Wind power applications

There are four basic wind applications:

What Are the Major Applications of Wind Energy?

Hydropower, also known as hydroelectric power, harnesses the force of moving ...

Wind energy is primarily used for power generation. Wind power conversion systems have been increasingly employed in the U.S., Europe, India, and more sparingly in some other locations over the last decade, due to the development of technology that allows relatively high efficiency of the wind resource conversion. The key process is the conversion of the kinetic energy of moving air into the mechanical kinetic energy of the rotating shaft of the turbine. Similar to solar energy resource, one of the main challenges with wind power is its intermittence and high variability, which requires systematic adjustments in operation as well as strategies to integrate the wind power into the grid.

We"ve all seen those creaky old windmills on farms and, although they may seem about as low tech as you can get, those old windmills are the predecessors for new modern wind turbines that generate electricity. The same wind that used to pump water for cattle is now turning giant wind turbines to power cities and homes. Have a look at this wind farm in the California desert. A hot desert next to tall mountains. An ideal place for a lot of wind. Here"s another one on the windy prairies of Wyoming. Now, today"s wind turbines are much more complicated machines than the old prairie windmills, but the principle is the same. Both capture the wind"s energy. Ok.

So, why are wind turbines so tall? Well, the higher up you go, the windier it is. More wind naturally means more electricity. And in many cases, larger turbines can also capture wind energy more efficiently. The blades can sweep a circle in the sky as long as a football field. Now, what"s really cool is that even a small wind farm, like this one in Wyoming, can generate enough electricity to power more than 9,000 homes. And larger farms can provide much more clean energy for our homes and businesses.

Book chapter: F.M. Vanek and L.D. Albright, Energy Systems Engineering: Evaluation and Implementation, McGraw Hill, 2008 - Chapter 12 Wind Energy Systems, pp. 331-366. (See E-Reserves in Canvas.)

This chapter contains sufficient background on the topic, including global perspective of the technology, some technical details and performance parameters, and economic insight. Here, our goal is to understand the main characteristics of the system (both technical and economic) that can be useful for technology evaluation.

Read pages 331-348 more carefully; you can just scan through the rest of the chapter. (We will not dig into the turbine design since it is beyond the scope of this course). While reading, try to spot the answers to the

following questions:

EROI is a common metric applied to the energy conversion systems. It is defined as the ratio of the lifetime usable energy generated by the system to the energy spent for the system manufacturing, operation, maintenance, and disposal. Obviously, EROI = 1 would mean that over its lifetime a system produces as much energy as has been consumed for its creation and operation. Such a situation would indicate very low feasibility.

For wind turbines, the typical estimate of the EROI is in the range from 5 to 35, depending on the type of system. This indicator significantly increases with the size of the turbine rotor. The latest generation large-scale turbines yield EROI values about 35 and higher (Kubiszewski et al., 2010).

The wind power generation systems have been commercialized for several decades now. The efficiency and durability of the systems was improved over time. So, recent developments explain the growing interest in wind energy and observed growth of wind energy market. Read more on the status of this technology in the NREL report: