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## The use of renewable energy in Vietnam: potential and challenge

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### Abstract

Vietnam is considered a country with huge potential for solar energy, especially in the central and southern regions of the country, with an average solar radiation intensity of about 5 kWh / m<sup>2</sup>. Meanwhile, solar radiation intensity is lower in the Northern regions, estimated at 4 kWh / m<sup>2</sup> due to weather conditions with cloudy sky and drizzle in winter and spring. In Vietnam, the average solar radiation of 150 kcal / m<sup>2</sup> accounts for about 2,000 - 5,000 hours per year, with a theoretical potential estimate of about 43.9 billion TOE. Solar energy in Vietnam is available year-round, quite stable and widely distributed in different regions of the country. In particular, the average number of sunny days in the provinces of the central and southern regions is about 300 days / year. Solar energy can be harnessed for two uses: electricity generation and heat supply. There are four types of solar technology currently available in Vietnam market. These are household-scale, commercial-scale solar technologies used for hotels, restaurants, hospitals, military and service centers, for villages such as public lighting and sound, TVs and charging stations. In Vietnam, photovoltaic panels (Photovoltaic: PV) are imported while other components of the system are domestically produced. Vietnam Posts and Telecommunications Group (VNPT) and Vietnam Electricity (EVN) own member companies that design and install solar power systems for internal use.

**Keywords:** renewable energy, biomass, solar energy, ocean energy

### Introduction

In Vietnam, solar power applications have been developing rapidly since the 1990s. The development of solar power in Vietnam in the last 10 years from 1998 to 2008 is shown as above. Applications include solar power for homes and service centers, solar water heating systems, PV solar power, electric lighting and drying systems. Hybrid technology of renewable energy sources, named Manicub, has been applied to ships, ambulances or solar powered villas. Among the applications, solar water heating technology is considered the most economical, efficient and popular today. Although solar energy source in Vietnam is recognized as having great potential, solar power projects have not been developed yet. Most solar power projects across the country are on a small scale and focus primarily on harnessing heat from solar energy. Large investment costs are a major barrier to the development of solar power projects in Vietnam. The investment in solar energy for research and development is significant. The funding sources for PV research activities come primarily from international organizations and the government. The PV application research has been going on since 1990. Some new applications have been successful in the design and installation such as Solarlab (Madicub)'s renewable energy hybrid technology used in ambulance, ship and villa; Grid-connected solar PV is also installed by Solarlab. Thanks to advanced technology and competitive prices, some PV technologies manufactured in Vietnam have been exported to some Asian countries such as Cambodia and Bangladesh. The capacity of PV panels ranging from 500 Wp to 1500 Wp has been installed in southern provinces for households, hospitals, schools and villages. The production of PV photovoltaic panels began to appear in Vietnam in the mid-1990s. Solar panels made of silicon crystals were produced in the laboratory during 1990-2000. A closed process for solar panel manufacturing was built and the first solar panel was produced in Vietnam in 2000. The Vietnamese government supported to transfer the latest PV technology into Vietnam. As well

as attracting foreign investment in domestic production, formed the PV photovoltaic panel manufacturing industry in Vietnam. Currently, private companies are leading in the field of PV photovoltaic battery production. Among those companies is the Red Sun Factory located in Ho Chi Minh City, supplying materials for solar cell production in Binh Duong, Viet Vmicro JS in Ho Chi Minh City. Ho Chi Minh. Solar water heating is a fairly developed and commercially available technology that has been applied on both household and industrial scale. Households and businesses are willing to invest in solar water heaters because they can save on electricity bills. So far, the technology of manufacturing solar water heaters can easily mobilize investment capital from the private sector. Currently, solar water heaters are manufactured by more than 10 small and medium enterprises in the country. To promote the use of solar water heating systems, within the framework of the National Target Program on efficient and economical use of energy, EVN has designed a program on hot water heating systems. Using solar energy in 2009. The program promotes the research, production and import of solar water heaters used by households and other service sectors such as trade centers. Commercial, apartment, hospital, school and government offices. Households participating in the program receive an investment support of one million VND (approximately US \$ 50). Electrical companies across the country, solar power equipment companies and energy-efficient and energy saving offices are also involved in the program. Up to now, EVN has piloted 900 solar water heaters systems, including PC2 (200), PC-HCM (300), Dong Nai PC (200) and Da Nang (200). The program continued with a plan to build 1,000 more solar water heating systems by PC (200), PC3 (250), HCM PC (300), Dong Nai PC (150) and MTV Da Danang PC (100)). Vietnam's renewable energy development strategy to 2030, with a vision to 2050, was approved by the Prime Minister in Decision No. 2068 / QD-TTg dated November 25, 2015. Accordingly, in September 2015 Vietnam has set specific targets, the amount of electricity produced from renewable energy sources will increase

from 58 billion kWh in 2015 to 101 billion kWh in 2020 and 186 billion kWh in 2030; 452 billion kWh in 2050. The share of electricity produced from renewable energy sources will increase from 35% in 2015 to 38% in 2020 and 43% in 2050. With a geographical location, a long, dense coastline Due to tropical monsoon climate and agricultural economy, Vietnam has abundant and diversified renewable energy sources, which can be exploited for energy production such as: Hydroelectricity, wind power, solar power generation, energy generation. Blocks, geothermal, biofuels ... Through research and assessment of renewable energy potential, by 2030 Vietnam is capable of developing about 8,000 MW of small hydroelectricity, 200 MW of wind power, 3,000 MW of electricity generation 30,000 megawatts of solar power. Regarding wind power, it is estimated that on land, Vietnam can develop about 30 GW of wind power. Along with the potential of offshore wind power, Vietnam can develop about 100 GW of wind power capacity. Solar potential is also appreciated when Vietnam is a country with a lot of sunshine time of year with high radiation intensity in the Central and the South. Meanwhile, the potential of biomass sources from agricultural wastes, animal wastes and organic wastes has a total capacity of about 400 MW. Hydroelectricity is still the highest renewable energy source, contributing about 40% to the total national electricity capacity. By the end of 2018, Vietnam has successfully promoted many renewable energy projects with 285 small hydropower plants with a total capacity of about 3,322 MW; 8 wind power plants, total capacity of 243 MW and 10 biomass power plants, total grid capacity of about 212 MW. Regarding solar power, more than 100 projects have signed power purchase contracts (PPA) with Vietnam Electricity (EVN), two projects came into operation with a total capacity of about 86 MW. The total capacity of renewable energy sources (excluding medium and large hydropower plants) accounts for 2.1% of the total system capacity. In modern life, the quality of human life depends very much on the sources of energy, so the exploitation and use of energy is of particular concern.

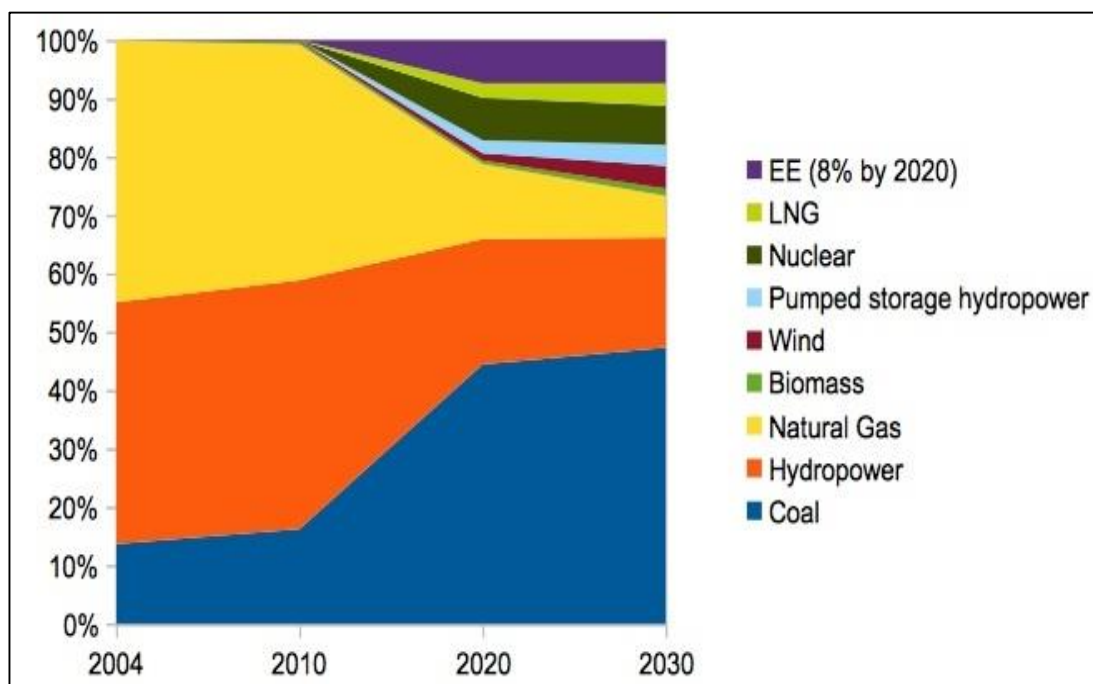


Fig.1: Using renewable energy in the world

Vietnam has set lofty goals for renewable energy, targeting raising total production from 58 billion kWh in 2015 to 101 billion kWh in 2020, 186 billion kWh in 2030 and 452 billion kWh in 2050. Under the country's renewable energy development strategy, which was approved by the Government in 2015, Việt Nam is aiming to increase the ratio of electricity from renewable sources from 35 per cent of total output in 2015 to 38 per cent in 2020 and 43 per cent in 2050. According to Nguyễn Văn Vy, Vice Chairman of the Việt Nam Energy Association, Việt Nam has abundant potential for renewable energy thanks to a long coastline and weather conditions favourable for the development of hydro, wind, solar, biomass and geothermal power, as well as bio-fuel. Research shows that Việt Nam could be in line to generate about 8,000MW from small-scale hydropower plants, 200MW of wind power, 3,000MW of biomass power and 35,000MW of solar power in 2030. As of the end of 2018, Việt Nam had 285 small hydropower plants with total output of 3,322MW, along with eight solar power plants (243MW) and 10 biomass power plants (212MW). The Việt Nam Electricity has signed power purchase agreements (PPAs) with more than 100 solar power projects, two of which have become operational with a combined capacity of 86MW. So far, electricity generation from renewable sources, excluding medium- and large-scale hydropower plants, has accounted for 2.1 per cent of the country's electricity output.

## 2. Renewable energy potential

The use of solar energy for water heating is also highly encouraged in the military. Department of Science and Technology under the Ministry of Defense is exchanging research and promoting the use of solar energy in the army. So far, about 10 solar water heating systems have been installed in military schools and facilities, especially for units on islands. However, the application of solar water heaters in Vietnam is still low. Only 60 collective systems and over 5,000 household systems have been installed. About 90% of solar water heating systems are used in urban areas and 5% in rural areas. Approximately 99% of these systems are invested by households and 1% belong to public facilities such as hospitals, kindergartens, hospitals, schools, hotels and restaurants. Solar water heater systems with the area of solar panels from 10 to 60 m<sup>2</sup> can provide daily from 1 to 5m<sup>3</sup> of hot water with a temperature of about 50 oC to 70oC. Household scale solar water heater system with 1-2m<sup>2</sup> panels can provide about 100 to 300 liters of hot water at temperatures from 40 oC to 70oC. Solar power in Vietnam is applied in rural and remote areas and islands. There are about 4,000 households benefiting from family-scale solar power systems (Solar Home Systems - SHSs) and 12,000 people across the country are receiving electricity from PV battery systems. As of June 2019, the total installed capacity of solar, wind and biomass projects in Vietnam will reach about 2.5 GW, expected by the end of June 2019, adding about 2 GW of solar power. is installed. The results are achieved thanks to the Government's commitment on development goals and policies to encourage energy development, the positive of localities and the coordination among ministries and branches in solving problems. In the process of implementing the project in order to create a good competitive environment, convenient for investors. The

21st century with sustainable global development strategies, especially the period of "green economy development", has begun to see new technologies to produce "cleaner" electricity, including electricity from endless renewable energy sources in nature or always arise in human life. These are the technologies that produce electricity from renewable energy sources in nature: wind; waves, tides; Sun; geothermal and marine heat. In particular, commercialization on a large scale is the wind power station (located on land, island or sea), solar power station, tidal power station and waves, sea heat. According to the International Energy Agency (IEA), in 2004, the total capacity of renewable energy sources worldwide was 160 GW (excluding large hydro), accounting for 4% of the total capacity of power plants, equivalent to one fifth of the total capacity of nuclear power plants in the world, with developing countries accounting for 44%, or 70 GW. The fastest growing renewable energy technology in the world is solar electricity connected to the national grid, with an average annual growth rate of 60 percent, covering more than 400,000 homes in Japan, Germany, USA (2000-2004). The second fastest growing source of wind power is the 28% annual increase. Currently, wind farms with a capacity of hundreds of MW have been completed in the UK, Denmark and many other countries such as USA, Japan, China, and Vietnam.

Renewable sources such as wind, solar and hydropower do not cause air pollution. In that gas, geothermal and biomass energy produce a small amount of air pollutants, but much less than the pollution caused by coal and gas fired plants. In addition, wind and solar energy operate without water and therefore do not pollute water sources or compete with agricultural water, drinking water or other essential water-related needs. In contrast, fossil energy sources have a significant impact on water resources. For example, mining or oil drilling, natural gas can contaminate drinking water. In addition, coal, gas and oil plants consume large amounts of water for cooling purposes during operation (UCS, 2014). As a result, water shortages for living, agriculture, etc. Hydroelectricity is the source of electricity produced from water energy. Most of the hydroelectric power is derived from the potential energy of water stored in dams that spin the turbine and generate electricity. Water can be from a river or man-made, such as streams flowing from a lake overhead through pipes and out of a dam. Hydropower is a popular renewable energy source. It plays an important role in today's integrated electricity system (contributing more than 16% of total electricity production worldwide and about 85% of global renewable electricity). Moreover, hydropower helps to stabilize fluctuations between supply and demand. This role will become more important in the coming decades, as the share of renewable energy sources - mainly wind and solar energy - will increase dramatically. The contribution of hydropower to carbon sequestration is twofold: providing clean renewable electricity and contributing electricity to the national grid. In addition, the hydropower pedal helps control water supplies, floods and droughts, water for irrigation. However, hydropower development should also take into account waterway and recreational activities. These goals can cause conflicts at different times but are often complementary to one another.

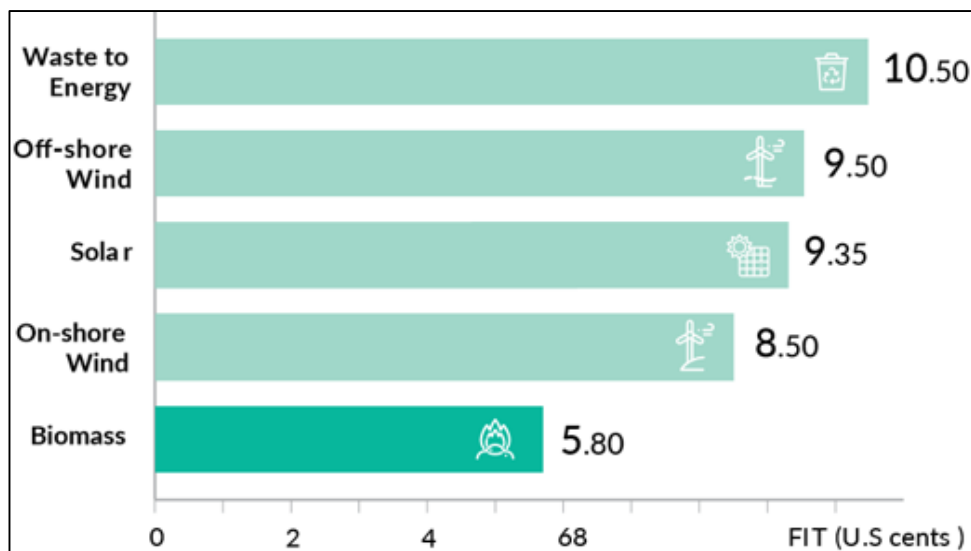


Fig.2: Potential of renewable energy in Vietnam

Investment in the solar sector is considered to be lucrative in solar water heating technology, especially when appliances can be produced domestically. Grid-connected solar PV is less profitable because of its higher cost compared to other forms of energy. For the household size, solar power is uneconomical because the price of finished products is expensive but the amount of electricity produced is small and unstable. The market for solar water heating systems with household as well as industrial scale is huge. Because the technology is commercially available, it can be used as a partial replacement for electric water heating systems in buildings and offices, and is currently estimated to consume around 3.6 billion kWh per year. Investment in solar power will increase dramatically. The Vietnamese Government has approved the use of ODA from the Japanese Government to build a grid-connected solar power plant with a capacity of 3-5 MWp from 2009. The government also approved the investment for a solar power plant in Cu Chi, Ho Chi Minh City, of First Solar, a US solar power corporation. Based on the most recent assessment reports, over 1,000 sites have been identified that have the potential for small hydropower development, ranging in size from 100 kW to 30 MW with a total installed capacity of over 7,000 MW and currently only exploits about 50% of potential. At present, 114 projects with a total capacity of 850 MW have been basically completed, 228 projects with a capacity of over 2600 MW are under construction and 700 projects Project is in the research phase. In addition, micro hydro projects with a capacity of less than 100 kW are suitable for deep-lying and remote areas, where terrain is difficult to self-subsist on small grids and households are also being reported waterfall. In 2015, electricity production from renewable energy, excluding hydroelectricity, accounted for 6.8% of global electricity output, including 3.5% of wind power, 1.9% of biomass and 1.0% solar power (photovoltaic). If including hydroelectricity (16.0%), the electricity output from renewable energy sources reaches 22.8%. Global renewable energy capacity including hydropower is expected to increase from 2,130 GW at the end of 2016 to over 2,400 GW by the end of 2018, including 1,300 GW of hydropower and 1,100 GW from power sources amount of renewable electricity outside hydropower. Annual growth in renewable energy capacity has reached a record high of

over 160 GW in 2016 and is expected to stand at that level in 2017 and 2018. This accounts for about 60% of global renewable energy capacity growth. China's renewable energy capacity growth from 2015 to 2016 reached nearly 70 GW, accounting for about half of global growth. The country's 2017 growth is expected to be close to 70 GW, including more than 40 GW of PV solar power. However, in 2018, although PV solar PV growth will remain at the previous year's level, the growth will be uncertain due to the shift from Feed-in-Tariff (temporary, support according to the prescribed tariff) to The Renewables Portfolio Standard policy, expand project auctions and improve stability. In India, since the inauguration of the Narendra Modi government in 2014, the country has rapidly increased the capacity of renewable energy sources, including PV solar power supported by surface radiation abundance, according to the national target of 175 GW (excluding large-scale hydropower plants) by 2022. The annual growth capacity will double from 8 GW in 2016 to about 15 GW in 2017 and 2018, focusing on PV solar PV. By the end of 2018, India could reach 120 GW of renewable energy capacity, surpassing that of Japan. The United States announced a record increase in renewable power capacity of more than 20 GW in 2016. The growth of renewable energy capacity in 2017 and 2018 will be about 20 GW due to the expansion of PV solar power source thanks to the state's policy of promoting renewable energy and rapidly reducing costs.

The field of renewable energy development in Vietnam is small hydropower in the northern mountainous provinces, Central Vietnam, the Central Highlands and the Southeast. However, the amount of electricity produced by the whole The country has only a modest amount of electricity, according to preliminary estimates, could develop over 4000 MW of small hydropower with an output of about 16 billion kWh. In addition, Vietnam has more than 1 million points that can develop micro hydro (capacity from 200 W-100 kW). Solar energy is the process of converting sunlight into usable forms of energy. Solar photovoltaics, solar thermal, solar heating and cooling are also made possible by solar technologies. Solar Photovoltaic: The photovoltaic system is a system that directly converts solar energy into electricity. The basic building blocks of solar photovoltaic systems include solar photovoltaic cells, a semiconductor

device used to convert solar energy into direct current. Solar photovoltaic cells are connected together to form PV modules, typically up to 50-200W. Solar photovoltaic modules are combined with other applications such as inverters, batteries, electrical components, and installation systems), forming a solar photovoltaic system. The modules can be linked together to supply power from a few W to hundreds of MW. Most solar photovoltaic technologies are silicon-based systems. Bioenergy is the energy derived from biomass conversion, in which biomass can be used directly as fuel or treated into liquids and gases. Biomass is a biodegradable organic substance derived from plants or animals. Biomass includes wood and agricultural crops, herbaceous and woody crops, urban organic wastes, as well as fertilizers. Bioenergy is the largest renewable energy source, providing 10% of the world's primary energy supply. It plays an important role in many developing countries, such as providing energy for cooking and heating, but it often causes health and environmental impacts. The development of clean fuels from biomass such as biofuels in developing countries is the main solution to improve the current situation and achieve the target of access to clean energy by 2030. At present, Biotech accounts for about 10% (50 exajoule (EJ = 1018 joules)) of the world's major energy. Most of this is in

developing countries used for cooking and heating. The use of biomass for rudimentary and inefficient stoves has a significant impact on health (smoke pollution) and the environment (deforestation). In the construction sector, modern bioenergy used to provide heat has reached about 5 EJs in 2012. In addition, 8 EJs are used in industry, mainly for paper and pulp production as well. Food processing sector to provide heat for processing at medium and low temperatures. In 2012, total electricity produced from bioenergy is 370 TWh, equivalent to 1.5% of the world's total electricity output. Technologies for generating electricity and heat from biofuels have existed from heating systems for buildings to biogas digesters for electricity generation, biomass gasification plants and biomass great. Combined biomass in existing coal-fired power plants can also be an option to achieve short-term emission reductions and more sustainable use of existing assets. In addition, new bioenergy plants are playing an increasingly important role in meeting the demand for electricity and heat. In the medium term, capacity and output of bioenergy are expected to increase significantly. Global bioenergy yield is expected to reach 560 TWh by 2018 (370 TWh in 2012-an average increase of 7% per year), which is driven by renewable energy targets in other countries.

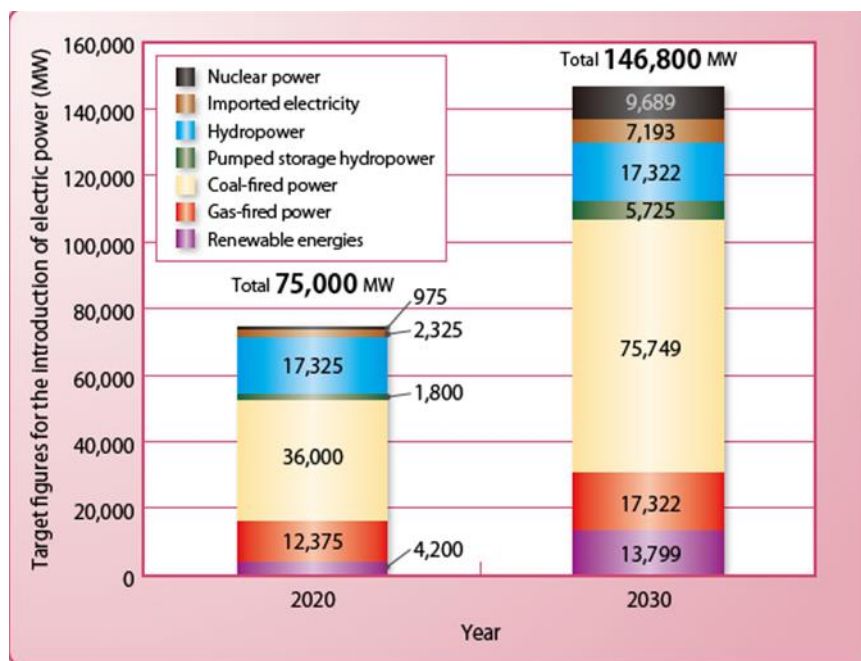


Fig.3: Renewable energy for electricity production

Solar potential is also appreciated when Vietnam is a country with a lot of sunshine time of year with high radiation intensity in the Central and the South. In the Northwest provinces (Lai Chau and Son La) the number of sunny hours in a year is about 1897 - 2102 hours / year. The remaining Northern provinces and some provinces from Thanh Hoa to Quang Binh are about 1400 - 1700 hours / year. The provinces from Hue to the South are about 1900 - 2700 hours / year. According to the assessment, areas with sunlight hours of 1,800 hours / year or more are considered to have potential to exploit and use. For Vietnam, this criterion is suitable for many regions, especially the southern provinces. According to EVN, as of mid-April 2019, the entire power system has only 4 solar power plants with a total capacity of less than 150 MW.

Within just over 2 months, by June 30, 2019, over 4,464 megawatts of solar power had been connected to the grid, of which 72 were solar power plants under the control of the National Load Dispatch Center (A0) with a total capacity of 4,189 MW and 10 power plants under the control of the Regional Dispatch Centers with a total capacity of 275 MW. Thus, the solar power source accounts for 8.28% of the installed capacity of Vietnam's electricity system. It is expected that from now until the end of 2019, A0 will continue to energize and put into operation 13 more solar power plants, with a total capacity of 630 MW, bringing the total number of solar power plants in the system to 95 houses. This is a valuable addition to the system in the context of difficult power sources, but a large number of solar power plants in

operation in a short time has caused many difficulties and challenges. for electrical system operation. The reason is due to the nature of uncertainty, depending on the weather of this type of power source. In addition, the hot and massive development of concentrated solar power projects in some provinces such as Ninh Thuan, Binh Thuan, Dak Lak has caused the 110 kV and 220 kV grid overload in the above areas. As an agricultural country, Vietnam has a huge potential for biomass energy resources. The main types of biomass are energy wood, waste - crop residues, animal wastes, municipal waste and other organic wastes. Biomass energy sources can be used by direct burning, or forming biomass fuels. The potential for biomass from agricultural wastes, animal wastes and organic waste is about 400 MW. The ability to sustainably exploit biomass for energy production in Vietnam is about 150 million tons per year. Some types of biomass can be immediately exploited technically for electricity production, or applying energy cogeneration technology (producing both electricity and heat) such as rice husks in the Mekong Delta, bagasse surplus in sugar factories, domestic waste in big cities, livestock waste from cattle farms, households and other organic waste from agro-forestry-seafood processing. Some sugar mills used bagasse to generate electricity, but only sold for more than 800 VND / kWh (4 cents / kWh). At the end of 2013, the Ministry of Industry and Trade submitted to the Government to consider the mechanism to support electricity production from biomass energy. Accordingly, the highest price that the industry buys electricity produced from biomass raw materials is VND 1,200 - 2,100 / kWh respectively. The proposed price will contribute to create motivation for the development of electricity from biomass resources in our country. The construction of waste-burning power plants is also being concerned with the goal of reducing environmental pollution, especially in big cities and urban areas. Currently, in our country there have been a number of waste incineration projects that have been put into operation or are under construction in Hanoi, Ho Chi Minh City, Can Tho, and Ha Nam

### 3. Conclusion

Vietnam's Renewable Energy Development Strategy up to 2030, with a vision to 2050, was approved by the Government. This can be considered as a basis for the development of renewable energy in Vietnam, encouraging and mobilizing all social resources to develop renewable energy at a reasonable price, gradually increasing the proportion of renewable energy in the country gross national energy output and consumption. However, in the process of implementing investment in renewable energy projects still faces many difficulties and obstacles. Representative of the Investment Management Board (EVN) said that besides the difficulties of finding capital, site clearance ... renewable energy projects still have many other obstacles such as, renewable energy planning. Only mention the scale of capacity by region, by region, the location of specific locations has not been determined, making it difficult to synchronously plan and develop the power grid. The generation capacity of renewable energy projects is not stable, varies with wind intensity, solar radiation ..., with large-scale capacity, it is necessary to have alternative backup power sources, accompanied by that are solutions to ensure safe and stable operation of the electricity system. In addition, the system of specialized

standards / design standards, operation ... for the renewable energy sector is lacking and inconsistent. In order to facilitate the development of renewable energy, the State should continue to study, complete and promulgate specific mechanisms and policies (capital, tax, land ...) to attract development investment resources of electricity from renewable energy. At the same time, to formulate a planning on development of renewable energy sources at the provincial and national levels, in association with the promulgation of national standards, regulations and specialized standards related to the design and operation of onions ... renewable energy sources; grid connection standards of renewable energy sources; technical standards of equipment allowed to participate in generation and transmission of electricity from renewable energy sources. In addition, the establishment and promulgation of synchronous mechanisms and policies on electricity transmission and distribution systems as well as other regulations, ensuring stable and efficient operation of the electricity system with the participation of Renewable electricity output.

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