U.S. DEPARTMENT OF ENERGY'S
CYBERFORCE® PROGRAM

CyberForce® 101

Intro to Wind Energy

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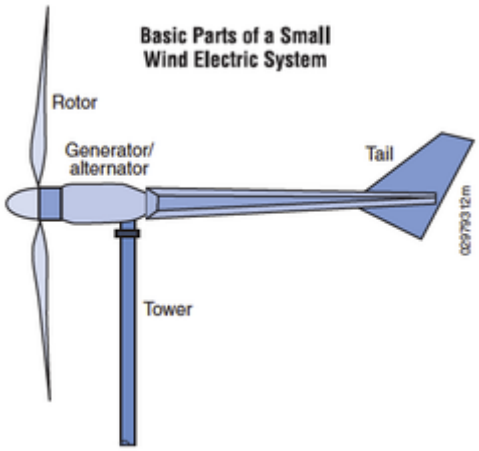
Intro to Wind Energy

Overview

Wind can be used to produce electricity by converting the kinetic energy of air into electricity. Using wind turbines, wind rotates the blades, which spin a shaft connected to a generator or the generator's rotor, which makes electricity. The amount of power generated depends on the size of the turbine and the length of its blades.

Parts of a Wind Electric System

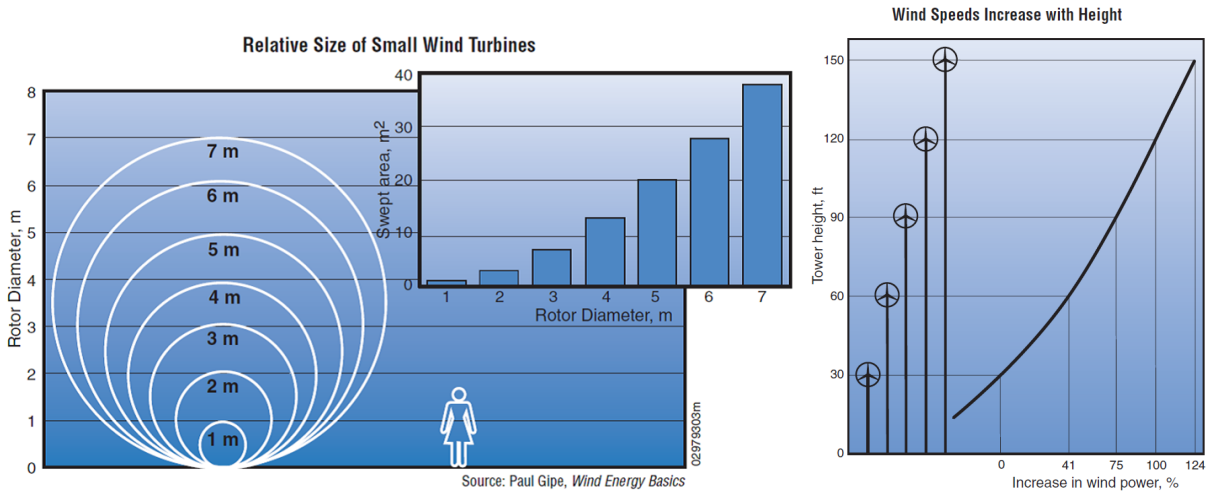
The basic parts of a wind electric system include: a rotor, a generator or alternator mounted on a frame, a tower, and the "balance of system" components. The balance of system components include: controllers, inverters, and/or batteries.



The amount of power a turbine will produce is determined by the diameter of its rotor, which defines its "swept area" (the quantity of wind intercepted by the turbine). Wind speeds increase with height, so the turbine is mounted on a tower. The higher the tower, the more power it produces. The balance of system components range based on if the system is grid-connected, stand-alone, or a hybrid system.

Wind Power Generation

A small increase in wind speed can result in a large increase in power. A taller tower increases the productivity of any wind turbine as it gives it access to higher wind speeds. Additionally, the larger a rotor, the more energy it can capture.



Wind turbine performance is best determined by annual energy output. Power (kW) is the rate at which electricity is consumed. Energy (kWh) is the quantity of electricity consumed.

Safety

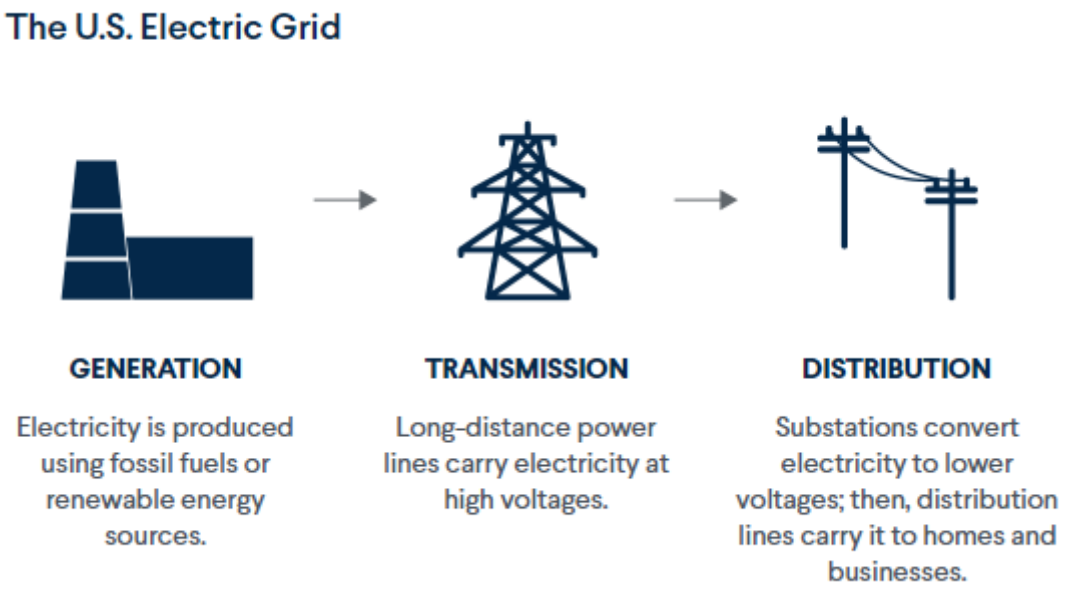
Wind turbine systems must automatically stop delivering electricity to power lines during a power outage in order to ensure line workers and the public's safety. These systems also must synchronize properly with the utility grid and match the utility's power in terms of voltage, frequency, and power quality.

Basic ICS for Wind Systems

IEC 61400-25 is the international standard that allows monitoring and control of wind resources through standard communication protocols. IEC 61400-25-2 specifies information model of devices and functions related to wind power plant applications. It specifically specifies compatible logical node names and data names for communication between wind power plant components.

Power Transmission to the Power Grid

The electric grid is made up of a network of power plants, transmission lines, and distribution centers. The grid must constantly balance supply and demand for energy. The grid works by sending electricity across long distances using high-voltage transmission lines. Power is at a high voltage to increase efficiency by preventing energy loss. With a higher voltage, you have lower current which decreases resistance loss in conductors. Substations then convert that high-voltage power to a lower voltage, which is a process known as "stepping down," to distribute it to nearby homes and businesses.



Backup Power Basics

Commercial standby generators are directly connected to a facility's electrical panel and are powered by using an external fuel supply such as diesel or natural gas. The generator, size of the generator, and fuel type determines what can be powered and for how long. Backup generators are commonly paired with an Automatic Transfer Switch, which prompts the generator to kick in within seconds of power loss. In addition to diesel generators, battery backup can also be used to keep a facility's electricity running in the event of an outage.

Sources

1. Wind Energy Basics
2. Small Wind Guidebook
3. How Does the U.S. Power Grid Work?
4. Power Grid: What Is It and How Does It Work?
5. What Is A Backup Generator And How Does It Work?