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Renewable Sources of Energy

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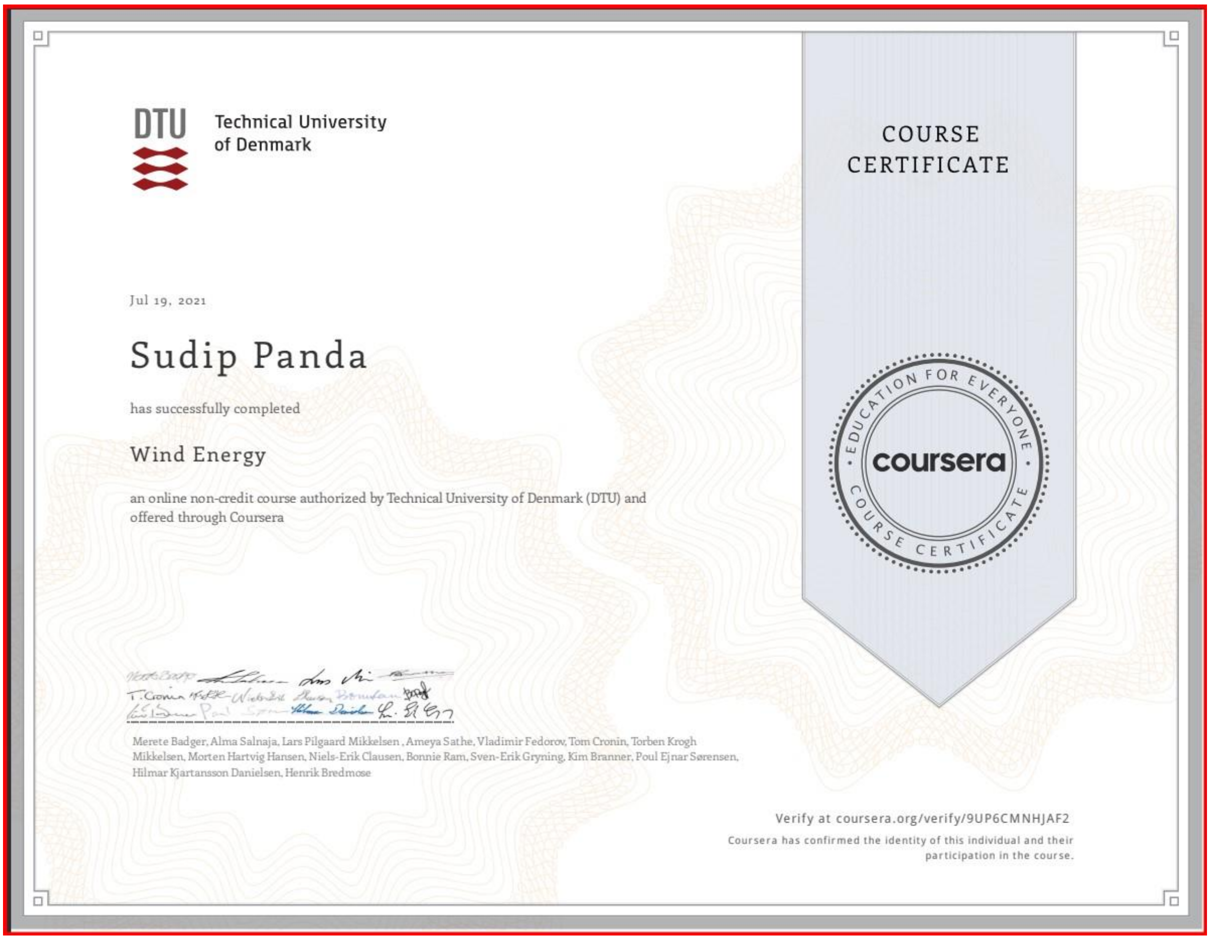
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REPORT

1. Introduction

In ancient times, wind was used to move the sails of the ships. In this Project, we will see how wind energy is used to generate electricity.

A turbine converts the kinetic energy of the wind to useful mechanical energy. This energy could be used in mechanical form or turn generator turbines and provide electricity. Just like in the hydropower systems, wind energy is harnessed through conversion of the wind kinetic energy to mechanical energy.

The wind turbines are largely classified into two types- Horizontal Axis Wind Turbines and Vertical Axis Wind Turbines. Large areas installed with wind turbines, that is, wind farms are increasingly emerging today.

Wind Characteristics

There are general characteristics of wind while others are more specific to the site. Some of the site specific characteristics include −

- **Mean wind speed** −This estimates the annual wind yield though it does not give the distributions.
- **Wind speed distribution** − There are three aspects namely annual, diurnal and seasonal characteristics. Understanding the wind speed variations and the spread is necessary when choosing a site.
- **Turbine** −This is the chaotic movement of wind in unpredictable patterns. Turbine results from continuously changing properties of wind motion that impact on energy production and fatigue on blades.

- **Long term fluctuation** − Irregular wind causes unpredictable energy supply. Before a wind turbine is set, the area should be studied for a constant wind flux.
- **Distribution of wind direction** − This is more significant in positioning of the blades especially for horizontal axis types.
- **Wind shear** − Shear is change in wind direction, speed or the height at which the maximum velocity occurs.

2. Problem Identification and the Cause of the Problem.

- **Wind power must still compete with conventional generation sources on a cost basis.** Even though the cost of wind power has decreased dramatically in the past several decades, wind projects must be able to compete economically with the lowest-cost source of electricity, and some locations may not be windy enough to be cost competitive.

- **Good land-based wind sites are often located in remote locations, far from cities where the electricity is needed.** Transmission lines must be built to bring the electricity from the wind farm to the city. However, building just a few-already proposed transmission lines could significantly reduce the costs of expanding wind energy.

- **Wind resource development might not be the most profitable use of the land.** Land suitable for wind-turbine installation must compete with alternative uses for the land, which might be more highly valued than electricity generation.

Turbines might cause noise and aesthetic pollution. Although wind power plants have relatively little impact on the environment compared to conventional

- power plants, concern exists over the noise produced by the turbine blades and visual impacts to the landscape.

- **Wind plants can impact local wildlife.** Birds have been killed by flying into spinning turbine blades. Most of these problems have been resolved or greatly reduced through technology development or by properly wind planes. Bats have also been killed by turbine blades, and research is ongoing to develop and improve solutions to reduce the impact of wind turbines on these species. Like all energy sources, wind projects can alter the habitat on which they are built, which may alter the suitability of that habitat for certain species.

3. Objective to be achieved

OBJECTIVE 1: INCREASE THE RATE OF WIND ENERGY GROWTH

The production of wind energy reduces reliance on fossil fuels and consequently reduces fossil-driven CO_2 emissions, but a given CO_2 reduction is more effective in mitigating global warming if made earlier than later. Wind energy growth rate will depend on cost (see RO2), but it will also depend on other factors, including government policy, public perception, our manufacturing base, and the rate at which local and national transmission is reinforced.

OBJECTIVE 2: DECREASE THE COST OF WIND ENERGY

At today's investment cost of $1837/kW, a 300-600 GW nationwide investment in wind energy would cost $550 billion to

$1.1 trillion, with the higher number being about a third of the 2009 U.S. federal budget. Building wind energy to this level will occur only if investors can earn a return, an ability that depends on several factors, chief among them being the life cycle cost, the wind resource available and financing. We will explore all of these measures.

OBJECTIVE 3: EXTEND PENETRATION LIMITS

Limitations to wind energy build-out are largely dictated by operational issues associated with the power grid. These issues include maintaining enough rotational inertia to withstand generation outages, maintaining continuous balance between generation and load through regulation and load following, avoiding CO_2 emission increase due to cycling of fossil-fired power plants not built for this purpose, and obtaining sufficient local and national transmission to move the energy.

4. Various Steps taken to achieve the objectives

Thrust Goal and Connection to Project Objectives

The goal of this thrust is to advance the national aim of increasing the production of renewable energy by enhancing the cost effectiveness of installed wind farms through improved characterization of wind resources, addressing RO2, and by expanding the penetration of wind power in the U.S. via better understanding multiple land uses in high-producing agricultural areas, addressing RO3.

Background and Need for Research

The national goal of achieving 20% of the U.S. energy supply from wind by 2030 puts a high demand on wind energy production in the Central U.S. Achieving this goal requires more efficient use of current production (i.e., better forecasting of future generation), better and turbine characteristics (height, wind turbine layout) of future wind farms, and public acceptance of expanded wind farm deployment into areas of high value existing land use (e.g., by understanding the interactions with agricultural crops).

Our attention is focused on key issues identified in a U.S. DOE workshop on resource characterization turbine dynamics, micro and array effects, me-so-scale processes, and climate effects. In addition, high wind penetration in the Central U.S. requires public acceptance of wind farms in regions already having a land use commitment of high national importance—the production of food, feed, and bio fuels. We will address these issues by using a combination of three research methods:

(1) Me-so-scale meteorology and large eddy simulation models built on first principles,

(2) physical simulations in wind tunnels of the atmospheric boundary layer (ABL) on various terrains to study its interaction with wind farms to optimize power output, and

(3) Field measurements of ABL wind profiles and surface layer mean and turbulence fields and vertical fluxes of heat, moisture, momentum, and carbon dioxide. The complex issues we address call for interdisciplinary approaches involving engineers, meteorologists, agronomists, sociologists, and economists, and a close working relationship with our European colleagues who have been studying some of these issues for the last ten years.

Dissertation Project Examples

Improving wind speed forecasting with lead times of 0-54 hr: Alternative forecasting techniques employing multiple scale models combined with advanced statistical analyses will be used to improve forecasts in the time window of highest economic value for power sales.

Cost effectiveness of taller towers for extracting energy from the low-level jet: Wind resources at elevations of ~140 m are substantially higher than those at current turbine hub height (~80 m) due both to a general increase in speeds with height and an enhanced increase on occasion due to the presence of the Low-Level Jet. Because the costs for construction and maintenance also will be higher, a combined meteorological/economic analysis is needed to evaluate this potential.

Wind farm sit and wind turbine interaction within a wind farm: The Aerodynamic/Atmospheric Boundary Layer (AABL) Wind and Gust Tunnel at Iowa State University will be used to generate an AABL in flat and complex terrains to study the wind flow characteristics (e.g., vertical wind speed profiles, turbulence, wake) with and without wind turbines as well as turbine interactions. Flow measurements with a multi-hole Omni probe and PIV will reveal the influence of upstream terrain, turbine blades and surrounding turbines for use in wind farm, optimization of wind power generation and calculation of wind loads on turbine components. Large eddy simulations, validated with wind tunnel data, and complemented with field measurements in local operating wind farms in our neighborhood using will help provide a comprehensive strategy for wind farm and turbine interactions.

Interactions of turbine-generated turbulence with agricultural crops: Turbulence from turbines can change the temperature, humidity, and fluxes of heat, moisture, momentum and CO_2 concentrations over crop canopies. The impact of this on the productivity of crops is unknown. Field measurements are needed to refine surface-layer models for evaluating season-accumulated

5. Effectiveness of the Project

Wind energy is one of the most effective methods of harnessing renewable energy today, behind hydroelectric and tidal power plants, and just about equal with carbon emitting gas and coal-fired power plants.
Advances in technology have made wind energy more and more efficient over the years, bringing the cost down from 40 cents per kWh in the 1980s to 2.5 – 5 cents per kWh today.
Most wind turbines in use today harness 30-45% of the wind energy that passes by their blades. In other words, if 100Kw of kinetic energy blew past the turbine as wind, the generator would on average be able to create 30-45Kw of electricity.

Wind energy is far from alone in the energy market. It shares the stage with a host of other technologies. By looking closer at the efficiencies of each of the major players, we can paint a clearer picture of how good we humans are at harnessing energy.

- **Hydroelectric** – Ranking at the top of almost any comparison, is Hydroelectric energy plants. Usually situated in a dam of some sort, these plants divert the still water into channels of flowing water, and use those channels to spin generators which gather between **90% – 95%** of the water's kinetic energy from the flowing water.

- **Solar Energy** – At the moment, solar panels gather from **15-20%** of the sun's energy, but recent advances in the technology have pushed that number up to around **40%**, and further advances will make those types of solar cells more available in the near future. So look out wind, solar is on the rise, if you'll pardon the pun.

Tidal – Tidal energy is one of the most efficient forms of renewable energy, raking in about **80%** of the tide's available

- kinetic energy. It harnesses the energy brought in by the tides twice a day.

- **Nuclear** – When atoms are separated at a fundamental level it creates a lot of energy. When done violently that energy looks like an atomic bomb; when done with more accuracy and finesse, *and with different materials*, it looks a lot more like a nuclear power plant.

Nuclear power plants use the heat released by the isotopes to boil water, and the resulting steam is used to turn turbines to generate energy. They are able to capture between **30-37%** of the radiant heat energy created by those nuclear reactions.

- **Gas/Coal** – There's no getting away from carbon emissions with this type of energy production: Coal- and gas-fired power plants harness **33-40%** of the available energy from the coal and gas that they burn. Meaning that 60-67% of the coal or gas that is being burned, isn't generating electricity.

6. Conclusion

Conclusion Wind energy is friendly to the surrounding as compared to fossil fuels, as the latter disturbs the environment by releasing carbon dioxide. When combined with solar electricity, wind energy becomes great source for the developing countries which provides reliable and steady supply of electricity. Wind energy is one of the solutions   energy demand. It has great potential and easy to manage. Every wind turbine lasts for 20–25 years and as long as the wind blows, the wind turbine can harness the wind to create power. Though wind turbines can cause complaints and fatalities of wildlife, it is one of the energy solutions. India has huge potential of renewable energy sources and due to government involvement there is sudden growth in renew-able energy sector.

The strategy for achieving this enhanced goal depends on the participation of NGOs, manufacturers, R&D institutions and entrepreneurs. In this study both actual and provisional scenario for wind energy in India has been discussed. The above discussion shows that the condition of wind system is satisfactory in India but requires additional attention for better growth. Although, The cost diminution and technological development of systems in recent years has been encouraging. To allow the widespread application of emerging technology such as remote sensing techniques for resource assessment in complex, hilly terrain and in offshore region, there is a need for further R&D improvements. Accurate and consistent measurement in lieu with better policy courage the investors in the development of offshore wind energy sector in India. The country will reach “Grid Parity” in wind energy in2022. For further development it is essential to focus on a specific technological system, accurate measurement, domestic manufacturing and logistics which requires better policy measurement and requires more effort of the government