

# Forecasted Trends of Green Energy Development in Vietnam

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**Abstract** - The paper focuses on the assessment of the current situation in production and consumption of different kinds of energy in Vietnam, including the potential of green energy sources, and the current situation in the development of green energy sources in Vietnam. Based on the above-mentioned assessment, the paper proposes targets for the development of green energy to ensure energy security and environmental protection. To ensure the feasibility of developing green energy, the paper presents the detailed assessment of green energy policies and mechanisms, which determine the future direction for green energy development in Vietnam.

**Index Terms** - environment; energy security; green energy sources; green energy policy; Vietnam.

## I. INTRODUCTION

Energy security today and in the next two decades is a concern and a real problem of many nations. Vietnam is a developing country, so energy supply and demand are very urgent issues. Many rich countries are also suffering from the problem of providing the economy with different kinds of energy to meet sustainable development goals in the context of rising energy prices.

According to the US Energy Information Administration (EIA) forecast, world energy demand could probably increase by 48% to 2040 [1-6, etc.]. However, fossil fuel energy is limited, are enough to satisfy the current energy consumption rate for 51 years. Today 84% of energy comes from fossil fuels [7]. Coal still provides about 40% of the world's electricity [8].

As stated by experts, Vietnam has a diversified source of fuel energy (coal, gas), but this source is not abundant. The National Assembly of Vietnam has voted to stop the project of building nuclear power plants in Ninh Thuan province, but this leads to a severe energy shortage in the future. In the context of the 4.0 technology revolution, energy plays an increasingly important role in the economic development, in the industrialization and modernization of the country. Without serious and effective decisions, energy security in Vietnam will not be guaranteed. Parallel to the urgent need to ensure energy security is a matter of ensuring safety for the environment. It has been estimated that greenhouse gas emissions have increased tenfold in the past 100 years [9]. Therefore, average surface temperatures could rise between 2°C and 6°C by the end of the 21st century [2,10,11].

Global warming leads to a significant global climate change, which has serious consequences for human life and the environment. The consequences of global warming are closely related to the energy production and consumption [12,13]. Vietnam is a country with a long coastline and should be one of the many countries most affected by climate change. Considering this situation, the paper assesses the potential of green energy sources and the current situation in the development of green energy sources in Vietnam, proposes targets for energy development to ensure energy security and environmental protection towards accomplishing the goals of sustainable development and response to climate change. The detailed assessment of green energy policies that will determine the future direction for green energy in Vietnam will be important and of great practical value.

The contents of this paper are as follows. Chapter II includes an overview of energy supply and demand in Vietnam. The need to develop clean, renewable energy is discussed in Chapter III. Chapter IV presents the development potential of the renewable energy industry in Vietnam. Chapter V explains the proposed goals for green energy development to ensure the national energy security and environmental protection. Chapter VI discusses acceptable policies and decisions for renewable energy development in Vietnam. The conclusions of this paper are presented in Chapter VII.

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II. OVERVIEW OF ENERGY SUPPLY AND DEMAND IN VIETNAM

Vietnam is a country with a developing economy. The country has reached the level of middle income. Such positive factors as the strength of the country, the desire for development, a golden population ratio, smart and creation people, the constructive and actionable government, indicate that Vietnam will continue to grow rapidly in the next decade. As the analysis shows, energy demand and supply in the world in general and energy demand and supply in Vietnam are pressing issues. The results of this research will clarify the problem of energy supply and demand in Vietnam in recent years:

Primary energy supply, converted to kilotons of oil equivalent (ktoe), in the period of 2000-2015 is demonstrated in Fig.1 [3].

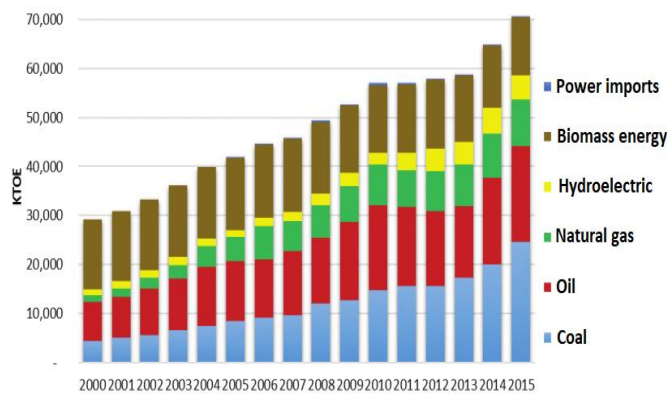


Figure 1. Primary energy supply in the period of 2000 - 2015.

A per year increase is 13.4% for gas; 12.2% for coal; and 6.2% for oil.

Energy consumption trend is presented in Fig. 2 [3].

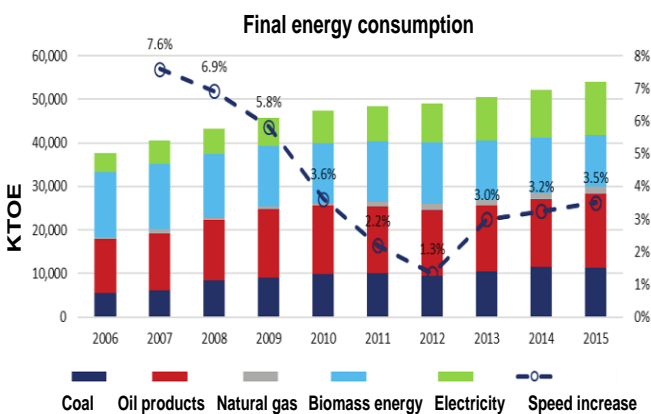


Figure 2. Energy consumption in the period of 2006-2015.

The chart shows that the types of fossil fuel energy used are increasing so rapidly that they meet the energy needs of the present. However, this leads to a completely negative environmental situation in the country.

BALANCE IMPORT AND EXPORT OF ENERGY (KTOE)

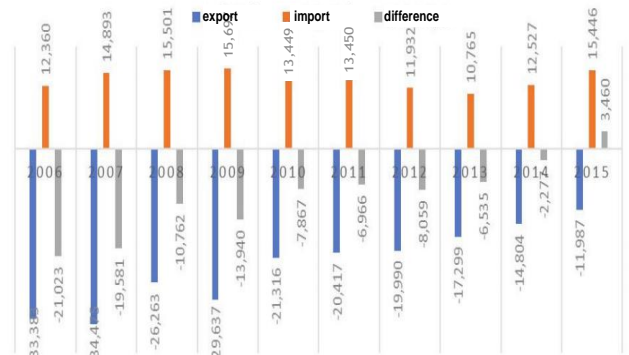


Figure 3. Energy import and export in the period of 2006-2015.

To ensure energy security, balance power sources between regions, provide power supply continuity, stability, and power quality, Vietnam had to import and export energy, which is illustrated for the period of 2006-2015 in Fig. 3 [3].

Previously, Vietnam was an energy exporter, but now the country imports energy from neighboring countries to ensure sufficient energy for consumption.

The comparison of different kinds of energy consumption in 2006 and 2015 by different sectors (million toe) is summarized in Fig. 4 [3].

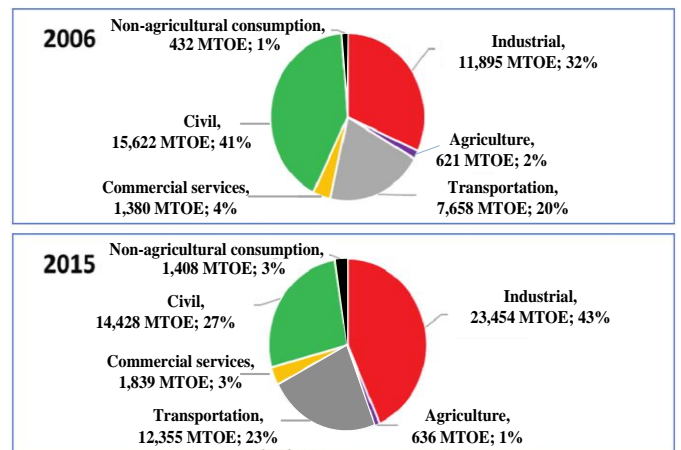


Figure 4. Energy consumption structure in the period of 2006-2015.

The structure of energy use has shifted sharply, from a backward agricultural country with the main source of energy used for living, to a developed industrialized country with a high rate of energy use.

The changes are particularly great in the installed capacity portfolio at the end of 2016, as is shown in Fig. 5 [4].

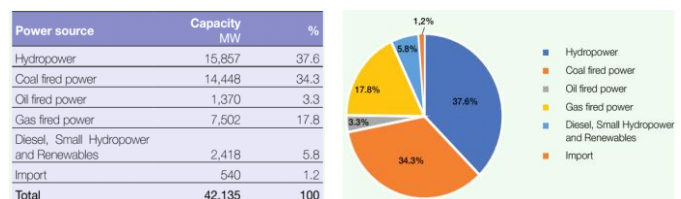


Figure 5. Installed capacity portfolio by the end of 2016.

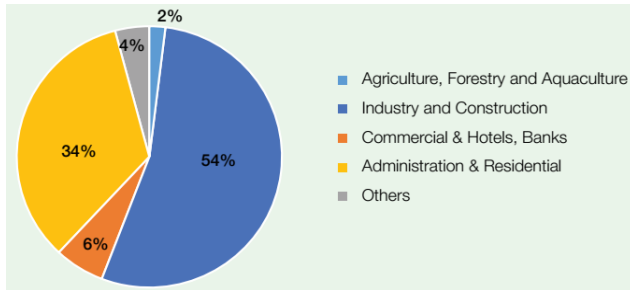


Figure 6. Power consumption in different sectors by the end of 2016.

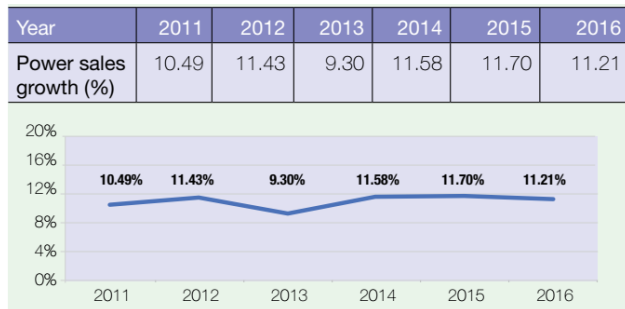


Figure 7. An annual growth rate of electricity consumption.

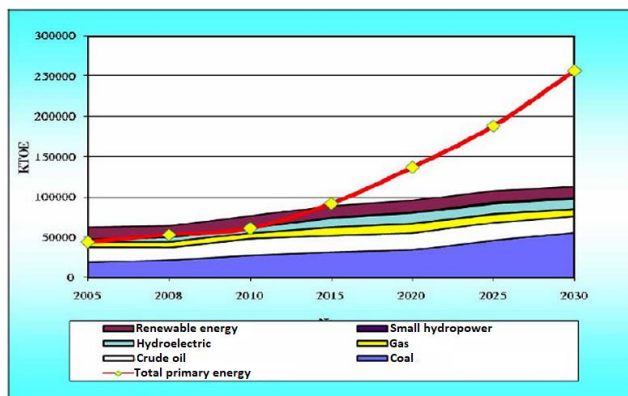


Figure 8. Overall demand and availability of primary energy in the long term.

Power consumption in different sectors by the end of 2016 [4] is shown in Fig. 6.

An annual growth rate of electricity consumption [4] is demonstrated in Fig. 7.

Nowadays, the situation of energy supply and demand is as follows. According to the expert estimations, Vietnam is a country with diversified, but not plentiful energy sources. The economic and technical potential of Vietnam's hydroelectricity is forecasted to produce 65÷70 billion kWh annually [5].

Under the mining plan of the coal industry, coal output will only be sufficient to supply about 12,000 MW, which means that no more than 72 billion kWh per year can only be produced, even by the years 2025-2030 [5].

In the light of the forecast of the offshore gas resources, they are only enough for the development of gas power plants to produce over 100 billion kWh per year and about 3-5% of the gas needed to supply the other industrial facilities [5].

The potential for crude oil production will soon reach the

Table 1. Overall demand and availability of primary energy in the long term

Energy Type	2010		2015		2020	
	Natural unit	KTOE	Natural unit	KTOE	Natural unit	KTOE
Primary energy demand		61123		91675		148786
Ability to locally supply		76889		89402		96172
Inside:						
Coal	49.8 m. tons	27888	60 m. tons	31680	70 m. tons	34562
Crude oil	19.86 m. tons	20217	20 m. tons	20360	20.7 m. tons	21073
Gas	7.98 b. tons	7183	11.43 b. tons	10288	12.68 b. tons	11413
Hydroelectric	30.13TWh	6478	54.4TWh	11695	60.4TWh	12994
Small hydropower	1.99TWh	428	4.2TWh	905	6.46TWh	1391
Renewable energy	44.5 m. tons	14695	43.8 m. tons	14474	44.6 m. tons	14740
Redundancy(+); Shortage (-)		+15766		-2273		-52614

ceiling level (around 17 ÷ 18 million tons per year) and gradually decline in the period after 2015. Based on the assessment of the increase in energy demand and the ability to exploit domestic energy resources, experts have estimated the balance of overall demand and the ability to meet the demand for primary energy types in the long term, as is shown in Table 1 and Fig. 8 [5].

Indeed, Vietnam is facing challenges such as rising energy demand, while environmental bindings are becoming increasingly tighter and heavier. On the one hand, this situation puts pressure on ensuring the national energy security, and on the other hand, creates the problems for the economy to mobilize sufficient investment capital for the energy sector. To ensure energy security, Vietnam is transforming from an energy exporter to an energy importer.

To solve the energy problem for the country's economic development, the Ministry of Industry and Trade (MOIT) suggested a policy mechanism with two approaches, one is using energy efficiently and cost-effectively, and the other is using environmentally friendly technologies to produce energy.

Vietnam is shifting from an inefficient use of fossil fuels to the use of clean, renewable energy sources, by changing production patterns and promoting sustainable energy consumption, aiming to achieve a low-carbon economy.

### III. THE NEED TO DEVELOP CLEAN, RENEWABLE ENERGY

The following arguments will indicate the need to develop renewable energy in Vietnam [6, 14, 15]:

- Contribution to energy security: the investment in energy efficiency and saving, consumption, and production with cleaner technologies; the development of renewable energy sources will contribute significantly to ensuring the national energy security.

- Contribution to sustainable economic growth: renewable energy can make a significant contribution to the sustainable economic growth, especially at the national level.

- Contribution to environmental sustainability.

- Contribution to health care for the people.

- Contribution to the energy supply to rural, mountainous and island areas; remote areas, areas with special difficulties.

- Contribution to the efficient development of the energy sector: at present, the investment costs for some renewable energy technologies are declining rapidly, especially in the electricity sector.

- Maximization of the value of resources in the country and each locality.

#### IV. THE DEVELOPMENT POTENTIAL OF THE RENEWABLE ENERGY INDUSTRY IN VIETNAM

The Ministry of Industry and Trade of Vietnam has approved the master development plan for wind power in some localities. According to this plan, by 2030: Ca Mau can develop 3,607 MW; Binh Thuan - 2,500 MW; Ninh Thuan - 1,409 MW; Tra Vinh - 1,608 MW; and Soc Trang - 1,470 MW [6].

The prospects for solar energy are as follows. For the countries with the tropical climate like Vietnam, solar energy is used almost all year round. According to the survey on the amount of solar radiation in the country:

- Northern provinces (from Thua Thien Hue province to the North) have an average of 1800 to 2100 sunshine hours per year. In particular, the sunny areas are in the Northwest (Lai Chau, Son La, Lao Cai) and the North Central Region (Thanh Hoa, Nghe An, Ha Tinh).

- The provinces in the South (from Da Nang to the South), have about 2000÷2600 sunshine hours. The amount of solar radiation is estimated at about 20% higher than in the northern provinces. In this area, the sun shines almost all year round, even in the rainy season. Therefore, for the South-Central and Southern provinces, solar radiation is a great resource for exploitation and use.

- An average annual solar energy intensity in Vietnam is 4.6 kWh/ m<sup>2</sup> / per day in the whole country (in comparison with the average level of the whole world). The northern area has an average radiation intensity of 3.69 kWh / m<sup>2</sup> / per day and an average radiation intensity in the southern area is 5.9 kWh / m<sup>2</sup> / per day.

In recent years, many localities, companies, and businesses have studied and promoted the development of solar power projects: Electricity of Vietnam (EVN) and its member units are planning and preparing 3 projects with a total capacity of about 3,100 MW, mainly on the surface of the lake. More than 20 investors have registered to invest in solar power projects in Binh Dinh province.

Biomass energy has the following prospects. Biomass energy is the form of energy derived from organic substances, such as wood, agricultural products, organic waste, urban solid waste, algae, and other plants. The potential biomass resources are:

- Firewood is fuels derived from wood, extracted from forests, perennial industrial plants, fruit trees and scattered trees, wood waste from wood processing factories. The total amount of firewood in Vietnam is about 32 million tons equivalent to 11.6 million TOE.

- Agricultural waste includes post-harvest agricultural waste such as rice straw, tops and leaves, branches and stalks, cassava stalks, etc., agricultural and industrial waste, rice husk, peanut husk, peanut pulp, etc. The total amount of agricultural waste in Vietnam is about 80 million tons equivalent to 17.6 million TOE.

- Livestock waste (cattle dung) can be used to produce biogas. The amount of biogas that can be recovered from livestock is about 11.3 billion m<sup>3</sup> / year.

- Waste, including organic waste, waste from urban and rural life; waste from production facilities, businesses, agencies can be used for energy purposes, etc. The capacity to recover energy from organic waste is about 0.82 million TOE.

- Organic waste sources (molasses, used cooking oils and fatty acids) can be used as the main raw material for biofuel production. The capacity to recover energy from these organic substances is currently about 0.8 million TOE.

- Totally, the potential of biomass energy in Vietnam is about 60 million TOE.

The other forms of renewable energy in Vietnam are the following.

- Hydropower: According to the hydropower ladder planning on major rivers and small and medium hydropower planning in localities approved by some competent authorities, Vietnam could develop 1279 hydropower projects with a total capacity of 26,500 MW. There are 1164 small hydropower projects (capacity ≤ 30MW) with the total installed capacity of 7745 MW. There are 72 medium hydropower projects (with a capacity of over 30 MW to 100 MW) and 43 rather large hydropower projects (with a capacity of more than 100 MW) with the total installed capacity of 14,583 MW. There is also the potential to develop more than 200 projects, mainly small hydropower ones, with a total capacity of over 400 MW. When fully exploited, Vietnam's hydropower plants can annually produce about 95-100 billion kWh including about 35÷40 billion kWh to be produced by small and medium hydropower plants.

- Geothermal: According to the preliminary estimation, the total capacity of geothermal plants in Vietnam, could reach over 400 MW. Areas with great geothermal potential are North West and North East of North, and especially Central Vietnam such as Le Thuy (Quang Binh), Mo Duc, Nghia Thang (Quang Ngai), Hoi Van (Binh Dinh), Tu-pho, Danh Thanh (Khanh Hoa) provinces, and the others. These sites are highly feasible for the projects on construction of geothermal plants.

- Ocean energy: Tidal power energy of Vietnam is estimated to be 1.5 billion kWh per year and is concentrated in Quang Ninh Coast (about 1.3 billion kWh per year). Additional 0.2 billion kWh / per year can be exploited with a small capacity in the lower river of Mekong.

#### V. PROPOSED GOALS FOR GREEN ENERGY DEVELOPMENT TO ENSURE ENERGY SECURITY AND ENVIRONMENTAL PROTECTION

The strategic objectives are the following:

- To increase step by step the rate of access to clean energy and electricity for people in rural, mountainous, remote, border and island areas.

- To strive to provide most households with electricity and modern, sustainable and reliable energy services at reasonable prices.

- To develop and to use green, renewable energy sources to meet the sustainable environmental objectives and to develop a green economy:

- To reduce greenhouse gas emissions from energy activities to compare with a normal development plan.
- To reduce imported fuel for energy purposes.
- To increase the total amount of renewable energy.
- To increase the amount of electricity produced from renewable energy.
- To increase the absorption area of the solar water heater.
- To increase households with solar-powered appliances (hot water boilers, cooking stoves, heating and cooling space, water distillation use solar energy).
- To increase the use of biogas technology.

According to the scenario of renewable energy development, Vietnam can exploit a 3,000-5,000MW capacity with an output of more than 10 billion kWh from renewable energy by 2025. If there is a reasonable support policy, this will be a big contribution to the National demand for electricity output. According to a preliminary study and assessment of the renewable energy development potential up to 2050, the potential of the wind, solar, geothermal and biomass energy development could be even greater.

#### VI. POLICIES AND SOLUTIONS FOR RENEWABLE ENERGY DEVELOPMENT IN VIETNAM

Despite the high renewable energy potential, the investment in renewable energy development in Vietnam has not yet met the potential and strengths available in the country. This situation is mainly because the economy of renewable energy sources is not really attractive, along with barriers related to mechanisms, policies, implementation organization, and technology application. This limits the implementation of renewable energy projects. To develop renewable energy in Vietnam, it is necessary to concentrate resources, use the maximum potential of renewable energy in the country with advanced technologies suitable for the practical conditions of each region, and enhance economic, social and environmental efficiency. It is necessary to expand the market for renewable energy technologies, to develop the machinery-manufacturing industry and provide the renewable energy services in the country. It is also required to strengthen the potential for research, development, transfer, and application of new forms of renewable energy.

At the same time, it is also imperative to have a strategy for hydropower, biomass, wind, and solar energy development and create mechanisms and policies for its implementation.

- It is necessary to encourage organizations and individuals with different forms of ownership to participate in the development and use of renewable energy and persuade the Government to protect the legitimate rights and interests of organizations, companies and individuals that develop and use renewable energy.

- The electricity companies should have to buy all electricity produced from renewable energy sources when these power plants are connected to the grid in their localities under their respective management. The electricity purchase

and sale are made through the power purchase agreement. Electricity projects using renewable energy sources for electricity production should be given a priority in the national electrical system.

- Organizations and individuals operating in the electricity sector have to be responsible for contributing to the development of the national renewable energy sector.

- Electricity end-users buying electricity from the national grid have to develop renewable energy sources with the main purpose of meeting their electricity needs and provide clearing mechanism.

- Projects on the development and use of renewable energy sources have to be entitled to investment credit preferences, which obey the current law provisions on investment credits and export credits of the Government.

- Projects on the development and use of renewable energy sources should be exempted from import tax for imported goods in order to create fixed assets for the projects. Imported goods, including raw materials, supplies, and semi-finished products which cannot be produced in the country are imported to serve the production of the projects in accordance with current regulations on export tax and import tax.

- The income tax exemption and discount for the enterprises involved in the projects on the development and use of renewable energy sources should be implemented for projects in the areas eligible for investment preferences under the current tax law.

- The land use levy or land rent for the projects on the development and use of renewable energy sources should be exempted or reduced, which complies with the current provisions of law applicable to projects in the areas entitled to investment preferences.

- Priority should be given to the studies related to the development and use of renewable energy resources in the field of science and technology and high-technology industries; it is also necessary to allocate funds to support scientific and technological research in pilot projects, industrialization projects for the development and use of renewable energy, promote technological innovations related to the development and use of renewable energy, reduction of production costs of renewable energy products and improvement of product quality, etc.

Some solutions to implement the Strategy are:

+ Real estate developers are responsible for fulfilling the requirements of using solar energy in the design and construction of buildings in accordance with technical standards issued by the Government agencies.

+ Petroleum trading enterprises must combine the sale of bio-liquid fuels to meet the national standards in the local fuel sale system.

+ The Ministry of Industry and Trade should annually promulgate specific regulations on the minimum proportion of biofuel liquid fuels to be sold in localities to petrol and oil trading enterprises.

+ It is necessary to set up a sustainable energy development fund using national budget funds, environmental fee revenues for fossil fuels, financial support and contributions from



organizations and individuals outside the country and other legal capital to support the financing of activities promoting the development of energy industry nationwide.

+ It is necessary to encourage and support the development of services and consulting organizations in the field of renewable energy use.

+ It is necessary to encourage and support universities, vocational training, design and scientific institutions to develop curricula, syllabus and teach new subjects related to renewable energy.

+ It is necessary to develop the renewable energy industry, encourage the research, transfer, reception and effective application of technical and environmental advances and technologies aimed at producing and using renewable energy.

+ It is necessary to establish and develop a renewable energy technology market, create equality based on healthy competition among enterprises of all sectors, promote the development of production projects, sales and service of renewable energy production and use, etc.

Companies should sign grid connection agreements with the enterprises using renewable energy sources for electricity generation, already licensed or included in the list of renewable energy source projects, approved by the competent authority, to purchase all electricity generated from renewable energy projects which meet the technical standards of connection to the grid in the area within the grid system managed by power companies.

## VII. CONCLUSION

Vietnam is undertaking industrialization in the direction of sustainable development, stepping into the 4.0 technology revolution, accelerating economic development, implementing the modernization of the country. Therefore, the sustainable development of the industries related to the exploitation and processing of fossil fuel is indispensable. The use of fossil fuels for energy production is one of the causes of global climate change. It also produces large quantities of ash, harmful gases and pollutants to the soil, water and air.

The paper analyzes in detail the environmental impact of energy production and consumption, the overview of energy demand, the relationship between the energy security and environment safety issues. Based on the assessment, the targets for the green energy development are proposed to ensure energy security and environmental protection. To ensure the feasibility of green energy development, an emphasis is made on the detailed assessment of green energy policies aimed at defining the future direction for green energy in Vietnam, toward accomplishing the goals of sustainable development responding to climate change.

## REFERENCES

- [1] EIA projects 48% increase in world energy consumption by 2040, EIA, 2016. [Online]. Available: <https://www.eia.gov/todayinenergy/detail.php?id=26212>

- [2] How Much More Will Earth Warm? NASA, Jun 3, 2010. [Online]. Available: [https://earthobservatory.nasa.gov/Feature\\_s/GlobalWarming/page5.php](https://earthobservatory.nasa.gov/Feature_s/GlobalWarming/page5.php)
- [3] Duong Trung Kien, "Status of energy management for Vietnamese industrial enterprises," *Economic seminar on energy and prospects*, Hanoi, December 14, 2017.
- [4] [Online]. Available: <http://evn.com.vn/userfile/files/2017/EVNAnnualReport2017-web.pdf>
- [5] [Online]. Available: <http://nangluongvietnam.vn/news/vn/nhan-dinh-phan-bien-kien-nghi/phan-bien-kien-nghi/giai-phap-nao-cho-an-ninh-nang-luong-viet-nam.html> (in Vietnamese)
- [6] Tran Viet Ngai, "The international situation and concerns about renewable energy in Vietnam," *Economic seminar on energy and prospects*, Hanoi, December 14, 2017.
- [7] Renewable energy: a key climate solution. IRENA, 2017. [Online]. Available: [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA\\_A\\_key\\_climate\\_solution\\_2017.pdf?la=en&hash=A9561C1518629886361D12EFA11A051E004C5C98](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_A_key_climate_solution_2017.pdf?la=en&hash=A9561C1518629886361D12EFA11A051E004C5C98)
- [8] World Energy Resources, 2016. [Online]. Available: <https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Resources-Full-report-2016.10.03.pdf>
- [9] T.A. Boden, G. Marland, and R.J. Andres, "Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions," Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., USA, 2017. doi 10.3334/CDIAC/00001\_V2017
- [10] M. Meinshausen, N. Meinshausen, W. Hare, S.C.B. Raper, K. Frieler, R. Knutti, D.J. Frame and M.R. Allen, "Greenhouse-gas emission targets for limiting global warming to 2 °C," *Nature*, no. 458, pp. 1158-1162, 2009. DOI: 10.1038/nature08017
- [11] D. P. Van Vuuren, M. Meinshausen, G.-K. Plattner, F. Joos, K. M. Strassmann, S. J. Smith, T. M. L. Wigley, S. C. B. Raper, K. Riahi, F. de la Chesnaye, M. G. J. den Elzen, J. Fujino, K. Jiang, N. Nakicenovic, S. Paltsev, and J. M. Reilly, "A temperature increase of 21st-century mitigation scenarios," *Proc. Natl Acad. Sci. USA* 105, pp. 15258-15262, 2008.
- [12] D. Starr, "The carbon accountant. Richard Heede pins much of the responsibility for climate change on just 90 companies. Others say that's a cop-out," *Science*, vol. 353, no. 6302, pp. 858-861, 26 August 2016.
- [13] R. Heede. "Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854-2010," *Climatic Change*, vol. 122, no. 1, pp. 229-241, January 2014.
- [14] N.L. Panwara, S.C. Kaushik, "Surendra Kothari, Role of renewable energy sources in environmental protection: A review," *Renewable and Sustainable Energy Reviews*. Vol. 15, no. 3, pp. 1513-1524, April 2011.
- [15] T.B. Johansson, A.K.N. Reddy, H. Kelly, R.H. Williams, *Renewable Energy: Sources for Fuels and Electricity*. Island Press, 1993.



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