

Application of Solar Energy in Production and Life in Ho Chi Minh City

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Abstract

Solar energy is one of the largest energy sources that people can take advantage of as it is a clean, almost endless source of energy and easily applied in many places. This energy source is used more and more to replace traditional energy sources that are gradually becoming scarce and exhausted, and also contribute to saving energy and reducing emissions to the environment. Therefore, it is necessary to develop renewable energy sources to meet the electricity demand for economic activities, people's living activities as well as ensure environmental safety in the context of global warming. This article will present research results on the application of solar power in life and production in Ho Chi Minh City. The equipment system includes a mirror to concentrate solar radiation, the great potential and deployment direction of solar power application in the future urban model of Ho Chi Minh City as well as other provinces in Vietnam.

Key-words: Environment, Solar Energy, Renewable Energy, Ho Chi Minh City, Potential, Application.

1. Introduction

The demand for human energy use in the era of science and technology, industrialization and modernization are increasing day by day. Meanwhile, the traditional energy sources being used from fuel sources such as coal, oil, gas, etc. are limited, making future energy shortage a concern leading in many countries. In addition, the emission of fuel sources also has a great impact on the environment, typically the global greenhouse effect. That leads to the research and development of new energy sources (Benjamin & Lakshmi, 2012).

Solar energy is a clean, readily available and easily utilized energy source with the potential to become a preeminent energy source in the future. Therefore, solar energy is increasingly widely used in the world (Hieu, 2020). Vietnam is a country with the advantage of being located in an area with a

lot of sunshine distribution on the world radiation map, especially the area of Ho Chi Minh City (HCMC) in the South, with a coastline stretching 3,000km long, there are many islands currently inhabited but the electricity grid is not complete enough, facing difficulties in electricity development in the island and archipelago areas. Therefore, it is extremely urgent to research and deploy renewable energy sources, including solar energy (Thong, 2015).

2. Content

2.1. Overview of Solar Research

In 1873, Willoughby Smith discovered selenium with photoconductive potential, which led to the 1876 discovery by William Grylls Adams and Richard Evans Day that selenium produces electricity when exposed to sunlight. In 1883, Charles Fritts actually produced the first solar cell made from selenium wafers. Solar panels were first created in 1883 by Charle Fritts with an initial efficiency of only 1%. But before that, the discoverer of the photoelectric effect was the French physicist Alexandre Edmond Becquerel in 1839 (Fraas, 2014). Solar technology came close to its current design in 1908 when William J. Bailey of the Carnegie Steel Company invented with an insulated box and a selenium rod. Until later, a number of appliances could harness solar energy as an alternative to the common electricity source, the new concept of solar application became more and more practical and popular (Sarver & Kazmerski, 2013).

2.2. The Current Situation of Fuel Sources that have been and are being used in Vietnam

2.2.1. Current Status of Energy Sub-sector in Vietnam

The energy sector plays an important role in Vietnam's continued development, and access to reliable, cost-effective energy sources will be an important factor for sustainable economic growth. Achieving the target of reducing global greenhouse gas emissions as set out in the Paris agreement on climate change will largely depend on the development path of developing economies such as Vietnam (Thong, 2015).

Renewable energy is interested in development, creating breakthroughs in ensuring national energy security, contributing to the conservation of energy resources, minimizing negative impacts on the environment and climate change in production of electricity. In the period 2016 - 2020, Vietnam achieved a breakthrough development in renewable energy. The Government's incentive mechanism

for solar power development has created a strong motivation, attracting investors to participate in solar power production. By the end of 2020, the total capacity of renewable energy sources in Vietnam has reached about 6,000 MW, including about 6,364 MWp of solar power (equivalent to about 5,290 MW), about 500 MW of wind power and 325 MW of electricity. biomass electricity capacity; the total capacity of wind power, solar power and biomass power has accounted for approximately 10% of the total installed capacity of the power system; The power output supplied from renewable energy sources has gradually increased from an insignificant level of 320 million kWh, accounting for about 0.41% of the whole system in 2016 to about 8 billion kWh, accounting for 2.53% of the whole system. system in 2020 (Vietnam Ministry of Industry and Trade, 2021).

2.2.2. Factors Affecting Solar Energy Consumption

Solar energy consumption behavior is influenced by many factors. The first factor to mention is perceived usefulness: the extent to which people believe that using solar power technology will improve their efficiency, economic efficiency, perceived ease of use: is the degree to which people believe that using solar technology will not take any effort, perception of risk: is the risk people perceive when using solar energy technology Solar potential and perceived convenience: is the perception of using solar power technology. In addition, there are factors related to policies on the use of solar power: the government's incentive policies when households and enterprises use solar power technology. Finally, there is the trust factor of people: their belief in the use of solar power technology and the intention to use factor: expressing the intention and level of interest in using the technology solar energy (Liem & Nhan, 2020).

2.2.3. Potentials and Challenges

Solar energy potential is highly appreciated when Vietnam is a country with a lot of sunshine in the year with high radiation intensity in the central and southern regions. 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 about 1900 - 2700 hours/year (Vietnam Energy Association, 2020).

In Vietnam, due to the huge demand for electricity, accelerating the development of solar energy also needs to pay attention to a number of issues such as: The instability of solar radiation

because of weather dependence. To ensure stable operation of the solar panel system, it is necessary to take into account the backup capacity, to make up for the shortage of capacity when the solar energy source cannot absorb or generate electricity. On the other hand, solar power sources are not capable of voltage regulation without strict regulations, requiring investment in protective equipment before designing.

In addition, power sources are operating under the competitive electricity generation market mechanism, which is likely to form a competitive electricity trading market. However, there is still no suitable mechanism for renewable energy as well as solar energy to operate in the electricity market. To overcome the above inadequacies, it is necessary to consider the planning on the development of renewable power sources at provincial and national levels. Renewable energy and solar energy projects need to ensure the synchronous development between the power source and the grid, ensure the safe and economic operation of the power system and the overall investment efficiency of the society (Liem & Nhan, 2020).

2.3. Methods, Subjects, Scope of Research

2.3.1. Research Objectives

Survey and evaluate the current situation of using solar energy to provide solutions to save energy and increase the efficiency of using solar power in the area of Ho Chi Minh City.

2.3.2. Research Methods

The article studies documents on economical and efficient use of energy in the world, and collects statistics and documents on solar radiation in the South of Vietnam. The article analyzes and synthesizes the effectiveness of energy saving in production and life, analyzes opportunities for economical and efficient use of energy in HCMC area.

2.3.3. Research Object

The object of the article's research is the potential application of solar energy to the future, electrical devices using energy in life and production.

Survey subjects: Students of FPT University in Ho Chi Minh City.

2.3.4. Research Scope

Research and apply solar power model using photovoltaic cells in production and life in HCMC area.

2.4. Research Results

2.4.1. Solar Energy Applications in the World

The issue of using solar energy in life and production has always been of interest to scientists. Over the years, there have been many significant research papers and inventions, but the proportion of energy produced from solar energy in the total The world's energy consumption is still modest. The current popular solar energy applications include major areas such as solar heat: home appliances, stoves with solar panels, drying equipment, appliances distillation, refrigeration and air conditioning equipment commonly used to run heat engines. The second area is solar power: using solar cells at different scales: small-scale off-grid, usually solar panels that generate electricity from solar energy and use it directly (such as in lighting). lighting, supplying electricity for daily life or for office equipment, automatic meters, telecommunications, electric vehicles, etc.); Small-scale grid-connected are usually solar panels installed on the roofs of households or offices and large-scale grid-connected (solar power generation plants) (Hoa, 2013).

2.4.2. Application of Solar Energy in Ho Chi Minh City Area

It can be seen that in Vietnam, the amount of solar radiation is very good, especially in the southern region. In the months of January, March and April, the sun usually starts from 7am to 5pm. The average solar radiation intensity is usually greater than 3,489 kWh/m²/day. The amount of solar radiation in Vietnam is a determining factor in solar power output. From the map of solar radiation in Vietnam, it can be seen that every area has potential for solar power. In the area of Ho Chi Minh City, there is a large amount of radiation, an average of about 1.581 kWh/m²/year, the highest is 6,3 kWh/m²/day in February and the lowest is 3,3 kWh/m²/day in July. The average number of sunny hours in a month ranges from 100-300 hours, continuously throughout the year. Specifically, in the dry season, the number of sunny hours is up to 300 hours, and in the rainy season, the number of sunny hours is about 150 hours (Vietnam Energy Association, 2020).

In addition, natural conditions play a very important role in the exploitation of solar energy. For densely populated areas such as Ho Chi Minh City, it is only possible to exploit solar energy in the form of electricity on the roofs of people's houses, on the rooftops of offices and factories, etc. to directly serve each household. home, office, or a certain residential cluster.

2.4.3. Survey Results and Discussion

Although solar energy is a vague concept and has not been fully exploited and applied, it almost always exists in human perception today. Through the survey, the preliminary awareness level of university students at FPT University in Ho Chi Minh City about the concept of solar energy is 16/16 (100%), which means that all students have heard or known the concept of solar energy. This concept and to better understand the importance of solar energy, some questions for students were raised as shown in Table 1.

Table 1 - Table of Benefits of Using Solar Energy

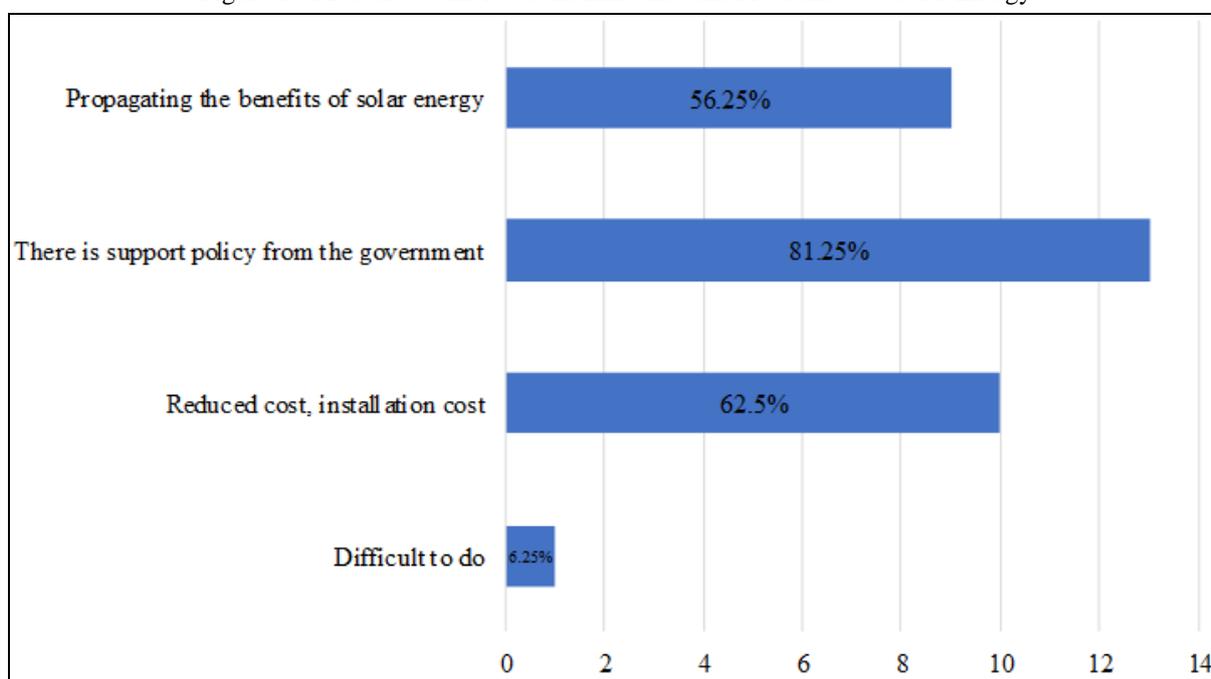
No.	Content rated	1	2	3	4	5	Total of answers	Total scores	Critical level
1	Using solar energy as an inexhaustible resource	1	2	4	5	4	16	57	0.2
2	Using solar energy to save costs	0	2	2	8	4	16	62	0.2
3	Using solar energy to protect the environment	0	1	3	6	6	16	65	0.2
4	Solar energy can be applied to life and production	0	0	3	9	4	16	65	0.2
5	Solar energy can be applied to the fields of science and technology - electronic technology	0	1	4	7	3	16	57	0.2
								306	1

Through the above assessment, most of the students are aware of the importance of applying solar energy in life and production. With regard to the idea "Energy can be applied to life and production", most of the students expressed their agreement, only 3/16 students (18.75%) were neutral. For the comments "Solar energy is endless", "Use solar energy to save costs", "Use solar energy to protect the environment", "Solar energy can be applied to the fields of science, technology - industry, etc.", most of the students answered yes, however, there were still some students who disagreed or held a neutral and unclear position. Since then, it shows that there are still some students

who do not understand well about solar energy, leading to problems and difficulties when answering the survey.

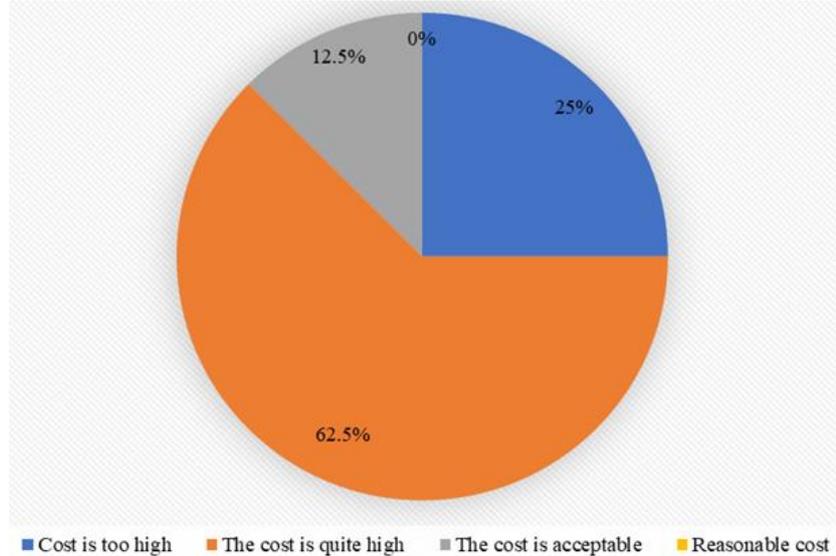
Thus, in order to provide the most objective methods to increase the impact and awareness of solar energy, a survey on measures has been given as follows:

Figure 1 - Measures to Increase the Influence and Awareness of Solar Energy



The majority of students can make their own choices, according to the opinion "Propaganda of benefits on solar energy" with 9/16 students agreeing (56.3%), with the opinion "Having a policy to support from the government" has 13/16 students agree (81.3%), with the opinion "Reducing cost, installation cost" has 10/16 students agree. This proves that the exploitation and application of solar energy requires coordination between the people and the government to fully exploit it. However, 1/16 students (6.3%) feel that this problem is very difficult to implement because even if the cost is reduced, it is still quite high compared to the people's current living standards as well as being familiar with national grid system. Through a survey problem "assuming the average monthly electricity bill is 2 million VND, the total cost of installing solar battery system will range from 80-100 million VND, the capital recovery time is about 4- 5 years", 4/16 students (25%) rated the cost too high, 10/16 students (62.5%) rated the cost as quite high, and 2/16 students (12.5%) rated the cost too high. acceptable fees (Figure 2).

Figure 2 - Survey on Installation Costs of Solar Battery Systems in Households



This result shows that although the use of solar energy can be capitalized and profitable, for households, the cost is still a problem. Thus, we can see that the application of solar energy in life and production still has many shortcomings, but 16/16 students (100%) agree with the idea that "resource technology will continue to develop" and growth in the future". Each country is well aware that natural resources will eventually be exhausted, it is necessary to have other alternative resources, and with the inexhaustible source of solar energy, the possibility of widespread use of solar energy in the future is possible (Benjamin & Lakshmi, 2012).

Not only related to costs, but also many other issues are always obstacles, risks and challenges for the development of research and use of solar energy (Arabatzis & Myronidis, 2011). Some of these obstacles and risks are shown in the following table.

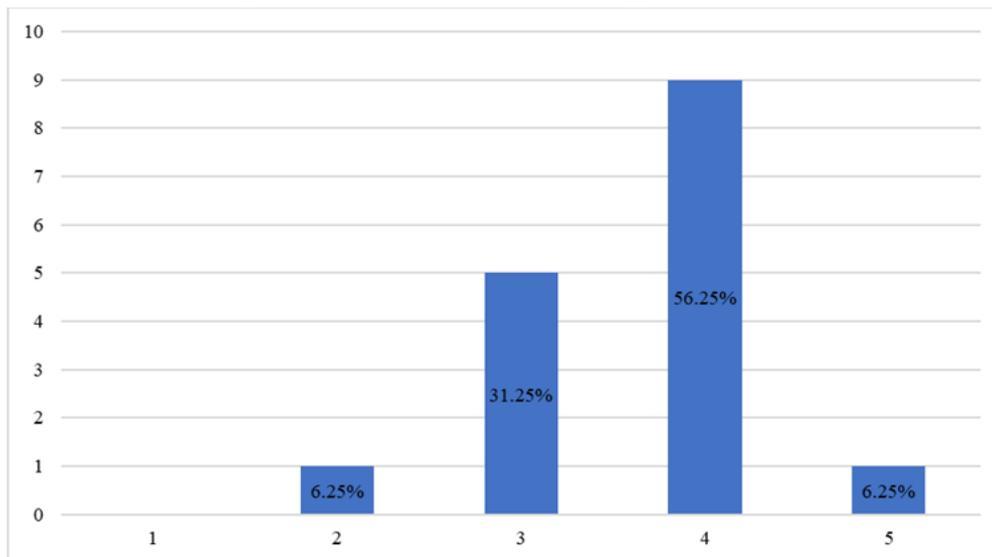
Table 2 - Risk Assessment Table, Risks of Using Solar Energy

Assess risks and risks in using solar energy	Degree evaluation					Total of answer	Total scores	Critical level
	1	2	3	4	5			
Cost, high cost	1	1	1	9	4	16	62	0.18
Need time to payback	0	3	6	2	5	16	57	0.16
Weather affects power generation efficiency	1	0	4	7	4	16	61	0.18
Solar panels have a short lifespan	0	1	5	9	1	16	58	0.16
Solar panels affect the environment after the end of their life	0	0	7	7	2	16	59	0.16
The benefits from using solar energy are not yet understood	0	0	7	8	1	16	58	0.16
							355	1

When being asked about risks and obstacles when using solar energy, with the opinion "Cost, high price", the number of students agreeing is 13/16 students (81.25%), this shows that investment cost is always the top concern in using solar energy. For other opinions, about 65% of the answers agree and 35% are neutral or have no opinion.

Through a survey on the importance, benefits and risks of using solar energy, 10/16 students (62.5%) intend to use solar energy, 5/16 students (31.25%) undecided and 1/16 students (6.25%) did not intend to use. This is shown in the following chart.

Figure 3 - Intention to Use Solar Energy in the Future



From the survey results, because of fear of initial investment costs, although the use of solar energy can return capital and make profits, only about 2/3 of students intend to use it, 1/3 of the remaining students still cannot decide and there are also students who do not intend to use solar energy. This shows that the current cost and economic efficiency problems still cannot meet everyone's consumption needs.

In this article, there are quite a lot of factors about awareness, benefits, risks mentioned and all have a positive influence on students' attitude in using solar technology and from the results. Research shows that although there are still inadequacies and unresolved problems, as well as the research on solar energy has not been completely thorough, but solar technology has always been highly appreciated and expected by people.

From the interview results, it has been shown that solar technology can be applied in many fields, especially science and technology and electronic technology (Mitsuru Kudo and others 2007).

For example, it is possible to apply research on solar energy in combination with future urban construction to save national resources, or in the field of cars, motorbikes, etc. to produce vehicles using solar energy, reducing emissions from petroleum also contributes to reducing the current greenhouse effect. In addition, the potential for the development of solar energy research is very large, but it is certainly difficult to apply in the near future because there are still too many shortcomings, especially in terms of equipment costs, causing obstacles in investment decisions of individuals, households and enterprises. It is very possible to use solar energy for production and life in the future urban model, including replacing the current national grid system, which households and factories can install. Direct use to save costs. Although there are still many influencing factors such as difficulty in maintenance, low-life solar batteries, expensive costs, but believe that the research into solar technology will achieve certain success.

2.5. Compare Solar Power Systems that can be Applied in Life and Production

Table 3 - Comparison of Current Solar Power Systems

Content	Independent Solar System	Solar power grid connected to the grid	Solar power grid connected to the grid with reserve
Basic ingredients	Solar panels	Solar panels	Solar panels
	Electric exciter	Grid adapter	Grid adapter
	Remote control	Power meter	Power meter
	Battery		Battery
Efficient energy saving	At least	Highest	Medium
	Limited power consumption due to battery storage	Do not use batteries, provide maximum power	Due to storage in the battery, the capacity is reduced
Investment price	Due to the battery, the price is 2 times higher than the grid-tied solar energy	Lowest cost	The highest cost due to the combination of the remaining 2 systems
Load consumption	Limit load consumption	Unlimited load consumption	Unlimited load consumption
Economic efficiency	Low	High	Medium
	Due to limited power supply in terms of capacity and battery	Optimal use of energy resources	Due to the high cost of batteries
Energy saving cost	Low	High	Low
Payback time	Long	Short	Longest
Application	Suitable for remote areas, areas without electricity	Areas with relatively stable grid electricity	Suitable for areas with frequent power outages
Preventing power failure	High	Low	High
Maintenance cost - maintenance	Very high	Low	High
	The battery is quickly damaged because it is not fully charged	Almost zero	Battery life is only 3-5 years
System stability	Low	High	High
	Depends on sunlight intensity and is therefore unstable as the load capacity increases.	Operate in parallel with the power grid, without affecting the stability of the system.	Operate in parallel with the power grid, without affecting the stability of the system.

The use of solar electricity replaces traditional forms of energy, contributing to saving electricity for families, economic development and ensuring national energy security. Currently, there are 3 solar power systems in use: stand-alone solar system, grid-tied solar system and grid-tied solar system with reserve.

Each solar battery system has different functions and applications, so it is necessary to choose, consider and evaluate carefully before applying solar power in practice. In Ho Chi Minh City area, currently the most suitable solar power system is the grid connected solar power system. Compared with the other two systems, this system has the lowest cost, optimal use of energy sources, and high and stable economic efficiency. However, there are still many inadequacies related to consumer behavior as well as support policies from the government, which can only be gradually implemented on a small scale, not able to comprehensively affect each individual, enterprises and households because investment costs are always high. However, solar energy still has a lot of potential for research and development, the higher the efficiency solar battery systems, the better the chance of being widely applied (Thang, 2012).

2.6. Direction of Deployment, Setting up Solar Battery System in Future Urban Model

The overall goal in deploying solar energy development in Vietnam is to firmly ensure the national energy system, reasonable prices and quality to meet the needs of sustainable socio-economic development, improve living people's lives and protect the environment. Building a competitive, transparent energy market, effectively exploiting and using domestic energy resources in combination with reasonable energy import and export, thoroughly practicing thrift and using efficiently energy.

The incentive mechanism for the development of solar power in Vietnam is considered a push to create momentum for the solar energy industry in the Ho Chi Minh City area to develop (Decision 13/2020/QD-TTg, 2020). Therefore, in order to promote the solar energy industry, it is necessary to have policies to support and encourage and call for socialization in the investment and installation of solar battery systems, bringing the installation of solar battery systems. become a compulsory criterion in construction standards of industrial parks and large buildings, gradually approaching household standards. In addition, it is necessary to limit the circulation of poor-quality solar battery products outside, guide the handling and recycling of used solar panels, and issue appropriate legal regulations on solar power, thereby promoting the development of solar technology, making good use of the inexhaustible energy source that people are gradually grasping and possessing thoroughly.

However, the investment in a solar system requires the investor to have available initial capital, which is usually relatively high and this is the main reason that hinders the widespread development of rooftop solar battery systems. houses of households (Tuan, 2020). Because the investment costs are quite large, there will be many shortcomings in the implementation of policies to encourage the use of solar energy. However, we can aim for a modern model such as sponsoring and renting a solar battery system with an appropriate level, this model will be able to support promoting the use of solar energy in the future.

3. Conclusion

The development of solar technology has created a new industry called solar industry, creating millions of jobs, contributing to economic and social development, environmental protection and enhancing energy security in Vietnam. many countries around the world. Another important cause of the strong development of solar energy is the attention of governments in formulating, promulgating and implementing appropriate policies and trends of renewable energy development globally is gradually moving to the development of solar technologies. Vietnam is considered to have some of the best renewable energy resources in the world. This clean energy source and great potential can completely contribute to the balance of national energy sources.

Limitations

Although the article has been tried to complete, it will certainly inevitably have shortcomings, hope to receive comments from everyone.

Acknowledgement

Sincerely thanks to the research articles of the forerunners, the survey subjects during the implementation of this scientific research topic.

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