

Energy Farm

Solar Farm vs. Wind Farm



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Executive Summary

Electricity power is required in adequate quantity and consistently for the growth in the economy of highly advanced industrialized nations. This holds for all sectors of a contemporary economy, from manufacturing to transportation as well as to other service sectors, and also to individual families. While the need for energy as well as its relevance for an effective power sector is self-evident, the world needs to formulate ways of generating power from sources that are free from pollution, cost-effective sources, and also ensure that the plants' maintenance is friendly and economical. Apart from its great contribution to the country's GDP, the power sector is critical to its economy since it ensures the constant availability of energy in various forms. The government of India, with the close collaboration with the ministry of power of Rajasthan, has for many years generated its power through the use of thermal energy to ensure that all the sectors are well equipped with the power to carry out their operations and for the growth of the Indian economy. However, the ministry has shown its concern about replacing the thermal plants with the plants which are more environmentally friendly such as solar farm or wind farm. This replacement lowers carbon footprints or pollutants generated during power generation. Numerous power stations in India operate on carbon fuels and pollute the surroundings. Therefore, the newly attributed plant must be carefully designed to provide enough assistance for the existing electricity infrastructure while being environmentally friendly.

This paper aims to give a clear recommendation to the ministry of Power in Rajasthan to assist them in choosing the best plant selectively to replace the thermal plant between wind farm and solar farm. The Ministry of Power in Rajasthan is looking for ways to reduce carbon footprints as pollution caused while producing electricity is increasing. Many power plants run on fossil fuels and are polluting the environment around them. The plan is to remove existing power plants with plants that produce electricity from renewable energy like solar or wind. The plant must be carefully engineered to properly support the current power grid and still be safer for the environment. In this theoretical situation, a client wishes to replace a thermal power plant from the grid with renewable energy. They must choose the type of renewable energy to replace fossil fuels. It is preferred that the replacement must be able to produce at least the same amount of electricity as a thermal power plant. Other options might incur unplanned or unpleasant costs and may make the project undesirable to continue. This impacts homeowners as well as the business owner, who may need to pay extra for electricity due to storage.

Introduction

The production of electricity, which is mostly dependent on fossil fuels, contributes to around one-quarter of the overall CO₂ emissions, which is the largest driver of harmful global warming. The Intergovernmental Panel on Climate Change (IPCC) offers the most comprehensive studies and statistics on the origins and effects of CO₂ on global warming (Suman et al. 79). The entire extent of the consequences and implications of increased CO₂ levels remain unknown, although a study by the IPCC together with others is underway. Although the technologies to reduce these carbon emissions in many countries are still underway, the ministry of Power in Rajasthan is keen on looking for alternatives to replace its thermal power plants, which have contributed heavily to the nation's pollution since a lot of CO₂s is emitted in these operations increasing the threat of global warming and other medical conditions that comes as a result of pollution. Renewable energy production may assist countries in achieving sustainable development by maximizing their use of renewable energy to create cleaner food and also energy security and alleviate socio-economic difficulties (Suman et al. 79). The plurality of capacity expansions in power production utilizing renewable energy is gaining speed in the current energy environment. Recently many nations have seen tremendous growth in the deployment of renewable energy technology for electricity production. After vigorous research, the ministry of Power in Rajasthan aims at replacing its thermal power plants with wind farm or solar farm, as discussed in the paper. This paper will also give an overview of the thermal power plants and also discuss in detail both the wind and solar plants' power in terms of maintenance, power production, availability, and the effects of these plants on the environment.

Overview

A thermal power station involves a power plant that converts heat energy into electrical energy. In most cases, heat is utilized to boil the water in a massive pressure vessel, producing high-pressure steaming that powers a steam turbine coupled to an electric engine. This turbine's low-pressure emissions travel via a condensing steam turbine and later return to the location where it was initially heated (Mills 19). This is referred to as the Rankine cycle. Natural gas, together with other fossil fuel extractions, is directly burned inside a gas turbine for heating the water used to power the steam turbine. One of the primary benefits of thermal energy is its cheap cost of generating (Swarnkar et al. 45). The plants produce electricity using fossil fuels that are still plentiful and cost-effective. Second, a thermal power plant may be constructed in any appropriate region, contrary to hydroelectric projects. Thirdly, thermal energy production is seen as a more dependable source of energy for meeting future energy needs since the power plants are adaptable to shifting power needs and demand patterns.

Nevertheless, its disadvantages outshine its benefits, mostly regarding environmental conservation. First, by burning fossil fuels to generate energy, a lot of carbon dioxide is emitted, which is the major contributor to global warming. The discharge of toxic gases such as sulfur dioxide, CO₂, and others has temporarily detrimental effects on the ecosystem. Additionally, certain thermal power plants have been reported to release a significant quantity of mercury and create fly ash, which may pollute the atmospheric air, water, and land (Mills 19). There is a possibility of pollution being generated by non-point sources such as coal transit, fuel loading, unloading, and coal and oil preservation. Water contamination may be produced by various factors, including plant waste, ash management, and demineralization (Swarnkar et al. 45).

Secondly, Thermal plants need a considerable quantity of water to generate steam that may be used to power turbines. The enormous demand for water has a detrimental effect on water sources such as rivers, reservoirs, and groundwater. Moreover, Thermal energy is generated using finite resources. Thermal energy production needs the exploitation of coal and also natural gas from the ground, resulting in their degradation. Thermal power production is also reliant on the purity of the coals or natural oil used, which might alter the optimal amount of output (Mills 19).

From the above-discussed disadvantages of the thermal Power plants to Indian people and the environment. I recommend the solar power plant and wind power plant to replace the thermal power plant since they are by far the most ideal since both remain generally recognized, can generate renewable power with fewer people, and are indeed most suited to Rajasthan's topography. Additionally, these solutions have earned favorable ratings and evaluations from residents around the state. However, although these solutions have their benefits and drawbacks, they are indeed the best to replace the thermal power plants.

Alternatives

The two system providers that I am recommending are solar power plants and wind farms. These two alternatives are the most suitable because both are widely well known and can provide renewable energy with less manpower and are best suitable for the geography of Rajasthan. These alternatives also have received high ratings and positive reviews from people across the state. Both alternatives have advantages and disadvantages that are discussed in terms of the criteria. In this recommendation report, one of these alternatives will be recommended for the client to go with.

Solar Farm

Solar Farm is a large-scale grid-connected photovoltaic power system (PV system) designed to store energy or supply it to the electric grid. They are differentiated from most building-mounted and other decentralized solar power because they supply power at the utility level, rather than to a local user or users. Solar Farm converts sunlight into electricity. This is an ideal alternative because most Rajasthan is a desert area and receives a lot of sunlight. There are different types of large solar projects, like community solar farms and utility-scale solar farms. Some solar projects, like those built to power data centers or other large users of solar power, have solar farms built purely for their use—sometimes onsite, sometimes offsite.



Figure 1: Solar Panel

Solar farms are large-scale grid-connected photovoltaic (PV) systems used to store or deliver energy to the power infrastructure. They are distinguished from the majority of building mounted as well as other localized solar energy systems by the fact that they deliver energy to the utilities instead of to a local consumer or consumers. Solar energy is converted into electricity within a solar power plant (Solar power). Solar power plants remain a ridiculous idea, given that most of Rajasthan is desert and gets plenty of sunshine. These large solar initiatives come in a variety of forms, including communal solar farms as well as utility-scale solar farms. Certain solar projects, such as those designed to power server farms or even other major solar energy consumers, have their solar farms constructed specifically for their application, sometimes on-site or off-site (Suman et al. 76).

Apart from the solar power plant being beneficial since the solar energy remains a genuinely sustainable form of energy that can be harvested in any region of the planet and is accessible daily, some of the other advantages include Through the use of solar energy, the electricity bills are reduced making it economical for many industries. Solar energy is versatile and may be utilized for a variety of applications. The people of India will have the option of generating power or heat. For instance, solar energy may be applied to generate electricity in locations without connectivity to the network, distill water in locations with minimal access to safe drinking water, and also to power space spacecraft. The solar power plant also has low maintenance power and is flexible to technology advancement. Although solar power has a fairly high cost of purchasing the equipment, its maintenance cost is relatively low. However, solar

power energy is weather-dependent, and sometimes energy storage is expensive (Suman et al. 76).

Wind Farm

Wind Farm is a group of wind turbines in the same location used to produce electricity. Wind farms vary in size from a small number of turbines to several hundred wind turbines covering an extensive area. Wind farms can be either onshore or offshore. Wind turbines work on a simple principle: instead of using electricity to make wind—like a fan—wind turbines use the wind to make electricity. The wind turns the propeller-like blades of a turbine around a rotor, which spins a generator and creates electricity. Wind farms are built in areas known to be especially windy regularly like on mountain tops. The winds turn the blades of the turbines. Then, the turbines turn the energy of the wind into mechanical power. Generators then turn the mechanical power into electricity.



Figure 2: Wind Turbine

This can be a good alternative because Rajasthan has a lot of mountains that are suitable for wind energy like the Aravalli hills where temperatures rarely go below 0 degree Celsius, so it doesn't damage the wind turbines. A wind plant is a collection of wind turbines located in the same place to generate power. Wind farms range from a few generators to several hundred turbines spread over a large region. Onshore as well as offshore wind plants are also possible. Wind turbines operate on a simplified principle: rather than utilizing power to generate wind just like a fan does, wind turbines generate electricity from the wind. Wind propels these turbine's propeller shaped-like blades around a well-designed rotor, which rotates a generator, which generates energy. Wind plants are constructed in regions known to be very windy, like the mountain tops.

The wind turns the turbines' blades; later on, the turbines convert the wind's power to mechanical energy. This mechanical energy is subsequently converted to electricity through generators (Al-Dousari et al. 184). This remains a viable choice since Rajasthan has many mountains suited for wind energy, such as the Aravalli range, wherein temperatures seldom fall below zero degrees Celsius, ensuring that windmills are not damaged. Although the wind power plant is said to be noisy and expensive upfront cost, the initiative will be fuel-free, clean energy supply reduces the dependency on fossils which emit carbon dioxide. Also, it doesn't disrupt farm operations (Al-Dousari et al. 184).

Criteria

The following are the criteria that will be used to compare the energy alternatives and make a recommendation for a thermal power plant.

Power Availability

The amount of sunlight or wind available in the state of Rajasthan can be harnessed to produce electricity.

Power Production

The amount of energy produced by these farms when they convert solar and wind energy to electricity.



Figure 3-Wind & Solar

Installation

These farms need equipment that can convert solar and wind energy into electricity like solar panels, wind turbines, and transformers to connect it to the electricity grid.

Price

The equipment used to construct these farms depends on location and predominantl0079 on the current market price.

Maintenance

These farms need maintenance over time, and each farm has its necessities like oiling gears in wind turbines, cleaning the glass of solar panels, and numerous more.

Comparison

Power Availability

The primary distinction between wind as well as solar energy is one of availability. Even though both remain intermittent, wind energy is accessible throughout the day, whereas solar energy is sometimes affected by weather changes. But Rajasthan has ample of sunlight because of vast desert. This has significant ramifications for power distribution since power use continues throughout the night.

Power Production

Wind energy is more effective than solar energy. Compared to solar panels, wind generators emit less CO₂ into the environment, use less energy, and generate greater energy overall. Indeed, one wind farm can provide a similar amount of power as around 48,704 solar panels per kWh (Mills 19). In terms of noise pollution, wind plant is noisy, while solar panels are free from noise pollution.

Installation

There is a significant variation in how wind and solar energy plants are installed and harvest power. Mechanical energy is captured from the wind by rotating turbines that generate electricity installations of turbines are said to be a bit expensive compared to installations of solar panels. In comparison, solar energy may be extracted via the widespread use of solar panels, and the second method is to make steam through the sun's heat where these solar panels are placed on the roofs. Unlike windmills, solar panels do not need special installation space and may be mounted on the rooftops of homes or businesses; hence, installation costs are lower than the wind power plant (National).

Price

The overall cost of the wind power plants depends on the size of the wind turbines used and the number of wind turbines. The larger the turbines the higher the cost and vice versa. For example, Wind energy generated on land remains one of the cheapest forms of energy accessible today, costing between 1 and 2 cents for each kilowatt-hour after the total production tax credit. The solar power plant, however, is cheaper than the wind plant since the plant typically costs \$ 0.89 to \$ 1 per kilowatt-hour after the total production tax credit.

Maintenance

Windfarm maintenance costs often remain lower than those for solar plants, which has aided in the economic viability of wind energy. Solar or even wind energy may be chosen depending on geographical location as well as energy demand. Making the incorrect option can result in significant financial damage. Renewable energy specialists in the ministry of Power in Rajasthan

can assist in assessing the circumstances and advising on the best kind of renewable power to replace thermal plants.

Recommendation

Based on the discussion in my comparison, I have determined which option is the best fit for each of the criteria. Table 1 displays my findings by marking the best choice in each category with a green box. This is a simple way to display and visualize my findings.

TABLE 1- CRITERIA ANALYSIS

	Solar Farm	Wind Farm
Power Availability		
Power Production		
Installation		
Price		
Maintenance		

In the Power Availability category, the Solar Farm is a clear choice. All things considered, Rajasthan receives more sunlight compared to wind and hence produces more solar energy compared to Wind Farm.

The Wind Farm is good in power production but due to lack of power availability, the wind farm will not be able to produce as much power compared to a solar farm.

Solar farm easily wins the Installation and Maintenance categories, with considerably easier installation and a minimized.

Considering all of these factors, based on my research and comparison, I recommend Solar Farm as the option best suited as an alternative for a thermal power plant in Rajasthan. I feel that this option will provide the best performance at an affordable price. By following this recommendation, I feel that Rajasthan will be able to reduce its CO₂ emissions in near future.

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