Turbine electricity

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Our editors will review what you"ve submitted and determine whether to revise the article.

Photo: A cutaway model of a steam turbine used to generate electricity ina power plant. This one is an exhibit at the Think Tank science museum in Birmingham, England.

Photo: An old-fashioned windmill. Photo courtesy ofThe Jon B. Lovelace Collection of California Photographs in Carol M. Highsmith"s America Project, Library of Congress, Prints and Photographs Division.

A windmill is the simplest kind of turbine: a machine designed tocapture some of the energy from a moving fluid (a liquid or a gas) soit can be put to use. As the wind blows past a windmill"s sails, theyrotate, removing some of the wind"s kinetic energy (energy ofmovement) and converting it into mechanical energy that turns heavy, rotating stones inside the mill. The faster the windblows, the more energy it contains; the faster the sailsspin, the more energy is supplied to the mill. Adding moresails to the windmill or changing their design so they catch the windbetter can also help to capture more of the wind"s energy. Althoughyou may not realize it, the wind blows just a bit more slowly after it"s passed bya windmill than before—it"s given up some of its energy to the mill!

The key parts of a turbine are a set of blades that catch themoving fluid, a shaft or axle that rotates as the blades move, andsome sort of machine that"s driven by the axle. In a modernwind turbine, there are typically three propeller-like blades attached to anaxle that powers an electricity generator. In an ancient waterwheel,there are wooden slats that turn as the water flows under or overthem, turning the axle to which the wheel is attached and usually poweringsome kind of milling machine.

Turbines work in two different ways described as impulseand reaction—terms that are often very confusingly described (and sometimes completely muddled up) when people try to explain them.So what"s the difference?

In an impulse turbine, a fast-movingfluid is fired through a narrow nozzle at the turbine blades to make them spin around. Theblades of an impulse turbine are usually bucket-shaped so they catchthe fluid and direct it off at an angle or sometimes even back theway it came (because that gives the most efficient transfer of energyfrom the fluid to the turbine). In an impulse turbine, the fluid isforced to hit the turbine at high speed.

Imagine trying to make a wheel like this turn around by kicking soccer ballsinto its paddles. You"d need the balls to hit hard and bounce back well toget the wheel spinning—and those constant energy impulses are the key to how it works. The law of conservation of energy tells us that the energy the wheel gains, each

time a ball strikes it, is equal to the energy that the ball loses—so the balls will be traveling more slowly when they bounce back. Also, Newton"s second law of motion tells us that the momentum gainedby the wheel when a ball hits it is equal to the momentum lost by the ball itself; the longer a ball touches the wheel, and the harder (more forcefully) it hits, the more momentum it will transfer.

Artwork: An impulse turbine like this works when the incoming fluid hits the buckets and bouncesback again. The exact shape of the buckets and how the fluid hits them makes a big difference to how much energy the turbine can capture. The buckets also have to be designed to that the action of the jet on one bucket doesn"t affect the next bucket.

Water turbines are often based around an impulse turbine (though some do work using reaction turbines). They"re simple in design, easy to build, and cheap to maintain, not least because they don"t need to be contained inside a pipe or housing (unlike reaction turbines).

Artwork: A Pelton water wheel is an example of an impulse turbine. It spins as one or more high-pressure water jets (blue), controlled by a valve (green), fire into the buckets around the edge of the wheel (red). Lester Pelton was granted a patent for this idea in 1889, from which this drawing is taken.Artwork from US Patent 409,865: Water Wheel by Lester Pelton, courtesy of US Patent and Trademark Office.