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Lesson 1: Is there profit blowing in the wind?

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Objectives:

After completion of this lesson, the students will be able to:

1. Describe the wind generation topics of this lesson by business structure, business origin and business profile: customers, competitors and the business's market share or niche.
2. Describe how wind generation electricity enterprises have overcome the challenges they faced when seeking to become a profitable enterprise.
3. Identify and describe opportunities that exist for wind generation electricity businesses in the future.

Materials/References Needed:

Small Farm Profitability: Is the Answer Blowing in the Wind? Case Study by Joel Schumacher, Cole Arthun and Gary W. Brester, Dept of Economics and Agricultural Economics, Montana State University, Bozeman, MT.

Wind Economics, http://www.windpower.org/en/tour/econ/economic.htm

Guide to the Wind Economics Calculator, http://www.windpower.org/en/tour/econ/guide.htm

Wind Economics Calculator, http://www.windpower.org/en/tour/econ/econ.htm

Brittan Cash Flow. Joel Schumacher. Excel Spreadsheet

VISUAL MASTERS (VM):

VM-1 PPT WIND POWER. Roger Rivera,
http://www.physics.rutgers.edu/~kotliar/honors/honsem02/somalwar/HonSem02/WINDPOWER.ppt

VM-2 PPT WIND ENERGY 101. Joe Rand,
http://www.kidwind.org/Presentations/Wind%20Energy%20101.ppt

VM_3: PPT 3 WIND ENERGY FOR STUDENTS. The KidWind Project,
http://www.kidwind.org/lessons/PPoint.html

Interest Approach:

At one time in American history, over six million water-pumping windmills served farmers. The daisy wheel of the western windmill on the Great Plains has been both a symbol of settlement and of isolation. It is considered by historians of technology as a successful intermediate technology that provided water for man and animal. The windmill's story has been chronicled by T. Lindsay Baker of Baylor University and Robert W. Righter, an environmental historian at the University of Texas at El Paso.

Windmills have been used for many hundreds of years to pump water, to grind grain and other materials, even to pump crude oil from shallow wells. While the concept of using wind to generate electrical power has been understood for a century or more, wind power has become a significant source of electrical power only in the last decade. Montana has several areas suitable for wind power generation. Most of the Panhandle region consists of open prairies, where the Chinook wind blows fairly consistently. In some mountain valleys of western Montana, there are several mountain ridges that run generally north and south. As wind blows over these ridges, it increases in speed making these valleys ideal locations for wind farms that can generate large amounts of electricity.

Student Activity:

When student numbers are sufficient, divide students into groups. Students should be instructed to:

- Read the wind case study assigned to their group.
- Where appropriate, divide the reading of the assigned Wind case study among their group.
- Each member is to provide an overview of his/her assigned reading to the group.
- Review and answer the questions related to their case study.
- Develop a clear, concise summary for the Wind electrical generation topic assigned.
- Develop the profile on notebook paper. Use the backside of this paper to write the final version of the group's answers and a profile the wind generation topic assigned. Write the profile in bullet form.
- Use PPTs and WWW reference to instruct students on related aspects of Wind Generation that apply physics and economics.

Questions:

1. What prompted Gordon to purchase and install a 65-kilowatt wind turbine on his property near Livingston, Montana?

Answer: *His motivations included testing the idea that local residents and community-owned wind projects could not only be used to generate electricity for rural communities but also to provide a business model that would help sustain them. He also hoped his project would serve as a model for other locally-owned wind energy projects in rural parts of the state.*

This case study examines the motivation and incentives that led Gordon to be on the cutting-edge of modern wind energy development in Montana. In addition, the economic factors surrounding small-scale wind energy production over the past 25 years.

2. Based on wind turbine electrical generation capacity found in the case study, how many homes can be supplied with electricity by a new GE 90 1.5 Mw wind turbine that is installed at the Judith Gap, Mt wind farm?

Answer: *375 homes. 1.5 Xs 250 homes. A 1-Mw wind turbine will supply the electrical needs for about 250 homes.*

The average residential customer uses about 920 kWh of electricity every month. A megawatt (mW) is equal to 1,000,000 watts. A wind turbine that produces 1 mW/year can supply the electrical needs of about 250 homes for an entire year.

3. How are Wind turbine projects often categorized? Compare Grid-connected projects to Off-grid projects?

Answer: *Wind turbine projects are often categorized as grid connected, direct current, alternating current or net metering projects. The term "grid" refers to the electrical distribution system that physically connects electricity producers and consumers. To ensure electrical safety, reliability and functionality, the electrical grid specifies equipment and usage rules for both producers and consumers.*

Grid-connected projects (most large wind projects are in this category) are required to follow certain standards, regulations and rules before access to a grid is allowed. Off-grid projects are subject to fewer rules and regulations, and are often used to provide power at remote locations.

4. Why is alternating current used for power generation and transmission around the world?

Answer*: Transmitting DC power over long distances is inefficient and expensive. These problems were overcome by George Westinghouse and Nikola Tesla in the late 1890s with the development of alternating current (AC) power generation. The technology to transmit AC power was much less expensive and more efficient over long distances. AC power allowed for the development of large centrally-located power plants with transmission lines connecting large numbers of consumers to relatively few power plants.*

It is worth noting that DC electrical generation must be converted to AC before entering the grid.

5. What is a net-metering project and why do special rules and regulations apply to net-metering projects?

Answer: *A net-metering project produces electricity for an owner's personal use. If an owner generates more electricity than is consumed, then extra electricity is transferred to the grid and is used by other electrical customers.*

Special rules and regulations apply to net-metering projects that determine how often the account is "trued up" and the price at which power will be purchased by a customer or sold to a utility company.

6. What was Gordon Brittan's initial investment and what kind of tax incentives did he receive upon purchase?

Answer: *Gordon Brittan's Windmatic turbine was purchased and installed on an 80-foot tower for $120,000.This represents an initial investment of $1,850 per installed kW. He received a 25 percent (15% federal and 10% state) income tax credit in the year of installation. The tax credit was calculated as 25 percent of the income generated by the sale of the turbine's generated electricity. Over the years, he has replaced one generator and several turbine brakes. Major repairs require the use of a crane and replacement parts that have to be ordered. Such work can require a month or more of downtime. Maintenance costs average approximately $1,200 per year.*

7. What is a power purchase contract and what risks did Gordon Brittan and Montana Power Company consider when they entered into their initial contract?

Answer*: A power purchase contract identifies many possible outcomes and protects both buyers and sellers from actions of the other party. In addition, the contract establishes a sale/purchase price for electricity.*

The risks faced by both parties included not just whether the wind would blow but also how well the equipment would perform over a 10-30 year time horizon. These risks required engaging in sensitivity analysis regarding potential benefits and costs of various possible outcomes. Due to the risky nature of wind energy and lack of experience in 1984, each of these cost-benefit estimates involved much more uncertainty than would a similar analysis today.

What were the alternative contract terms offered to Gordon by MPC?

One option included a 10-year contract that valued Gordon's wind-produced electricity at 5.76 cents/kWh. A second option was a 30-year contract that would pay 7.30 cents/kWh. Based on historical wind conditions, it was estimated that Gordon's 65-kW wind turbine would produce an average of 150,000 kWh/year. His actual production has ranged from a high of 187,000 kWh/year to a low of 130,000 kWh/year. The annual average gross revenue would be $8,640 if the 10-year contract was selected and $10,950 if the 30-year contract was selected.

The risk of signing the 10-year contract was not only associated lower gross returns for the first 10-years but also the risk that future contracts might be offered at even lower rates. Gordon decided to sign the 10-year contract based on an expectation that future power contracts would be offered at higher rates. Unfortunately for Gordon, his prediction that future energy prices

would rise by 1994 was incorrect. After the expiration of his 10-year contract in 1994, MPC offered a new contract for 2.25 cents/kWh (3.51 cents/ kWh less than the 1984 contract), which was 5.0 cents/kWh less than the 30-year contract he could have signed in 1984.

8. How did Gordon Brittan reduce risk?

Answer: *Insurance premiums for wind turbines were expensive in 1984 due to lack of data, quality of construction and design problems. Nonetheless, Gordon purchased insurance that reduced the risk of the project.*

9. What was the percentage increase in farms that were connected to the power grid between 1936 and 1945?

Answer: *The percentage of farms with grid-connected electrical service increased from 11.6 percent in 1935 to 45.7 percent in 1945. The consistent power offered by an electrical grid connection dramatically reduced the demand for DC wind energy systems.*

10. How did the energy crisis of the early 1970s affect the price of electricity? How did it affect government legislation aimed at supporting alternative generation of electricity?

Answer: *Prices for all types of energy increased during this period. The average household retail electricity price increased 25 percent from 2.5 cents/kWh in 1973, to 3.1 cents/kWh in 1974.*

National Energy Act (NEA) of 1978. The NEA focused on increasing domestic energy conservation and efficiency. Another important piece of legislation was the Public Utility Regulation Policy Act (PURPA) which focused on the development of facilities to generate electricity from renewable energy sources. These acts opened the door for wind energy development in the 1980s by providing a 15 percent federal income tax credit. Many states also offered incentives for wind energy development. In Montana, a 10 percent income tax credit was offered to wind energy producers.

Note: The next major policy change to impact the wind energy market was the decision in 1996 by the Federal Energy Regulatory Commission (FERC) to deregulate much of the energy market. Deregulation opened electric markets to competition and also coincided with a period of increased energy prices. These increased prices and the opportunity to compete gave a lift to wind projects across the country.

11. How has Invenergy reduced the risk of owning and operating the Judith Gap wind farm?

Answer: T*he project is relatively low risk because of the development of insurance markets for equipment failure. The insurance is offered by WindPro, and the policy has a 30-day deductable for a claim of loss. If a turbine experiences mechanical problems, the insurance will help reimburse the policy holder for lost revenue beyond 30 days of inoperability. Currently, the turbines are under a five-year warranty from GE. After this period, the insurance policy will cover the costs of some major parts.*

12. Why was Judith Gap chosen for a commercial wind farm and what is its production capacity and its specifications?

Answer: *The Judith Gap location was chosen, in part, because of its proximity to transmission lines. Each Judith Gap turbine is capable of producing 1.5 mW of electricity compared to his 65-*

kW turbine. The wind farm includes 90 GE 1.5-mW wind turbines and sits on over 14,000 acres of land. Each turbine has 126-foot long blades mounted on towers that are approximately 260 feet tall (Figure 2). Each massive tower requires a seven-foot deep, 48-foot diameter concrete base (470 cubic yards of concrete). Invenergy studied the Judith Gap site for nearly five years. According to their on-site Energy Center Supervisor, John Bacon, the Judith Gap project has delivered acceptable returns on the investment.

13. What percent of energy is provided to Northwestern's customers in Montana from the Judith Gap wind farm?

Answer: *This project provides about 7 percent of the energy used by Northwestern's customers in Montana according to the Montana Department of Natural Resource and Conservation's website.*

14. What some important considerations when selecting a location for a wind farm?

Answer: *Wind farms need to be close to transmission lines and located within a good wind resource to be successful. Class 4 wind speeds (with average wind speeds of 15.7-17.9 miles per hour) or higher are needed to support a commercial wind* project. *The minimum wind speed for the Judith Gap turbines is about 8 miles/hour and the maximum speed is about 55 miles/hour.*

15. How is the Two Dot Wind company business model different than typical wind farm operations?

Answer: *The Two Dot Wind model is quite different from other large-scale projects. Two Dot Wind purchases used turbines, refurbishes them and installs the newly refurbished turbines in small wind farms ranging from 1 to 11 turbines. Each turbine has a generating capacity of between 65 kW and 250 kW. Although the older equipment is less efficient than newer equipment, Two Dot Wind has been able to purchase these turbines at discounted prices.*

16. What role does government policy play in the development of alternative energy?

Answer*: The most important federal policy is the Renewable Electricity Production Tax credit. This program provides a 1.5-cents/kWh income tax credit for electricity generated from wind. In addition, Montana's Alternative Energy Investment Tax Credit and Residential Alternative Energy System Tax Credit are important state initiatives. The former provides an income tax credit of up to 35 percent of the income generated by alternative energy investments. The latter allows an income tax credit of up to $500 for the installation of a non-fossil fuel form of energy generation.*

17. What are the results to date of Gordon Brittan's wind power project?

Answer: *Gordon Brittan's 65-kW wind turbine continues to produce electricity that is sold to the electrical grid. His buyer has changed from MPC to NWE, and contract terms have changed over the years. In 2005, Gordon signed a new contract that prices his electricity at about 4 cents/kWh. This price combined with the federal production incentive (REPI) of 1.5 cents/kWh generates 5.5 cents/kWh. This price is lower than he the one received in 1984. Although his wind turbine has performed well over the past 20 years, the project has not been profitable to date.*

18. Which wind power business scenario offers the best opportunity for a shorter payback period based on current costs and incentives?

Answer: *Small-scale, net metering projects generally offset retail electricity prices, which averaged nearly 9 cents/kWh in 2007. In these cases, it is possible for such projects to have payback periods that are much shorter than those based on wholesale prices.*

19. Why is the current outlook for commercial wind farms bright?

Answer: *These projects involve substantial initial investments and are often erected on land leased from federal, state and private land owners. Land owners receive rental payments in exchange for the loss of land use. However, land owners generally have few, if any, out-of-pocket costs associated with such projects. In many cases, the opportunity cost of the land used for such projects is quite low.*

20. What new concern has recently strengthened wind power discussions?

Answer*: Atmospheric greenhouse gases*

Conclusion:

The main focus of this lesson is the successes, challenges and opportunities of wind power businesses. Through examining case studies of wind power operations and business, students can learn through real-life examples about wind power from the people and companies who took the initiative and monetary risk in an attempt to capture profits from a renewable natural resource - wind.