



# Heartland Science

Ohio's Legacy of Discovery & Innovation



## Energy

From Amps to Air Conditioning

### World's First in Electric Power

The world's first commercial "supercritical" electric generating unit went into operation in 1957 at an American Electric Power (AEP) generating station in Philo, Ohio, about 55 miles east of Columbus. Unit 6 of AEP's Philo facility made a technological leap – from "subcritical" to "supercritical" steam – that the American Society of Mechanical Engineers (ASME) compared to aviation's advance from subsonic to supersonic flight.



The facility included mechanical engineering innovations that resulted in greater efficiency in generating electricity. By using higher steam pressure and temperature, Philo could produce more electricity with less coal than previous electric power plants. That reduced the cost of making electricity, and also cut the amount of air pollution produced as a by product, since efficient plants need less coal to make the same amount of electricity. Every 1 per cent increase in thermal efficiency results in a 2-3 per cent decrease in emissions of carbon dioxide, the major greenhouse gas linked to global warming.

In the 1950s, the best electric power plants had an efficiency of about 30 per cent, meaning that they converted only 30 per cent of the energy in a ton of coal into electricity. The rest went to waste. Philo boosted efficiencies to almost 40 per cent. By breaking the critical steam barrier, Philo 6 became the model for a new generation of other highly efficient electric generating units built around the world.



Thomas Edison built the world's first central power plant in 1882. Central generating plants make large amounts of electricity in one place, and then ship it over wires to customers.

The Pearl Street Station in New York City burned coal to heat water in a container called a "boiler," where liquid water converted into steam. The steam built up to high pressures, and then hissed out to drive a steam engine, much like a locomotive engine. The engine powered a "dynamo," or electric generator, which produced electric current.

The basic technology used to make most electricity in the United States -- turbines and steam -- are the same today.

However, the equipment for making electricity with coal -- the energy resource Ohio used most -- changed in the 20th Century as engineers tried to make the process more efficient, squeezing more energy out of each ton of coal. One, for instance, involved eliminating the steam engine that Edison used to turn the generator. Engineers replaced it with a steam turbine that used steam power directly, with less waste, to turn generators. New materials and technology gradually allowed construction of electric power plants that worked more

efficiently at higher and higher pressures. Edison's Pearl Street Station in New York City operated at a maximum pressure of 160 pounds per square inch (psi). It had an efficiency of only 2.5 per cent and needed 10 pounds of coal to make one kilowatt of electricity.

By the mid-1950s, pressures had reached thousands of pounds per square inch and power plants needed less than 0.7 pounds of coal to make each kilowatt of electricity. All of them, however, operated below the so-called "critical" pressure of 3,208 psi and temperature of 705°F. That's the point where water and steam have the same density, and the two act like they are the same substance.

Breaking that barrier to produce steam at higher temperatures and pressures ("supercritical" steam) was the key to further increases in efficiency; it involved solving many engineering challenges. Philo 6 operated from 1957 to 1975 when AEP decided to retire the facility. AEP demolished the entire Philo plant in 1983, but kept rotors from Philo 6's steam turbine, and used them in a sculpture at AEP headquarters in Columbus. They are a symbolic representation of Philo 6, which ASME designated as a Historic Mechanical Engineering Landmark.

#### Find out more....

- How Power Grids Work  
(<http://science.howstuffworks.com/power1.htm>)