

Wind Power and its Impact on the stability of the electric grid in Kuwait

Submitted by

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Abstract

Wind energy has been known to man since long time ago, as he relied on it completely, as it is one of the energy-saving energies, and works to convert the kinetic energy generated by the wind into electrical energy or mechanical energy that can be used, and it was used in the past in the form of windmills, which were contributing to the Accomplish a lot of tasks such as pumping water and grinding grain, but nowadays you use windmills in a different way, where they rotate the mechanism necessary to generate electricity, and we will talk in this research about wind energy and its role in generating electricity and impact on the stability of the electric grid in Kuwait.

Introduction

In ancient times and for long periods, wind energy was used by using windmills that were grinding different grains such as wheat, barley and others, and also pumping water. Now we use the most advanced wind machines that are known today as wind turbines in more parts of the world to be It converts the kinetic energies of the wind into electrical energies. In the current era, we find the most modern commercial wind turbines that are produced by using the rotational energies to operate the generators from high and high columns or towers, where at the top of the turbines they have large blades and the base includes the engine where the length of the blades of the large wind turbines is about 1.8 megawatts of energy, i. More than 130 feet, and these blades can be placed on very

high towers, including 260 feet, or about 80 meters, but there are also small turbines in size, and they are used in personal and individual homes to generate power ⁽¹⁾ .

Energy means the ability to do certain actions, that is, it is the ability possessed by a certain system or certain bodies to do actions and activities. Energy may exist in various forms such as kinetic, thermal, electrical, chemical, and other forms. No one can destroy energy or create it, but it can be changed from forms to other forms, and energy has many sources, including non-renewable sources and renewable sources; Non-renewable energy sources are those that can be exhausted and cannot be used repeatedly, such as coal, petroleum, natural gas, etc., and renewable sources of energy are those that cannot be exhausted and can be used many times, such as solar energy, wind energy, and others. ⁽²⁾

Energy of wind

Wind is an important source of clean energy, but it is also used in many sources to produce energy, and wind energy is energy that has been gained from the wind kinetic energies using wind turbines or wind turbines to generate electric, and it is one of the types of electromechanical energies, energy of wind is one of the renewable energy type that have been used widely used instead of fossil fuels, and they are among the energies that are abundant and renewable and are found in many areas, especially the public, but there is a diversity in their availability and they differ from one site to another, and they are clean energies that are renewed not It produces emissions such as greenhouse gases or greenhouse gases during the operation process, and the sizes of their areas vary according to the sizes of the stations. Therefore, we find

that there are those who need varying areas, and all this is due to the size of the stations and the types of towers that are use ⁽³⁾ .

wind farms

Wind farms are large groups of wind turbines that are used in one place and used to produce electricity, and we find that large wind farms use hundreds of individual turbines of wind that are distributed to cover extended areas, and the land that locates between the turbines is exploited and used for many purposes like agricultural purposes, and we find that the majority of wind turbines that are large one have almost the same designs, and wind turbines have horizontal axes rotating three blades directed upwind, suspended on the chassis of engines on top of a tall tubular tower ⁽³⁾.

wind energy of offshore

It is wind farms construction in the midst of large bodies of water to generate electric. These farms are more efficient than those on land because the winds in the sea region are more powerful and more frequent, but the cost of building them is higher than that of land farms, and their maintenance is very expensive ⁽³⁾ .

Benefits of wind energy use

Wind energy is used to produce electricity for many benefits, like:

- **low cost**

Wind power generation is one of the most cost-effective ways of generating energy, as the construction of the project does not require high costs and can make use of the electricity generated to reduce the costs associated with it. It is one.

- **Clean fuel source**

The energy harvested from the air does not pollute like in power plants that rely on fossil fuels burning like coal and natural gas, that results in a variety of particulates, nitrogen oxides, and sulfur dioxide on the skin. Damage that causes health and financial problems. Wind turbines do not release into the atmosphere the emissions that cause rain of acid, fog, and gases of greenhouse.

- **Durability and renewable resources**

Energy of wind is a type of solar energy because it results from atmosphere heating by the sun, the earth rotation, and the earth's surface irregularity. The ability to build windmills on farmland helps rural economies and brings significant benefits. Windmills use a land fraction, so ranchers and farmers can continue to work the land. ⁽⁴⁾

- **Provide jobs opportunities:**

In the US, wind energy provides thousands of jobs and is in great demand for wind turbine engineers. ⁽⁴⁾

How can wind turbines work

Wind turbines - engines that generate energy from wind - are one of the world's fastest growing sources of energy, and they are distinguished by their generation of electrical energy without emitters of greenhouse gases to the environment, such as those resulting from fossil fuels, and windmills are currently used to convert mechanical energy from Wind into electrical energy, and wind turbines consist of three main parts as follows:

- **The tower:** It is the long column that is connected to the ground.
- **The blades:** to be at the top of the main center or the rotor.
- **Al-Basna:** It is the engine cover and is located in the form of a box behind the **blades** and contains the generator.
- **The rotor** or the main center in the turbine rotates in the event that it is exposed to strong enough winds, and the rotor is connected to a thrust rod, and this rod in turn reaches the pedestal behind the blades and operates the generator, and the generator in turn produces electrical energy that can be converted into the electrical voltage appropriate to the electrical network, usually placed Wind turbines that energy providers use in groups or rows called wind farms to take advantage of areas where the wind is present. ⁽⁵⁾

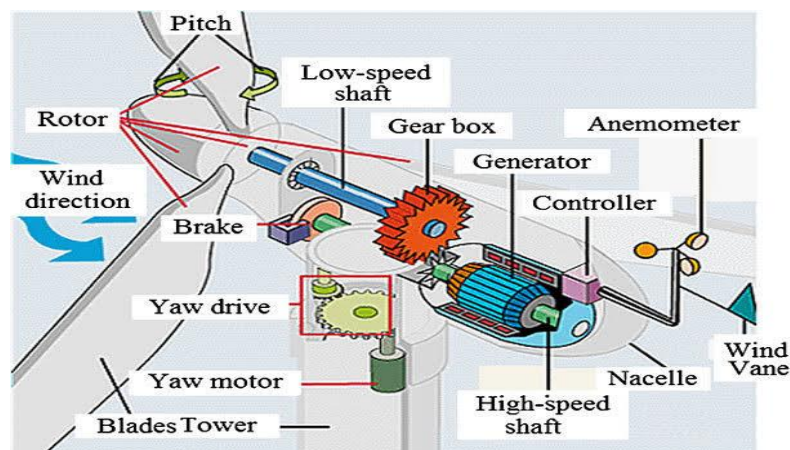


fig1: show the structure of wind turbines and How can they work

How to convert wind energy into electrical energy

It is based on the principle of producing electricity from the wind to convert wind turbines to the wind that are directed towards it with mechanical energies. The rotating force then passes to a generator of electricity that produces electricity, where the energy of electric generated from more not only one wind turbine but more than one that located in the farm of wind is collected, transferred to the main network of electricity to be utilized. The wind turbine composed of three blades on a steel shaft about 80 meters in height. It also contains nickel part that houses generator, the gearbox, the shaft and the controller that reach the speed to double of the kinetic energy transmitted to it. (°)

More than century ago, wind turbines first emerged. Following it the starting of electric generator invention in the 1830s, engineers began to attempt to energy of wind harness to generate electricity. In 1887 and 1888, generation of energy of wind took place in the US and United Kingdom. But latest energy of wind is considered the leading in developing in Denmark, in 1891 wind turbines horizontal axis was built and a wind turbine of 22.8 began to work in 1897.

Energy of wind is used to extract electricity by created kinetic energy be motion of air. To transform it into electrical power through wind energy conversion systems or wind turbines. When wind hits a blade of turbine firstly, that lead to rotation and turning the turbine connected to them. That kinetic energy transformation to rotational energy through moving a shaft which is linked previously to generator.

The amount of power that can be extracted from wind relying on the size of turbine and blades length. The result we gain is proportional to dimensions that owned by rotor and to the speed cube that related to wind. Theoretically, when the speed of wind is about the double, potential of power of wind elevates by the eight-factor.

Over time capacity of wind turbine has increased. In 1985, typical turbines had a rated capacity about 0.05 MW and diameter of rotor about 15 m (6).

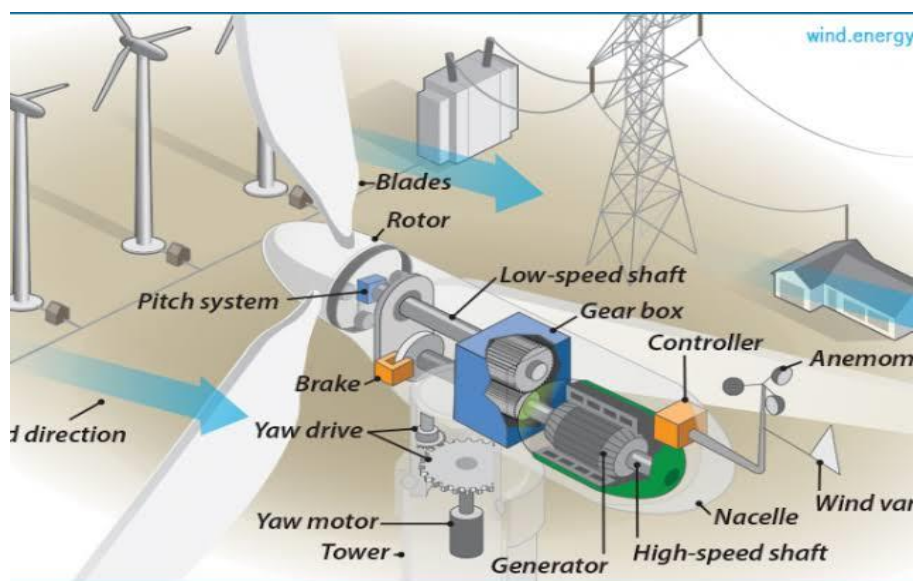


fig2: show how to convert wind energy into electrical energy

Impact on the stability of the electric grid

Wind energy and its uses are a form of transformed energy, and where does this vitality come from the way of misusing the evolution of the wind and transforming it into another form to become a form of vitality,

where turbines through the vitality of the wind transform into electrical or mechanical vitality, and the vitality of the wind decreases under the influence of vitality. energy resources. A renewable option to fill excavations, small turbines can be used to control the supply of homes, there are unusual wind farms which are ranges where a large number of wind turbines are grouped together to maintain more important source of vitality, and in the past, wind energy in the form of windmills was used for several Centuries to the task of grinding grain and pumping water, wind turbines use current to exchange energy for power generation by utilizing rotating dynamics to control an electric generator. Due to the many preferences of the wind breeze, it has resulted in the use of many areas. (6)

For renewable integration in a milestone, national renewable energy laboratory and General Electric operated wind turbine common class in mode of grid-forming, that is when the generator can set voltage and frequency of grid and if necessary, operate without electric grid power.

The NREL demonstration using controls of GE showed that the popular turbine technology type-3 can supply fundamental stability to the power grid bulk. Such grid-forming controls could allow the turbine to make up for some stability conventional sources on the grid, like natural gas fired or coal generators (6)

Demonstration of this real-device is the first of many in the energy department wind energy technologies office project.

As renewable make up a larger share of power supply, they will also need large responsibility share as grid stability stewards. That responsibility contains the restart power capacity following an outage, to restabilize following temporary electrical event, and to generally form the baseline

power resource that known as grid. For fleets wind turbine and other resources like battery storage and solar PV, grid- forming controls could open a new opportunity in market in the form of grid services; that is, grid stability as another stream value for resources that are renewable. With this demonstration, using solution of GE, NREL has validated one more approach for renewable assets to supply progressive stability. And with platform of ARIES, NREL can help proving renewably sourced stability by partners on their systems (6).

Effect of wind turbine generator structure's different technologies

There are several and different types of generators that are unique to the wind energy packages in use today. There may be a fundamental difference between the types of fixed and variable frequency wind generators.

- **Wind turbine generator with fixed speed**

In wind energy's first stage of development, maximum farms of wind are equipped with windmills and induction generators at a constant pace. A wind generator with constant pace is usually fitted with a cage that is squirrel induction generator with limited pace versions. Energy can be managed in the simplest way via the stand's versions. Since the performance of a windmill is determined by the ratio of speed, the power of a strong and fast generator of wind differs with frequency of wind without delay. Since machine induction lacks reactive power, capabilities

of management, power side correction structures, whether fixed or variable, are typically used to adjust generator reactive power recovery.

(⁶)

- **wind turbine generator with variable speed**

Different tempo parameters let wind turbines to function at a higher top speed rate and then a higher rated power factor for a large temperature range of wind. The most used widely is wind generator with variable speed standard is DFIG and a synchronous generator driven by a transformer.

- Wind Turbine Multiplier Feed for Induction Generator

Given the benefits including increased power performance and controllability, DFIG's variable speed wind turbines are receiving additional attention. The type of “DFIG” is rotor-wound induction generator which is essentially standard with a supply transformer voltage attached to the sliding earrings of the rotor. The winding of stator is connected to the network once and the winding of rotor is connected to the power transformer (⁷).

- **Synchronous converter generator motor**

A synchronous generator, which may be an excited electrically synchronous generator or a permanent machine of magnet, is used in this type of windmill. This generator is linked to the community through a variable converter of frequency, which isolates the generator from the community completely. This allows for variable speed operation. Even if the community frequency remains constant, the generator electrical

frequency may fluctuate due to changing in frequency of wind. In these wind turbines, the grade of the transducer related to the power that is rated of the plus losses of generator. (7)

Situation of renewable energy in Kuwait

The sector of renewable energy in Kuwait is still nascent, however, in recent years, there has been high activity mainly leys on need account for energy resources diversification, concerns of climate changes and awareness of public. The character of oil- rich that Kuwait has, has embarked on journey that is ambitious to meet of its energy requirements about 15 per cent that equal to 2000 MW from resources of renewable energy by 2030. (7)



One of the developments that are promising is the initial phase kick-starting of 2GW Shagaya park of renewable energy in previous December. As the investment more than \$8 billion to achieve targets of renewable energy in Kuwait.

The good potential in the country of Kuwait is energy of wind as the average speed of wind is at about 5m/s that is located in regions like AlTaweel and ALWafra and this speed is good. Kuwait in fact already has an existing 2.4 MW Mini wind farm of Salmi, that completed totally in 2013, that serves mainly towers of telecommunication in far areas and the bridge station of fire in Salmi. Farly, concerning of biomass energy occurs, as it has very scope limitations in country of Kuwait because of lacking resources of water and the arid climate.

Program of Kuwait renewable energy

One of the earliest renewable energies advocated in the Middle East is country of Kuwait. With its dating back that involvement to mid of 1970s; however, the renewable energy sector in Kuwait is in its early level. The good news is that, starting of renewable energy has been occur to move into agenda of development and discourse of politics in Kuwait.

The KAPP and KISR in Kuwait are playing major role in pushing Kuwait towards the economy of low carbon. Particularly, KISR has been mandated by Kuwait government to enhance alternative energy systems of large scale that occurs in collaboration with technology companies and international institutions.

Program of Kuwait renewable energy, with the generation aim 2 GW of renewable energy near by 2030, has been divided into 3 steps. The first one maintains 70 MW construction integrated park of renewable energy (that contain solar thermal, wind and PV) at project of Shagaya that was scheduled to be completed totally at the end of 2016. The second step and third step are designed to produce about 1000 MW and 930 MW. These three steps will meet the demand of electricity of 100,000 homes and save barrels of oil of about 12.5 million per completion year. ⁽⁷⁾

Conclusion

Wind energy is defined as one of the different types of energy conversion. Windmills or engines of turbines can convert wind kinetic energy into electrical or chemical one, which can be used as a source of energy. Where trade winds, or winds traveling in the same direction, were regularly help in moving ships and freight the oceans, and where some ships that are large are still use wind power till now. Wind farms are large groups of wind turbines that are used in one place and used to produce electricity. Benefits of using wind energy are low cost, clean fuel resource and durability and renewable resources. Converting wind energy into electrical one is based on the principle of producing electricity from the wind to convert wind turbines to the wind that are directed towards it with mechanical energies. The rotating force then passes to a generator of electricity that produces electricity. The KAPP and KISR in Kuwait are playing major role in pushing Kuwait towards the economy of low carbon. Particularly, KISR has been mandated by Kuwait government to enhance alternative energy systems of large scale that occurs in collaboration with technology companies and international institutions. Program of Kuwait renewable energy, with the generation aim 2 GW of renewable energy nearby 2030.

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