Energy economies

3000 BCE Candles invented in Egypt and Crete
600 BCE The Greeks discover the electric attraction produced by rubbing fur on amber
450 BCE Empedociles proposes that all substances are made up of a combination of four elements — earth, air, water, and fire — an idea later developed by Plato and Aristotle
400 BCE Democritus theorizes that matter consists of tiny particles called atoms that cannot be divided
200 BCE The world's first known well for natural gas created in China
100 BCE Water-powered mills used for grinding grain in Illyria (Serbia, Montenegro, and Albania) and probably in western Anatolia (Turkey)
100 BCE Coal used to heat houses in China
85 BCE A water mill operates in Asia
100 Heron of Alexandria invents the aeolipile, the first steam engine
300 Reference to a perpetual motion machine appears in a Sanskrit manuscript
300 The Chinese learn to use coal instead of wood as fuel for making cast iron
615 "Burning water" (petroleum) used in Japan
644 Windmills used in ancient Persia (now Iran)
900 Arab chemists and physicians prepare alcohol fuel by distilling wine
1000 Waterwheels become widespread in Europe
1086 *The Domesday Book* lists 5,624 waterwheel-driven mills in England south of the Trent River
1150 Indian mathematician Bhaskara is the first to describe a "perpetual motion" machine
1180 First documented European windmill found in Normandy
1185 Earliest written record of a windmill in England
1200 The monk Reinier of Liège provides the first documented proof that coal is mined in Europe
1300 Iron begins to be manufactured by water-driven blowing furnaces
1307 London forbids the burning of coal because of the pollution
1340 Windmills in Holland used to pump excess water from soil
1400 More than 10,000 windmills operate in England, mostly near large wheat fields
1400 Blast furnaces with water-driven bellows used in France's Rhine Valley
1504 Leonardo da Vinci's *The Codex Leicester,* a collection of scientific writings, describes a device that measures the expansion of steam
1592 The first wind-driven sawmill built in the Netherlands
1603 Hugh Platt discovers coke, a substance similar to charcoal that is produced by heating coal
1609 First attempt to harness the ocean's energy from tidal forces occurs in Canada
1612 Santorre Santorio's *Commentariar in artem medicinalem Galeni* (Commentary on Galen's Art of Medicine) mentions Galileo Galilei's thermoscope, a forerunner to the thermometer
1621 Dud Dudley builds the blast furnace, a coal-fired, iron-smelting furnace
1641 Ferdinand II, the Grand Duke of Tuscany, invents a thermometer that uses liquid in a glass tube with one sealed end
1650 The term *electricity* coined to describe the force found when amber is rubbed together with silk (static electricity)
1659 Natural gas discovered in England — a first for all of Europe
1670 Christian Huygens builds a motor powered by gunpowder explosions

1679 Denis Papin, assisted by Huygens, invents the steam digester, a pressure cooker
1680 Sir Isaac Newton proposes that a jet of steam can power a carriage
1690 The recycled paper manufacturing process introduced in Pennsylvania, where the Rittenhouse Mill makes paper from the fiber of recycled cotton and linen rags
1698 Thomas Savery patents the first crude steam engine, a machine that pumps water from coal mines
1709 Daniel Gabriel Fahrenheit invents the alcohol thermometer
1714 Fahrenheit invents the mercury thermometer
1724 Fahrenheit invents the first temperature scale bearing his name
1744 Benjamin Franklin invents the Franklin stove, which furnishes heat with a lower consumption of fuel
1752 While flying a kite in a storm, Franklin successfully extracts sparks from a cloud and proves that lightning has electrical power
1765 James Watt invents the steam engine
1766 English physicist and chemist Henry Cavendish discovers the element hydrogen, calling his discovery “inflammable air”
1774 Joseph Priestley and Karl Scheele independently discover the element oxygen
1774 Allesandro Volta invents the electrophorus, a device that produces static electricity
1775 Pierre-Simon Girard invents the water turbine
1776 American rebels recycle paper and metals to provide materials for the War of Independence
1777 First buildings since Roman times use warm-water central heating systems
1786 Johann Georg Picket experiments with coal gas for lighting
1789 Martin Klaproth discovers uranium, though it is not isolated until 1841
1790 Gas from carbonized coal becomes the primary fuel for illuminating houses and streets in much of Europe
1792 William Murdock invents the gas-jet lighting fixture
1797 Edmund Cartwright invents an engine that runs on alcohol
1799 Volta creates the first electric battery, called the Voltaic pile
1804 Frederick Albert Winsor patents an oven that manufactures coal gas
1810 First gas light patent in the U.S. awarded to David Melville
1812 British Parliament grants a charter to Friedrich Winsor (a German) to establish the Westminister Gas Light and Coke Company, thereby accelerating the general use of gas
1817 Baltimore becomes the first U.S. city to establish a gas company
1821 Johann Seebeck observes that two metals connected at different places and kept at different temperatures produce an electric current (an effect later used to develop semiconductors)
1823 Samuel Brown invents an internal combustion engine with separate combustion and working cylinders to power a vehicle
1826 Captain Samuel Morey of New Hampshire patents an internal combustion engine
1827 Georg Simon Ohm publishes results demonstrating that the electrical current equals the ratio of voltage to resistance — the first statement of Ohm’s law
1830 Jacob Perkins invents a radiator to use with hot-water central heating
1831 Michael Faraday discovers electromagnetic induction, the creation of a proportional electromotive force by a magnetic field changing in time
1832 Joseph Henry discovers electromagnetic self-induction
1834 E. M. Clarke produces the first commercial electromagnetic generator

1835 Joseph Henry invents the electrical relay, which allows for the transmission of currents across large distances
1836 John Frederic Daniell invents the Daniell cell, a more reliable electric battery than voltaic cells
1839 Alexandre Edmond Becquerel discovers the photovoltaic effect in which sunlight can generate electrical currents
1839 William Robert Grove develops the first fuel cell, a device that produces electrical energy by combining hydrogen and oxygen
1842 Julius Robert Mayer notes that heat and mechanical work are both forms of energy — the first law of thermodynamics
1848 Gaslight turned on in the White House for the first time
1850 Paraffin from oil first used for lighting by the Kerosene Gaslight Company in Canada
1850 Rudolf Clausius discovers the first statement of the second law of thermodynamics, which he restates in 1865 as "entropy always increases in a slow system"
1853 Samuel Kier extracts kerosene from petroleum
1854 Heinrich Gobel makes an incandescent lamp by placing a filament of carbonized bamboo in a glass vessel
1855 Abraham Gesner patents the process of extracting kerosene from bituminous shale and coal
1857 Werner von Siemens designs the shuttle windings for the armature of the electric generator, an important step in developing electric generators without permanent magnets
1859 George Simpson patents the electric range, originally called an electroheater
1859 The first commercially productive oil well drilled in Pennsylvania
1859 Gaston Plante in Paris invents the first rechargeable lead-acid storage battery
1860 The earliest known record of direct conversion of solar radiation into mechanical power
1861 Auguste Mouchout receives a patent for a motor running on solar power
1865 Samuel Van Syckel completes the first major oil pipeline that successfully transports crude petroleum
1868 George Leclanche invents the zinc-carbon battery
1872 First long-distance pipeline for natural gas completed in Pennsylvania
1874 Curbside recycling begins in Baltimore
1876 Nikolaus Otto develops the four-cycle internal combustion engine (similar to what is used today)
1879 Thomas Edison invents the lightbulb
1882 The first electric central station to supply light and power created in New York
1882 The first commercial hydroelectric power plant begins operating in Wisconsin
1885 The Massachusetts Gas Commission formed as the first governmental body regulating energy sales, consumption, prices, and consumer advocacy
1887 Crude oil discovered in Texas
1887 Gottlieb Daimler powers a four-wheel vehicle with an internal combustion engine
1890 Nikola Tesla designs the alternating current (AC) power generator
1891 First long-distance, high-voltage line for transporting electricity established in Germany
1893 George Westinghouse and Tesla introduce electrical power to the general public at the World's Columbian Exposition in Chicago by using alternating current to illuminate part of the exhibition
1894 The first dam built specifically to drive a hydroelectric power plant operates on the Willamette River in Oregon

1894 The first electric automobiles powered by rechargeable batteries appear on the market
1895 Uranium's radioactive properties first demonstrated in France
1896 John Holland builds his first contract submarine with a steam engine for surface propulsion
1897 Joseph Thomson discovers the electron, which makes electric currents and is the first known particle smaller than an atom
1900 Thomas Edison invents the nickel-alkaline electric battery
1900 The first offshore oil wells drilled off the California coast
1902 Marie and Pierre Curie discover the atomic weight of radium
1902 Robert Bosch invents the spark plug in Germany
1903 First large scale steam-turbine generator used commercially in Illinois
1905 Albert Einstein formulates his special theory of relativity to describe the motion of particles moving close to the speed of light
1908 Oil struck for the first time in the Middle East (Iran)
1910 Charles Steinmetz warns in *Future of Electricity* of the pollution caused by burning coal and disposing sewage into rivers
1912 The electric starter replaces the hand crank to start gasoline cars
1913 William Burton patents his process of converting oil to gasoline
1914 The world's largest power dam opens in Illinois and Iowa
1916 The U.S. federal government starts the Waste Reclamation Service with the motto "Don't Waste Waste — Save It" in response to the raw material shortages during World War I
1917 Ernest Rutherford splits the atom for the first time
1918 Jan Czochralski develops a way to grow single-crystal silicon, a necessary step in the production of solar cells and computers
1921 Einstein wins the Nobel Prize for his theories about the photoelectric effect and the properties of light
1923 Seismic methods used in Mexico for the first time to search for petroleum
1927 General Electric introduces the first refrigerator to receive widespread market acceptance
1927 Oil discovered in Iraq
1928 Public concern about the dangers of radioactivity triggers the creation of the International Committee on Radiological Protection
1930 First commercial greenhouse use of geothermal energy undertaken in Idaho
1936 The Hoover Dam, the first hydroelectric power plant, completed in Nevada
1937 The first working jet engine built in England
1938 Otto Hahn and Fritz Strassman demonstrate fission, the basis for atomic energy, in Germany
1939 First house to be heated by solar energy built in Massachusetts
1939 After receiving a direct appeal from Einstein, President Franklin Roosevelt creates the Advisory Committee on Uranium, a U.S. government committee to coordinate and provide limited funding for early uranium research
1940 Henry Tizard, chairman of England's Committee for the Scientific Survey of Air Warfare, sets up the MAUD Committee, a sub-committee to investigate the feasibility of building an atomic bomb
1941 Glenn Seaborg identifies plutonium, a human-made radioactive material more likely to fission than uranium
1942 Enrico Fermi produces the first self-sustaining nuclear chain reaction under Stagg Field at the University of Chicago

1945 The U.S. explodes the first atomic bomb during a test in New Mexico
1945 The U.S. drops additional bombs (one uranium-based, one plutonium-based) on Hiroshima and Nagasaki
1946 The United Nations (U.N.) establishes the International Atomic Energy Commission to promote the peaceful use of nuclear energy and prevent its use for military purposes
1946 Iran signs an agreement with the U.S.S.R. to give the Soviets 51% of Iranian oil for the next 25 years
1946 The first Soviet nuclear reactor begins operation
1946 Percy Spencer invents the microwave oven
1946 The U.S. Atomic Energy Commission founded primarily to control the peacetime development of atomic technology
1948 World's largest oil field discovered in Saudi Arabia
1950 The first nuclear reactor in England becomes operational
1951 Under the leadership of Prime Minister Mohammed Mossadegh, the Iranian parliament votes unanimously to nationalize the oil industry, thereby shutting out the immensely profitable Anglo-Iranian oil company (which becomes British Petroleum in 1954)
1953 President Dwight Eisenhower, though in favor of the hydrogen bomb, outlines a plan to curtail the stockpiling of atomic weapons in his "Atoms for Peace" speech to Congress; toward the end, he states: "Against the dark background of the atomic bomb, the United States does not wish merely to present strength, but also the desire and the hope for peace"
1954 The U.S.S.R. opens its first atomic power plant
1954 President Eisenhower signs the first major amendment to the 1946 Atomic Energy Act by permitting private industry to build nuclear reactors for electric power
1954 After the CIA and British intelligence stage a coup to remove Iranian Prime Minister Mossadegh, British ownership of the Anglo-Iranian oil company is restored (though without a monopoly on Iranian oil)
1955 Western Electric begins selling commercial licenses for the silicon photovoltaic technology used to manufacture solar cells
1956 The U.S. Atomic Energy Commission authorizes the construction of private nuclear power plants
1956 The first commercial coal pipeline completed in Ohio
1957 The nuclear reactor in Windscale, England, catches fire and releases large amounts of radioactive contamination into surrounding areas
1960 The first commercial nuclear power plant to produce power for distribution established in Massachusetts
1960 The Organization of Petroleum Exporting Countries (OPEC) established by Middle Eastern countries and Venezuela to coordinate petroleum policies in response to calls by American-, British-, and Dutch-owned companies to lower payments to oil producers
1961 President John F. Kennedy publicly advises Americans to build nuclear fallout shelters
1965 Fuel cells are used successfully in two U.S. spacecraft *Gemini* and *Apollo*
1969 The National Environmental Policy Act requires the U.S. government to consider the environmental consequences of any major federal action
1969 Geologists discover oil in Alaska's North Slope
1970 The Geothermal Resources Council formed to develop geothermal resources worldwide

1970 The Clean Air Act requires the Environmental Protection Agency (EPA) to develop and enforce regulations to protect the public from exposure to airborne contaminants known to be hazardous to human health
1970 Egypt's Aswan High Dam power station completed, more than doubling the country's electric capacity and allowing for industrial growth
1972 The first electric power plant using municipal refuse as fuel begins operations in Missouri
1972 An experimental power plant in Germany produces electricity by using coal converted to gas before being burned
1973 OPEC announces that its member nations will no longer ship petroleum to nations supporting Israel in its military conflicts with Egypt and Syria
1973 The U.S. government sets price limits on and rations gasoline
1974 OPEC members lift the oil embargo after earning more than $100 billion in extra profits
1976 The Resource Conservation and Recovery Act passed in the U.S. to protect the environment and human health from the hazards of waste disposal
1977 The Trans-Alaska Pipeline System, one of the largest oil pipelines in the world, opens
1977 President Jimmy Carter bans the recycling of used nuclear fuel from commercial reactors
1979 A major accident and partial meltdown occur at the Three Mile Island nuclear power plant in Pennsylvania
1979 OPEC raises prices on crude oil by 50% over prices of the previous year
1979 President Carter announces a six-point program to reduce U.S. dependence on foreign oil; Carter states: "We can manage the short-term shortages more effectively, and we will; but there are no short-term solutions to our long-range problems. There is simply no way to avoid sacrifice"
1979 Iranian militants seize the U.S. embassy in Tehran and take approximately 70 Americans captive; President Carter responds by placing an embargo on Iranian oil
1980 The Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) requires the EPA to identify and clean up dangerous sites, such as abandoned hazardous waste dumps
1980 Israel requires the installation of solar water heaters in all new buildings (including residential buildings, hotels, and institutions, but excluding industrial buildings, workshops, hospitals, and high rises)
1981 President Ronald Reagan ends price controls on crude oil and refined petroleum products
1983 OPEC cuts the price of crude oil by about 15%, the first price cut in the organization's history
1984 Itaipu Dam, the world's largest dam, begins operating along the border of Brazil and Paraguay
1985 The Soviet Union announces a nuclear testing moratorium
1986 A Chernobyl nuclear reactor explodes in the U.S.S.R. (now Ukraine), killing 30 people immediately and causing radioactive fallout to drift as far as eastern North America
1988 The Intergovernmental Panel on Climate Change established under the U.N. Environment Program to assess the impact of climate change and formulate strategic responses
1989 Exxon Valdez oil tanker strikes a reef in Alaska's Prince William Sound, spilling almost 240,000 barrels of crude oil
1989 President George H. W. Bush signs the then-secret National Security Directive 26, which begins: "Access to Persian Gulf oil and the security of key friendly states in the area are vital to U.S. national security"

1990 Iraq's invasion of Kuwait causes the world price of crude oil to climb from $16 to $28 per barrel
1990 The Acid Rain Program of the 1990 U.S. Clean Air Act, which allows energy producers to buy, sell, and save emission "allowances," becomes one of the most successful emissions trading systems
1991 The end of the Persian Gulf War, a conflict between Iraq and a U.N.-mandated, U.S.-led coalition force of approximately 30 nations, causes crude oil prices to decline roughly to 1989 levels
1992 The largest group of thin film photovoltaic modules used to convert sunlight into electricity begins operation in California
1993 China starts construction of the Three Gorges Dam, the largest hydroelectric dam in the world and more than five times the size of the Hoover Dam; the project requires the displacement of more than a million people due to rising waters
1993 300,000 Ogoni protest Shell Oil's activities and the environmental destruction of Ogoni land in Nigeria
1994 The U.S. and North Korea sign the Agreed Framework, under which North Korea agrees to freeze the operation and construction of nuclear reactors suspected of being part of a covert nuclear weapons program in exchange for two proliferation-resistant nuclear power reactors
1995 The Nigerian government executes Ken Saro-Wiwa and eight other environmental activists involved in the Ogoni protests against Shell Oil
1996 The California legislature passes Assembly Bill 1890, endorsing the breakup of the regulated monopoly structure of the electric utility industry
1997 The U.N. Framework Convention on Climate Change initiates the Kyoto Protocol to reduce greenhouse gas emissions
1998 The Australian Greenhouse Office establishes the National Greenhouse Strategy to lower greenhouse gas emissions less aggressively than outlined in the Kyoto Protocol
1998 Chicago adds hydrogen fuel-cell buses to mass transit
1999 Nuclear power, previously the fastest-growing energy source, becomes the slowest, responsible for less than 17% of the world's total electricity
2000 The World Dam Commission reports on alternatives to massive hydroelectric dam projects to reduce the destruction of important archaeological sites
2000 After wholesale electricity rates rise as much as 300% in California, rate caps and rolling blackouts are instituted
2000 The U.S. National Photovoltaics Program announces its plan to increase the use of solar energy to satisfy 10% of U.S. total electricity demand
2000 The transnational oil giant BP Amoco re-brands itself "Beyond Petroleum"
2000 The most powerful solar panel array in space installed in the International Space Station
2001 Civil lawsuits filed against multiple wholesale energy companies for conspiracy and price-fixing
2001 A NASA satellite survey of more than 2,000 glaciers reveals that most of the world's glaciers are shrinking
2002 The European Union (E.U.) declares its intention to shift energy production away from fossil fuels and nuclear power toward renewable power
2002 53 additional countries, including the U.K., all E.U. members, and Japan, ratify the Kyoto Protocol

2002 The U.S. refuses to sign the Kyoto Protocol and announces an alternative strategy that makes no promises to cut greenhouse emissions but instead sets a national target of reducing emissions for every unit of gross national product
2002 Australian Prime Minister John Howard makes a public statement that Australia will not ratify the Protocol without the U.S.'s support
2003 Researchers develop the first, ultra-thin solar cells comprised entirely of inorganic nano-crystals
2003 Canada pledges $215 million for the Hydrogen Early Adopters Program, which provides funding to support the development of hydrogen-compatible technologies such as fuel cells
2003 President George W. Bush signs a $273 billion energy and water bill that includes funding for a nuclear waste repository at Yucca Mountain, Nevada
2003 Libya announces that it will abandon programs for weapons of mass destruction and comply with the Nuclear Non-Proliferation Treaty
2003 Regular trading begins at the Chicago Climate Exchange, the world's first voluntary, legally binding trading system in which members buy and sell emission allowances to reduce the overall level of greenhouse gases
2003 The government of Chad announces that it has begun its first ever crude oil production
2003 ExxonMobil begins construction of the $34 billion Kizomba B offshore development project in Angolan waters
2003 The International Atomic Energy Agency (IAEA) finds traces of weapon-grade enriched uranium in Iran
2004 Wind energy, the world's fastest growing energy source, reaches 60,000 megawatts (70% of the total capacity rests in Europe)
2004 For the first time in a decade, the U.K. imports more oil than it produces
2004 Russia approves and ratifies the Kyoto Protocol
2005 205,749 hybrid vehicles sold in the U.S. (1.2% of total vehicles sold)
2005 Hurricane Katrina kills at least 1,836 people and causes $75 billion in damage, including a number of natural gas processing facilities on the U.S. Gulf Coast
2005 ExxonMobil, Shell Oil, and other energy companies make record profits as a result of surging oil and gasoline prices before and after Hurricane Katrina
2005 U.S. government experts and international scientists confirm that the traces of bomb-grade uranium found in Iran in 2003 came from contaminated Pakistani equipment and are not evidence of a secret nuclear weapons program
2006 Iranian President Mahmoud Ahmadinejad proclaims his country's membership in the "club of nuclear countries" and announces that Iran can now manufacture enriched uranium for power stations

The source for much of the information in this timeline is the California Energy Commission's website at www.energyquest.ca.gov.