Other Clean Energy Technologies

Clean Energy Sources

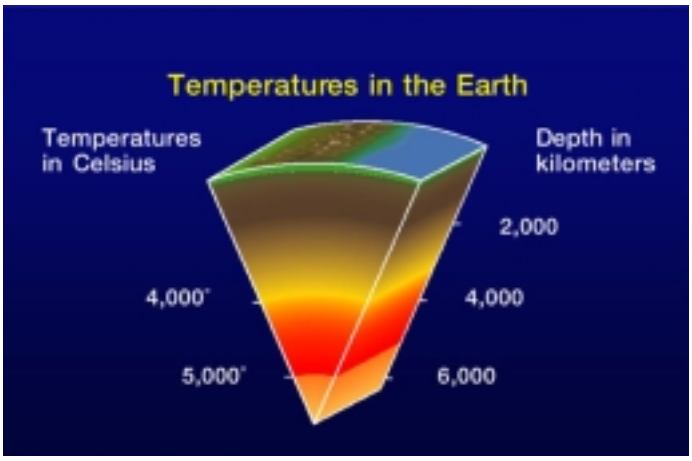
Wind, solar, biomass, and water are not the only sources of clean, environmentally friendly energy. Other energy sources can also provide heat, light, and electricity without polluting the air or disturbing large areas of land or water. This backgrounder covers a few of these new technologies, some of which are likely to become mainstream sources of energy in the approaching decades.

Geothermal Heat

People have known since ancient times that the Earth's interior is very hot. The temperature of the Earth's core is estimated to be between 3000 and 5000° C (scientists are still not sure what the exact temperature is). This heat is generated by the slow breakdown of radioactive elements, and by the immense gravitational pressures acting on the rocks and minerals of the Earth's interior. Temperatures in excess of 500° C can be found in the Earth's crust just a few thousand metres below the surface, but geothermal heat right at the surface of the land is barely detectable.

Heat from the Earth's interior is known as geothermal heat. *Photo courtesy of United States Geological Survey*

Geothermal heat has been used to heat homes and businesses on a commercial scale since the 1920s. In most cases, communities take advantage of naturally occurring geysers, hot springs, and steam vents (called fumaroles) to gather hot water and steam for heating. Geysers and fumaroles occur when ground water seeps through cracks and comes in contact with volcanically heated rocks. In Iceland for instance, wells are drilled into volcanic rocks to extract hot water and steam. The hot water or steam is carried to communities in insulated pipes and used to heat homes and businesses. In some cases, the water is superheated (heated under pressure to temperatures greater than 100° C). Superheated water quickly turns to high-pressure steam, which can turn high-speed turbines that drive electrical generators.



Geothermal heat comes from pressure and nuclear reactions at the Earth's core.
Photo courtesy of the Geothermal Education Office

Ground Source Heat Pumps

The temperature of the soil below about 2 metres remains constant regardless of the weather or season. In most places throughout southern Canada, soil temperatures at this depth hover between 5 and 10° C.

A geothermal heat utility. *Photo courtesy of DOE/NREL*

Geothermal steam can be used to make pollution-free electricity. *Photo courtesy of DOE/NREL*

The difference between air and deep soil temperatures can be used for heating and cooling in a very efficient manner, with a ground source heat pump, also called a geothermal heat pump.

A ground source heat pump works the same way your refrigerator does. Like your fridge, a heat pump uses a compressor, lengths of sealed tubing for gathering and dispersing heat (heat exchangers), and a gas called the refrigerant. An essential part of the heat pump is the network of tubes buried deep in the soil near the home. The compressor motor, located inside the house, circulates refrigerant around this network. Heat from the surrounding soil warms the liquid refrigerant in the buried tubes, changing it to a gas. The refrigerant gas enters the compressor, which squeezes it, raising its pressure and temperature. The hot refrigerant circulates through radiators inside the house, releasing the heat collected from the soil to the inside of the house. This process changes the refrigerant back into a liquid and the process starts again.

By reversing the flow of the refrigerant, the heat pump system can cool the house in summertime. Heat collected from inside the house can be released back into the cool soil, resulting in a highly efficient air conditioning system for the home. A ground source heat pump requires some electricity to run the compressor. In an efficient, well-insulated home, this electricity could be easily supplied by a rooftop solar panel.

A view of a ground source heat pump used for heating and cooling a home. *Photo courtesy of NRCAN*

Hydrogen Fuel Cells

One of the main problems with fossil fuels is that they release large quantities of carbon dioxide when they are burned. But what if there was a fuel you could burn that produced no carbon dioxide at all? In fact, there is such a fuel, namely hydrogen. Hydrogen is a flammable gas, which, when burned with oxygen, produces harmless water vapour. Combining oxygen with hydrogen is a clean, efficient way to make huge amounts of both heat and electricity!

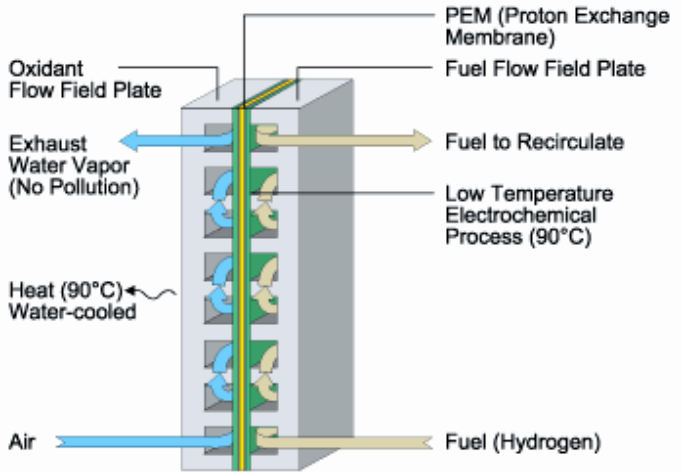
Hydrogen fuel cells are used to make electricity for American Space Shuttle's computers and electrical systems. Hydrogen is also the fuel used by the Shuttle's main engines on lift-off. *Photo courtesy of NASA*

Instead of burning the hydrogen in the presence of oxygen, fuel cells allow the two gases to pass near each other on opposite sides of a thin membrane. The chemical interaction of oxygen and hydrogen

across this membrane produces an electric charge, similar to that produced by a regular alkaline battery. But unlike the battery, which goes dead after the chemicals inside it are used up, the fuel cell continues to produce electricity as long as it receives fresh supplies of air and hydrogen. The only by-product of the process is water, which the fuel cell releases as steam.

The biggest difficulty faced by engineers designing fuel cells is figuring out how to store and handle the hydrogen gas safely. Hydrogen is composed of extremely tiny molecules that can squeeze out of most materials normally used to contain gases. Hydrogen is also highly explosive and flammable. For efficient storage, it must be compressed and cooled to minus 253° C to form a liquid. Liquid hydrogen must be stored in specialized containers and pumped through high-tech valves and tubes, all of which make hydrogen expensive and tricky to handle.

Another technical problem is in making the hydrogen gas. Currently, hydrogen is made by "stripping" methane or natural gas-a fossil fuel. This process produces carbon dioxide, one of the greenhouse gases associated with climate change. In the future, hydrogen gas may be manufactured in large quantities



Fuel cells require complex systems for cooling, and for containing hydrogen gas, which leaks freely from most ordinary containers.

A fuel cell car designed by Daimler-Chrysler.
Photo courtesy of the Methanol Institute

from ordinary water at solar-powered production facilities. The only by-product of this process would be oxygen, a gas with many practical uses that is already present in the atmosphere in large amounts.

Hydrogen fuel cells are now being used to produce electricity in remote settings such as in Canada's Arctic, and at mountaintop communications installations. They are also being tested for use in city buses and cars, and may soon be used to power everything from wristwatches to golf carts.

Questions

1. Why would geothermal heat be considered a form of renewable energy?

2. What are some possible environmental problems that could occur with ground source heat pumps?

3. Can you think of places or communities in Canada where ground source heat pumps would not be workable and why?

4. Currently, the hydrogen used in fuel cells comes from natural gas. What are the environmental problems connected with using natural gas as a source for hydrogen? What is an environmentally friendly alternative?