energy deployment in APEC economies and world-side has been the costs and risks associated with potentially slow project development processes, particularly when these have low transparency and little indication of likely success or failure early in the project development cycle before too much expenditure has occurred. Timely network connection has proved particularly problematic in some cases with fully developed projects unable to export to the grid, and hence start being paid, for significant periods.

Recommendation 17: Improve investment environment with clearer, specific and more transparent guidelines including permitting and registration requirements, fiscal incentives within the FiT and RPS arrangements

The government should consider more simplified and clear procedures for RE projects in general and in particular, for wind, solar power projects in order to better attract foreign investment. In wind power sector for example, all related authorization procedures currently seems to be complicated for foreign investors. In order to achieve the national wind power plan, elaborated action plans needs to be developed through close inter-ministerial cooperation because many ministries are involved from initial project development phase to commercial operation in terms of permissions and approvals. Applying a fixed timelines for network connection arrangements and delivery of investment approval for project developers is recommended.

Recommendation 18: Continue and strengthen 'polluter pays' principles for fossil fuel deployment to enhance the effectiveness of incentives for renewable energy deployment including greater use of environmental levies/fees on the use of fossil fuels and reductions in current subsidies to them.

Imposing appropriate environmental taxes on fossil fuel use is a challenge for all APEC economies, including Viet Nam. However, there is a growing appreciation of the broader economic as well as environmental harms of their use, and currently low fossil fuel prices creates an opportunity to reduce subsidies and increase environmental levies and fees.

Recommendation 19: Develop a more programmatic rather than project specific framework for isolated (off-grid) renewable hybrid systems in order to benefit from learnings and scale.

While Viet Nam has had great success in extending the grid, there are still significant numbers of communities in geographically remote or challenging regions that require isolated systems. There is a growing awareness in APEC economies and more broadly, of the value that renewable generation can bring to such systems when currently reliant on fossil fuels (primarily oil / diesel). While the promise of renewable hybrid systems is great, experience worldwide has highlighted the challenges, yet benefits, of a more programmatic approach to their deployment. Beyond the development of standardised technology solutions and appropriate skills, there are opportunities to take the learnings of earlier deployments to improve later projects.

Recommendation 20: Better define the role of large/impounding hydropower generators in the national power development plan may facilitate the recognition of the need for the deployment of various renewables (particularly solar and wind)

The development of large, impounding and storage hydropower potentials could provide the necessary technical support as backup or reserve capacities to variable renewable energy sources such as solar, wind, biomass, and run-of-river/small scale hydropower, in terms of grid stability. As such, there is a need to define purpose of development and power supply capability of the same, whether for baseload, peaking, ancilliary, or reserve capacities.

3.2 Infrastructure

ACHIEVEMENTS AND CHALLENGES

Achievement 9: Viet Nam's extensive transmission and distribution networks have served to achieve a very high electrification rate but also provide an excellent basis to facilitate the connection of high levels of renewable energy deployment to 2020 and beyond.

The Viet Nam electricity industry has delivered relatively low-cost, low emissions intensity, high access (electrification) and reliable electricity by regional standards, particularly given its still relatively low, although rapidly growing, income. This has been achieved despite the very high underlying growth rates in electricity demand, and the planning and investment challenges this entails.

Viet Nam's almost threefold expansion of its generation capacity and 500/220kV transmission network over the past decade is a remarkable achievement. This has been achieved with industry arrangements that have successfully combined both State-Owned Corporation and private investment in generation and distribution, in a changing electricity industry context looking to establish a progressively greater role for market competition.

Challenge 7: The key infrastructure challenge to achieving Viet Nam's ambitious renewable energy deployment targets would seem to be achieving effective investment delivery, particularly for 2020 (or there is not yet clear which way to achieve an effective investment delivery in Viet Nam for renewable energy deployment).

While demand growth forecasting is always challenging, and Viet Nam is no exception to this, recent forecasting scenarios suggest that this growth rate will moderate somewhat to 2020 but still require major generation and network expansion. Growth over the past decade has necessitated significant levels of debt by some key electricity industry players. Renewable energy projects typically require greater upfront investment than fossil-fuel generation alternatives, increasing the challenges for mobilising and delivering the necessary investment.

Evolving industry arrangements to establish greater wholesale competition provide a potentially challenging, as well as promising, context for greatly expanded renewable energy deployment given the uncertainties and hence risks involved in such market transitions. It will involve new players, changing rules and evolving roles for existing players including the SOEs.

Challenge 8: Uneven distribution and competitiveness of RE resources across the provinces (competitive hydropower concentrates in the North while big demand centers and wind, solar energy are more in the Southern part) induce challenges in management of the development scale and speed of various RE sources and electric grids in North and South within the Viet Nam competitive power market

RECOMMENDATIONS

Recommendation 21: Facilitate capacity building of key stakeholders in whole RE supply and deployment chain, including network operators, construction companies and the local renewable energy industry

It is necessary to facilitate capacity building of key stakeholders including network operators, construction companies and the local renewable energy industry to help them deliver effective and efficient renewable energy deployment. Suitable training, learnings from earlier projects and international collaboration will all be valuable in this regard. Consider facilitating the clean energy industry association.

Experience in APEC economies and elsewhere has highlighted the key role that knowledgeable and skilled participants right across the renewable energy supply and deployment chain play in effective and efficient major deployment efforts. Gaps in any link of this chain can delay the entire pipeline with significant cost impacts.

There are mechanisms to expand the transparency of project deployment in its early phases that can provide valuable learnings for later projects by other market participants. Targeted training programs can assist as well as international collaboration, including with other APEC economies that have experience with renewable energy deployment, and similarly ambitious plans as Viet Nam.

More generally, it can be useful to facilitate the development of a renewable energy industry association to assist these key stakeholders to engage effectively with the policy development and implementation process.

Recommendation 22: Enhance planning capabilities and tools for better integration of transmission and distribution network planning with renewable energy deployment planning, as well as management of electricity market operation.

New planning challenges and opportunities require new planning and investment tools. Existing power system planning tools are often not well suited to the very different operational and investment characteristics of key, highly variable and somewhat unpredictable, renewable energy technologies such as wind and photovoltaics. Enhance planning capabilities and tools for better integration of transmission and distribution network planning with renewable energy deployment planning is necessary. Tools that include probabilistic techniques to manage the highly variable and somewhat unpredictable characteristics of some renewable energy resources, supported by detailed

temporal and locational renewable resource mapping and characterisation, will be required. These tools must also be compatible with greater market-based decision making.

Viet Nam has already undertaken some highly valuable renewable resource mapping. However, greater temporal and geographical resolution is very valuable for planning, given the importance of extreme as well as average renewable energy project performance for overall power system operation.

Also, given the importance of carefully coordinating renewable project delivery with any necessary grid extension and augmentation, network and renewable deployment planning needs to be integrated – ideally at the tool level.

Finally, evolution of electricity industry arrangements towards a greater role for private, commercially motivated, generation decision making poses new challenges for planning tools and frameworks developed in the context of regulated monopoly utility operation with centralised investment decision making. Again, a number of APEC economies have valuable experience to share in this regard following their own electricity industry restructuring efforts.

Recommendation 23: Regular, timely and transparent presentation of the planning framework and its key outputs to all relevant stakeholders, with opportunities for genuine stakeholder engagement in the process.

Planning processes and tools only have value to the extent that they can guide effective and efficient decision making by all key stakeholders. Furthermore, such processes and tools can greatly benefit from effective engagement with these stakeholders. Transparent planning arrangements with regular opportunities for end-user engagement are therefore of great value. So are ongoing processes that can quickly incorporate and respond to unexpected changes in the electricity industry context that threaten successful renewable energy deployment.

4 BIOENERGY-BIOFUELS, BIOMASS

4.1 Biofuels

ACHIEVEMENTS AND CHALLENGES

Achievement 10: The biofuel program in Viet Nam has been initiated since 2007, high level and aggregate targets and considerable technical regulations for biofuel production, trading and use have been issued and that helped to boost R&D activities and gradually develop biofuel industry and related infrastructure

Since 2007, the government has promoted biofuels through the PMVN's Decision No. 177/2007/QD-TTg approving the biofuel development scheme to 2015 and with perspective to 2025. During 2007-2015, State budget has supported 11.78 million USD for fundamental research and disseminating applications on biofuels. About 58 R&D and pilot projects have been implemented. R&D projects focused on 1) Improving the productivity of biomass as raw materials for biofuel production, 2) Blending technologies, additives and catalysts to improve energy efficiency of different biofuel types, 3) Diversifying sources of raw materials for bio-fuel production, such as agricultural and forestry waste products, biomas and algae, etc.

Large-scale commercial E5 has been first introduced in 8 cities in 2014, namely Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho, Quang Ngai, Quang Nam and Ba Ria-Vung Tau, following the PMVN's directive on Decision No.53/2012/QD-TTg. In December 2015, E5 was further introduced in other areas of Viet Nam. As of October 2015, there are 740 E5 fuelling stations, which account for 21% of total gas station numbers in Viet Nam.

On bioethanol production side, there are six bioethanol production plants in operation and under construction as of end 2015, with the total production capacity of around 500,000 m^3 of bioethanol per year.

Challenge 9: The promotion of bioethanol production market can be challenging with the current policy to support bioethanol suppliers and inattractive bioethanol fuel price structure to consumer

Due to the fact that the Vietnamese cassava also has market share in other industries including the export industry and food industry, the promotion of bioethanol production market can be challenging. However, the bottleneck constraint seems to come from consumer demand side. The capacity of bioethanol production from cassava is now exceeding the domestic demand. The bioethanol surplus portion, with the amount of 200,000 m^3/year out of total 500,000 m^3/year bioethanol production capacity, was exported. The possible reasons of low bioethanol domestic demand could be from bioethanol fuel price structure that makes it not attractive enough to consumers. At present, the retail price difference between bioethanol and normal gasoline was about 3 U.S.cent/liter.

So far, the policy target on Vietnamese biofuel program has not been met, as seen from the number of E5 gas station which was only 50% progress towards the target by the end of 2015. Therefore, the target of having E10 gas station economy-wide by the end of 2017 will be very challenging.

Challenge 10: Vietnamese government does not yet have a clear direction for near and long term biofuel program strategies. An effective information program on biofuel and capacity building is still lacking

Another challenge is that the Vietnamese government does not yet have a clear direction for near and long term biofuel program strategies. Capacity building on human resource development in the field of biofuel production/development in Viet Nam is still not sufficient at present, and thus need more support from the government. Consumers might not have much confidence on bioethanol fuel quality.

Challenge 11: The bioethanol production in Viet Nam relies on only one single feedstock – cassava. There is a strong competition in price and also likely conflict in use with other use.

The bioethanol production in Viet Nam relies on only one single feedstock, which is cassava. Cassava is one of the economic crops of Viet Nam. There are 60 cassava processing plants in operation with total processing capacity of 3.2-4.8 million tons of fresh roots/year. The total cassava starch production in Viet Nam was about 800,000 -1,200,000 tons, in which 70% was exported and 30% used domestically. Viet Nam is ranked as the second largest exporter of cassava products after Thailand. The main importers of Vietnamese cassava are China, following by Korea and Chinese Taipei. The total export in year 2009 was around 4 million tons of cassava chip and more than 350,000 tons of cassava starch and flour.

RECOMMENDATIONS

Recommendation 24: Set clearer near and long term biofuel targets and strategies with more details on storage and distribution infrastructure and economic regulations in order to boost effectively the biofuel production and consumption market in Viet Nam.

Set a more attractive incentive pricing mechanism is recommended as a first priority in government's action in order to expand E5/E10 gas station economy-wide, as indicated in the government's existing plan, in order to increase market opportunity for bioethanol fuel. Also, the investment incentives need to be strengthened further to attract more private sectors involved in developing supply infrastructure, so as government's targets can be achieved.

Recommendation 25: Consider promoting stronger uptake of E10 through a sale obligation on fuel retail. Adoption of a bioethanol blending ratio E10 target might be a better option than an E5 target not only to close the oversupply production-demand gap, but also in the aspect that E10 usage could reduce the risk of phase separation.

The term "phase separation" means the condition that water and ethanol are fully miscible and thus cause the ethanol and water to separate from the gasoline and form two distinct layers. The two main variables of phase separation are water content and temperature. Phase separation can happen in an underground or an aboveground storage tank, a vehicle tank, a boat tank, in any type of equipment tank. When this happens, serious engine problem may occur.

To improve the consumer's confidence on biofuel quality, the government should take rigourous measures to ensure that fuel mix inspection is carried out on a regular basis and restrictedly follow the biofuel quality standard guideline and safety regulation that have been developed.

Recommendation 26: Raise more public awareness on bioethanol usage via campaign program designed to match with different target groups.

The information and knowledge will definitely help to increase consumer confidence necessary to sustain bioethanol production and usage. The campaign program should be designed to match with different target groups. It could be in the form of a unique grassroots education campaign to a more technical education campaign.

Recommendation 27: Provide continuous support for research and development (R&D) in biofuel-related technologies in both upstream and downstream activities.

As for R&D aspect, it is desirable that the government shall provide continuous support for research and development on cassava yield improvement as well as broadening more biofuel feedstock options. Not only supporting the R&D on the feedstock improvement, the government should also encourage the R&D on biofuel technology development, including production technology and fuel blending technology.

Recommendation 28: Establish clear programs to strengthen human resource capacity building in the biofuel area, both at government agencies and in enterprises.

Government should establish clear programs to strengthen human resource capacity building in the biofuel area, both at government agencies and in enterprises. This includes the technical staff with in-depth knowledge and skills in areas related to biofuel production and the technicians with general skill on biofuel production.

Recommendation 29: Make more efforts to promote domestic biodiesel production and deployment, as well as to introduce clear targets and strategy for biodiesels development.

The biodiesel development in Viet Nam seems not to make much progress at present, as compared to the bioethanol program. Therefore, the government shall put more effort to promote domestic biodiesel production and deployment, as well as to introduce the strategies for biodiesel blends.

4.2 Biomass

ACHIEVEMENTS AND CHALLENGES

Achievement 11: The government has well recognized the important role of traditional biomass and biogas as low-cost fuel sources of millions of households in rural area and made continual and significant efforts to cooperate with private sectors and households in investment to improve energy efficiency and sustainability in traditional biomass and waste use in Viet Nam.

There are abundance biomass resources in Viet Nam. Firewood and agricultural residues are an important source of energy in the rural areas. Since Viet Nam is a low middle-income economy with two third of population living in rural areas, traditional biomass consumption remains significant in its energy system and accounts roughly for one fifth of total primary energy sources. Most of the bioenergy is used in rural areas in Viet Nam as home energy (firewood and straw for cooking and heating).

Through national target programs on rural development and modernisation (initiated since 1990s) and energy savings (accelerated since 2005), the government in cooperation with private investors and households have made considerable efforts and investment to improve energy efficiency in biomass use to meet heat demand in residential sector. High energy-effcient biomass-fired stove (efficiency at 30-35% on average) has been gradually introduced to replace traditional stove (energy efficiency at 11-13%). Biogas technologies have been widely deployed and developed in rural areas with strong growth of forestry and husbandary sectors. Biogas programs had constructed household biodigesters, mostly using pig dung as feedstock. These developments have also contributed significantly to environment sanitary improvement in Viet Nam.

In 2014, FiT mechanism together with standardised PPA and connection priority have been introduced to encourage the development of biomass energy projects.

Achievement 12: Encouraging development of biomass CHP across provinces in Viet Nam

Viet Nam's biomass energy installed capacity was approximately 150 MW. It includes mainly bagasse CHPs which were built at capacity scale ranging from 4.5 MW to 25 MW to produce heat and power for own use of the sugar mills. Exisiting plans of sugar mill's CHPs show potential expansion to 341 MW in installed capacity by 2017-2018. There is also one rice husk co-generator built in the Mekong Delta region, out of about 10 FS (with a combined capacity of 95 MW) carried out during 2009-2011 in this region.

Challenge 12: Accelerate large scale industrial applications of biomass for heat and power generation and improve the efficiency of biomass usage to achieve targets set by the government toward 2020 and 2030

Considerable biomass potential remains unexploited. According to ADB's assessment, more than 37 million tons of biomass residues are produced annually and 15 million m^3/day of biogas can be recovered. Crop yields in 2010 indicate that the annual theoretical potential of biomass energy from the combustion of rice husks, rice straw, corn cobs, cassava stalk, bagasse, and sugarcane wastes is about 84,875 GWh (ADB, 2015). The ADB study completed in 2015 on Renewable energy potential and developments in the Great Mekong subregions shows the Viet Nam's bioenergy potential as summarized in Tables 2.2 and 2.3. The technical level is, however, much less than this because of the difficulty of collection of the residues and their inclusion in the grid network.

Large scale household biogas systems and bioenergy for industrial use are currently limited. Lack of investment capital is identified as a barrier. In addition, it is challenging to develop an effective biomass supply chain. Primary residues tend to be of low volume because of the small size of farm holdings and the difficulty of collection. Agriculture secondary residues are usually available in large quantities at milling and processing sites but potential biomass CHP developers may lack of land for project construction and have difficulty to find an appropriate and stable consuming market for their excess heat produced. The under development of the biomass energy technology market currently is also a difficulty to overcome to implement targets specified in the RE strategy.

Table 2.2: Biomass potential capacities in Viet Nam

Biomass Residue	Total Yearly Biomass Production (10^3 tons)	Total Theoretical Energy Potential (GWh/year)	Estimated installed capacity* (MW)
Rice husks	9,197	32,830	1,606
Rice straw	17,875	29,897	1,463
Maize or corn cobs	1,151	4,591	225
Cassava stalks	750	1,440	70
Sugarcane tops and trash	4,816	8,996	440
Sugarcane bagasse	3,987	7,121	348
Total	**37,776**	**84,875**	**4,152**

Note (*): APEC Peer Review Team's estimation with assumptions of efficiency 30%, power factor 0.7
Source: ADB, 2015; APEC Peer Review Team, 2016

Table 2.3: Technical potential of biogas production

Husbandry waste	Daily Biogas Production (m^3/day)	Energy Content per Day (kWh/day)	Estimated installed capacity* (MW)*
Buffalo	88,640	531,840	7.9
Cow	193,920	1,163,520	17.3
Pig	13,679,526	82,077,156	1,221.4
Poultry	1,036,725	6,220,350	92.6
Total	14,998,811	89,992,866	1,339.2

Note (*): APEC Peer Review Team's estimation with assumptions of Efficiency 25%, power factor 0.7

Source: ADB, 2015; APEC Peer Review Team, 2016

RECOMMENDATIONS

Recommendation 30: Consider diversified biomass sources while implementing the national strategy for renewable energy, especially in rural areas

- Sugarcane bagasse and rice husks (secondary residues) are usually available in large quantities at processing sites. In order to minimize the cost of biomass logistics, utilisation of secondary residues on sites directly for heat and/or power generation is highly recommended.
- Agricultural residues (primary and secondary residues) such as maize or corn cobs, or cassava stalks, coffee husks, nut shells, coconut wastes, and other biomass (wood waste, etc.)
- Waste water: The use of waste water (such as from sugar and other industries) to produce biogas for power generation.
- Digested sludge: Digested sludge is a good fertilizer, increasing land and biomass productivity and farm incomes. It can also increase biomass feedstock supply, and form the positive cycle of bioenergy industry

Recommendation 31: Give more focus on establishing a biomass supply chain

Establishing a biomass supply chain is needed for more efficient and cost effective for bio-power development.

- Developing anaerobic treatment of relatively dry biomass is recommended. Anaerobic fermentation of relatively dry agricultural waste has advantages compared with traditionally used wet biomass due to lower energy consuming and lower expense of transportation.
- Densification (pelletisation) of first residues (such as maize or corn cobs, or cassava stalks) is beneficial for transportation, storage and end use.
- A satellite storage and delivery system may be a cost effective way to collect distributed agricultural first residues.

Recommendation 32: Co-firing with biomass in existing or new coal-fired power plants is encouraged.

Coal-fired power plant plays an important role in Viet Nam electricity system for the period 2015-2030. Co-firing with biomass (<3~5%) in existing or new coal-fired power plants is encouraged. It not only provides more stable electricity but also reduce carbon dioxide emission.

Recommendation 33: Increase the electricity capacity factor of the existing bagasse CHP

To increase the electricity capacity factor of the existing bagasse CHP, other biomass (wood waste, coffee husks, nut shells, coconut wastes etc.) can be used as feedstocks during the non-sugarcane production seasons (8 months).

Recommendation 34: Municipal solid waste (MSW) to energy conversion processes should be considered in more detail.

The population of Viet Nam is about 92 million. Municipal solid waste (MSW) to energy conversion processes should be considered in more detail. Establishing the waste separation and recycling system, and a centralized incineration system is recommended to increase the capacity of waste-to-energy.

Recommendation 35: Consider developing manure-based small power system; prioritizing the technology systems that produce both energy and fertilizer.

Anaerobic digestion for converting waste (livestock and poultry) to energy has been demonstrated. The government has been promoting biodigesters especially for household use (cooking and heating). The manure distributed among industrial farms have potential to develop small-scale electricity generation system (50~500 kW). Consider promoting the installation of systems thar produce both energy and fertilizer.

Recommendation 36: Study to promptly apply FiT as incentives for promoting biogas

Viet Nam's renewable energy policy includes FiT and avoided-cost tariffs for different types of biomass. FiT for biogas is an incentive for developing larger-scale biogas utilization.

5 WIND ENERGY

ACHIEVEMENTS AND CHALLENGES

Achievement 13: Since 2011, the government has set ambitious targets and clear supporting mechanisms for wind power development toward 2020 and with perspective to 2030

The important role of commercial wind energy is well recognized by Vietnamese government and reflected in the PDP7, approved by the PMVN in 2011. The government set a target for wind energy dissemination to 1 GW (0.7% of electricity production) by 2020 and to 6.2 GW (2.4%) by 2030

utilizing significant wind energy resource. Same capacity targets are indicated in the RE Stratergy (2015).

To implement these targets, Viet Nam has actively cooperated with governments of Germany (2009-2018), Finland (from 2015) and the World Bank (from 2015) to have necessary technical and financial assistances to establish concrete supporting programs, aiming at rapidely building capacity in government agencies and industry, formulating regulatory framework, financing very first wind power and wind turbine or tower manufacturing projects in Viet Nam.

In 2012, the Ministry of Finance (MOF) introduced a FiT with a standardised PPA and applied to wind power. FiT for wind is decided of USD 0.078/kWh excluding VAT to encourage the wind market. FiT is currently under revising to reflect recent changes in the domestic and international wind power technology market.

Various incentives are introduced such as corporate tax exemption, import tax exemption, and standard power purchase agreement for 20 years with the intention of attracting more participants. More details are as follows:

- Concerning import duties, wind power projects are exempted from import duties for any goods as long as it creates fixed assets of the project as raw materials, semi-products which have not been manufactured in Viet Nam.
- Wind power investors can raise funds in different forms permitted by relevant laws from individuals and organizations in and out of the economy and may have access to State credit for investment pursuant to the laws.
- Wind power projects can benefits the same preferential treatment in investment in terms of exemption and reduction of corporate income tax as for other projects in line with the Law on Investment, Law on Corporate Income Tax and other documents guiding the enforcement of these laws; Preferential corporate income tax rate of 10% applies to newly established companies for 15 years.
- If the given project is classified as a large scale project, a project using high or new technology and in special need of investment, the above tax rate may be extended to less than 30 years.
- In addition, other preferential treatments in infrastructure for wind energy projects as available as follows:
    - Projects on installing wind powers, lines and transformer stations connected to the national grids can benefit the same exemptions and reductions in land rental as projects being entitled to special investment treatment.
    - In line with the approved development plan, the provincial people's committee allocates land to the investor to implement wind power projects. The compensation for existing land users and support for site clearance complies with the provisions of land law in force.
- Wind energy operators are also subject to exemption and reduction of land use fee and rental in accordance with the regulations governing projects in special priority sectors for investment.

Achievement 14: Encouraging growth in wind power capacity and wind manufacturing industry development has been recorded within the last five years, proving that the government policies are capable of develivering deployment

By January 2016, Viet Nam's large-scale wind power capacity in opearation and under construction reached about 249 MW, a strong development from only 8 MW in 2008. It consists of 2 onshore wind farms in Tuy Phong (120 MW) and Phu Lac (24 MW) of Binh Thuan province, 1 wind farm in Phu Quy island (6 MW) also of Binh Thuan province and 1 offshore wind farm in Bac Lieu province (99.2 MW).

In aspect of manufacturing, Viet Nam started to have first manufacturing factories of wind turbine towers and generators, invested by foreign and domestic investors as follows:

- GE: produces wind generator in Hai Phong
- CS wind: produces wind turbine tower in Ba Ria-Vung Tau
- VINA HALLA Heavy Industries: produces wind turbine tower in Ba Ria-Vung Tau
- UBI Tower: produces wind turbine tower in Hai Duong

Challenge 13: More detailed implementation plans and more attractive policies and supports are required to achieve the ambitious targets set by the government for the years 2020 to 2030

Viet Nam has ambitious wind power development plan as mentioned above but has challenges to achieve the goal.

Unattractive FiT rate for wind power in Viet Nam domestic power market and in ASEAN wind power market

The consumer electricity tariff is regulated by the ERAV. EVN, in principal, cannot purchase electricity from independent power plants at the rates higher than the consumer rates. Current average consumer rate is about USD 0.06/kWh.

The current FiT is evaluated as low by the market and it is hard to expect any significant increase considering financial conditions of EVN. In other words, FiT itself is not much attractive to invite foreign investment. Especially, single wind tariff cannot reflect different construction and operation conditions and costs of each wind farm. A wind farm located far from a substation for grid connection takes higher capital investment compared to a wind farm located near a substation. However, the same tariff is applied to those two wind farms without reflecting difference of investment costs.

Table 2.4 shows wind tariffs of selected economies/countries. Among the three Southeast Asia economies/countries in the table, the Philippines offers the highest tariff which is about three times higher compared to Viet Nam.

Table 2.4: Comparison of wind tariffs in selected economies

	Contract Term	US cents/kWh
China		8.9
Germany	20	12.1
France	15	11.1
Portugal	15	10.0
Thailand (>50kW)	10	11.6
Philippines	12	24.6
Viet Nam	20	7.8

Source: German Agency for International Cooperation (GIZ), 2014

For an instance, the province of Ninh Thuan has licensed many wind power projects since 2005, only one has actually progressed to the construction phase. Similar cases can be observed in other provinces. According to the MOIT, 48 wind power projects have been registered for investment economy-wide but only three projects have come into operation. It can be explained in several ways but the most critical reason of those delays is the low price of electricity.

To develop the wind market and industry, German Agency for International Cooperation (GIZ) has proposed Vietnamese government to increase wind tariff up to USD 0.104/kWh and revising the tariff is under consideration.

Complicated investment procedures

One of critical challenges is that Vietnamese government is heavily dependent on foreign investment in wind power deployment so that more elaborated implementation plans need to be developed to attract more foreign investors after consideration of administrative permission processes, financing responsibilities, and economy-wide allocation program of wind farms reflecting transmission and distribution lines with wind resources, etc.

Unreliable wind resource data

According to the project report of *Information on wind energy in Viet Nam* conducted by GIZ/MOIT in 2011, the assessment of wind power potential remains incomplete. Therefore, project developers must survey wind resource assessment at prospective sites by themselves.

About 150 meteorological stations built along Viet Nam provide measured wind data, which show wind speed ranges of 2 to 3 m/s in land, 3 to 5 m/s in coastal areas, and 5 to 8 m/s on island areas. Although, the Institute of Energy examined wind energy potential using the obtained meteorological stations data, the data is considered unreliable because the stations are usually located in cities or towns and most importantly the measurement heights are too low of around 10 m with only 4 readings in a day.

Another wind resource map available is wind energy resource atlas sponsored by World Bank in 2001. The atlas is based on meteorological data and the *Mesoscale Map* simulation model. Therefore, it provides a rough estimate of wind energy potential in Viet Nam at 65 m and 30 m above ground level.

Currently, 62 to 65 meteorological masts are measuring wind data in Viet Nam; 27 masts are installed and operated by EVN and MOIT and another 35 to 37 meteorological masts are run by wind power developers or others. The categorized results according to installed location show 12 masts in northern region and 50 to 53 masts in southern region, which has better wind resource than north. It is unclear if those all meteorological masts are installed in the purpose of wind resource analysis.

It seems that obtained data from ENV and MOIT masts are even not syntagmatically collected by a relevant government agency and not publically available. A reliable wind resource atlas is still in development process with World Bank and it brings many difficulties to wind power project developers and increases project development expenditure.

High dependency on foreign technologies and finances

Viet Nam's domestic wind industry is still in early stage especially in wind turbine manufacturing and wind farm construction. Wind turbine systems are imported from foreign OEMs (Original Equipment Manufacturers) and only a few components are produced in domestic such as wind turbine towers and generators. For small wind turbines, the Institute of Energy developed 150W small wind and the Ha Noi University of Technology and the HCM University of Technology developed small wind turbines in the range of 150 to 500W during 1990's. However, any successful commercialization of small wind turbines has not been reported mainly due to vulnerable manufacturing industry.

Lack of qualified human resources and appropriate infrastructure to support the construction of large-scale wind farms

Another difficulty is a deficiency in qualified human resources and technical infrastructure. It is hard to find systematically trained and well experienced Vietnamese engineers. Therefore, wind farm design and construction is performed by foreign engineers.

For instance, multi-MW wind turbines usually have hub height of 80 m and need about 1,000 ton cranes to install a nacelle but availability of that kind of heavy installation equipment in Viet Nam is limited.

Road network is not well organized so that transportation cost of tower, nacelle, and blades increases during construction phase. Especially in rural areas, narrow and winding roads limit transportation of heavy components and installation equipment.

RECOMMENDATIONS

Recommendation 37: Invest to improve wind resource data reliability and consider establishing a specific agency responsible for unifying and managing wind resource data in an efficient way for wind power planning and development.

It is recommended that the government develop a blue print for national wind farm development based on reliable wind resource data. Securing reliable data can be done by assigning a public institution, which syntagmatically collect and analyse data measured from economy-wide meteorological masts. The blue print needs to reflect not only wind resources but also grid connection conditions such as available capacities of substations and transmission and distribution lines, and public acceptance, etc.

The most desirable deployment strategy will be that the government suggests promising wind farm sites to foreign investors based on the blue print and let them bid for winning projects. In that case, wind farms can be developed predictably in accordance with the government wind power plan.

Recommendation 38: Consider adopting a concentrated development of wind farms along the southern coastal line for a better efficiency

According to GIZ and the MOIT, southern coastal area has better wind energy potential compared to other regions so that concentrated development of wind farms along the southern coastal line is recommended considering environmental impact, mobilization of heavy equipment, terrain characteristics and accessibility, etc. That is, inland or high mountain area takes more costs to develop than coastal area and better be remaining to a lower priority.

Recommendation 39: Consider the introduction of graded tariffs when designing FiT for wind power

A single FiT of USD 0.078/kWh is currently applied for all wind farms regardless of installed capacities, construction costs and operation and maintenance costs. FiT is supposed to work as a key mechanism to encourage wind power in Viet Nam but it is evaluated by market not much attractive to foreign investors. Although the government is now considering the revision of tariff, it is hard to expect significant increase due to current low-cost power system in Viet Nam and EVN's financial status.

Under the given circumstances, more effective way to use limited budget for FiT is introduction of graded tariffs in a certain range reflecting capital expenditure for wind farm development and operation. For an instance, higher tariff can be applied to a wind farm built with more capital expenditure and lower tariff for a wind farm with less expenditure.

Graded tariffs may bring another positive effect; a developer always prefers to construct wind farms at sites with high mean wind speeds. If lower tariff is applied for economically feasible sites, then EVN can save FiT budget and becomes affordable to offer higher tariff for less economically feasible sites to ensure return on investment. Differentiated tariff has leverage effect to promote wind power projects at less preferred site by developers within a given FiT budget.

Recommendation 40: Establish a local certification scheme for wind turbine

Wind turbine certification scheme is an effective way to increase availability and reliability of wind turbines. Although foreign imported wind turbines have certificates issued from local or international certification bodies, they are not designed and evaluated considering Vietnamese climate conditions such as monsoons and typhoons. If the government introduce local certification scheme in line with international standards and procedures such as IEC 61400 series, then it will contribute to enhance availabilities of wind turbines.

Recommendation 41: Complete national power grid code with additional code for connected wind farms

Grid code defines requirements for wind farms connected to national grid to ensure safe, secure and economic proper functioning. In general, grid code specifies the required behaviours of grid connected wind farms during system disturbances including voltage regulation, power factor limits and reactive power supply, response to a short circuit, response to frequency changes on grid, and requirements to ride-through short interruptions of the connection.

In Viet Nam, wind power deployment is in early stage and is expected to rapid growth according to the government wind power plan. As grid connected wind farm capacity increases, transmission system operators (TSO) must maintain stability and reliability of wind power dispatch. In this regard, grid code development is recommended as wind power penetration to the national grid increases.

It will help clear, transparent and reduced technical negotiations between transmission system operators and wind farm operators. On wind farm operators, they need to design equipment and controllers considering grid code requirements and they should not make any changes without transmission system operators' permission to operate the national grid in stable. Grid codes have been implemented in economies/countries with high wind power penetration since 2000 as on the following table.

Table 2.5: Grid codes in economies with high wind power penetration

Country/economy	Transmission System Operators	Release Date
Denmark	Energinet.dk	December 2004
Germany	E.ON, EnBW, Vattenfall, RWE	August 2007
Spain	Red Electrica	March 2006
UK	NGET	June 2009
Ireland	EIRGRID	April 2008
USA	FERC, WECC	June 2005
China	CEPRI	July 2009

6 SOLAR PV, SMALL-HYDRO, GEOTHEMAL ENERGY

6.1 Solar PV

ACHIEVEMENTS AND CHALLENGES

Achievement 15: The Vietnamese government has actively promoted and introduced solar energy technologies by integrating in initiatives/programs of electricity savings and rural electrification. Initial development of solar energy applications, for both thermal and electricity generation, and recently announced high targets set to 2050 are laudable.

The solar energy technologies in Viet Nam are primarily deployed for thermal and electricity generation. The most popular solar energy application is solar water heating installed in households

and hotels, as well as in industrial facilities. Electricity generation, on the other hand, employs solar photovoltaic (PV) technologies, either for stand-alone systems or grid-connected scale. Despite the huge disparity in installation cost and end-use consumer electricity tariff, the Viet Nam Government actively promoted and introduced solar energy technologies. Currently, a total of 5 MWe PV installed capacity represent 0.014% share of the capacity mix. The first large scale grid-connected solar PV power plant with a capacity of 19.2 MW was initiated in Quang Ngai Province, Central Viet Nam on 29 August 2015 and expected to be commissionned by mid-2016. The FiT rate for solar power is currently drafted and tariff rates of 11.2 US cents/kWh and 13-14 US cents/kWh are eyed for ground-mounted and rooftop installations, respectively. Some aggregate capacities of 900 MW are targetted by 2020 and increasing to 3200 MW by 2050.

Achievement 16: Viet Nam has achieved initial successes in attracting private investment in building manufacturing capacity of solar industry

Government's attractive incentive packages led to the establishment of solar PV assembly factories that include the following: (1) Redsun at 12 MW/year capacity in Long An Province; (2) IREX – Solar BK at 150 MW/year capacity in Da Nang City; and (3) Bo Viet / Boway at 150 MW/year capacity in Bac Giang Province. These facilities serve primarily the international market (export) with a small quantity for local/domestic supply.

Challenge 14: Low electricity tariff at 7.3 US cents/kWh in Viet Nam is major challenge for solar power development. The promotion of net metering concept with tariff based on levelized consumer price of electricity may not be attractive, especially for household participants

Challenge 15: There remain some needs to further enhance initiatives on solar energy, particularly in formulating clear guidelines in project development and clear mechanism implementation.

RECOMMENDATIONS

Recommendation 42: Consider developing clear sub-targets for utility scale and rooftop installations with appropriate supporting data and analysis of daily electricity consumption by location.

Quoting the ADB study, "the government's renewable energy resource targets[3] omit reference to solar power." While there are indicative directions to push more solar power installations from central to southern portions of the economy, where the potentials are greater than the northern part, the targets are not demand-based. As such, there should be a daytime consumption assessment and forecasting, wherein large daytime demand could aid in setting targets, particularly for distributed generation and rooftop installations. Clear sub-targets for solar power development should be mentioned in the revised version of PDP7 or in a subsequent strategy/plan specific for solar energy development.

Recommendation 43: Promptly establish the FiT system for solar power development to attract more private-sector participation.

The ongoing consideration of the FiT rates for solar power development is necessary to be timely to attract more private-sector participation. There should be a good balance between the FiT rate and end-use consumer price of electricity, wherein the source of fund to cover the cost difference should be clearly established. A possible government subsidy, especially at the initial phase of the FiT system implementation, should be considered. The government subsidy however should diminish overtime (employment of smart subsidy scheme).

[3] ADB study refers to PDP7 issued in 2011

To complement the tariff rates, clear, specific and transparent guidelines should be developed and promulgated for FiT system and net metering programs. Such guidelines should include permitting and registration requirements, as well as the available fiscal incentives to create positive investment environment.

Recommendation 44: The tariff rate scheme for net metering implementation should consider the levelized pricing of electricity consumers, to attract even small household consumers, and control appropriately large installations.

A tariff rate scheme for net metering implementation should likewise be in place. The rate scheme should consider the levelized pricing of electricity consumers in order to attract even the small household consumers. The same should look into the tendency of large electricity consumers to limit installations because large installations may result to reduced consumptions and eventually lower tariff.

Recommendation 45: Continue to conduct capacity building activities. An information, education and communication campaign should be scaled down to household level.

6.2 Small-hydro power

ACHIEVEMENTS AND CHALLENGES

Achievement 17: The development of small-hydro power, in term both of installed capacity and power generation achieved rapid growths at 31.6% per year and 30.6% per year on average during 2000-2014.

Competitiveness of hydropower in Viet Nam together with government policy to encourage investors from all economic sectors to participate in small-hydro power development induced rapid growths at over 30.6% per year on average during 2000-2014 (GOV, 2015b, MOIT, 2016a). While capacity increased from 37 MW in 2000 to 1670 MW in 2014, power generation increased from nearly 148 GWh in 2000 to 6.5 TWh in 2014, accounting for 4.5% of total power generation.

Achievement 18: The government has applied in combination both planned management and market mechanisms to attract investors from all economic sectors to participate in developing small-hydro power capacity.

The government has paid attention to establish early national and provincial master plans for hydropower development. Also, the government introduced avoided-cost tariff and standadised PPA to support small-hydro power development since 2008, earliest compared to other renewable power sectors. The avoided-cost tariff for small-scale hydropower development at present is about 0.05 US cent/kWh (MOIT, 2016a). Other mechanism to support small-hydro power expansions such as Renewable Portfolio Standards (RPS) has beend identified to be applied beyond 2016.

Achievement 19: Well-defined and excluding large hydropower (above 30 MW) in implementation of mandatory RPS to generators and distribution utilities is an effective way to facilitate the accelerated developments of small-hydro power and other renewable energy sources.

The well-defined and huge target for large-scale hydropower development should work to the advantage of small-scale hydropower and other renewable energy resources. Hydropower development at capacities greater than 30 MW is excluded in the mandatory RPS to generators and distribution utilities and will accelerate the development of small and variable renewable energies.

Challenge 16: There is no clear target for small-scale hydropower development but rather lumped in other renewable energy target.

RECOMMENDATIONS

Recommendation 46: In power sector planning and investment management, classification of hydropower development might be better emphasised on scheme of development rather than based on capacity scale; run-of-river hydropower should be further promoted.

The overall hydropower development in Viet Nam may be further accelerated by emphasizing classification based on scheme of development, i.e., impounding/storage and run-of-river, rather than based on capacity. Run-of-river scheme development promotes lesser environmental impact than impounding and storage hydropower scheme. It also optimizes the development potentials of a river system through cascading scheme of development and embedded generation concept (i.e., directly connected to distribution lines instead of interconnection with main transmission system).

Recommendation 47: Consider improving investment environment with clearer and more specific, transparent guidelines including potential sites, permitting and registration requirements, fiscal incentives under the FiT and RPS system

Private sector participation and investment need a clear and attractive investment climate with reduced administrative costs. Such costs could be lessened with clear, specific and transparent guidelines in project development, particularly in availing and qualifying under the FiT and RPS systems. Moreover, detailed assessment and inventory of small-scale and run-of-river hydropower potentials will aid in setting clearer installation targets, prioritize development based on location or region, and promote embedded generation. Private sector access to this information will encourage more investments.

6.3 Geothermal energy

ACHIEVEMENTS AND CHALLENGES

Challenge 17: There is limited information on geothermal energy resources and no clear targets set for geothermal energy development

The geothermal energy development program of Viet Nam is at the initial exploratory stage. There is limited information on geothermal energy resources, although resource manifestations are indicated. The Power Development Program did not mention geothermal energy development as part of the renewable energy development plans.

RECOMMENDATIONS

Recommendation 48: Geothermal resource potential inventory and assessment should be prioritized among any initiative toward this end.

Viet Nam should acquire possible assistance from international donor and partner institutions in research and exploration activities and build capacities through bilateral cooperation. First hand information should be acquired through study tours and plant visits to gain actual experience and knowledge, which should involve exploration and development of geothermal resources, as well as operation and maintenance of geothermal facilities.

Recommendation 49: Consider to set clear targets for geothermal energy development, including power, non-power and thermal applications of geothermal resources.

Finally, geothermal resource exploration and development should not be limited to power generation. Non-power and thermal applications of geothermal resources should be highly considered.

7 POWER SUPPLY SYSTEM - FEED-IN TARIFF (FIT), SMART GRID, PRIVATE PARTICIPATION

7.1 Feed-in Tariff (FiT)

ACHIEVEMENT AND CHALLENGE

Achievement 20: Viet Nam was a relatively early adopter of Feed-in Tariffs to support renewable energy deployment and already has some experience of the potential capabilities, yet also challenges, of this policy mechanism for small-hydro, wind generation, biomass and, most recently, municipal solid waste.

As noted in other Sections of this peer review, FiTs have contributed to some significant renewable energy deployment outcomes including around 2GW of small-hydro (around six times greater capacity than in 2009), while wind deployment in now accelerating after a slow start to be approaching 249 MW, while there are also around 150MW of biomass projects in place (largely bagasse).

The 'settings' of these FiTs have been changed in some cases given early learnings, particularly slow uptake, and there look to be excellent opportunities to expand small-hydro, wind and biomass where there are opportunities for considerable expansion of existing projects and the use of new fuel streams. A solar FiT is also under development for likely implementation in 2016.

Challenge 18: Adjust and implement appropriately the present FiT framework to create a very large acceleration in renewable energy technology deployment over the next 5 years to meet government targets is a key challenge

The key challenge for the present FiT framework would seem to be in achieving the significant **2020 renewable energy deployment targets** set by the Viet Nam Government. While the 2030 targets for each technology involve significantly greater increments of deployment the 2020 targets need to be seen in the context of fairly modest deployment of key renewable energy technologies to date, and hence the very large acceleration in deployment required to meet targets that are now only five years off.

The FiT mechanism does not, itself, inherently mandate deployment targets. It is not uncommon for FiT policy measures to deliver too little, or too much too quickly; sometimes transitioning between these two undesirable states unexpectedly as technology costs or the FiT tariffs change.

FiT can be implemented together with other policies such as RPS that do provide a stronger incentive to achieve particular deployment targets. However, the interactions between these mechanisms can be complex and unpredictable. FiTs can also be implemented in tandem with other policies such as net-metering to drive greater deployment outcomes. Again, however, the interactions between these mechanisms can be unexpected and not always helpful.

Finally, standardised and 'fixed' FiT payment rates do not necessarily incentivise renewable energy development towards those projects that provide the greatest overall electricity industry value. For example, different wind farms providing the same average generation can offer quite different electricity value depending on the necessary network investment required to connect them, the availability of sufficient adjacent network capacity for this output to reach load regions, and the general temporal pattern of generation – perhaps predominantly day time generation well timed to assist in meeting the higher demand generally seen then, versus perhaps a predominantly night time wind resource.

RECOMMENDATIONS

Recommendation 50: Develop a forward looking and proactive process around the queuing of renewable energy projects with a mechanism for timely revision of FiT rates and other arrangements subject to their performance.

Experience in some other APEC economies has highlighted the difficulties with FiT when they are set at such an attractive rate that they drive great project interest, inquiries and applications. The mechanisms put in place to manage applications can be overwhelmed by such sudden and overwhelming interest. In such cases, the position of projects in the queue can become critical, with potential for disputes if the process isn't clear. In such cases, it is also important to be able to adjust the FiT rates. Given the importance of investor confidence and certainty, the process by which this will be done needs to be made clear as early as possible in the scheme.

Recommendation 51: Consider mechanisms such as additional FiT premiums for renewable energy projects that provide greater industry and Viet Nam benefits in terms of transmission costs, regional demand needs and the temporal value of the energy they provide.

As noted above, FiT mechanisms don't inherently provide greater incentives for renewable projects that offer greater value to the broader Viet Nam electricity industry. Project developers naturally focus primarily on expected MWh production rather than the timing and network implications of such generation. Green certificate and feed-in premium mechanisms can have some advantages in this regard as they expose project developers to some measure of energy market pricing that should, given suitable industry arrangements, provide some measure of such value.

Additional FiT payments to projects offering additional value are one way to address this challenge by incentivising project developers to undertake project evaluation beyond just their expected MWh production.

Recommendation 52: Consider a specific FiT for co-firing of biomass in existing and proposed coal-fired generation

A number of APEC economies include co-firing of biomass in existing coal-fired generation within their renewable policy support mechanisms. Such project can take advantage of existing thermal plant infrastructure and the high thermal efficiency that new, large, thermal power plants can offer. There are complexities including the impact of biomass on plant life and reliability, however, there are certainly potential opportunities for such projects in Viet Nam.

Recommendation 53: Need careful management of interactions between FiT and other policies such as RPS to avoid adverse interactions such as providing unreasonable advantages to incumbent market players

As noted above, FiT mechanisms do not in themselves provide assured deployment to meet government targets. RPS can assist in this regard while encouraging existing large industry players to bring their financial and technical resources to bear on expanding renewable energy deployment. However, there are also some potentially adverse implications. For example, green certificate and RPS mechanisms can sometimes advantage incumbent players who have an RPS obligation, against potential new entrants who would need to come to a suitable commercial arrangement with such incumbents to be able to assist them in meeting this obligation. Therefore, a careful management of interactions between FiT and other policies is required so that the implementation of multiple instruments offer opportunities to enhance the robustness of a FiT in achieving renewable deployment targets and there are less adverse interactions.

7.2 Smart-grid

ACHIEVEMENTS AND CHALLENGES

Achievement 21: The government has set up institutional framework for smart grid development in Viet Nam

The Vietnamese government and relevant industry stakeholders have given smart grid options, and the opportunities and challenges they present, detailed consideration over the past decade. The valuable role that smart grids could potentially play in Viet Nam was highlighted in the government's

National Strategy on Green Growth (2012). The Prime Minister assigned the MOIT to develop a smart grid program in 2011, and ERAV has developed (2013) a smart grid project and implementation roadmap with three phases extending to 2030. They have also established (2013) a smart grid development steering committee to oversee implementation of this.

Efforts to date have focussed understandably on transmission level opportunities, largely around monitoring and control to enhance generation and transmission planning and transmission network operations. There has also been World Bank funding for a distribution efficiency project, and a number of projects relevant to renewable energy integration into the electricity industry including development of a wind network connection code.

Challenge 19: Appropriate application of smart grid technologies to effectively enhance renewable energy development as well as efficiency and resilience of whole power system in Viet Nam

A key challenge for Viet Nam would seem to be establishing a value proposition for **distribution network and electricity consumer smart grid** technology deployment in order to:

- Facilitate distribution network level renewable energy deployment
- Provide greater opportunities for energy consumers to engage in renewable energy deployment through mechanisms including the net-metering proposed for Viet Nam

At present, the limited application of smart grid technologies has hampered the development of new business models, facilitators, technology standards and regulatory arrangements to support these opportunities.

RECOMMENDATIONS

Recommendation 54: Better integration of smart grid within broader government ICT strategy and deployment given new low-cost energy monitoring and control technologies that energy consumers could usefully deploy, and which can utilise existing ICT infrastructure

There are potential synergies between smart grid deployment and broader government information and communication technology (ICT) deployment strategies given the ability of smart grid to either take advantage of ICT rollout through use of broadband and mobile phone networks, or potentially to provide additional ICT services in some cases. Relatively low cost metering with on-line reporting and communication to network businesses are a particular opportunity, particularly given the high costs of standard network metering solutions and associated, often bespoke, communication platforms.

Recommendation 55: Seek broader stakeholder engagement for development and implementation of the Government's smart grid strategy including membership of its smart grid steering committee.

There are many potential stakeholders in smart grid deployment beyond governments and utilities including, of course, the equipment vendors yet also energy users and, of particular relevance here, renewable energy industry players. Experience in a number of APEC economies has highlighted that broader engagement in smart grid strategy can facilitate greater innovation both in terms of technologies (particularly consumer side) as well as business models.

Recommendation 56: Make good used of valuable smart-grid opportunities in Viet Nam's isolated power systems including opportunities to pilot smart renewable energy integration, storage and customer side applications.

There are particularly valuable smart-grid opportunities in Viet Nam's isolated power systems including opportunities to pilot smart renewable energy integration, storage and customer side applications.

Off-grid systems pose particular operational challenges given the generally limited number and types of generators and often peaky and highly correlated loads. Introducing renewable energy generation and associated technologies such as battery storage systems into these systems adds to both operational challenges yet also opportunities. As such, these small isolated systems provide excellent potential test beds for innovative metering and control technologies for both small-scale generating plant as well as the energy consumers.

7.3 Private participation

ACHIEVEMENT AND CHALLENGE

Achievement 22: Private participations have well contributed in all renewable energy markets in Viet Nam

Viet Nam is creating a competitive wholesale market for new, non-baseload electricity generation allowing private investment and participation. One of the specific mechanisms given in the RE Strategy is to encourage participation from organizations and individuals with different forms of ownership. Private companies have already been involved in electricity generation on both an Independent Power Producer (IPP), BOT bases. There has also been private investment biomass cogeneration, principally at sugarmills.

There is an increasing number of professional associations established to operate in various renewable energy fields, such as VBA, VBFA, SHPGEA and VCEA. These are institutional platforms with active participation of both private and SOEs.

Challenge 20: It is not yet clear if the incentives and supporting frameworks provided for private investment in RE generation projects are sufficient to attract the investment required to meet the targets in the RE Strategy.

RECOMMENDATION

Recommendation 57: Particular attention should be given to ensuring SOEs and other existing participants do not receive unfair advantages under the policies developed so that new private participants can compete on a level playing field

Incumbent providers often have advantages over new entrants to a market, including existing relationships, significant information about customers and market conditions and trends. SOEs may enjoy concessionary financing and state-backed guarantees, as well as having a lower expectation around profitability. It is important that privately owned investors are given the opportunity to compete fairly against state owned, incumbent energy companies.

8 GREENHOUSE GAS MANAGEMENT

ACHIEVEMENTS AND CHALLENGES

Achievement 23: The government of Viet Nam has timely issued a number of strategies and programs to make clear and enhance the communication to international community on the climate policy development in Viet Nam

Viet Nam, as a Party to the UN Framework Convention on Climate Change (UNFCCC), has implemented climate change mitigation and adaptation activities backed by several governmental strategies and programs. Chronological milestones for climate policy in Viet Nam are as follows:

1994 Ratification of the UNFCCC

2002 Ratification of the Kyoto Protocol to the UNFCCC

2003 1st National Communication (NC1) submitted

2008 National Target Programme to Respond to Climate Change issued

2010 2nd National Communication (NC2) submitted

2011 Mainstreamed into National Socio-Economic Development Strategy, and Socio-Economic Development Plan

2011 National Climate Change Strategy issued

2012 National Green Growth Strategy issued

2014 1st Biennial Update Report (BUR1) submitted

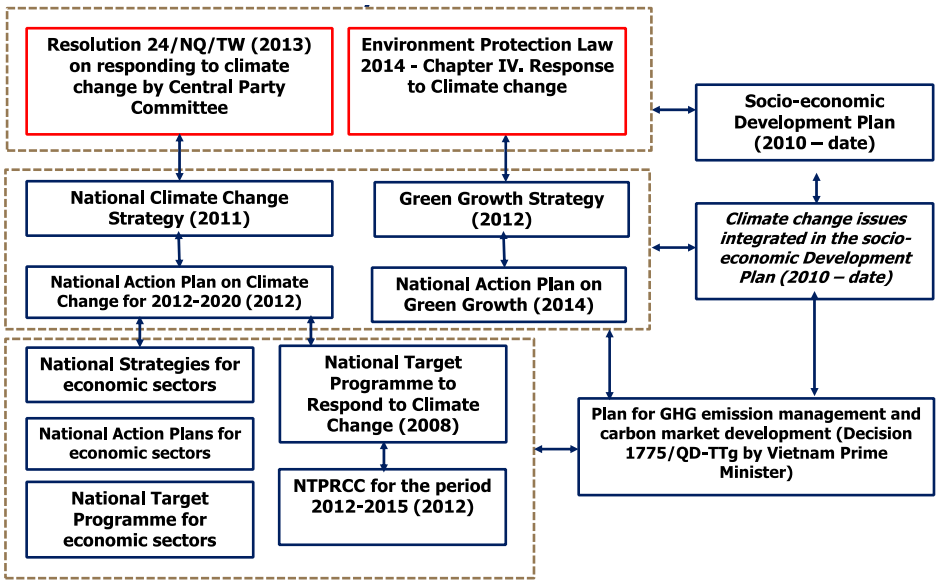
2015 Intended Nationally Determined Contribution (INDC) submitted

Viet Nam's INDC is to reduce GHG emissions by 8% by 2030 compared to BAU GHG emissions projected by Viet Nam to be 787 $MtCO_2e$ (GOV 2015), and by up to 25% with international support. It includes a GHG emissions intensity target to reduce the GHG emissions intensity of GDP by 20% relative to 2010 (the latest year of the national GHG inventory and includes the energy, agriculture, waste and LULUCF sectors), or by 30% with international support.

Achievement 24: Viet Nam has been significantly strengthening inter-ministerial collaborative structure (MONRE – the focal point) as well as the quantification (Measurement, Reporting and Verification (MRV)) schemes of GHG emissions and reductions

It is noted that Viet Nam has been strengthening inter-ministerial collaborative structure (focal point: MONRE) as well as the quantification (MRV) schemes of GHG emissions and reductions fostered by NAMA[4] readiness activities (Figure 2.5) staring from 2011.

Figure 2.5: National Policies related to NAMA



Source: Nguyen Van Anh, "NAMA Framework in Viet Nam", Presentation on December 2015.

Challenge 21: Viet Nam might face challenge to revise its INDC to NDC1 with suitable reconsideration of assumptions with methodologies and possible inclusion of additional and strengthened policies and measures, as well as political decisions as necessary

[4] NAMA stands for "Nationally Appropriate Mitigation Action" requiring MRV as well as inter-ministerial coordination to be described in the biennial update reports (BURs) every two years.

The INDC is the starting point what Viet Nam is intended to target and implement after 2020 under the new international framework of the Paris Agreement (UNFCCC, 2015).

The Conference of the Parties (COP) to the UNFCCC will prepare the guidelines for preparing of Nationally Determined Contributions (NDCs) including the methodologies and information to be including in it by each economy member. It will also undertake the interim global stocktake of aggregated effects of INDCs/NDC1s in 2018 to assess whether it is on the track to 2^0C global goal.

Scientifically, it is obvious that the aggregated level of emission targets is insufficient. Therefore, it will be encouraged for every member economy government to reconsider and strengthen its NDCs.

Therefore, Viet Nam will face a challenge to revise its INDC to NDC1 with suitable reconsideration of assumptions with methodologies and possible inclusion of additional and strengthened policies and measures, as well as political decisions as necessary.

RECOMMENDATIONS

Recommendation 58: Viet Nam should actively prepare for the development and introduction of domestic PDCA (Plan-Do-Check-Act)-cyclic evolutionally process on climate strategy

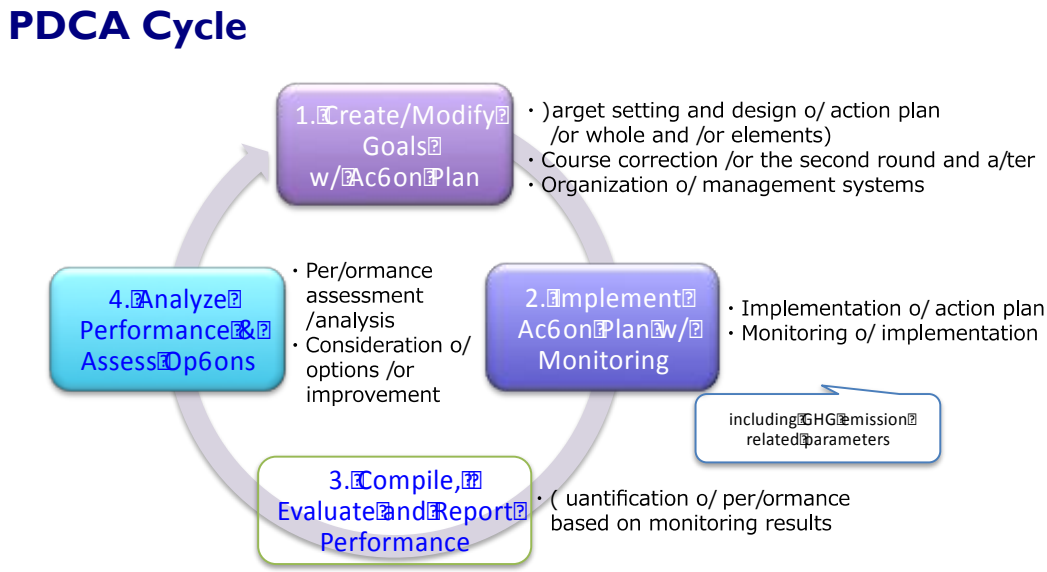
The Paris Agreement will establish the international **PDCA[5] cyclic evolutionary process**, especially for climate mitigation, either in a global or each economy level:

(1) *Every 5 years*, each Party shall develop its NDC. Then, the aggregated emission level of NDCs will be assessed whether it is on track to 1.5–2^0C global goal above pre-industrial level (global stocktake). If not, Parties will have a pressure to strengthen its NDCs.

(2) Each Party shall develop and submit a report *every 2 years* showing the progress of its national actions as well as its GHG inventory (incl. historical trend). The report will be reviewed internationally by experts and by other Parties.

It is noted that the Paris Agreement is an international treaty to facilitate implementation of actions voluntarily.[6] Every government is encouraged to strengthen its target as the NDC as shown in (1)

[5] **PDCA** (**plan–do–check–act**) is an iterative four-step management method used in business for the control and continuous improvement of processes and products. This method is universal and proven to be effective for application to various kinds of activities including GHG management.



[6] On the other hand, the Kyoto Protocol set the legally binding targets in its Annex enforcing each developed Party to meet it.

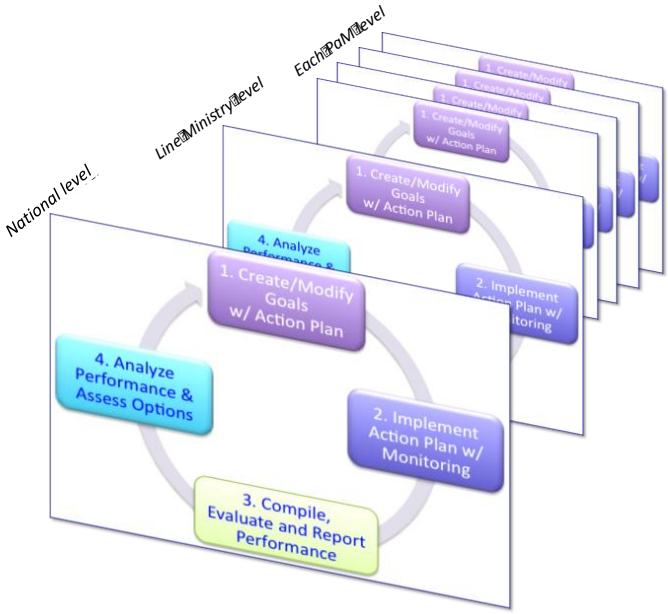
above. On the other hand, the Paris Agreement does not require Parties to implement some specific actions. It is the economy's own jurisdiction how and what kind of actions to be implemented as well as the framework to foster them. For each Party, the international 2- and 5-year PDCA cyclic processes under the Paris Agreement can be the trigger for each economy to prepare its 'domestic' framework to meet its NDCs.

We recommend Viet Nam to prepare the 'domestic PDCA-cyclic processes' of its actions synchronizing the international cycle specified in the Paris Agreement, with its Five Year Development Plans. Integration of climate actions[7] with its development plan is crucial.

Each ministry is responsible for the relevant actions which also have climate objective. Since the PDCA cycle is a framework to implement the actions effectively, we also recommend Viet Nam to prepare *multi-layer PDCA cycles* (Figure 2.6), *i.e.*, economy-widel level, ministerial level and each policy/measure/program level to raise overall performance. It is also noted that the intra and inter-ministerial coordination should be strengthened for effective implementation of actions at economy-wide level.

Although how to design PDCA cyclic process for each case may differ and challenging, how to design and implement such PDCA cycles has common points.

Figure 2.6: Image of multi-layer level PDCA cycles



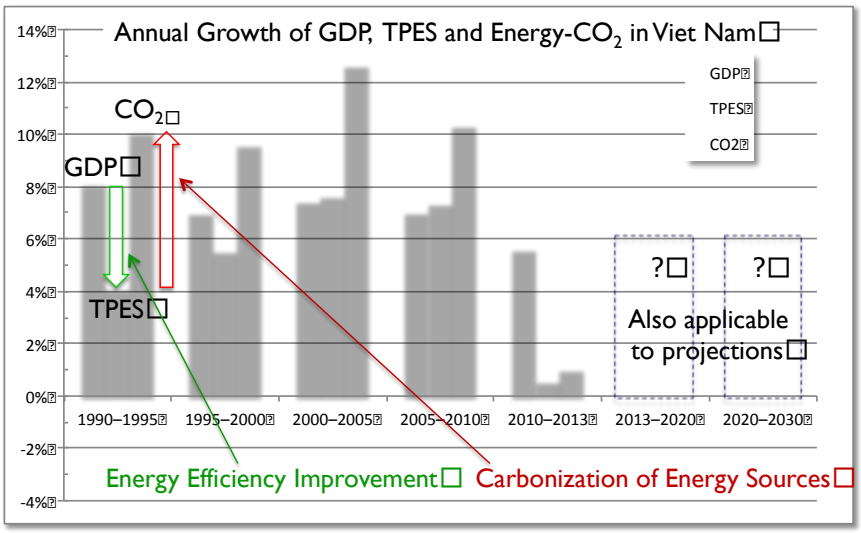
Recommendation 59: Viet Nam should consider developing a monitoring, evaluation and analysing framework

Although PDCA-cycle is a strong and evolutionally process to foster the action and attain the target, it is challenging to design it in an effective manner.

One important aspect is proper recognition of status quo through studying historical trends and/or comparison with other cases. Among various tools, "factor analysis" is simple but strong tool for the assessment. For example, Figure 2.7 shows a factor analysis of national energy CO_2 emissions.

[7] Most of the "climate" action has its primary objective rather than climate mitigation or adaptation. This implies that the PDCA cycle should be designed to focus on and meet such primary objective.

Figure 2.7: Factor analysis of Viet Nam economy-wide energy CO_2 emissions[8]



Source: IEA statistics

The figure includes rich contents to analyse Vietnamese energy and CO_2 and good to assess what happened and how it influenced macro-economically and the reason why, historically. The same analyses can be applicable to future forecast/projection including those used to develop the (I)NDC. The factor analysis is also applicable to sector by sector. For example, in the passenger transport sector, "passenger-km" may be used instead of GDP (as the "driver" of energy demand).

The first step of PDCA process is to set some target(s). It is not obvious on which parameter the target should be set to assess the actual performance. For example, for renewable energy promotion program case, there are several indicators to be considered such as (kW or kWh?), (annual additions or accumulated value?). If the levelling of peak demand is the main interest, kW is better than kWh, for example. The indicator on which target is set should be concrete[9] and can be plural. It is not necessary to link to CO_2 emissions.

Another crucial aspect is how to assess the performance, including which parameters to be monitored and calculated. Usually, some "intensity" (e.g., energy demand/activity data for specific area concerned) is a key indicator for the assessment. In addition, such indicators should be compared with some value, such as its historical performance, some benchmarking value, same parameter of the neighbouring countries, *etc*.

Next question is what additional actions are needed to improve the performance.

These steps are to be designed for each action as well as the aggregated effects of each ministry and economy-wide level as shown in the Figure 2.6.

We recommend Viet Nam to institutionalize these PDC-cyclic processes to improve the performance of any governmental action.

Recommendation 60: Viet Nam needs to re-assess the current INDC targets and upgrade them to prepare NDC1 with new methodologies

The COP will prepare the guidelines to develop the NDCs. Viet Nam will need to upgrade its INDC to the first NDC in a few years. This is a good chance for Viet Nam for reassessment of the current INDC.

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[8] The IEA data differs considerably from APERC's statistics for some years. Utilizing several data sources for analysis is a good way to find out statistical errors and improve its reliability.

[9] For example, the indicator can be "passenger-km", "penetration rate of LED", "operation rate of power plants", willingness-to-pay", ..., dependent on the objectives of the specific action concerned.

The current domestic target is 8% reduction against BAU emissions in 2030. This implies around 0.5% annual reductions per annum in average. It looks inconsistent considering another target shown in the INDC as 20% reduction of GHG/GDP intensity compared to the 2010 level assuming that Viet Nam will keep high economic growth rate and moderate energy efficiency improvement in the BAU.

It is recommended to apply the above-mentioned factor analysis and other tools to reassess the methodology again. These methodologies are to be clearly documented (probably required by the COP Guidelines) with the relevant assumptions.

Not only economy-wide level emissions, sector-specific, ministry-specific and action-specific breakdown will enable the Government to assess its feasibility as well as the judgement whether and how to raise its ambition.

It is also useful how to mobilize domestic resources as well as to obtain emerging international support in a transparent and effective manner.

9 OVERARCHING ISSUES

Below are 6 overarching issues that require special focus and greater efforts from the Vietnamese government in order to improve the effectiveness in management for RE development in the economy:

Recommendation 61: To clarify targets, roadmap, supporting measures, as they may not be clear in some specific areas (e.g., hydropower, solar power, biodiesel).

Recommendation 62: To improve energy statistics with more detailed data by subsectors (e.g., new and renewable power, transportation data, environmental impacts), renewable energy resource data quality, hence helping the formulation of policy to be more precise.

Recommendation 63: To improve cooperation and coordination among governmental ministries and agencies, cooperation between government and industry through establishing a regular dialogue mechanism.

Recommendation 64: To improve capacity building through bilateral and international cooperation, study tours, information sharing, and education and communication campaign.

Recommendation 65: To improve information and data in English provided on government and enterprise web portals to increase foreign investors' interest.

Recommendation 66: To continue and strengthen regional and international cooperation, including APEC.

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APPENDIX C: ACRONYMS AND ABBREVIATIONS

ADB	:	Asian Development Bank
BOOT	:	Build–Own–Operate–Transfer
BOT	:	Build - Operate – Transfer
BUR	:	Biennial update report
CHP	:	Heat and Power Co-generator
CIT	:	Corporate Income Tax
ERAV	:	The Electric Regulatory Authority of Viet Nam
EVN	:	Viet Nam Electricity Company
FiT	:	Feed-in-tariff
GDP	:	Gross Domestic Products
GHG	:	Greenhouse Gases
GIZ	:	German Agency for International Cooperation
GPS	:	Global Positioning System
HCMC	:	Ho Chi Minh City
IEA	:	International Energy Agency
IEC	:	International Electrotechnical Commission
IPP	:	Independent Power Producer
LCOE		Levelized cost of electricity
MARD	:	Ministry of Agriculture and Rural Development
MOF	:	Ministry of Finance of Viet Nam
MOIT	:	Ministry of Industry and Trade of Viet Nam
MSW	:	Municipal Solid Waste
NC	:	National communication
PDP7	:	The National Power Development Plan for the period 2011-2020 and with orientation to 2030 (issued in 2011)

PM	:	Prime Minister
PPA	:	Power purchase agreement
PRLCE	:	The Peer Review on Low Carbon Energy Supply Policy project
PV	:	Photovoltaics
RE	:	Renewable energy
RPS	:	Renewable Portfolio Standards
R&D	:	Research and Development
SOEs	:	State Owned Enterprises
TCVN	:	Viet Nam standards
TFED	:	Total Final Energy Demand
TPES	:	Total Primary Energy Supply
TSO	:	Power Transmission System Operator
US, USA	:	The United States
VCEA	:	The Viet Nam Clean Energy Association
VND	:	Vietnamese dong

Units of Measurement

GW	:	Gigawatt
GWh	:	Gigawatt-hour
KWh	:	Kilowatt-hour
Mtoe	:	Million Tonnes of Oil Equivalent
MW	:	Megawatt
TOE	:	Tonne of Oil Equivalent
TWh	:	Terawatt-hour
USc/kWh		US cents/kWh

APPENDIX D: REFERENCE

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