The Ascent of Wind Power in Nova Scotia: Pubnico Point Wind Farm

MARY SNOW AND RICHARD SNOW
Applied Aviation Sciences Department
Embry-Riddle Aeronautical University
Daytona Beach, Florida
USA
Richard.Snow@erau.edu

Abstract: The government of Nova Scotia, Canada, passed the Environmental Goals and Sustainable Prosperity Act in 2007 which establishes guidelines for long-term economic and environmental well-being. The general objective of the act was to demonstrate, that though proper planning and management, Nova Scotia can provide the daily needs of its citizens while promoting a healthy and sustainable environment. The specific goals outlined by the act include a 10% reduction of greenhouse gas emissions (below 1990 levels) by 2020, along with the production of 18.5% of the province's electrical energy from renewable sources. The driving force behind the Environmental Goals and Sustainable Prosperity Act is climate change. Nova Scotia has 7,600 kilometers of coastline. Its leaders understand the serious concerns of rising sea levels and the forecast increase in both the frequency and strength of nor'easters and hurricanes, as well as their related storm surge. To mitigate these risks, Nova Scotia is reducing its dependence on fossil fuels for generating electricity through the development of wind energy. This research examines the establishment of the Pubnico Point Wind Farm on the southern coast of Nova Scotia by analyzing the general considerations in determining a successful wind energy production site, including the identification of favorable and unfavorable environmental and cultural components, and the importance of incorporating the participation of the local population during the planning phase of the project. The paper describes impacts of a wind field on the environment and its inhabitants, and explains the necessity of ongoing monitoring, maintenance, and management of a wind farm as it is integrated into a community.

Key-Words: Wind energy, wind turbines, wind farms, renewable energy, climate change, Nova Scotia

1 Introduction

The global community has finally realized the necessity of developing and implementing sustainable energy into their power grids due to the limited quantities and rising costs of fossil fuels. Additionally, the increasing amounts of greenhouse gases being emitted globally and the growing concern for the negative impacts of climate change have world leaders seeking alternative means of producing energy. In most developed countries, the electricity sector is primarily dependent on energy generated from fossil fuels [1]. Thirty-three percent of greenhouse gas emissions in the United States are produced through electricity production, which is higher than the emissions from transportation or any other economic sector [2]. When coupled with their natural abundance, the advantages of renewable energies are economically and environmentally attractive [3].

Wind energy is among the most popular alternative energy technologies being developed and applied today [4]. For centuries, humans harnessed wind power in the form of sailing ships as a means of traveling, trading, and obtaining natural resources. Due to innovations in the design of windmills, by the 1800s wind energy was supplying twenty-five percent of Europe's industrial power. The United States finally began using wind power in 1888 to generate electricity [5]. By 1982, the first wind farm was developed in California [6]. Since that time, advancements in technology and the utilization of wind energy have increased dramatically. From 2000 to 2012, wind electricity generation rose from 5,593 gigawatt hours (GWh) a year to 140,089 GWh annually in the United States [7].

There are a variety of reasons to explain the appeal of wind energy for local communities. Among these is the fact that wind farms can be developed in rural areas providing a domestic power supply for the neighboring urban center. With fossil fuel supplies becoming limited and global tensions increasing as nations compete for these dwindling resources, utilizing wind power improves security and the economy by allowing communities to be electrical energy independent. The health of the public and the environment are also enhanced through the reduction of greenhouse gas emissions and pollution from fossil fuels. However, there are economic, environmental, and social challenges to using wind energy despite the benefits.

The site selected for a wind farm should be determined based on the environmental factors and wind speed potential of an area. The public must be assured that ecosystems will not be disrupted beyond their ability to recover and that natural areas will be conserved [8]. The typical impacts of wind farms on the environment that are cited in the literature are noise generation, visual aesthetics, safety factors, electromagnetic issues, and bird collisions [9]. Still, most scientists and citizens agree that the benefits of wind energy such as mitigating climate change, reducing kilowatt costs, and eliminating the adverse health impacts imposed by burning fossil fuels far outweigh the negative consequences.

2 The Planning Process

To evaluate a prospective wind power site, engineers tend to analyze four fundamental potential concepts which include theoretical, available, technological, and economic potential [10]. Theoretical potential examines the existing wind characteristics of a place to ascertain the maximum wind energy that might be generated. After considering factors such as topography and distance to the local urban area, available potential is the portion of the theoretical potential that can be obtained without any negative environmental impacts. An assessment of the existing technological capabilities allows for the determination of the technological potential while economic potential can be established by considering the economic viability of generating wind power based on parameters such proximity to transmission grids and existing roads.

Public opinion also must be considered when assessing possible locations for wind farms as well as the four basic potential concepts previously outlined. There are numerous argumentative views that exist between private and public organizations regarding the use of wind energy which must be addressed before proceeding with a wind farm project [11]. The local community should be engaged in every aspect of the planning process and numerous methods for achieving this end are detailed in the literature [12]. These studies suggest that participation through open meetings and interactive web-based tools increases public involvement thus reducing discord regarding decisions made by administrators [13]. This is especially important when determining exactly where a wind farm should be located [14].

3 Site and Situation

The Canadian province of Nova Scotia is ideal for harnessing wind energy. The peninsula is nearly surrounded by the north Atlantic Ocean and comprised of a multitude of bays and estuaries. In fact, there are no locations across Nova Scotia that are more than 65 kilometers from the sea. Thus, the climate is classified as maritime.

As a result, the moderating effect of the water causes the climate to seldom be extremely cold or hot. Mean winter temperatures are between 0 and -15 degrees Celsius while temperatures during the summer average between 20 and 25 degrees Celsius. Nova Scotia is under the influence of mid-latitude westerly winds and nearly the entire coastline of the peninsula experiences average wind speeds at 50 meters above sea level of 6.5 meters per second (m/s) or more. This is noteworthy as the National Renewable Energy Laboratory and the U.S. Department of Energy report that locations with annual average wind speeds of 6.5 m/s at a height of 80 meters are generally considered to have suitable wind resources for generating electricity.

West Pubnico is a small fishing village which lies at one of the numerous southern tips of Nova Scotia on Pubnico Harbor. The population is about 3000 people most of whom make their living from the sea. Average annual wind speeds there are greater than 9.0 m/s at a height of 50 meters, which is one of the primary reasons it was selected for wind farm development. The idea for harnessing the strong and steady Pubnico winds began in 2000 when Brad d'Entremont, a descendant of the original settlers of Pubnico, and Joerg Losse were discussing German wind farms and realized the power potential in their own neighborhood. The two enlisted the aid of a couple more partners and created the Atlantic Wind Power Corporation. In just three years they won the bid to construct a 30.6 megawatt wind farm in West Pubnico, the first in Nova Scotia.

4 Carbon Emission Reduction

The West Pubnico Point Wind Farm project was commissioned in 2005. In 2008, the entire project was purchased by NextEra Energy Canada. The wind farm currently is one of the largest in terms of generating capacity in the province. The need and justification for this wind generation project arose from the recognition that as citizens of a developed country, Canadians are one of the highest per capita producers of carbon dioxide (CO_2). Atlantic Canada is the region of Canada comprised of the four provinces located on the Atlantic coast, excluding Quebec. These Maritime Provinces are New Brunswick, Prince Edward Island, Nova Scotia, and the easternmost province of Newfoundland and Labrador. In Atlantic Canada, 44 percent of greenhouse gas emissions are from the generation of electricity. Much of the electricity used in the region is for home space heating and water heating.

The Government of Canada announced its ratification of the Koyoto Protocol to the United Nations Framework Convention on Climate Change on December 17, 2002. Under that legally binding agreement, industrialized countries pledged to reduce their collective greenhouse gas emissions by 2012. Canada's reduction target was 6 percent below 1990 levels by 2012. In the more recent, but not legally binding, agreement that was reached at the 21st Conference of the Parties (COP21) held in Paris in 2015, Canadian Prime Minister Justin Trudeau arrived at the summit with targets of a 30 percent reduction in emissions from 2005 levels by 2030. On the first day of COP21, Canada announced it had pledged $300 million to the Mission Innovation initiative for clean technology development. Additionally, Mr. Trudeau promised to put $2.65 billion into emissions-reduction projects for developing countries.

Canada’s $260 million Wind Power Production Initiative (WPPI) is anticipated to increase the amount of wind energy available across the country by 500 percent over a five-year period as part of the country’s commitment to address climate change. A study carried out by the Pembina Institute estimates that energy generated from wind farms have 98.5 percent fewer emissions than natural gas and coal-fueled systems respectively [15].

5 Wind Turbine Technology

The 17 wind turbine generators located at the West Pubnico Point Wind Farm are Vestas V-80 turbines each of which produces 1.8 megawatts of electricity. The wind turbines installed on site consist of towers that are approximately 80 meters tall with a blade diameter of 82 meters. The turbines are comprised of four components: the foundation, the tower, the nacelle, and the blades. The tower is made of steel and is a conical shaped structure. The towers consist of several sections that are assembled on site by bolting the sections together. The base of the tower is approximately 5 meters in diameter. The towers have a locked entrance that enables access for the maintenance personnel, and there are ladders and safety harnesses inside. There are no outside ladders or foot holds that would entice visitors to climb the tower, or that would accommodate bird nesting or perching. Specific control devices for the individual wind turbine w4are located inside the base of the tower. The forms for the foundation were built, and the reinforced concrete foundation was poured with an attachment of the mounting ring for the wind generators.

The nacelle is an enclosure that is placed on top of the tower behind the blades. The nacelle houses the generation equipment, gearbox, electronics, the unit’s transformer and other internals. The nacelle is bolted into place during the installation process. Cables in the nacelle from the generation equipment are threaded down through the tower and out of the secure base to the on-site cable assembly system. Each wind turbine generator has three blades which are constructed from reinforced fiberglass. Each blade is approximately 40 meters in length, so the total diameter of the swath covered by the turning blades is approximately 80 meters. The total height of the wind turbine, from the base to the tip of a blade when at it is at its highest point, is approximately 120 meters for the Vestas V-80. The blades turn at a rate of approximately 15 revolutions per minute (rpm). Generally, the rotors of the turbines will automatically shut down in conditions where wind speeds exceed 25 m/s. Certain of the wind turbines are lit in accordance with the Canadian Aviation Regulations administered by Transport Canada.

Each turbine has a main breaker that provides protection and isolation of the unit. The main breaker has 1000 volt cables installed in ducts underground that reach a transformer located approximately 5 meters from the base of each wind generator tower. The 17 turbines in the Pubnico Point Wind Farm are arranged in four rows. This configuration is expected to generate the maximum amount of electricity annually which is then fed to the Nova Scotia Power Incorporated (NSPI) grid.

A submarine cable extends 1,093 meters, the shortest route, from the wind farm on West Pubnico Point to the NSPI grid across the mouth of Pubnico Harbour. This connection is made via a 25,000 volt submarine cable system installed across and beneath the bed of the harbor. The cables are buried to a depth of 1.2 meters for most of the crossing and are entrenched approximately 60 meters inland from the highwater line on the East Pubnico side. From there, the cables are connected to overhead lines that run to a substation and then to the power grid.

The wind turbines operate on a continual basis except during extreme weather conditions or maintenance activities. Each turbine undergoes periodic maintenance and inspections. Regular maintenance involves oil changes, and light bulbs are replaced when needed. The design life of a wind farm is typically 20-25 years. However, capital improvement and replacement programs can extend safe and efficient operations beyond this time.

4 Conclusion

Many countries are turning to renewable energy sources to minimize greenhouse gas emissions and mitigate the impacts of climate change. While numerous alternative energy applications exist, wind power has been harnessed by humans since the dawn of civilization.

Advancements in turbine technology, electrical transfer, and power storage over the last decade have enabled wind energy to move to the frontlines in the battle to slow and eventually stop global warming.

The potential for wind energy worldwide is enormous. In the central portion of the United States, the Great Plains have been called the Saudi Arabia of wind energy. Wind towers have a relatively small environmental footprint and can be compatible with farming, grazing, and other land uses. Some ranchers and farmers in the Great Plains region receive royalties from wind energy companies or lease their land for wind towers garnering incomes that exceed those from their farming operations. Farmers with their own turbine can find themselves able to sell excess power back to the utility grid through reverse metering. According to some assessments, the Great Plains states could provide all the power the United States could foreseeably need.

Wind farms generate more than electricity. There are more jobs created per million dollars of investment through wind energy than by any other means of generating energy. This source of energy is also free from the up and down economic cycle of coal and oil. Globally, wind power is free from the volatility of the world energy market which is forecast to become less stable. In short, wind energy offers a clean, cost-effective, inexhaustible, and readily available means of helping to mitigate climate change while answering the increasing demand for electricity.

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