

Potential and application of solar energy in Vietnam

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Abstract: Vietnam is considered a country with great potential for solar energy, especially in the central and southern regions of the country, with an average solar radiation intensity of about 5 kWh / m². Meanwhile the solar radiation intensity is lower than in the northern regions, estimated at 4 kWh / m² due to weather conditions with cloudy weather and drizzle in winter and spring. In Vietnam, the average solar radiation of 150 kcal / m² accounts for about 2,000-5,000 hours per year, with an estimated theoretical potential of 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 central and southern provinces is about 300 days / year. Solar energy can be exploited for two uses: electricity production and heat supply. There are four types of solar technology currently available in Vietnam market. It is household-scale solar technology, commercially used for hotels, restaurants, hospitals, military and service centers, public lights, sound, and stations for charge.

Keywords: solar energy, application, solar battery, solar cells

1. Introduction

Solar energy, radiating light and heat from the Sun, has been exploited by humans since ancient times by using a variety of technologies developed more than ever. Solar radiation, along with secondary solar energy resources such as wind and wave power, water power and biomass, make up most of the renewable energy available on Earth. Only a very small part of the available solar energy is used. Solar power means power generation based on heat engine and photovoltaic battery. Using solar energy is limited only by human ingenuity. Partial list of solar applications for space heating and cooling through solar architecture, over-drinking water distillation and disinfection, daylight lighting, solar hot water, solar cooking, and high temperature thermal process for industrial purposes. To collect solar energy, the most common way is to use solar panels. Solar technology is widely described as either passive solar or active solar energy depending on how they capture, convert and distribute solar energy. Active solar technology involves the use of photovoltaic panels and solar thermal collectors to harness energy. Passive solar energy techniques include a building orientation towards the Sun, choosing materials with favorable heat mass or dispersed light properties, and designing natural air circulation space.

Due to the rapid development of the economy, the use of electricity increased rapidly. But accelerating the exploitation of fossil energy sources will lose the ecological balance leading to environmental pollution and directly affect human life. Currently, some countries in the world have advanced science is promoting the research and development of nuclear power system. However, the problem when developing this energy source is safety, namely technical safety and nuclear waste. In addition, factors such as the risk of proliferation of nuclear weapons, the security of national nuclear facilities. The issue of highly qualified human resources and experience, especially management and technical experts, are also major barriers to using and developing this energy source. Under the above conditions, developing and using solar energy is a good way to respond to factors such as safety, environmental,... Solar energy is an endless source of energy that, when exploited and utilized them effectively, will bring great benefits to people. Using solar energy instead of fossil energy will reduce emissions of environmental pollution, less reliance on fossil energy extraction, and thus limit the ecological environment. At present, many countries focus on researching, developing and exploiting solar energy sources for life. Solar energy research and research has become popular, so the prices of devices in the system are getting higher and more stable. In the past, cost was a barrier to the application of solar energy, but in recent years there have been many companies and organizations of various countries that are strong in research, manufacture and cost-making better.

The current consumption of the world is very large, while the main sources of electricity still depend on fossil fuels such as coal, gas, oil, ... So many countries being caught up in the scarcity of fossil energy, and the fact also indicates that depleting this resource is only a matter of time and Vietnam is such a country. With fossil resources exhausting while growth in electricity demand is 10% per year, investing in developing renewable energy is an inevitable thing. Renewable energy is the energy obtained from continuous sources and is considered infinite. Infinite has two meanings: Either energy exists so much that it cannot become exhausted because of human use or self-renewable energy in short and continuous periods in processes that still progress. for a long time on Earth. Vietnam is a country with great potential for developing renewable energy, especially

solar energy, because it is located in the tropics. However, at present, the exploitation of renewable energy in Vietnam is quite small, sporadic and not yet highly synchronous. The national grid system is still largely dependent on fossil fuel sources. Therefore, the increase in the rate of electricity produced from renewable energy is an indispensable requirement for the development of the electricity system, which should be more specifically included in the Vietnam Power Plan.

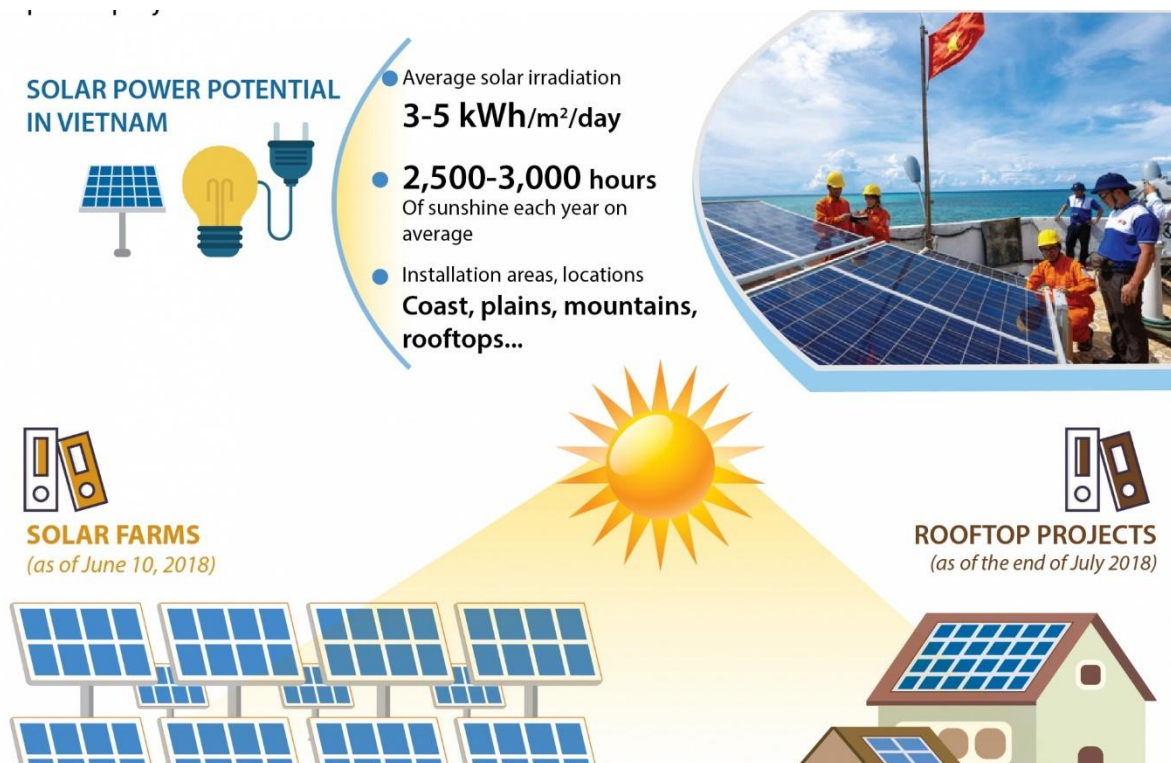


Figure 1 Potential of solar energy in Vietnam

2. Solar renewable energy in Vietnam

Solar energy is a source of energy due to solar radiation reaching the ground, can be retrieved and transformed in the form of heat or electricity. Solar energy has advantages such as: Clean, fuel cost and low maintenance, safe for users ... At the same time, developing solar cell manufacturing industry will contribute to replacing energy sources. fossil, reduce greenhouse gas emissions, protect the environment. Therefore, this is considered a valuable energy source, which can replace the old forms of energy that are running out. For a long time, many parts of the world have used solar energy as an alternative to traditional resources. The use of solar energy has so far included four basic methods:

- Convert solar energy into heat energy.
- Convert solar energy directly into electricity.
- Converting solar energy into chemical energy: photochemical effect.
- Converting solar energy through photosynthesis effect.

Vietnam is a country with a favorable position for the development of solar energy because there are large and stable solar radiation areas throughout the year. Among them, Ho Chi Minh City is the most popular one, followed by the North West region (Lai Chau, Son La, Lao Cai) and the North Central region (Thanh Hoa, Nghe An, Ha Tinh) and Cao region Former Central, Central Coast and Southern, Mekong Delta. On average, the solar radiation energy is 4-5kWh /m² per day. According to the assessment, the areas with sunshine hours of 1,800 hours / year or more are considered to have potential to exploit and use. The theoretical potential of Vietnam's solar power exploitation and development is estimated in the following table

Table 1. The theoretical potential of solar power

| Area | Average total radiation (kWh/m ² /day) | Acreage (m ²) | Solar battery capacity (MWp) | Electrical Power / day |
|---------------------------------|---|---------------------------|------------------------------|------------------------|
| Hong river delta and East North | 3.95 | 65.637.000.000 | 8.204.625 | 21.065.375 |
| North West | 4.8 | 50.684.000.000 | 6.335.500 | 19.766.760 |
| North Central | 4.9 | 51.459.000.000 | 6.432.375 | 20.487.114 |
| South Central and Highland | 5.3 | 99.018.000.000 | 12.377.250 | 42.639.626 |
| East South and Mekong delta | 5.15 | 64.153.000.000 | 8.019.125 | 26.844.021 |
| Total | | 330.951.000.000 | 41.368.875 | 130.802.896 |

The South Central and Central Highlands regions have the highest potential of solar power due to the highest area of land and total solar radiation in the country. Because of such advantages, Vietnam has been investing in solar renewable energy. Vietnam currently has more than 100 monitoring stations nationwide to monitor solar data and has 5 large solar power systems, including a system in Gia Lai, with a total capacity of 100 kWp (extreme capacity great when the sun is maximum). The Government is also investing to build 100 household solar power systems and 200 crowded solar power systems in Northeast islands with a total capacity of 25kWp. 400 more solar-powered family solar systems are being built for communities in Tien Giang and Tra Vinh with a total capacity of 14kWp.

As a large energy source and easily absorbed and used, solar energy is slowly becoming one of the most utilized renewable energy sources over the years and creators are looking for a lot. Better way to exploit this energy source. Those are applications for installing solar batteries on rooftops, vehicles, clothes, mobile phones and more. And all the solar energy to be absorbed and used is through a part that is solar battery



Figure 2. Solar battery

Solar cells are a method of generating electricity directly from solar energy through photovoltaic transmitters and are a very important part of solar power systems. Solar cells have a compact advantage that can be installed anywhere with sunlight. Solar energy application in this form is developed at a very fast pace, especially in developed countries. Today people have used solar cells in the field of aerospace, to run cars, electricity, and places where the grid has not been able to gradually replace traditional energy sources. Currently the main material for solar cells is crystalline silicon. Solar cells from silicon crystals are divided into 3 types:

- A crystal or single crystal module produced based on czochralski process. This single crystal has an efficiency of up to 16%. They are often very expensive due to the cutting of tubular ingots, these mono sheets have blank surfaces at the corner of the module.

- Polycrystalline made from cast ingots - carefully prepared from fused silicon, cooled and solidified. These batteries are usually cheaper than single crystals, but less efficient. However, they can form square panels that cover the surface more than single crystals compensate for low efficiency.

- Silicon strips are made of thin film pieces from molten silicon and have polycrystalline structures. This type usually has the lowest performance, however it is the cheapest of all types because there is no need to cut from silicon.

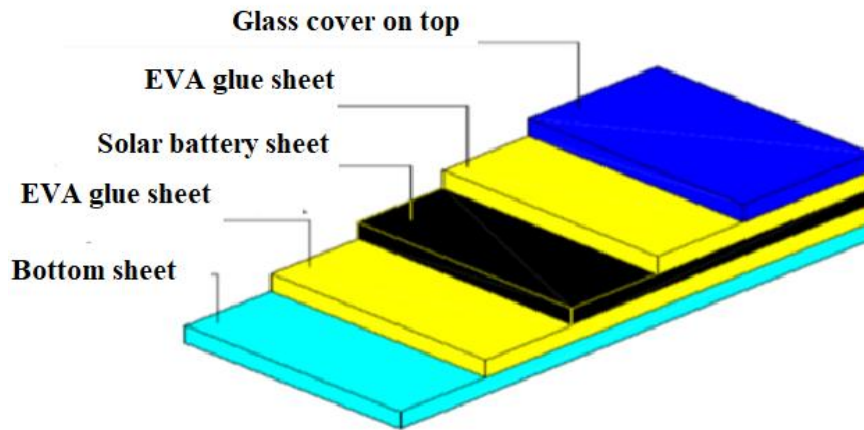


Figure 3. PV module construction

The principle of operation of solar cells is based on the principle of photovoltaic. If radiation photons release from the surface of the material, the effect of the photoelectric effect on the external circuit will be generated, ie, the current generated by the load will be generated. The case of radiation photons does not come out of the circuit but only moves like a free electron inside the material, creating an electric current called the photoelectric effect. The photovoltaic effect of semiconductor materials is the basis for creating solar cells.

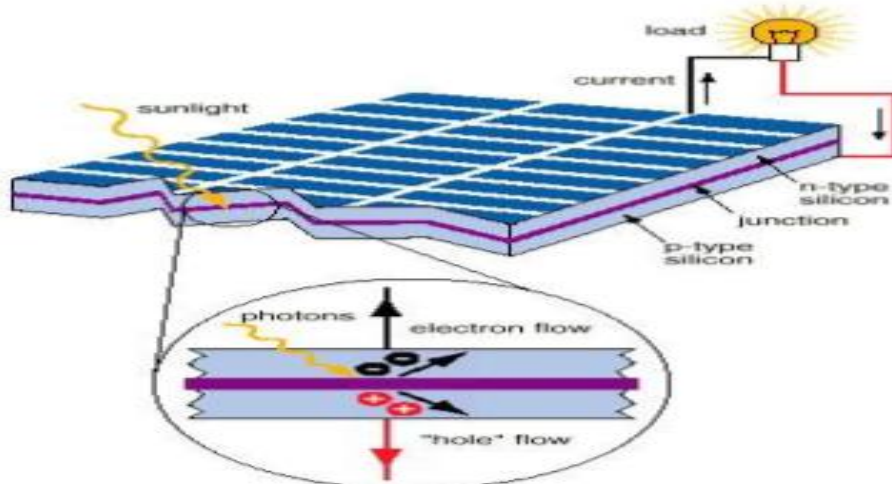


Figure 4. Principle of solar cell operation

The solar system (PV system) is now divided into 3 basic types:

- PV system works independently: Independent PV systems are often used in remote areas, where the grid does not pull. The block diagram of this system is as follows:

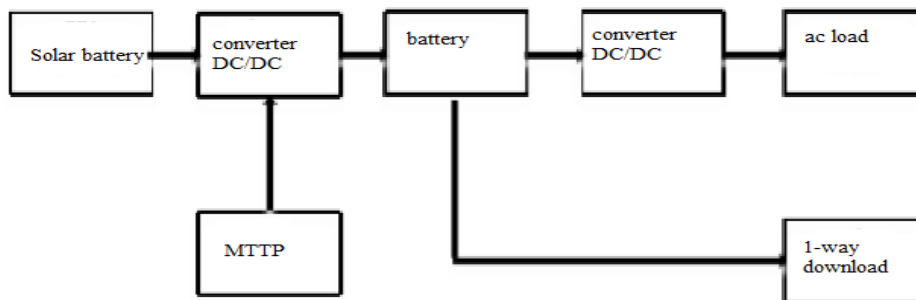


Figure 5. Photovoltaic system block diagram working independently

- PV system works with the grid: solar cell network is connected to the grid through the converter without a power reserve. In this system, the DC / AC converter for the electrical parameters of the battery to work with the grid must be synchronized to the grid in frequency and voltage. When solar cells generate a lot of energy, this excess energy will be transferred into the grid, while in bad weather conditions, without sun or rain, solar cells don't generate enough energy. In order to meet the load, the system will take electricity from the grid.

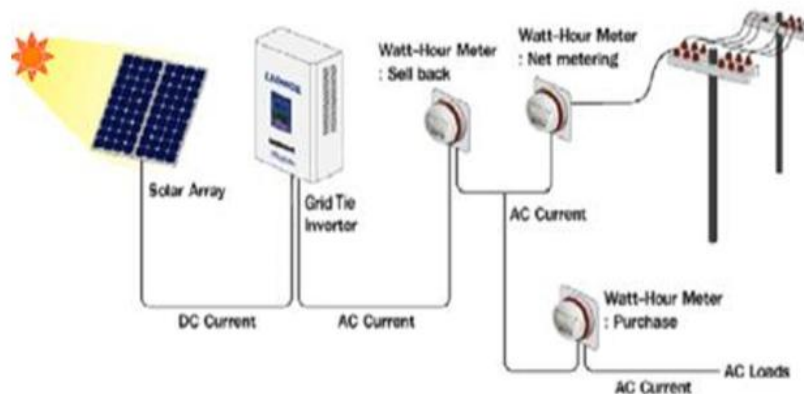


Figure 6. PV system working with grid

- PV system works independently combining solar energy and other energy sources: The system combines solar panels with other generators such as wind turbines, small hydropower, diesel engine sets ... with all advantages of local energy sources, used for high and continuous power load needs. This is a system with many outstanding advantages such as:
 - + The ability to combine two or more renewable energy sources based on the renewable energy potential of each locality
 - + Protect the environment especially to reduce CO2 emissions
 - + Diversified and stable supply
 - + Easy to install
 - + Fuel is abundant, considered endless
 - + Expected costs are not affected by fuel price fluctuations.

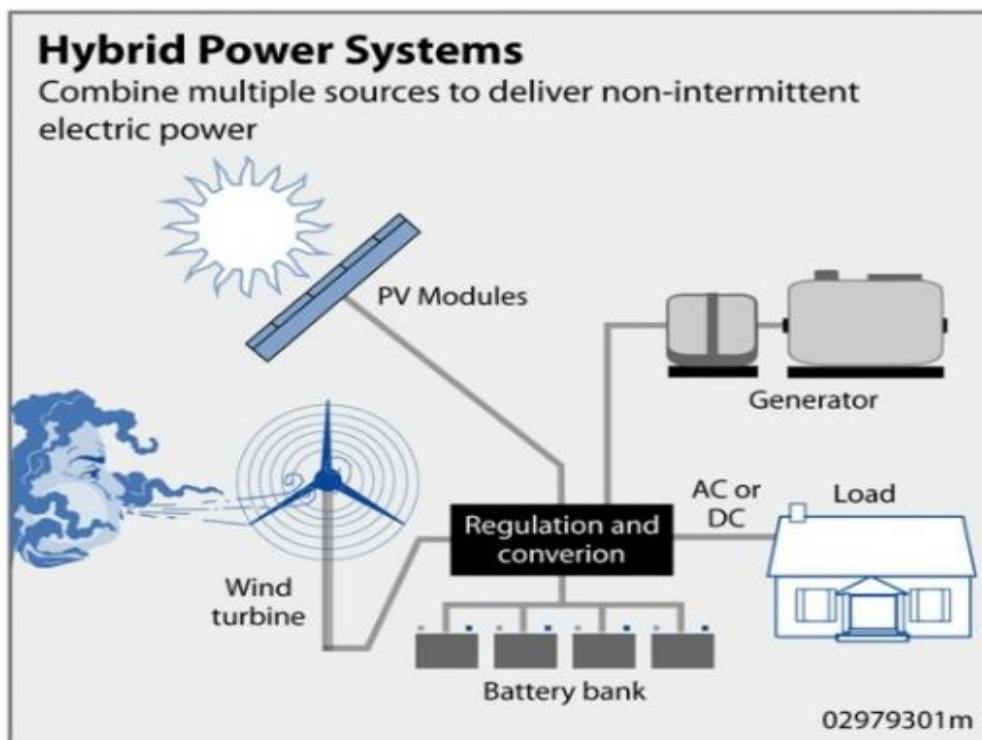


Figure 7. Hybrid solar and wind

Application of solar energy to shrimp farming: Solar energy application in recent times has been applied by shrimp farmers in 2 provinces of Bac Lieu and Ca Mau. The results showed that the application of solar energy to shrimp farming is a solution to protect the environment of ponds, reduce production costs, increase profits for farmers. Solar oxygen generation system will help reduce pollution, and contaminants in aquaculture ponds. This solution eliminates the possibility of pollution from other energy sources such as diesel, compressed air ... When used for industrial shrimp farming, absolutely no diesel or electric fan system is used, thereby will reduce production costs for shrimp farmers. According to the manufacturer's calculations, on the pond area of about 0.5 ha, if using diesel powered machines to operate the fan assembly, the average production cost per about 30 million VND. If using oxygen generation system which is applied by solar energy, production cost will be negligible due to no cost of fuel, machine and many other tools.



Figure 7. Solar energy application in shrimp farming

Application of solar energy, street lights, and traffic lights: Operating traffic lights with solar energy instead of electricity to create a clean green environment is a popular trend in many countries in the world. Not only saving electricity, but this alternative energy source also helps to limit traffic congestion every time you lose power and reduce the theft of power cables. The 3.6 m² solar panels are angled to ensure maximum performance in the acquisition of sunlight, which can provide power to operate the lights continuously.



Figure 8. Solar application for street lights

Hydrogen production: Electrolysis can separate water molecules into hydrogen and oxygen atoms, then hydrogen can be used as fuel. If the amount of electricity needed for the electrolysis process is supplied from fossil fuel sources, then CO₂ will be released into the environment, but if the electrolysis phenomenon carried out by solar cells will No environmental pollution. Some car companies around the world are testing some engines that use hydrogen fuel. Hydrogen is stored in several tanks placed in the vehicle body. Then a dynamic system will convert hydrogen into electricity to operate the vehicle. With this new method, the amount of hydrogen gas used as fuel depends entirely on the proportion of metal oxides (a conclusion The combination of iron, cobalt, aluminum, oxygen) and the amount of steam introduced into the system, the temperature of the adjustment process is suitable through a steam valve.

3. Conclusion

Energy and energy security are always considered the foundation for safe and stable development for all countries and territories. Therefore, in the context of traditional energy sources becoming increasingly exhausted, developing renewable energy, including solar power is considered a solution to energy problems for all economies. In Vietnam, with the great potential of wind energy, biomass energy ... and especially solar energy, the development of renewable energy has been posed as an urgent issue, a key task for with the electricity industry and concretized by the Government with the Renewable Energy Development Strategy. This is also confirmed in the revised VII Power Plan as Vietnam aims to bring the total solar power capacity from the current negligible level to around 850MW by 2020; about 4,000MW in 2025 and about 12,000MW by 2030. The proportion of solar electricity is 0.5%, 1.6% and 3.3% respectively. Energy and energy security are always considered the foundation for safe and stable development for all countries and territories. Therefore, in the context of traditional energy sources becoming increasingly exhausted, developing renewable energy, including solar power is considered a solution to energy problems for all economies. In Vietnam, with the great potential of wind energy, biomass energy ... and especially solar energy, the development of renewable energy has been posed as an urgent issue, a key task for with the electricity industry and concretized by the Government with the Renewable Energy Development Strategy. This is also confirmed in the revised VII Power Plan as Vietnam aims to bring the total solar power capacity from the current negligible level to around 850MW by 2020; about 4,000MW in 2025 and about 12,000MW by 2030. The proportion of solar electricity is 0.5%, 1.6% and 3.3% respectively.

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