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Green technology for sustainable development: Practice and experience of renewable energy in Vietnam

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Abstract

In 2015, the Vietnam's Renewable Energy Development Strategy up to 2020 with an outlook to 2050 was approved. Renewable energy sources were developing to ensure energy security and addressing the growing power demand of the country. Increasing renewable energy sources such as biomass, solar, wind and small hydro is the way to shift Vietnam to a sustainable energy future. The general picture on Vietnamese renewable energy practice and experience are presented in this paper. Also it offers suggestion the technical and political keys to minimize the barriers in renewable energy sector. It is the general review of available sources on Green technology for sustainable development: Practice and experience of renewable energy in Vietnam. In conclusion the study gives brief status of energy barriers, biomass, renewable energy, small-hydro power, solar power, and wind power of Vietnam

Keywords*:* barriers, biomass, renewable energy, small-hydro power, solar power, wind power,

Introduction

In the Southeast Asia region, Vietnam known as a most efficient power markets by the remarkable yearly 10% increasing on electricity demand (EREA, 2020). A total power installed capacity in Vietnam was 69,300 MW and 55,000 MW at the end of 2019 and 2020, in which the total capacity of renewable energy (RE) was 5,203 MW and 17,351 MW in respectively (EVN, 2021). It is the baseline of Green technology for sustainable development in Vietnam.

Method and objective

The study is a random literature review of available resources of Vietnam. The world is highly conscious and vigilant on the issues of energy and climate change for sustainable development. Thus to generalize the Green technology for sustainable development: Practice and experience of renewable energy in Vietnam has been studied.

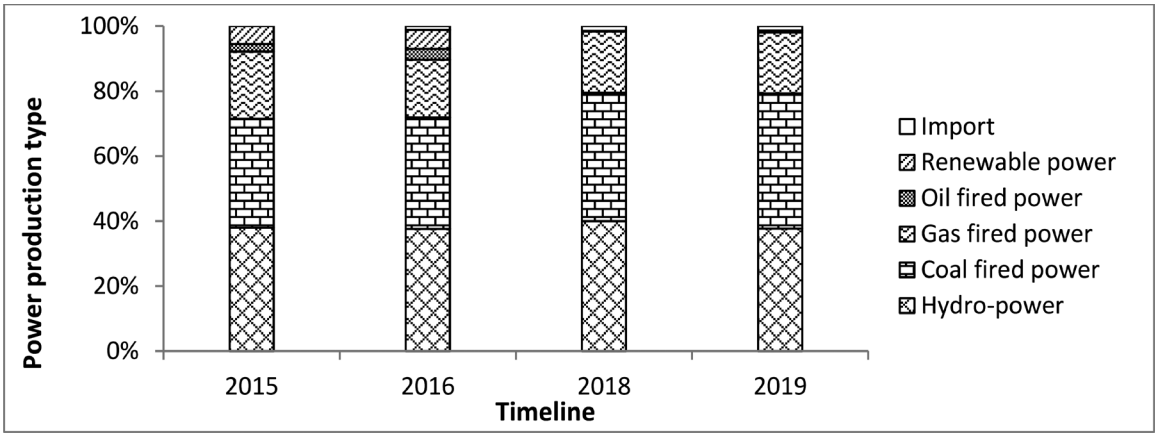
Discussions

Power

Within power generation sources, coal-fired and hydro powers are led, followed by gas-filter and RE (Figure 1). Indeed, coal-fired power remains the main source of electricity with 41.2% of electricity produced in 2019. Moreover, this type of power will be increasing up to 55% of electricity produced in 2025 and to 53.2% in 2030 according to the Decision No. 428/QD-TTg (Prime Minister, 2016).

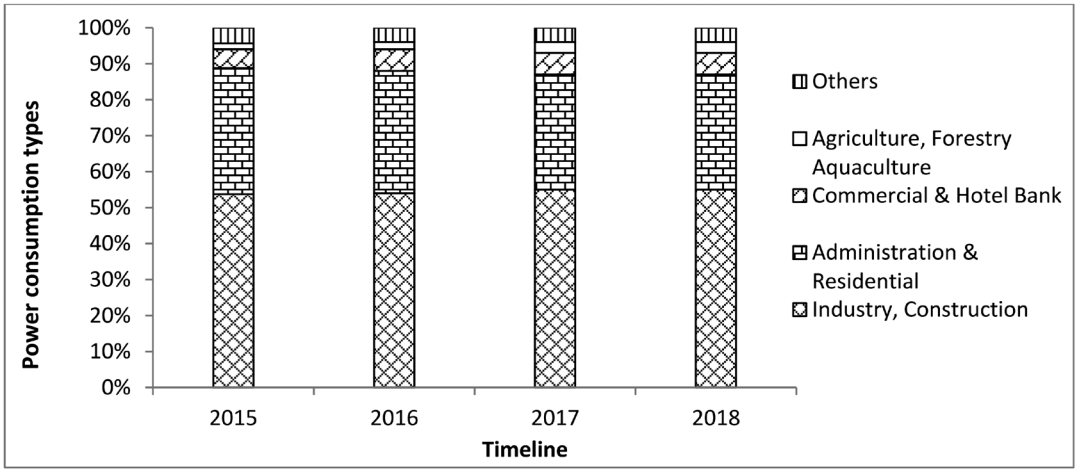
Among power consumption types, industry and construction sectors take a largest part of electricity produced, followed by administration and residential, and commercial, hotel and bank sectors (Figure 2). Although consuming approximate 55% of electricity produced, the industrial sector only contributes 33.7% of national economic structure (GSO, 2021). It also seen that Vietnam is shortage of electricity and have to import the electricity from neighbor countries of China and Laos. To sustainably meet energy needs for national development, Vietnam should add RE to the national power grid to ensure energy security with lowered environmental and social costs.

Figure 1 *Power generation by fuel types*



(Source: EVN, 2016, 2017, 2018; GIZ Energy Support Program, 2020)

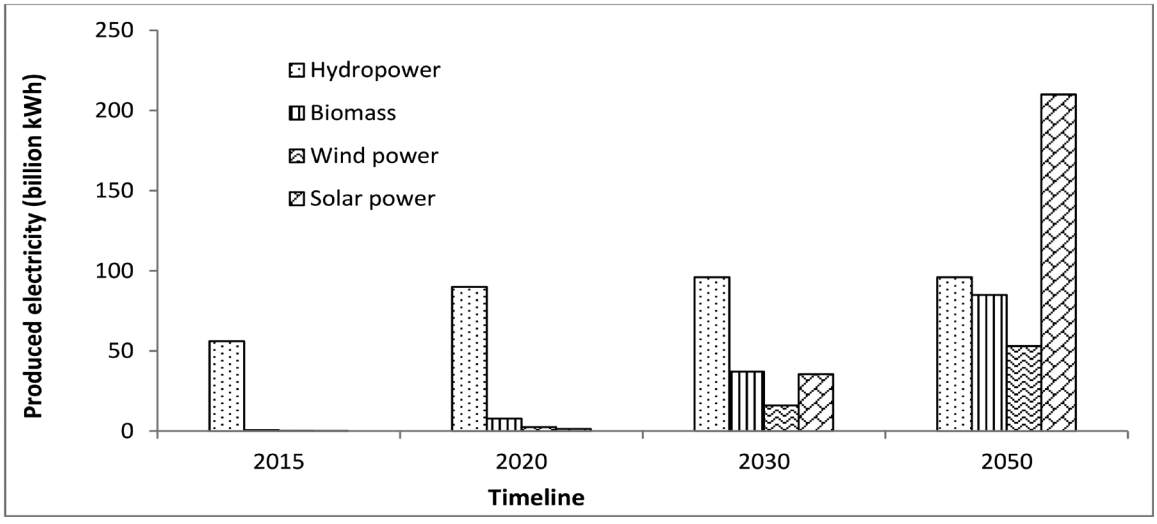
Figure 2 *Power sales by customer types*



(Source: EVN, 2016, 2017, 2018; Vietinbank Securities, 2019)

For the long-term renewable energy expansion, Vietnam promulgated the Decision No. 2068/QD-TTg titled "Renewable Energy Development Strategy - REDS" in 2015. This Decision aims to base on hydropower, wind power, solar power and biomass powers to generate energy sources to the national electricity system and supply thermal energy for heating needs. As expected, in 2030 the RE capacity contribute 32.3% of total primary energy consumption, but shall be increasing up to 44% in 2050 (Prime Minister, 2015). The expected electricity productions of each RE sources are show in Figure 3.

Figure 3 Electricity produced from RE source in planning



(Source: Derived from data of Prime Minister, 2015)

Renewable energy - current status and its potential

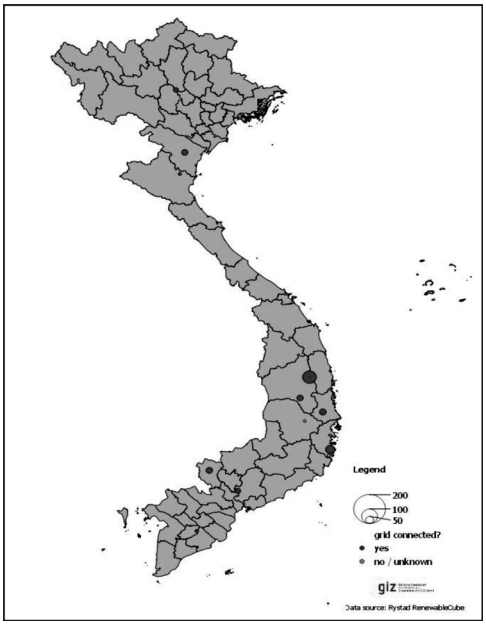
Biomass

Vietnam is an agricultural country and the potential for biomass development is resourceful (Nguyen Phuong Anh, 2019). Biomass in Vietnam can be produced from sources of organic material, such as trees, grasses, agricultural crops, firewood, rice husks, coffee husks, straw, and bagasse (Le Thi Thoa, 2020).

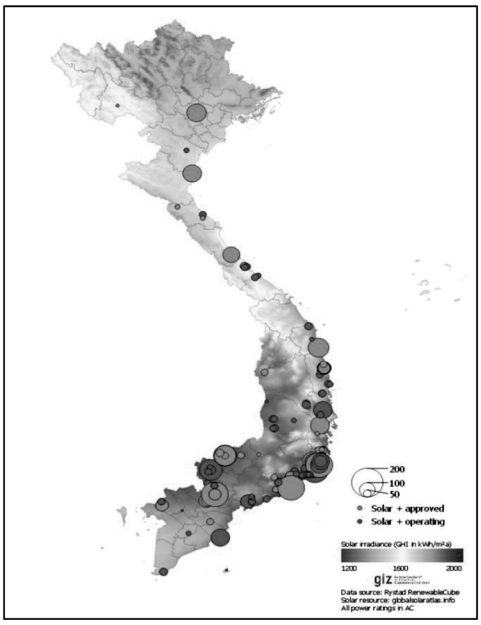
In April 2014, the government of Vietnam issued Decision No. 24/2014/ QD-TTg that stated a feed-in tariff (FiT) for biomass electricity project (Prime Minister, 2014). The Decision particularly encourages biomass projects which use bagasse from sugar cane production to generate electricity for self-consumption and for supplying into the national power grid. In March 2020, the Decision No. 24/2014/QD-TTg was amended and supplemented by the Decision No. 08/2020/QD-TTg which issued mechanisms for the development of biomass power projects in Vietnam, particularly the increase of FiT was introduced (Prime Minister, 2020). This new tariff is attractive enough to investors for their biomass power projects in the country. Under this amendment, combined heat and power (CHP) biomass power projects, tariffs at the delivery point are increased from 5.8 US cent per kWh to 7.03 US cent per kWh in VAT exclusive. For other biomass energy projects, tariffs at the delivery point are 8.47 US cent per kWh (exclusive of VAT), which is adjusted in accordance with the VND-USD fluctuation rate of exchange and is to be applied throughout 20 years from the commercial operation date (Baker McKenzie, 2020). The revised FiT is in fact an incentive for sugar-manufacturing companies to develop and utilize their sugar wastes by expanding their bagasse-fired co-generation power projects of the sugar production line. The electricity by biomass will be generated during the rainy season and is an additional resource to dispel power shortages, which may lead to the mobilization of oil-fired and gas-fired powers for ensuring the local and provincial/national energy security.

Vietnam has adopted the revised NPDP 7 and the REDS, in which the country aims to raise the share of biomass energy in electricity production to 2.1% in 2030 and 8.1% in 2050. The revised NPDP 7 sets the goal for biomass electricity production, to increase up to 1,200 MW in 2025 and to 3,000 MW 2030, respectively (Prime Minister, 2015). In terms of the percentage of electricity of the country's total energy mix, the NPDP 7 targeted biomass energy production to constitute 1.2% (in 2025) and 2.1% (in 2030).

Figure 4 *Map of RE projects which already installed or approved in Vietnam*



Biomass power



Solar power

(*Source: GIZ Energy Support Program, 2020*)

Solar energy

Vietnam is considered a great potential for solar energy with the total number of sunshine fluctuating between 1,400 - 3,000 hours per year. The daily average intensity of solar radiation is about 4 - 5 kWh per square meter (Nguyen The Bao, 2018).

Solar energy is quite stable and widely distributed across different regions of the country. In particular, the average number of sunny days in the Middle and Southern provinces is about 300 days per year (Nguyen Thanh Hao, 2012). There are 102 solar power projects which have been operated with a total capacity of 6,314 MWp (Create Capital Vietnam Joint Stock Company, 2020). There was number of new solar power plants in a short period of time, typically: BIM Group at Phuoc Minh commune - Thuan Nam district - Ninh Thuan province with the capacity of 330 MW; Thanh Cong Group in Phong Dien district - Thua Thien Hue province with the capacity of nearly 90 MW; Tata Power plant in Ha Tinh province with the capacity of 300 MW; GT & Associates, Mashall & Street Ltd. factories in Quang Nam province with the capacity of 150 MW, etc. (Tran Cuong, 2020). Solar energy projects in Vietnam are attractive to foreign investors from Thailand, China, Philippines, Singapore, etc. because of the appropriate mechanisms and policies.

The electricity output from solar power energy in 2020 is 10.6 billion kWh, accounting 4.3% of the total output of the entire national power system. It is forecasted that in 2021, the amount of electricity generated by RE will increase more than two times compared to 2020. According to the latest data, as of December 2020, the total installed capacity of solar power in the country has

reached about 16,500 MW, accounting for about 25% of the total installed capacity of the national power system. In which, there are about 8,000 MW of roof-top solar power and more than 8,400 MW of large-farm solar power (Toan Thang, 2021).

Wind energy

Located in the monsoon climate zone and characterized by its more than 3,000 km long coastline, Vietnam has considerable potential of 31,000 km2 of land can be used for the development of wind farms (Nguyen Quoc Khanh, 2007c). Besides that, Vietnam has great potential for the expansion of offshore wind energy. The wind project potential in Vietnam is mainly located in the Southern Central coastal region (Binh Thuan and Ninh Thuan provinces) and the Southern Coastal region (Tra Vinh, Bac Lieu and Soc Trang provinces) where having the average wind speeds of 7 m/s or higher (Joost & Eric, 2018).

At the end of 2013, only four wind energy projects with full or partial capacities had been commissioned. By June 2019, there are nine wind farms in operation, mainly in the provinces of Ninh Thuan and Binh Thuan. The largest wind farm is in Bac Lieu province with a total capacity of 99 MW while these other plants only have an output of less than 40 MW (Vo Hong Thai & Cao Thi Thu Hang, 2019). The installed wind power capacity in Vietnam was significant lower than in other Asian countries such as Japan, Taiwan, South Korea and Thailand; although the wind energy potential in Vietnam is greater than in the mentioned countries (GWEC, 2019). This implies that Vietnam has made much greater efforts in recent years to effectively use and utilize the wind energy potential as many wind energy projects are under construction.

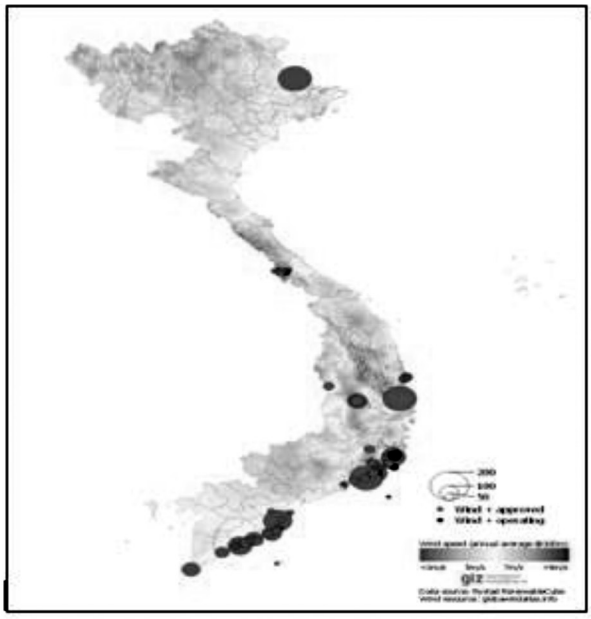
The total current capacity of wind power is 327 MW. With foreign capital on the rise, Vietnam is expected to install wind power projects both offshore and inland by 2021 to increase capacity up to 1 GW (GWEC, 2021). If successful, Vietnam will surpass Thailand to lead the wind energy industry in the region. Vietnam is also the only country in the ASEAN to develop offshore wind power with installed projects currently reaching 99 MW (GWEC, 2019). Not only that, in the current national electricity development plan, Vietnam also has a target to increase the total wind power capacity to 6,000 MW by 2030 (Das, 2020; Lim, 2020).

According to optimum geography condition, Vietnam has a best wind resource to develop wind projects for coastal, offshore and onshore areas (Nguyen Quoc Khanh, 2007c). The average wind speeds of 9 to 10 m per second which appropriate for wind strength development (Netherlands Enterprise Agency, 2018). Wind power is one of the greatest growth prospects among RE sources in the nation (Nguyen Duc Luong, 2015).

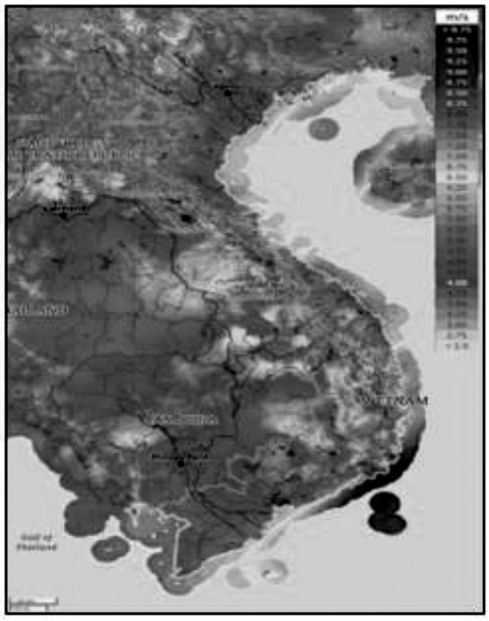
In view of the increasing scarcity of electricity and energy supply across the country in recent years, the use and utilization of wind power in Vietnam is of great importance in order to ensure national energy security. The supply of high quality energy that is suitable for socio-economic development, and the rapid, efficient and sustainable development of the energy sector in connection with environmental protection (Nguyen Duc Luong, 2015). Vietnam is considered a new “wind power hero” and will soon rise to the top in the field of wind power exploitation in Southeast Asia. As a country most affected by climate change, Vietnam has invested heavily in wind power to reach the domestic energy demand and reduce greenhouse gas emissions.

Figure 5 *Map of wind power projects already installed or approved in Vietnam*

Figure 6 *Wind energy potential region in Vietnam*



(Source: GIZ Energy Support Program, 2020)



(Source: Netherlands Enterprise Agency, 2018)

Hydropower energy

With an average annual precipitation of 1,800 to 2,000 mm, the high mountain terrain in the North and the Western border, Vietnam has high opportunity for hydropower development. There are more than 3,450 rivers and streams with an average annual water volume of about 830 billion cubic meters. According to theoretical calculations, the total hydropower capacity of Vietnam is about 35,000 MW, of which 60% is concentrated in the North, 27% is distributed in the Middle and 13% is in the South. The yearly produced potential is more than 100 billion kWh, of which small hydropower projects have up to 15 - 20 billion kWh (Nguyen Huy Hoach, 2021).

According to the rule of Ministry of Industry and Trade, since 2007, small hydropower is defined as projects less than 30 MW of capacity, and this kind of project is considered as RE source. Small hydropower project is a viable choice in Vietnam due to its proper utilization of water resources, cost effective and sustainable source of energy, solid technology and development of rural and remote areas (Ferreira & Camacho, 2016). As report by Dang Dinh Thong (2017), Vietnam has more than 1,000 locations where potential for small hydropower. It is note that since 2017, the national power planning only accounts hydropower projects which upper than 3 MW (VietNam News, 2020).

Within ten years of 2009 to 2018, there was 1,850 MW of small-scale hydropower which accounted

5.9% of the energy was successful distribution under the Vietnam Renewable Energy Development Project (World Bank, 2021). Most of potential small hydropower projects located in the provinces of Ha Giang, Lao Cai in the North region, Nghe An, Ha Tinh in the Southern Central region, and Gia Lai in the Central Highland region (Nguyen Manh Hien, 2019).

Renewable energy barriers

Data from the EVN annual reports showed that demand for power will continue to grow at a higher rate than that of economic growth. While the primary sources for power generation like coal, oil and gas are exhausted, this has made Vietnam gradually increase its RE to ensure safe and stable operation of the national electricity load. According to barrier in deployment of RE (Seetharaman *et al*., 2019), the development of RE sources in Vietnam is facing to following indicators:

Social challenges: the local community awareness on RE benefits was improper, land tenure and land use changed

Local community awareness: the government or investors did not well supply information on financial benefits to local community (Vo Hong Thai & Cao Thi Thu Hang, 2019).

Changed of land use: changed of land use effect to the income of local residents that causes of social custom changed (Vo Hong Thai & Cao Thi Thu Hang, 2019).

Economic challenges: factors concerning to economic and financial issues are high initial investment, less of financial supporting or less attracted from investors, competition of RE themselves and to traditional fuels.

High initial investment: due to the lower efficiency of renewable technology, the net pay back period of RE project is high. Besides that, it is necessary to divide all project costs, especially the State projects in two categories: investments cost for initial phase (construction, installation, etc.), and annual cost for active phase (operation, maintenance, prevention, replacement, etc.).

Less attracted investors: while the fee to produce REs are fluctuated by regions, the FiTs of each RE sources are a fixed price that cause limited of competition within RE investors (Vietnam Investment Review, 2020). In addition, there is lack of clarity over future energy prices, insufficient capital and funding opportunities, un-bankable power purchasing agreements caused of less attract from investors or fewer financial support to RE projects (Tachev, 2021).

Self-competition: RE production costs have become more competitive because of the rapid development of technology in the industry and lower installation costs, especially in wind and solar power (Nguyen Phuong Anh *et al*., 2019).

Tough competition from fossil fuel: fossil fuels will remain a dominant player in supplying energy in the future. Coal consumption has grown 75% in the last five years (Borton, 2021) which makes coal-fired power cheap and against to RE powers.

Technology barriers:

Limited availability of infrastructure and facilities: RE has seen large growth and focuses on some

localities that affecting to the release capacity as well as the dispatching and operating the electricity system (Vietnam Investment Review, 2020). The development of RE also increases challenges posed on power system, particularly grid congestion, power quality, demand for backup power, and reliability of power supply to the system (EVN's Activities, 2018).

Lack of operation and maintenance culture: there are not enough backup sources and storage system to integrate RE on a large scale (Vietnam Investment Review, 2020). It is also lack the needed smart grid equipment and the capacity to manage supply and demand to speed up the renewables transition (Vo Hong Thai & Cao Thi Thu Hang, 2019). Upgrade its power transmission system as well as digitize control system to balance the power sources on the system (EVN's Activities, 2018).

Technology complexities: the low FiT slow-down on creates the market. There are not enough backup sources and storage system to integrate RE on a large scale (Vietnam Investment Review, 2020).

Lack of research and development capabilities: no in-depth study on RE characteristics, especially on tidal and wave powers; no any officers responsible on RE data collection, updating, and statistic. Need to study on the development of offshore wind power projects in Vietnam. RE equipment and technologies not available at internal markets but need to import, etc. (Vo Hong Thai & Cao Thi Thu Hang, 2019).

Regulatory barriers:

Improper legal framework: some implemented renewables regulations were very detailed and impractical but confusing to investors (Neefjes & Dang Thi Thu Hoai, 2017). Especially, there is no bidding mechanism to attract RE investors (Vietnam Investment Review, 2020).

Impractical government commitments: lack of after-sale support of RE service, (Vo Hong Thai & Cao Thi Thu Hang, 2019). The RE development policy has not been applied for a long time (Vietnam Investment Review, 2020).

Lack of standards and certifications: lacked technical standards for rooftop solar power (Vietnam Investment Review, 2020).

Renewable energy outlooks

Vietnam faces rising energy demand coupled to deal with vast development of social economic sectors. However, the country's existing fossil fuel sources will drain within the next decade in existing usage levels. By the great conditions of tropical country, Vietnam planning to increase and diversify electric supplier from various RE sources. Together, the mentioned decisions supported to pursue the RE development strategy in the nation.

To generate a significant proportion of the country's energy from renewable projects, Vietnam has set out a target whereby the total production and use of RE sources from approximate 37 million tons of oil equivalent (TOE) in 2020; approximate 62 million TOE in 2030 and 138 million TOE in 2050 (Prime Minister, 2015). It could say that Vietnam is in the "golden era" for RE development, particular on solar and wind powers investment. However, to attract more both national and

international investors to jump in the RE sector, solutions to crack barriers is proposed as below.

Technical solutions:

That need to developed large batteries which can compensate for the times when a renewable resource is not available

Encouraging for in-depth research on RE sources that could offering as informative data to potential investors.

Pay attention on capacity building, especially on technical training for each type of RE sources.

Policy solutions:

Creating policies to liberalize the RE market to attract non-governmental investment. In additional, organize after-sale activities for RE services.

Steadily increase FiTs or remain a proposed FiTs therefore investors would be clear on the expected price. Introduce a low-interest loan funding that leads to increasing the international financing for RE projects.

Conclusion

Renewable energy sources were developing to ensure energy security and addressing the growing power demand of the country. Increasing renewable energy sources such as biomass, solar, wind and small hydro is the way to shift Vietnam to a sustainable energy future. The general picture on Vietnamese renewable energy practice and experience are presented. It is the general review of available sources on Green technology for sustainable development: Practice and experience of renewable energy in Vietnam. In conclusion the study gives brief status of energy barriers, biomass, renewable energy, small-hydro power, solar power, and wind power of Vietnam.

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