

Fuel Cells

One of the most rapidly developing energy technologies is the fuel cell. The Intergovernmental Panel on Climate Change identifies hydrogen fuel and fuel cells as a key technology necessary to achieve long term control over greenhouse gas emissions.

The Technology

A fuel cell converts chemical energy directly into electricity by combining hydrogen and oxygen in a controlled reaction.

Fuel cells emit virtually no pollution as the waste “exhaust” is simply water vapour and heat. In many applications, the waste heat can be used, making a fuel cell system much more efficient than conventional power supplies.

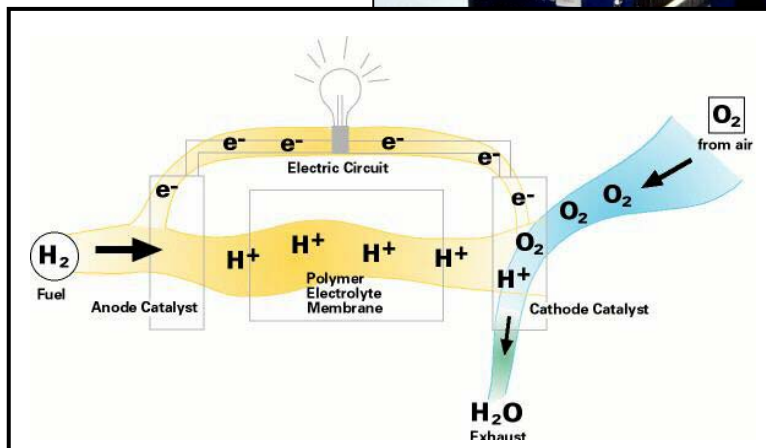
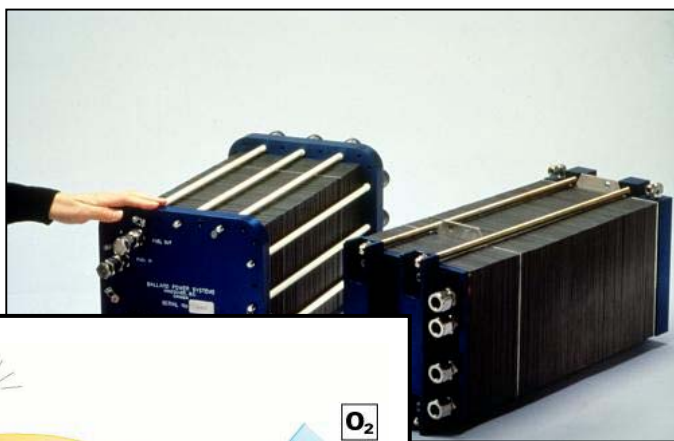
In some applications, fuel cell systems can convert 80% of the energy available in the fuel into electrical and heat energy.

Although the fuel cell is not a renewable energy technology per se, it can certainly be a core element in a renewable energy system, particularly if the hydrogen comes from a renewable fuel or process, such as a bio-fuel or electrolysis via solar-generated electricity. Fossil fuels like natural gas can also be reformed for use in fuel cells for low emission, efficiency performance. Gas from coal and diesel fuel are poor choices of fuel since they cause an overall increase in CO₂ emissions.



This type of system can be the ultimate power source. By combining hydrogen and oxygen to produce electricity and heat, the “exhaust” from a fuel cell is simply water vapour. Put the reaction in reverse—use electricity from a renewable resource to split water into hydrogen and oxygen—and a complete, cyclic, and a virtually non-polluting process can create both electricity and heat.

William Grove first conceived the idea of a fuel cell in 1839, some 40 years before the invention of the internal combustion engine. There are five basic technologies under development for both stationary and mobile applications by more than 30 major private companies, including all the major automobile manufacturers.



Schematic of a PEM fuel cell

Fuel cells (above) convert the chemical energy of hydrogen and oxygen directly into electricity (left) (diagram courtesy Breakthrough Technologies Institute/Fuel Cells 2000).

The different technologies use a number of methods

to control the re-combination of hydrogen and oxygen, including membranes. Fuel cell types under development include proton exchange membrane (also called ‘polymer electrolyte membrane’ or PEM), phosphoric acid, alkaline, molten carbonate, and solid oxide fuel cells.

Fuel cells are under development to provide power in applications ranging from a few watts (to power a cell phone, for example) to tens of megawatts (a district power supply). They are inherently modular and can be expanded to suit different applications.

Motive Power

For motive applications, particularly road transport, the PEM fuel cell is the current technology leader used by almost all major vehicle manufacturers. PEM fuel cells have the advantage of operating at low temperatures (about 80°C). Using special “reforming” technology, virtually any hydrogen-rich fuel can be used in PEM cells, including methanol, propane, natural gas, and gasoline. However, fuel cells with such reformers are more costly and complex than fuel cells using pure hydrogen.

Stationary Power

A number of firms already offer commercial systems and more firms plan to offer residential fuel cell systems in 2002. These systems will likely use a PEM fuel cell to produce both power and domestic hot water in a casing not much larger than a conventional hot water system. Further, the overall efficiency of this type of system is 50 to 100 percent *greater* than conventional methods.

In these systems, excess electricity may also be exported into the local power grids where, in new competitive markets, there is an increasing demand for the cleaner “green” electrons.

For larger commercial applications, phosphoric acid, solid oxide, or molten carbonate fuel cells are suitable with the added benefit that the waste heat (up to 400C) can be used for cogeneration of heat or cooling raising overall efficiency.

Environmental Benefits

When using natural gas, fuel cells can reduce carbon dioxide emissions by half compared to an average fossil fuel power plant and by three-quarters if the fuel cell’s waste heat is utilized. Fuel cells can also virtually eliminate emissions of nitrous oxides, carbon monoxide, hydrocarbon and particulate matter. Due to the reforming process, diesel fuel results in higher emissions than a diesel engine illustrating that unlike other renewable technologies each fuel cell application must be considered carefully to determine overall environmental benefits.

UNEP has prepared a "Fuel Cell Market Prospects and Intervention Strategies" report on opportunities for investors interested in fuel cells projects, which is available on the web (www.unep.org/gef/download/fc/).

Project Risks

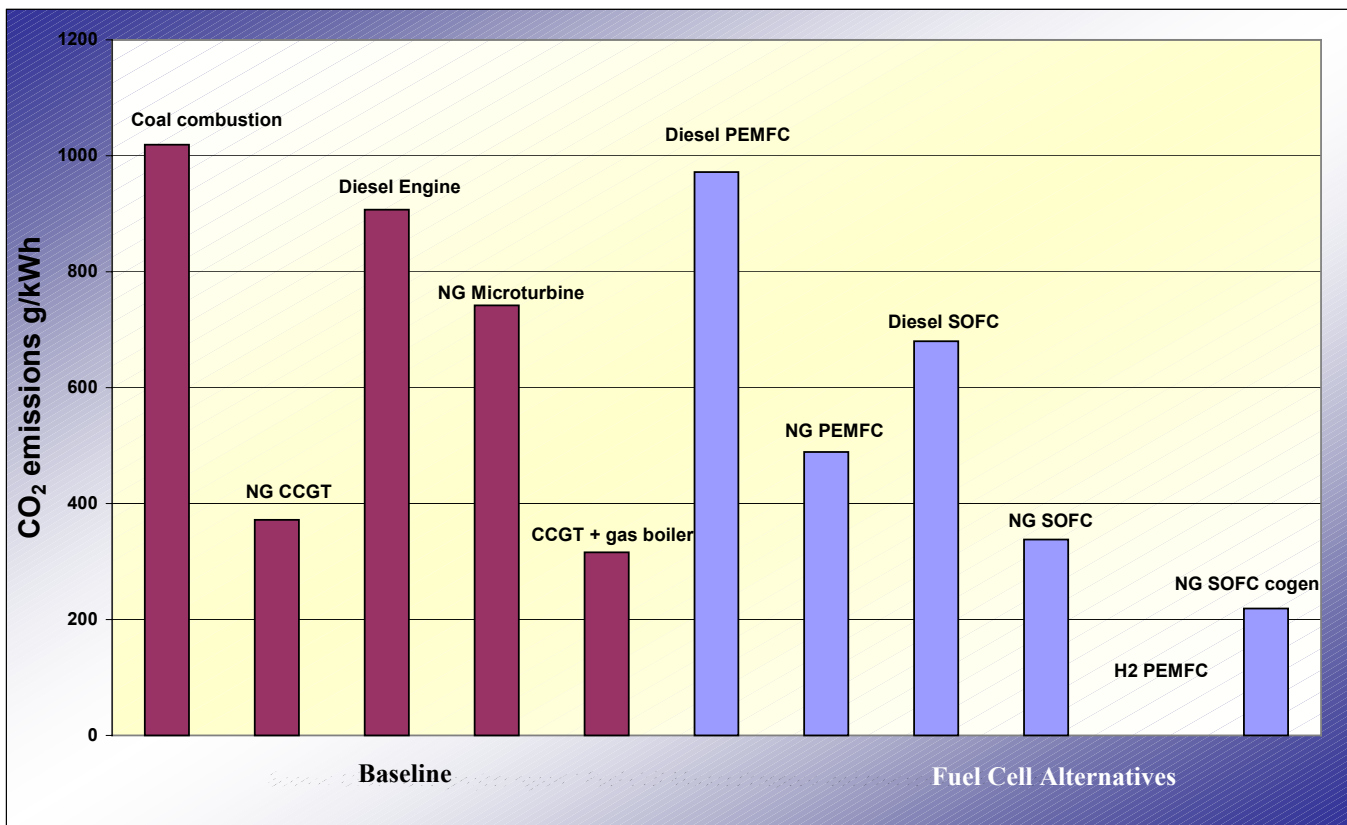
Technology:
Fuel cells are generally at early stages of commercialization and so projects have substantial technology risk. Technical innovation is progressing rapidly and some stationary power phosphoric acid fuel cells in the range of 250 kilowatts are commercially available. Operation and maintenance costs are currently high but expected to fall as technologies mature.

Environmental:
Fuel cells present little environmental risk and emit far less airborne pollutants than conventional fossil fuel combustion systems.

Planning:
Planning is a consideration in stationary applications. As fuel cells are relatively small and modular, they can be easily installed in buildings or as stand-alone facilities.

Key Points

- Fuel cells are a key major technology for both motive and stationary applications.
- There are a number of major technologies under development by more than 30 companies, including major automakers
- Costs are declining rapidly.
- Fuel cells can power a wide range of applications, from a cellphone to a large building.



Source: UNEP/GEF project report "Fuel Cell Market Prospects and Intervention Strategies"