By J.B. Fisher

There is much discussion today about alternative energy sources replacing fossil fuels, but what exactly is meant by "alternative energy"? In one sense, it refers to sources of energy other than fossil fuels - oil, natural gas, and coal. More broadly, however, the term refers to sources of energy that can replace fossil fuel sources without undesirable consequences, or at least the undesirable consequences that accompany the use of fossil fuels.

Alternative energy sources include both renewable and non-renewable sources of energy. Hydroelectric, tidal, ocean thermal, solar, wind, and biomass are the renewable types. Geothermal is non-renewable. Nuclear energy can also be viewed as an alternative energy source, since it does not depend on fossil carbon fuels. Even so, nuclear energy consumes uranium, which is a natural and non-renewable resource. However, nuclear energy will not be renewable until commercial breeder reactors are developed that can make more fissionable isotopes than they consume.

Let's Hear It for the Sun

The source of most forms of alternative energy is the sun. For example, hydroelectric power is generated by the downhill flow of water. However, the source of this action is actually just one part of the solar energy-driven water cycle. The exceptions are geothermal energy and tidal energy. The source of geothermal is natural radioactive decay within the earth. The source of tidal energy is the gravitational pull of the moon and the sun.

What is called solar energy arises from the capture of incoming radiation from the sun. This energy is captured either as heat or by direct conversion to electricity. Ocean thermal energy uses a process that makes use of the difference between warm surface water and cold deep water in the ocean. Wind energy arises from pressure differences in the earth’s atmosphere caused by uneven solar heating. Biomass energy relies on the chemical bonds made by plants during photosynthesis. This is the process by which plants convert carbon dioxide into organic compounds using sunlight.

Search for Energy

Until the invention of a reliable steam engine by James Watt in 1775, nearly all energy used by humans came from water, solar, wind, and biomass sources. Let's look at examples: Water drove mills that ground grain. Solar evaporated seawater to make salt.
Wind moved sailing ships and pumped water. Biomass lighted and heated homes, using tallow candles from animal fat and wood fires. Biomass energy also powered most means of land transportation. How? It harnessed the muscle power of grain- and grass-fed animals.

**Nothing Is Forever**

A significant advantage of fossil fuels over alternative energy sources is their energy density - that is, the amount of energy in a given mass or volume of fuel. For example, a gallon of gasoline contains just over four times the amount of energy as the same volume of wood. Gasoline is also a fluid, while wood is a solid. Fluids are much easier than solids to use as fuels. Fluids take on the same shape as their container and can be easily moved from a fuel tank to an engine. Further, gasoline can be burned more efficiently than wood and does not leave any solid waste behind.

Even so, whatever advantages fossil fuels have, they are not renewable. This means that fossil fuels will one day be in such short supply that they will not be affordable. This is not to say that the world will run out of oil tomorrow. But, almost everyone agrees that the world will one day run out of oil that can be accessed and refined affordably.

**No 'Free Lunch'**

The production of energy definitely affects the environment. For instance, the extraction of fossil fuels results in environmental damage. The consequences of coal mining are acid drainage and surface scars. Petroleum production can cause oil spills, saltwater spills, and the release of the greenhouse gas methane into the atmosphere. When fossil fuels are burned, the pollutants released into the atmosphere include carbon dioxide, a gas that contributes to global warming. Other pollutants that are released include sulfur and nitrogen oxides, which are acid-rain-producing gases, and haze- and smog-producing materials.

The burning of coal releases the same pollutants into the atmosphere as burning oil-based fuels. In addition, this burning generates a massive amount of solid waste in the form of ash, much of which is disposed of in landfills. In 2009, a total of 136.6 million tons of coal ash were produced in the United States. Of this amount, 56.6 million tons were disposed in landfills. By way of comparison, 131.9 million tons of municipal solid waste were disposed in U.S. landfills in 2009.

**And the Negatives Are...**

Alternative energy sources also have their environmental drawbacks. Hydroelectric dams stop the natural flow of sediment and are barriers to migrating fish. Solar cells require industrial scale production of silicon semiconductors. Such production produces large amounts of toxic wastes and consumes large amounts of energy. The
wind-driven turbines that produce electricity from wind energy sometimes kill large numbers of birds. Biomass energy comes from farmed crops, and farming requires energy inputs at nearly every stage of production. For example, nitrogen fertilizers are produced from natural gas. The application of pesticides and fertilizers to maximize crop yield can result in serious air and water pollution. Converting land from food production to energy production can increase the cost of food. Therefore, the economic and environmental costs of alternative energy sources must be taken into account as the world transitions to new energy sources.

It is widely accepted that the burning of fossil carbon fuels harms the environment and that, at some point, pumping oil will become unprofitable. Nevertheless, the relative mix of energy sources in the United States, and probably the world, will remain about the same for the foreseeable future. We depend upon reliable sources of energy for nearly every daily need. For more than 200 years, fossil fuels have served as a reliable energy source. But, those sources to which there is fairly easy access are, without doubt, running out. To be sure, workable and affordable alternatives to fossil fuels are needed before the situation becomes critical. However, replacing these sources with alternative ones may take a long time.

**Little Change Predicted**

According to the Energy Information Administration (EIA), about 84 percent of the energy consumed in the U.S. in 2011 was derived from fossil fuels. About half of this fossil-fuel-derived energy was from oil. Of the remaining 16 percent of energy consumed in the U.S. in 2011, nuclear energy accounted for 9 percent. Renewable energy sources, including hydroelectric power, accounted for the remaining 7 percent.

The EIA's projection of energy consumed in the U.S. in 2035 indicates that oil and other fossil fuels will provide less energy and that renewable energy sources will provide more. However, the relative balance of the sources for energy consumed in the U.S. will change very little from that of 2011. Fossil fuels will still provide 80 percent of total energy, with oil providing 35 percent of total energy. Nuclear will remain essentially unchanged at 9 percent, and renewable energy sources will provide 11 percent of total energy. This represents a shift from fossil fuel to renewable sources of energy of just 4 percent.