

The Energy Epoch: From renewables to non-renewables and back again

by Angela Reid

How did we ever become so dependent on non-renewable energy? One might expect that with all we've learned about the negative impacts of using non-renewables for energy production, an advanced culture like ours would have taken strides to diversify its energy portfolio. It's not as if renewable energy is a new idea. In fact, long before we discovered fossil fuel, renewables were all we had. Read on to see how renewables have been used through the ages, and what University of Victoria's Dr. Andrew Weaver — world-renowned climatologist and climate change expert, and recent recipient of the Order of British Columbia — has uncovered about the history of energy. The mounting urgency to address climate change, combined with some technological innovations, will take us right back where we started a few million years ago.



Man first used the renewable energy of the sun. (Renewable energy comes from sources that can be regenerated or renewed over a useful period of time, and at a rate that does not degrade nature by physical means.) For *Homo erectus*, the sun provided light, heat, and the photosynthesis needed for food production.

THE FIRE AGE

Occasionally lightning struck, causing fire, which early humans eventually learned to make on their own. The fire age was the first time in history people controlled energy to make their lives easier by creating heat, light, and protection from predators. The fire age was the longest of the energy ages, lasting about 1.5 million years using renewable biomass, primarily wood.

As civilizations formed, several other renewables were harnessed — including wind, solar, and geothermal. Egyptians made the first wind-powered sailboats about 5,500 years ago; Greeks built the first passive solar homes 2,500 years ago using the sun's light and warmth; and Romans soaked in hot baths heated by geothermal hot springs.

Population growth in these early civilizations posed challenges and demanded innovation to produce food and goods on a larger scale. About 2000 years ago, the Greeks developed water wheels to grind grain, which were further adapted to tan leather, smelt iron, saw wood, and enable other industrial processes. Locations with good potential for water power became centres of economic activity, and 750 years later, large blades that captured wind were used for similar purposes.

Notwithstanding all these diverse forms of energy, wood remained the most common source, and over time, was harvested at an unsustainable rate. By the 12th and 13th centuries, nature could not reproduce trees as fast as they were being cut down, and most of the trees in Europe were being logged. In the 1300s, Germans built blast furnaces to burn wood at extremely high temperatures, allowing mass production of iron, but putting more pressure on already diminishing forests, creating the need to identify new sources of energy.



George Stephenson (1781-1848) was a British engineer who invented the first coal-fired steam locomotive engine for railroads. Stephenson's locomotive "Blucher" was completed and tested on the Cillingwood Railway in 1814. On an uphill track of four hundred and fifty feet, the engine hauled eight loaded coal wagons weighing thirty tons, at about four miles an hour. The engine's performance encouraged Stephenson to experiment further: In all, he built sixteen different engines.

THE FOSSIL FUEL AGE

Thus began the emergence of the age of fossil fuel, a non-renewable energy. (Non-renewable energy comes from sources which, when depleted, cannot be renewed in a useful amount of time.) By 1600, coal had become more popular than wood in England. The rate of technology and invention began to intensify, and what followed were a series of inventions and developments in the extraction and use of fossil fuels.

The coal-fired steam engine was introduced in the early 1800s. Because locations for steam power weren't limited by good hydro sources, the number of steam engines grew rapidly, spurring the Industrial Revolution. By the mid- 1880s, coal emerged as a predominant energy source, second only to wood. The first natural gas well was dug in 1821 in Fredonia, New York by William Hart, while the first modern oil well in America was drilled in Pennsylvania by Colonel Edwin Drake in 1859, where he also found natural gas. Both fuels were used to light homes and streets, and eventually replaced whale oil, which was growing scarcer due to the over-harvesting of whales. By the late 1880s, coal use slowly declined as oil and natural gas consumption steadily rose, with the U.S. leading the world in consumption. With the invention of electricity, the power plant, and an electric distribution system in 1882, energy could now be routed almost anywhere. Fossil fuel-based electricity replaced gas and oil for lighting, and electric trolleys replaced horse- and steam-powered street railways.

The gas car was invented a little more than 100 years ago. Trains started switching to diesel locomotives, and many were replaced by trucks. In 1901, vast oil fields in Texas were discovered, and by 1920, several million automobiles were on the roads. In the 1950s, atomic energy emerged, but was halted by the U.S. in the 1970s due to seismic and toxic waste disposal concerns. In the past 30 years, use of fossil fuels has tripled and now accounts for more than 80 percent of world energy. While total fossil fuel consumption and the resulting greenhouse gas (GHG) emissions rose 70 percent over pre-industrial times between 1970 and 2004, an interesting phenomenon is highlighted by Dr. Andrew Weaver in his latest book, [Keeping Our Cool: Canada in a Warming World](#).

"Since the transition away from wood to coal and other fossil fuels, and then on to nuclear and renewables, we have continuously been 'de-carbonizing' our energy sector. For every unit of energy produced, we have been producing less and less CO₂. This trend stopped around 1980, and the market share of all forms of energy has remained in a relatively steady plateau ever since." This effectively stopped the natural emergence and growing market share of renewables like solar and wind. Why? Dr. Weaver speculates there are many reasons, ranging from dominance in the market place, investment in distribution infrastructure, politics, and resistance to change.

Over the ages, energy has been used to make our lives easier, but our unsustainable consumption of fossil fuels is putting all of humanity at risk due to global warming and the resulting social, environmental, and economic impacts; not to mention security concerns. This problem could be multiplied by growing populations in developing nations, but as Dr. Weaver points out, "many of these nations do not have existing infrastructure that needs to be changed," providing developed nations like Canada and the U.S. the opportunity to lead them by creating low-carbon economies at home.

So, what in the world should we do? We have developed our built communities and economies around the availability of abundant, cheap, and accessible resources. Fossil fuels are no longer any of these things. By reviewing our history of energy use and consumption it becomes clear that we are repeating past mistakes; extracting resources at an unsustainable rate. This problem is exacerbated by an energy sector dominated by strong vested interests that have been fuelling a resistance to change.

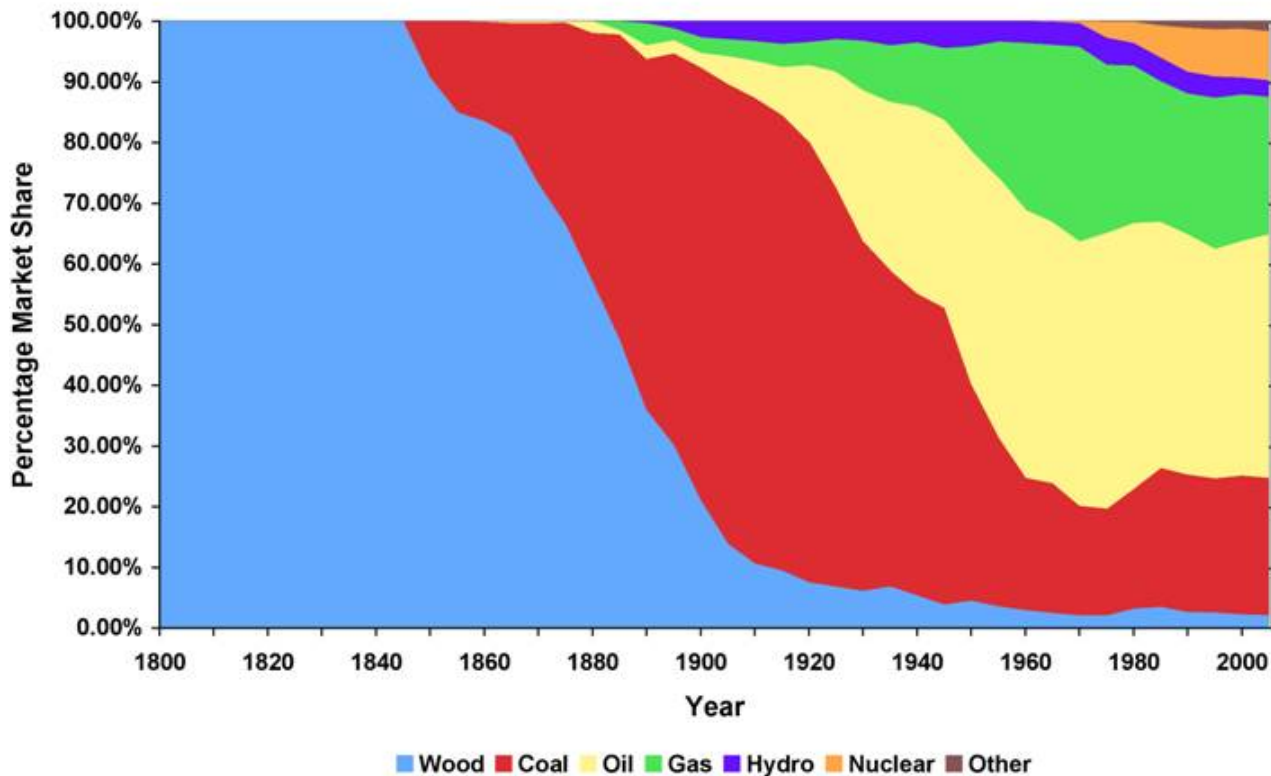


In 1680, Dutch physicist Christian Huygens conceptualized, but never built, an internal combustion engine that was to be fuelled by gunpowder. More than two centuries later, in 1885, Gottlieb Daimler invented what is often recognized as the prototype of the modern gas engine. It had a vertical cylinder and a carburetor, through which gas was injected. Daimler first built the two-wheeled "Reitwagen," (riding carriage) with this engine. A year later he built the world's first four-wheeled motor vehicle. In 1886, Karl Benz received the first patent for a gas-fuelled car. Daimler built an improved four-stroke engine in 1889, with mushroom-shaped valves and two v-slant cylinders. In 1890, Wilhelm Maybach built the first four-cylinder, four-stroke engine.

Thankfully, we can also see that when humanity faces a challenge as great as this, we innovate, and that's just what we're doing in BC and around the world. Tune in next time to learn about the impacts of fossil fuel consumption, the challenges we face in a fossil fuel-based economy, and why the urgency to change is now greater than ever.

The graph below shows how the transition from wood to coal and then onto other fossil fuels began in the mid-1800s, based on their percentage of market share. As each new energy source emerged, it gradually gained market share, reducing the use of the energy source before it. Scientists know that oil produces less CO₂ per BTU (British Thermal Units) than coal, and natural gas produces less CO₂ per BTU than gas, so with the transition from "dirtier" to "cleaner" energy sources, we were decarbonizing our total energy portfolio based on energy intensity, particularly as we moved away from fossil fuels and onto renewables. However, this trend stopped around 1980, and each source of energy has maintained a relatively stable percentage of market share, resulting in no more significant reductions to the amount of CO₂ per unit of energy.

US Energy Percentage Market Share Since 1800



Angela Reid helps build green businesses through her company, Tigress Ventures Inc. Current projects focus on renewable energy and the comprehensive integration of sustainability principles into business. Her most recent venture is the co-founding of GreenStep, a consultancy that helps organizations identify and implement sustainability initiatives. She was recently elected to Kelowna City Council.