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Wind energy as a green trend for future perspective

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Abstract
Wind power or wind energy is the use of wind to provide the mechanical power through wind turbines to turn electric generators and traditionally to do other work, like milling or pumping. Wind power is a sustainable and renewable energy, and has a much smaller impact on the environment compared to burning fossil fuels. Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electric power, competitive with or in many places cheaper than coal or gas plants.Onshore wind farms also have an impact on the landscape, as typically they need to be spread over more land than other power stations and need to be built in wild and rural areas, which can lead to "industrialization of the countryside"and habitat loss. Offshore wind is steadier and stronger than on land and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electric power to isolated off-grid locations.Wind is an intermittent energy source, which cannot make electricity nor be dispatched on demand. It also gives variable power, which is consistent from year to year but varies greatly over shorter time scales. Therefore, it must be used together with other electric power sources or batteries to give a reliable supply. As the proportion of wind power in a region increases, more conventional power sources are needed to back it up (such as fossil fuel power and nuclear power), and the grid may need to be upgraded.

Keywords: Wind energy, application, environmental perspective

1. Introduction
Wind power is one of the fastest-growing renewable energy technologies. Usage is on the rise worldwide, in part because costs are falling. Global installed wind-generation capacity onshore and offshore has increased by a factor of almost 75 in the past two decades, jumping from 7.5 gigawatts (GW) in 1997 to some 564 GW by 2018, according to IRENA's latest data. Production of wind electricity doubled between 2009 and 2013, and in 2016 wind energy accounted for 16% of the electricity generated by renewables. Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones. Offshore wind power offers tremendous potential. Wind turbines first emerged more than a century ago. Following the invention of the electric generator in the 1830s, engineers started attempting to harness wind energy to produce electricity. Wind power generation took place in the United Kingdom and the United States in 1887 and 1888, but modern wind power is considered to have been first developed in Denmark, where horizontal-axis wind turbines were built in 1891 and a 22.8-metre wind turbine began operation in 1897. Wind is used to produce electricity using the kinetic energy created by air in motion. This is transformed into electrical energy using wind turbines or wind energy conversion systems. Wind first hits a turbine’s blades, causing them to rotate and turn the turbine connected to them. That changes the kinetic energy to rotational energy, by moving a shaft which is connected to a generator, and thereby producing electrical energy through electromagnetism. The amount of power that can be harvested from wind depends on the size of the turbine and the length of its blades. The output is proportional to the dimensions of the rotor and to the cube of the wind speed. Theoretically, when wind speed doubles, wind power potential increases by a factor of eight. Wind-turbine capacity has increased over time. In 1985, typical turbines had a rated capacity of 0.05 megawatts (MW) and a rotor diameter of 15 metres. Today’s new wind power projects have turbine capacities of about 2 MW

offshore. Commercially available wind turbines have reached 8 MW capacity, with rotor diameters of up to 164 metres. The average capacity of wind turbines increased from 1.6 MW in 2009 to 2 MW in 2014.Indispensable energy for human life and all production and business activities. Satisfying the increasing demand for energy is a big challenge for most countries in the world [1][2]. With the current economic growth rate of Vietnam, the demand for energy is even greater and the risk of electricity shortage is always a concern of the electricity industry as well as businesses and people [3][4]. After the incident of the Chernobyl nuclear power plant (Ukraine, 1986), the Western governments headed by Germany from the early 90s were well aware of the potential risks of nuclear power to enforce the roadmap to narrow down nuclear energy [5][6]. Next, the rapid and unpredictable global climate change in recent years is a long-term consequence of the overuse of fossil fuels. In the framework of the implementation of the Kyoto Protocol (signed November 11, 1997) on reducing greenhouse gases that force developed countries to cut down on fossil energy sources and drive towards the use of clean energy sources such as wind, sun, biomass, ...[7][8] Because the wind does not blow regularly, in order to provide continuous energy, electrical energy generated from wind turbines can only be used in combination with other energy sources such as solar energy: The wind blowing at night is usually stronger than the day [9]. Another possibility is to use power plants with storage pumps to pump water into elevated tanks and use water to operate turbines when there is not enough wind[10]. Construction of these power plants with pump storage is a major impact on nature because they must be built on high peaks [9]. The reserve capacity depends on the accuracy of the wind forecast, the adaptability of the network and the demand for electricity [11]. There is another technology to store wind energy. The impeller will be driven directly to rotate the compressor. The kinetic energy of the wind is accumulated into the system of many compressed air cylinders. This series of compressed air cylinders will be rotated weekly by spraying on turbines to turn the generators [12]. Thus wind energy is stored and used more stably, the system of compressed air cylinders will be charged and discharged alternately to ensure the continuous supply of rotating energy [13][14].

2. Wind energy application

Wind power has been used as long as humans have put sails into the wind. Wind-powered machines used to grind grain and pump water, the windmill and wind pump, were developed in what is now Iran, Afghanistan and Pakistan by the 9th century. Wind power was widely available and not confined to the banks of fast-flowing streams, or later, requiring sources of fuel. Wind-powered pumps drained the polders of the Netherlands, and in arid regions such as the American mid-west or the Australian outback, wind pumps provided water for livestock and steam engines. The first windmill used for the production of electric power was built in Scotland in July 1887 by Prof James Blyth of Anderson's College, Glasgow (the precursor of Strathclyde University). Blyth's 10 metres (33 ft) high, cloth-sailed wind turbine was installed in the garden of his holiday cottage at Marykirk in Kincardineshire and was used to charge accumulators developed by the Frenchman Camille Alphonse Faure, to power the lighting in the cottage, thus making it the first house in the world to have its electric power supplied by wind power. Blyth offered the surplus electric power to the people of Marykirk for lighting the main street, however, they turned down the offer as they thought electric power was "the work of the devil. Although he later built a wind turbine to supply emergency power to the local Lunatic Asylum, Infirmary and Dispensary of Montrose, the invention never really caught on as the technology was not considered to be economically viable. Across the Atlantic, in Cleveland, Ohio, a larger and heavily engineered machine was designed and constructed in the winter of 1887–1888 by Charles F. Brush,. This was built by his engineering company at his home and operated from 1886 until 1900. The Brush wind turbine had a rotor 17 metres (56 ft) in diameter and was mounted on an 18 metres (59 ft) tower. Although large by today's standards, the machine was only rated at 12 kW. The connected dynamo was used either to charge a bank of batteries or to operate up to 100 incandescent light bulbs, three arc lamps, and various motors in Brush's laboratory.

With the development of electric power, wind power found new applications in lighting buildings remote from centrally-generated power. Throughout the 20th century parallel paths developed small wind stations suitable for farms or residences. The 1973 oil crisis triggered investigation in Denmark and the United States that led to larger utility-scale wind generators that could be connected to electric power grids for remote use of power. Today, wind powered generators operate in every size range between tiny stations for battery charging at isolated residences, up to near-gigawatt sized offshore wind farms that provide electric power to national electrical networks.

A Principle to convert wind into electricity

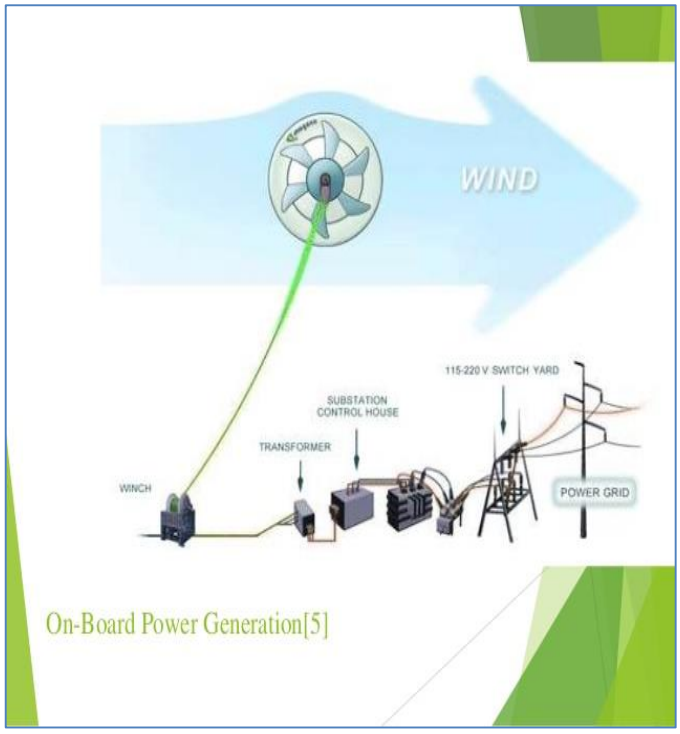

Fig. 1: Wind energy systems

How does a wind turbine generate electricity? A simple way is that a wind turbine works in contrast to an electric

fan, instead of using electricity to generate wind like an electric fan, the wind turbine uses the wind again. Generate electricity. Wind energy is described as a process; it is used to generate mechanical or electrical energy. Wind turbines will transform from wind dynamics into mechanical energy. This muscle energy can be used for specific tasks such as pumping water, or food crushers, or for a generator that can convert from mechanical energy to electrical energy. Wind turbines operate on a very simple principle. The energy of the wind makes 2 or 3 rotors spin around a rotor. Which rotor is connected to the main shaft and the main shaft will drive to rotate the rotation axis to generate electricity. Modern wind turbines are more cost-effective and reliable, and have increased their capacity to megawatts (MW). Since 1999, the average turbine capacity has increased significantly, the turbines installed in 2016 have an average capacity of 2.15 MW. Research by the US Wind Energy Technology Office (WETO) has contributed to improving this process through the development of longer, lighter blades, taller towers, more reliable powertrains, and Control system optimizes performance. Over the past two decades, this office has worked hard to develop a number of prototype technologies, many of which have become viable commercial products. An example is the GE Wind Energy 1.5 MW wind turbine project. Since the early 1990s, WETO has been working with GE and its predecessors to test parts such as rotors, generators and control systems on turbine designs and led to the GE 1 turbine model, 5 MW, this design accounts for more than half of commercial wind power generation in the US and is a major competitor in the global wind turbine market.

Turbine of a wind power station

In wind power applications, wind turbines play an important role in turning wind into electricity. The basic part of a wind farm is a turbine with a horizontal rotor shaft.

Its structure based on Figure 4 includes:

- Wings to catch wind direction and impact on turbine blades. Lifting force makes the turbine blades rotate. Each wing itself can turn around in the direction of the arrow as shown in Figure 2.
- Rotation motion is transmitted from the upper shaft through the gears. Thanks to the movement mechanism, it can move motion to the lower axis to the power generating part. The general trend in the world is to use more wind energy in the future when the technology is "mature" and construction and installation costs are no longer "expensive". In order to partly solve the energy shortage due to the economic development process in addition to continuing to exploit traditional Vietnamese energy sources, step by step harnessing wind energy. To accelerate the exploitation of renewable energy such as wind power, biomass, solar, then the macro level we need to solve the following basic problems:
- The State proposes a national program on clean energy use, in which there should be priority policies in terms of technology, equipment, finance, loans, purchase and sale prices ...and step by step remove the monopoly and allow private businesses to participate in electricity business.
- Vietnam electricity industry needs to have a satisfactory policy on electricity trading contracts of wind power plants with prices from 4.5–5 cents / kWh in accordance with Vietnam's current electricity prices and facilitating wind power plants to participate in national networks.
- Solving the above basics, will greatly increase the number of wind power plants in Vietnam. In the near future, wind power plants in Vietnam are fully capable of contributing to Vietnam's energy balance. First of all contribute to ensuring a 10-15% rate of using clean energy in the total electricity of Vietnam, which Vietnam electricity industry agreed to sign in the electricity industry conference of ASEAN countries in 2005.

In the long term, Vietnam needs to develop a strategy and roadmap to develop new energy sources. In this strategy, economic costs (including internal and external costs of the environment and society) need to be carefully analyzed, taking into account new developments in technology, as well as reserves. And price fluctuations of alternative energy sources. In these new energy sources, wind energy emerges as a worthy option, and therefore needs to be fully assessed. Vietnam has many advantages to develop wind energy. The lack of investment in research and development of wind power is a big waste while the risk of electricity shortage is always permanent, affecting the economic growth rate and national competitiveness. Meanwhile, the current national strategy on electricity seems to be only interested in large thermal and hydroelectricity. Whether Vietnam can "go off and take a lead" in wind energy development depends very much on state policies

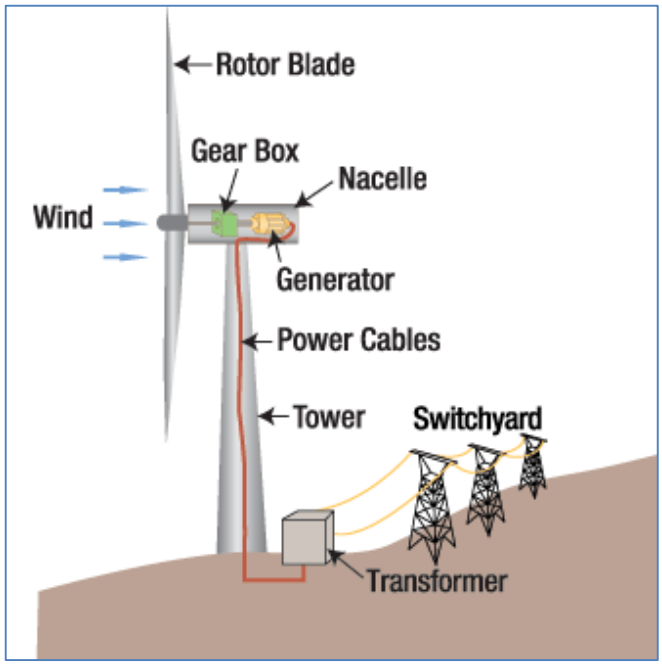

Fig. 2: Structure of wind turbines

A wind turbine, or alternatively referred to as a wind energy converter, is a device that converts the wind's kinetic energy into electrical energy. Wind turbines are manufactured in a wide range of vertical and horizontal axis. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of large turbines, known as wind farms, are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on

fossil fuels. One assessment claimed that, as of 2009, wind had the "lowest relative greenhouse gas emissions, the least water consumption demands and... the most favourable social impacts" compared to photovoltaic, hydro, geothermal, coal and gas. People distinguish three types of wind power stations: onshore, near shore and offshore. Stations located on the coast or on the continental shelf often produce higher yields than domestic stations because the coast often has strong winds. This solution saves construction land, while transporting large structures on the sea is also more convenient. Inland, it is possible to use mountains and wild hills to install wind power stations. This case does not need to be a high pillar, saving a significant amount of construction costs. In addition, the high-rise roof can also set up the station to meet the specific needs of the house as well as supplying electricity to the city. Electrification of the railway industry is an inevitable trend of industrial countries. Just put with a distance of 10 km of a 4,800 kW station along the railway lines that have enough power for all trains in Vietnam today [30]. Thus, diesel and coal locomotives that consume large amounts of fuel and pollute the environment are replaced by electric locomotives in the future.

Wind energy is the fuel produced by wind, so it is a clean fuel. Wind energy does not pollute the air compared to thermal power plants that rely on burning coal or gas. Wind energy is available in many areas. So the country's wind power supply is very rich. Wind energy is a renewable form of energy that is low in price due to advanced science today about 4 to 6 cents/kWh. That depends on the source of the wind, the finance of the project and the characteristics of the project. Wind turbines can be built on farms, so it is an economic condition for rural areas, the best place for wind to be found. Farmers and ranchers can continue their work on their land because wind turbines use only a fraction of their farmland, wind energy investors only have to pay compensation to farmers. And owners of farms whose land is used to install wind turbines. But the main disadvantage of wind power is that it depends entirely on wind conditions and thus will affect the quality of the current. Wind energy must compete with conventional sources at a basic price. That depends on how strong the wind is. So it requires a higher initial investment than other fuel-powered generators. Wind energy is an intermittent energy source and it doesn't always have to be electricity. Wind energy cannot be stored and not all wind power can be exploited at the time of the need for electricity. Places with good wind power are often located in remote locations away from the city, but those places need electricity.

Located in the monsoon subtropical region with a long coastline, Vietnam has a fundamental advantage to develop wind energy. In the energy assessment program for Asia, the World Bank has a detailed survey of wind energy in Southeast Asia, including Vietnam. According to the calculation of this study, in the four countries surveyed, Vietnam has the largest wind potential and more than neighboring countries such as Thailand, Laos and Cambodia [31]. While Vietnam has 8.6% of the territorial area assessed as having potential from "good" to "very good" to build large wind power stations, this area in Cambodia is 0.2%, in Laos is 2.9%, and in Thailand is only 0.2%. The total wind power potential of Vietnam is estimated at 513,360 MW, which is equal to more than 200 times the capacity of Son La hydropower and more than 10 times the total capacity forecasted by the electricity industry by 2020. Of course, to switch from theoretical potential potentials can be exploited, so that the technical potential and ultimately the economic potential is a long story [32]. Considering the standard for building small wind power stations for economic development in difficult areas, Vietnam has 41% of rural areas that can develop small wind power. If comparing this figure with neighboring countries, Cambodia has 6%, Laos has 13% and Thailand 9% of the rural area can develop wind volume. This is indeed a privilege for Vietnam but we are still indifferent to how to make use of it.

Until the 1990s, people still thought the cost, including the installation and operation costs of wind power stations was quite high. But this prejudice is currently under review, especially when the concept of cost includes not only economic costs but also external costs (such as social costs due to relocation and resettlement, or environmental costs due to loss of land or environmental pollution. While fossil fuel energy sources are considered to be less stable and tend to increase, along with the rapid development of technology, the cost of wind power stations is getting cheaper. Take the example of Son La hydropower plant with 6 units, total design capacity of 2,400 MW, is expected to be built in 7 years with a total investment of 2.4 billion USD. The cost of electricity generation (excluding environmental costs) is 70 USD / MWh. So to get 1 KW capacity needs to invest 1,000 USD in 7 years. Meanwhile, by the time of 2003, investment in 1 KW of wind power in many European countries was also about USD 1,000. It is noteworthy that this price falls steadily every year due to technology improvement. If the average usage time of each wind farm is 20 years, the depreciation cost for one KWh of wind power will be 14 USD. In addition to regular costs, the total cost of management and operation will be in the range of 48-60 USD/MWh, equivalent to hydroelectricity, which is considered a cheap and efficient energy source. As predicted, by 2020 the cost of wind power will decrease significantly, only about 600 USD/KW, then the management and operation costs will decrease significantly, to about 30 USD/MWh. In a wind power project, there are many different costs: Turbine costs account for 45%, pillars 25%, installation 7%, power transmission 8%, project management 2%, other costs 13%. Here are some economic calculations for a wind power project (51 MW, total investment of 65 million USD, electricity output of 150 million KWh) according to 3 calculation plans of: Germany, Vietnam and Vietnam + Germany (see table 4). In general, economic indicators such as NPV and IRR can be considered acceptable. Construction of hydropower has many impacts on the environment and society such as dam failure risks, relocation and resettlement, loss of traditional cultivation and cultivation land, loss of forest land, mineral resources, and Cultural relics, ... And nuclear power plants are at risk of nuclear leaks. Fossil-fueled power plants are always the cause of heavy pollution due to greenhouse gas emissions. Moreover, these fuel sources are less stable and prices tend to rise. Wind energy is considered to be the most environmentally friendly and has little negative impact on society. There are some researches that wind farms disrupt or ruin the natural landscape, affecting the movement of birds. But these effects are negligible and can be moved easily if needed. When fully calculating external costs

(costs incurred in addition to traditional production costs), the benefits of wind power utilization become more pronounced. When using wind energy, people do not suffer losses due to loss of crops or resettlement and also do not incur additional medical and health care costs due to pollution[35]. In addition to dispersing and lying close to residential areas, wind energy saves transmission costs. Furthermore, wind power development requires a highly specialized workforce such as engineers or technicians to operate and monitor. Thus it created more jobs with high skills. In European countries, wind power plants do not need to invest in land to build stations but immediately rent land from farmers. The rental price of land is about 20% of the regular operation cost, which has helped to bring a stable source of income for farmers, while the cultivated area is not much affected. Finally, wind energy helps to diversify energy sources, which is an important condition to avoid dependence on one or a few key energy sources; and this helps to spread risk and enhance energy security.

3. Conclusion

All renewable energy sources are generated by heat generated by solar radiation. Wind is also a phenomenon caused by the warming of the earth's atmosphere. Sunlight on the surface of the earth unevenly makes the atmosphere, water and air unevenly heated. As a result, hot air will move upwards, cold air will move downwards. The change in position between hot air and cold air will form wind. Wind power can be harnessed by one. One of the drawbacks of wind power today is the expensive cost of making turbines, where each turbine requires 1 ton of rare earth metal. However, it could be much cheaper with superconducting adhesive tape that EcoSwing is starting to apply. Not only did this significantly reduce the cost of producing wind turbines (down from US $ 45.5 / kg to US $ 18.7 / kg), it also helped reduce weight and size requirements. It can produce the same power but save about half the weight and mass of a conventional turbine. Currently all countries in the world are facing the fight against global climate change, with the implementation of the goal of Paris COP 21 is to ensure the average global temperature rise from now to 2100 in levels below 2 ° C, by reducing the production and use of energy from fossil fuels (coal, oil, gas), which causes two-thirds of the greenhouse gas (CO2) that is replaced by sources of renewable energy (renewable energy) such as wind, solar and biomass.

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