Integrating Wind and Biomass to Manage Carbon Emissions

Exploring Technologies

The University of Minnesota, Morris (UMM) is a rural university campus located in a heavily agricultural region of the United States (figure 1). In 2001, the campus began planning strategies to meet its future energy needs. The campus decided to pursue renewable energy technologies that would demonstrate its commitment to improving the environment, while providing reliable energy at reasonable costs.

A key environmental goal of the new energy systems was the ability to manage carbon emissions. The University began looking at technologies to reduce carbon emissions in order to:

- Demonstrate to students and the community that carbon emission reductions were possible.
- Limit possible increases in fuel or operation costs should carbon emissions trading become mandatory in the United States. It is expected that mandatory carbon credit values would be similar to the values in Europe, whereas the current voluntary credits have little value.

Exploring Technologies

A wide variety of renewable technologies can be used to replace fossil fuels. However, each technology has advantages and disadvantages for a particular application based on available resources and needs.

- The largest energy uses on campus, and corresponding carbon emissions sources, were thermal energy for heating campus and electricity for campus-wide electric cooling system.
- Two energy resources were particularly attractive to UMM: wind and biomass. The area has good wind speeds and a high frequency of windy days (figure 1). Local agriculture produces abundant biomass yearly.
- Based on campus needs and resources, a wind turbine (figure 2B) was installed in 2005 and a biomass gasification steam heating system (figure 2A) is currently being commissioned.

Integrating systems

Each renewable energy platform will reduce fossil fuel consumption resulting in a decrease in carbon emissions. However, each of these systems has disadvantages that can be compensated for by pairing it with other systems.

- **Wind:** The wind turbine has reduced electricity purchases from coal-fired generating plants by 50% (figure 3). The biomass system requires additional electrical power to run motors and control systems, which can often be supplied with power from the wind turbine. An absorption chiller, to be added this summer, will supplement electrical use for the campus cooling systems with biomass derived steam energy.

Active Management

Key to achieving peak performance is proper system design and management. To fully reach the goal of carbon neutrality, the overall system is being designed to almost completely replace fossil fuels. Within the next 6 to 18 months, construction should begin on a second wind turbine, a steam generator, and an absorption chiller.

By actively monitoring campus energy needs, available wind and biomass resources, the system can be optimized to fulfill the campus’ energy needs with the most efficient (least costly) and most environmentally friendly energy resources. For example, electricity from wind energy can be used when chilled water is needed for cooling in summer. However if there is no wind power available, the absorption chiller can be used to produce chilled water using biomass derived steam energy.

Results

By adding equipment to make full use of wind and biomass resources and integrating these platforms, the University of Minnesota, Morris expects to dramatically reduce carbon emissions within the next year and to be carbon neutral by the year 2010 (figure 4). Almost all fossil fuel use will be eliminated and carbon credits will cover the emissions of the small amount of carbon released by the remaining fossil fuel consumption.

Conclusions

- Using a single renewable energy platform is not likely to bring carbon footprint to zero in situations where multiple energy uses require a variety of energy sources.
- For the University of Minnesota, Morris campus, wind and biomass are the best energy platforms and will compliment each other when integrated.
- By properly managing these systems, carbon emissions will be significantly reduced and likely brought to neutral by 2010.

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