CHAPTER 2

ENERGY AND ELECTRICITY
How we produce most of our electricity

TERMS IN GLOSSARY

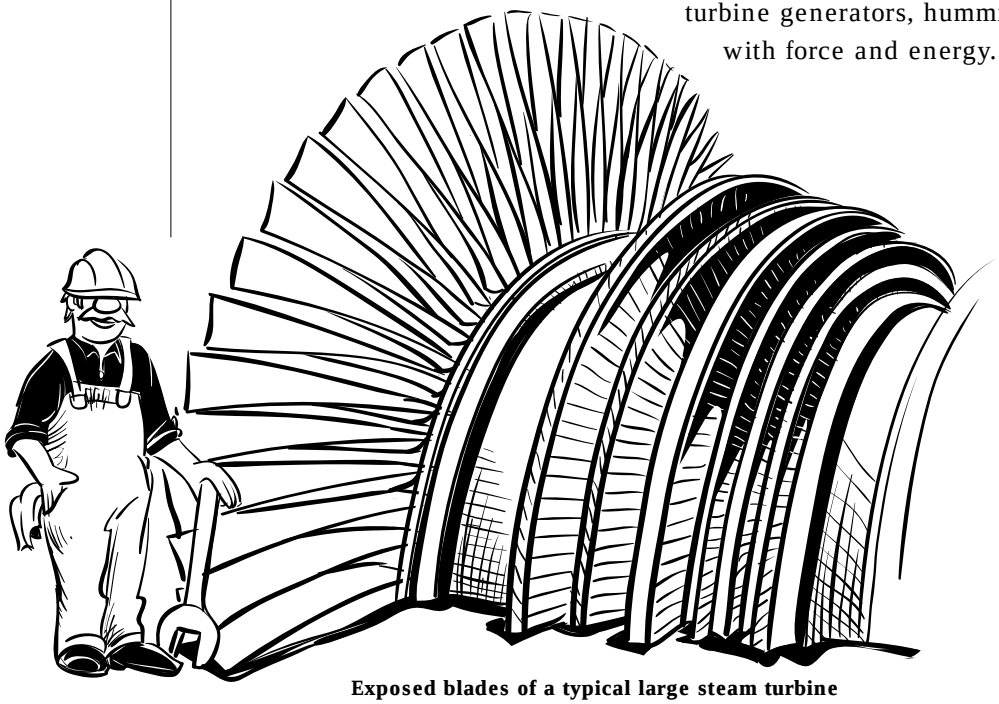
alternating current (AC)
ampere (amp)
atom
baseload power
blackout (brownout)
centigrade
complete circuit
condenser
conductor
demand
direct current (DC)
electric current
electrical energy
electron
energy conversion (transformation)
Fahrenheit
generator
grid
heat (thermal) energy
kilowatt
kilowatt-hour
magnetic field
mechanical energy
megawatt
negatively charged
neutron
nucleus
peaking power
positively charged
power load
proton
resistance
static electricity
substation
transformer
transmission lines
turbine
vaporize
velocity
watt
watt-hour

HOW OFTEN DO YOU THINK ABOUT where your electricity comes from? If you are like most of us you don't give it too much thought, since most people in industrialized countries are many miles of wire removed from the places where their electricity is generated. (Those of us lucky enough to have our own way of generating electricity — such as from a wind turbine or solar panels — are still the exception.)

Behind the scenes, energy producers are working day and night to provide us with a steady supply of electrical power. Using improved technology and know-how, today's electricity suppliers have figured out many different, and sometimes complex, ways to generate electricity. But the most common and widespread method uses an age-old apparatus, the turbine, attached to a much more modern device, the generator. For over 120 years these two machines have worked together in power plants to produce vast quantities of electricity, revolutionizing the way people live, work and play.

A TYPICAL POWER PLANT

Basically, a turbine, a generator, and a source of energy make up a power plant, no matter how large or small. Even a single wind turbine can be thought of as a power plant. But usually when we think about electricity generation, we picture a huge steam-driven power plant filled with great turbine generators, humming with force and energy.



Exposed blades of a typical large steam turbine

The Turbine

A turbine is any device with blades attached to a central rod, or rotor, that spins when a force hits the blades. This spinning motion can do a lot of useful work. Water wheels and windmills were actually our first turbines. Their wooden blades captured the power of wind or rushing rivers to lift water for irrigation or to rotate great stones to grind grain.

It wasn't until the 1880s, when the generator was first invented, that people began using turbines to produce electricity. Today we have many turbine designs. Some are small or have just a few main blades attached to the rotor (wind turbines, for example). Some turbines (such as those that use steam) are enormous, standing much taller than the average person. (See illustration, page 11.) These very sophisticated turbines have thousands of different-sized blades attached in a complicated pattern to the central rotor. These huge turbines are the kind used in most of today's large power plants.

Turning the Blades

The force of high-pressure steam powers most of today's turbines. We usually make the steam by burning a fuel such as coal, natural gas, or wood products to heat water above its boiling point.

But we don't always have to burn something to produce heat for making steam. The heat can come from the sun (in a solar thermal plant), from deep underground, using the earth's natural hot water and high-pressure steam (in a geothermal power plant), or from nuclear reactions (in a nuclear power plant). And forces other than steam, such as falling or running water, the wind, and ocean waves and tides, can also spin turbines. There are even ways we can generate electricity without using turbines at all. (See Chapter 3, "Energy Sources for Electricity Generation.")

Generating Electricity Using Electromagnetism

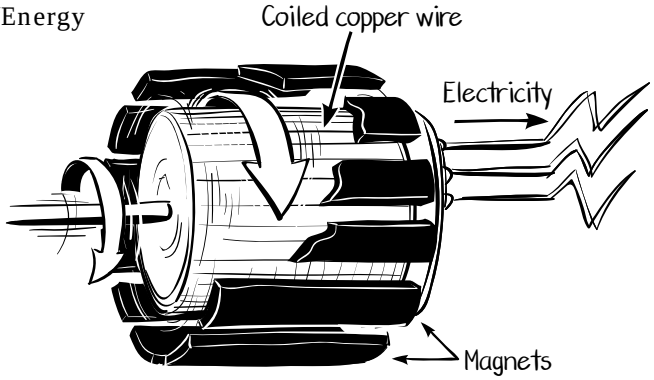
In a power plant, the sole function of a turbine is to spin a generator. A generator changes the mechanical energy of spinning to electrical energy. In a generator, coils of copper wire attached to the rotor spin inside a space surrounded by huge stationary magnets (or, as an alternate design, the magnet spins inside coils of wire). The magnetic field causes electrons in the wire to move, creating an electric current.

WHAT IS ENERGY?

Energy is the capacity to do work — to move something, heat it up, or change it in some way.

When work is being done, energy is always changing or converting. For example, when you run, your body converts chemical energy from food you've eaten into the energy of your actions (mechanical energy) and heat. Often there are several energy conversions, which are considered an "energy chain."

A steam-driven power plant has a series of energy conversions in an energy chain that goes like this: Heat energy (to make steam from water) is converted to mechanical energy (the spinning of the turbine blades); then, in the generator it's converted again to electrical energy.



A generator