Residential Fuel Cells: Hope or Hype?

Russ Barlow

A Plug Power LLC technician evaluates a prototype for the Plug Power 7000 residential fuel cell system. The system will provide an output of 7 KW, enough to power an average-sized home.

Imagine a furnace that not only heats your home, but also quietly produces economical and eco-friendly electrical power. Even better, what if this device could use a number of portable fuels, including propane? This may sound like home power nirvana, but if this technology lives up to its developers' promises, it may herald a new era in residential electrical power.

Almost Heaven, Pennsylvania

I became interested in fuel cells after I purchased a piece of rural property in the Laurel Highlands about 50 miles (80 km) east of Pittsburgh, Pennsylvania. Planning to build has forced me to consider the need for electrical power. When the local utility engineer gave me the bottom line for the 3,500 foot (1.07 km) line extension, I got sticker shock.

The utility wanted over US$15,000, and that didn't include the cost of the right of ways. Not only was it expensive, but they wanted me to pay them to cut down my beautiful trees in order to install ugly power poles. I thought that maybe underground lines might be the solution. "No problem," the utility engineer said, "just double the price."

I was beginning to think that my great deal on this property might not have been so great after all. There had to be a solution. I needed practical answers that would allow me to be my own power company. My search led me to *Home Power* magazine. I purchased the outstanding *Solar3* CD-ROM and scoured its archives for ideas. I soon had some answers.

Which Do You Want First?

Bad news: the winter daily average of just over two hours of full sun here ruled out cost-effective PV power. Good news: my building site, located high on an exposed open hill, was a good candidate for wind power. My mate seemed a little amused by my scheme. With a wife's keen insight, she asked only two things: "What do we do when the wind stops blowing?" and

"We will have air conditioning—right?" More bad news: I realized that some form of backup power would be needed. And unfortunately, I knew what that meant—a big, expensive, noisy, polluting generator. So much for my rural serenity! There had to be a better way.

As my search continued, I learned of a little-known technology that several cutting edge companies are hurriedly preparing to bring to market. The reward for the winners of this race will likely be huge. These devices have been widely used by NASA in the manned space program over the last three decades to provide reliable electrical power. Even though Sir William Grove first discovered the principles of this technology in 1839, technological advances have only recently made fuel cells affordable.

Hoping that this technology was the answer to my problem, I set out to learn as much as I could about it. While there are a number of companies developing these systems, my schedule allowed time to visit only three. I set out to visit the companies that seemed closest to actually delivering a commercial product. Only two of these were willing to indulge me in a visit.

A Fuel What?

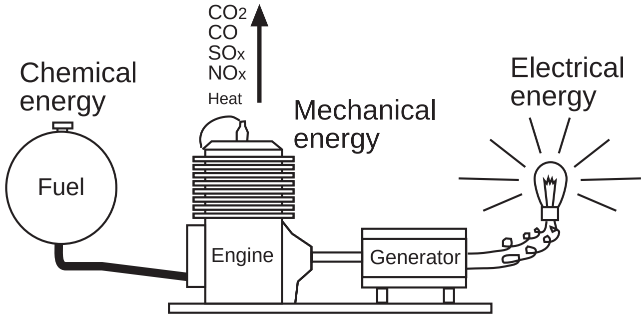
Fuel cells combine hydrogen and oxygen without combustion to produce electricity. Water and heat are the only byproducts of this reaction. The process combines oxygen from the air and hydrogen extracted from any one of a number of suitable hydrogen-containing fuels. The result is DC electrical power produced with far greater efficiency than most of the other non-renewable generation methods, such as internal combustion engine generators. The efficiency of fuel cell systems is approximately 30 to 40 percent.

The promise of fuel cells for the on-site production of electricity is great. Many say fuel cells may do for the power industry what desktop computers have done for the computer business. Just as cellular phones and satellite TV have "unwired" their respective industries, fuel cells may herald a new age in electrical power distribution.

Dr. David Edlund (right), founder of Northwest Power Systems, explains the features of their very compact and efficient fuel processing unit to the author.

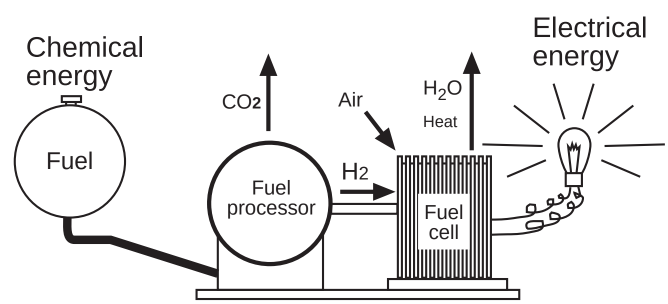
As most readers of *Home Power* have long known, there are many advantages of onsite electrical production. For developing countries, which have not

Conventional Generator



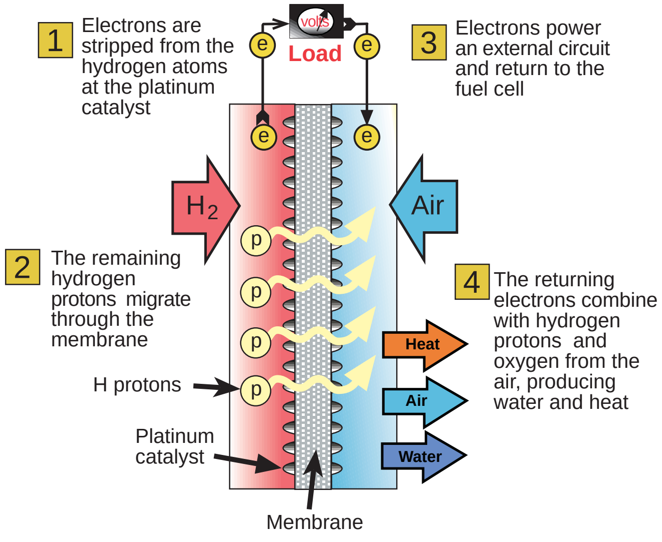
Efficiency = 15–20%
noisy, dirty

Fuel Cell Generator



Efficiency = 30–40%
quiet, clean

How a Fuel Cell Works



already made massive investments in electrical utility infrastructure, the rewards are even greater. The residential fuel cell may well be the vehicle by which the masses learn to think "outside the box" when it comes to their electrical power.

Fuel cell systems have a purpose similar to the conventional generator that many already use for primary or standby power production. Chemical energy from fuel is converted to electrical power.

In the case of a generator, fuel is converted to mechanical energy by an internal combustion engine. This mechanical energy in turn drives an electrical generator or alternator to produce electrical power. The primary byproducts are heat, CO_2 (carbon dioxide), and water. With most fuels, there are also some nasty emissions including CO (carbon monoxide) and various oxides of nitrogen and sulphur. Typically, the energy efficiency of these internal combustion generators is approximately 10 to 20 percent. That means that about 80 to 90 percent of the potential energy in the fuel is not converted to electricity.

The fuel cell power system likewise converts chemical energy to electrical power, but with a considerably simpler and more efficient path. First the fuel is converted to hydrogen by a series of chemical reactions in a processor. The resulting hydrogen is then combined with oxygen from the air in the fuel cell to produce electrical power in a single step.

Regardless of the fuel used, the chemical byproducts of the complete process are almost entirely CO_2, water, and nitrogen. Considerable low-grade heat suitable for home heating also results.

Heat

The fuel cell system produces waste heat that is easily used for home space and water heating. A simple heat exchanger is all that is needed to make the transfer of fuel cell heat to the home. In fact, most fuel cells use air or water cooling to regulate temperature for better efficiency. The plumbing for heat exchanging is already there and requires little additional cost.

One prototype system uses a single machine as both a furnace and a fuel cell generator. When home heating requirements exceed the waste heat produced by the fuel cell system, additional natural gas is added to the burner to make up any deficit.

Waste heat from engine generators is seldom used due to the carbon monoxide threat and the inconsistent availability of the heat. Fuel cells, in contrast, pose no such hazard and continuously produce some level of usable heat.

In a typical American home, the energy consumed for electrical power (except heating) and the energy consumed for domestic hot water heating are about equal. The heat byproducts from a fuel cell system just about perfectly meet the water heating needs for the average home. One manufacturer's system produces about 1.3 KW of recoverable heat energy for every 1 KW of electrical energy generated.

An American Fuel Cell employee points out the insulated reformer on their RPG-3K fuel cell system. The system can deliver heating in addition to electrical power of 3 KW continuous and 10 KW peak.

Benefits Of Residential Fuel Cells

What are the benefits of fuel cells in producing electrical power? More specifically, what advantages might they provide to the residential home power user?

1. Conversion Efficiency

Fuel cells offer an efficient way to convert chemical energy directly into electrical energy. As any mechanic knows, the fewer moving parts, the better. The fuel cell stack itself is the picture of simplicity, quietly producing electrical power without a single moving part.

2. Grid Independence

I don't need to preach to regular readers of this magazine about the benefits of onsite power production. In addition to the well known benefits, fuel cells offer several other advantages. First, locating power generation at the point of consumption allows the recovery of any heat generated. This heat can be used to further increase overall system efficiency. This co-generation should eventually allow fuel cells to produce electricity at costs below current grid rates.

Second, the typical 7 to 8 percent losses in power line transmissions are eliminated, and so are the large power line capital costs. Finally, fuel cells offer freedom from concerns about grid reliability and weather related interruptions. Third world countries, with no existing electrical distribution infrastructure, have shown a special interest in residential fuel cell systems. In many of these countries, utility grid transmission and distribution losses approach 50 percent, largely due to theft.

3. Grid Connection

Strangely enough, fuel cells also offer many advantages when connected to the grid. So many advantages, in fact, that utility companies are major investors in several of the fuel cell development startups. Connecting fuel cells to the grid allows utility companies to incrementally increase capacity without the capital outlays required in building new power plants. Unlike PV or wind power, residential fuel cells are available to supplement grid power on demand, regardless of weather, day or night.

4. Environmental Advantages

Residential fuel cell systems offer numerous ecological advantages compared to current utility power production. The operation of the fuel cell itself combines hydrogen and air, with water as the only byproduct. Fuel processing units, also called reformers, are able to convert various fuels into useful hydrogen. Ideally, CO_2 is the only byproduct of this reforming process.

The almost doubled electrical efficiency of the fuel cell means that it produces only about half the greenhouse gases of other non-renewable forms of electrical generation. Utilization of waste heat for water or space heating even further reduces the relative amount of CO_2 emissions. Traditional internal and external combustion engines also make emissions that create smog and acid rain.

The Northwest Power Systems 5 KW mobile demonstration fuel cell system. Note the fuel cell located on the right side of the unit.

Low noise profile is another environmental advantage. A fuel cell system is typically less than one fourth as loud as a comparably sized gas or diesel generator, so it has a minimal impact on the quiet of a rural setting.

5. Renewable Compatibility

As reliable distributed power production becomes available, it will be much easier for users to create hybrid systems utilizing PV, wind, and microhydro. Fuel cells produce direct current, just as these renewable sources do. Batteries and an inverter are part of both types of systems. Whether renewable systems are added to an existing fuel cell system, or a fuel cell generator is added to an existing renewable system, the combination is a natural and easy one.

6. Fuel Flexibility

Power systems based on fuel cells offer great flexibility for the homeowner. Multiple portable fuels can be used, including propane, natural gas, methanol, ethanol, diesel, and gasoline. Just about any liquid or gas hydrocarbon fuel can be used as a source for hydrogen atoms in the cell.

This innovative fuel processor by Northwest Power Systems can convert a number of fuels into high purity hydrogen to power a fuel cell stack.

Other interesting renewable fuels that can be used with a residential fuel cell system include natural gas made from biomass and home distilled ethanol. Solar-produced hydrogen could also power a fuel cell unit without the need for complex fuel processing, and it would be totally emission-free.

7. Ease of Use and Maintenance
Fuel cell systems run continuously. Compared to a generator set, they operate at low temperatures and have very few moving parts. These systems should require only periodic maintenance and replacement similar to your home furnace.

Fuel Cell Drawbacks
Despite all of their advantages, there are still a few issues that may cloud the short term outlook for fuel cell use in residential applications. What obstacles stand in the path of this new source for renewable energy systems?

Northwest Power System's palladium alloy filter produces extremely pure hydrogen gas, and is good for at least six months service before replacement.

1. Cost
Although pricing for fuel cells continues to drop at a rapid pace, there is still a ways to go before it will be widely affordable. As with any new technology, those who jump in first will no doubt pay a premium price for a less capable product than those who wait. I think anyone who has bought a computer in the last five years can appreciate this phenomenon. The value of fuel cell systems can be fairly appraised only by comparing costs and benefits to competing technologies.

Current initial estimated cost for a turnkey 5 KW fuel cell system is about US$6,000 to $8,000. From this total, about 40 percent of the cost is associated with the fuel processor. The next largest expense is the fuel cell stack, accounting for 27 percent of the total. Power conditioning (18 percent) and controls (15 percent) are the remaining costs for a complete system.

2. Unproven Technology
Although considerable testing goes into any new product, we all know that only after large-scale deployment do many of the bugs show up. There will be risks for those who embrace this technology in its infancy, just as there were with early wind and PV systems.

3. Continuous Parasitic Loads
Unlike an engine-driven generator, which can start and produce power almost immediately, fuel cells work best when operated continuously. This means that the internal loads associated with their operation are present even when no power is produced. Usually about 10 percent of the generator's maximum output, this parasitic load is essentially a fixed cost for having power readily available.

Fuel Cell Basics
A fuel cell is an electrochemical device that silently produces direct current electrical power without combustion. Some people have likened a fuel cell to a battery in which the stored power is never depleted, but is constantly being replenished. Although the electrical response of a fuel cell to loads is similar to that of a battery, the electrochemical process is considerably different.

Just like a battery, the core of the fuel cell consists of two electrode plates—the anode and the cathode. In the fuel cell, however, these bipolar plates are separated by a polymer membrane electrolyte. This membrane is coated on both sides with a thin layer of platinum catalyst. At the anode side of the membrane, hydrogen fuel catalytically dissociates into free protons (positive hydrogen ions) and electrons.

A technician tests a fuel processor that runs on kerosene and produces up to 50 liters per minute of hydrogen containing about 2 ppm of CO.

In a sort of reverse electrolysis, the free electrons are conducted in the form of usable electric current through the external circuit. The protons migrate through the membrane electrolyte to the cathode side. There they combine with oxygen from the air and electrons from the external circuit to form pure water and heat. This proton migration through the membrane gives this type of fuel cell its name: the proton exchange membrane (PEM) fuel cell.

Although there are other kinds of fuel cells, PEM fuel cells show the most promise for residential applications and are the type used in all systems currently under development. This is largely due to their relatively low operating temperatures (under 100° C; 212° F) and favorable costs.

Recent gains in technology have reduced the amount of costly platinum catalyst required by a factor of almost 100. New, cheaper, and more effective membrane materials have continued to lower costs. Until now, fuel cells were all hand built. But mass production soon promises to bring costs to consumer levels. Just as cheaper silicon chips enabled the home computer revolution in the late 1960s, inexpensive fuel cells are poised to dramatically change the home power industry.

The electrical potential, or voltage, produced by each individual cell is limited by the reactants supplied to the cell. The theoretical maximum for a hydrogen and oxygen cell is 1.23 V, but typical values in current cells are about 0.7 V. To produce higher voltages, individual cells are stacked one against another, wired in series.

Current produced by the cell is directly proportional to the cross-sectional area of the cell where the reaction takes place. Thus, by varying the size and number of layers in the fuel cell "stack," it is possible to custom build a unit in order to meet a wide range of DC electrical requirements.

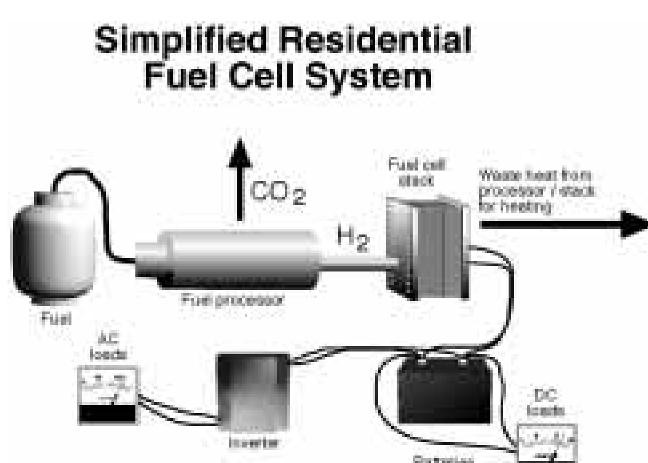
A Typical Residential Fuel Cell System

Although the fuel cell is the heart of the device, there are other important components that make up a residential fuel cell system. First, the fuel processor must convert usable fuel into pure hydrogen for use by the fuel cell stack. Next, the fuel cell stack converts this hydrogen into direct current electrical power. Finally, as in most renewable energy systems, power must be stored and conditioned for consumption, using batteries and an inverter.

Fuel Processor

The fuel processor is what really makes residential fuel cell systems practical. In order to operate, fuel cells require extremely pure hydrogen. Typically this must contain CO concentrations of no greater than 50 parts per million (ppm) with less than 10 ppm desirable. The job of the fuel processor is to take an available fuel and convert it in sufficient purity and quantity to run the cell. At the same time, it should eliminate the undesirable emission byproducts of the conversion.

The majority of fuel processors currently under development for residential fuel cell systems utilize the following process. First, the fuel processor removes



This remarkably compact fuel processor by Northwest Power Systems can deliver enough high purity hydrogen to power a 1 KW fuel cell.

sulfur from incoming fuel by utilizing a bed of zinc oxide. The fuel, steam, and air react at about 1,500° F (816° C) in a process called steam reforming. The result is hydrogen gas that contains excessive amounts of carbon monoxide.

Carbon monoxide is reduced by a water shift conversion reaction, during which large amounts of the carbon monoxide react with steam to produce CO_2 and additional hydrogen. Finally, the remaining carbon monoxide is almost eliminated through a selective oxidation reaction that creates CO_2. The resulting hydrogen gas is then of sufficient purity for use by the fuel cell stack.

An Innovative Exception

An exception to this fuel processor model was the unit I saw during my visit to Northwest Power Systems in Bend, Oregon. Their rather simple fuel processor utilizes steam reforming like the other processors, but removes the additional carbon monoxide in a unique way. Their process is borrowed from an approach long used by the hydrogen gas industry. The carbon monoxide-contaminated hydrogen gas is filtered through a membrane that allows only the hydrogen to pass through.

The filter is made up of about 20 membrane layers of palladium alloy foil, each only one thousand of an inch (0.025 mm) thick. It produces hydrogen with carbon monoxide levels of about 2 ppm. This purity is almost twice as good as any other reforming method. Gases that do not pass through the membrane are looped back and burned to heat the steam reformer. "This method of hydrogen purification was our starting point, and we built our fuel processor backward from there," explained Dr. David Edlund, founder and president of Northwest Power Systems.

The result is a fuel processor which is far less complex, is much smaller, and costs less. While I was at their lab, I observed these units producing large quantities of very pure hydrogen while using methanol and kerosene as fuels. Dr. Edlund showed me a small processor, about nine inches in diameter and only six inches high (23 x 15 cm), that could produce sufficient hydrogen to support a one kilowatt fuel cell.

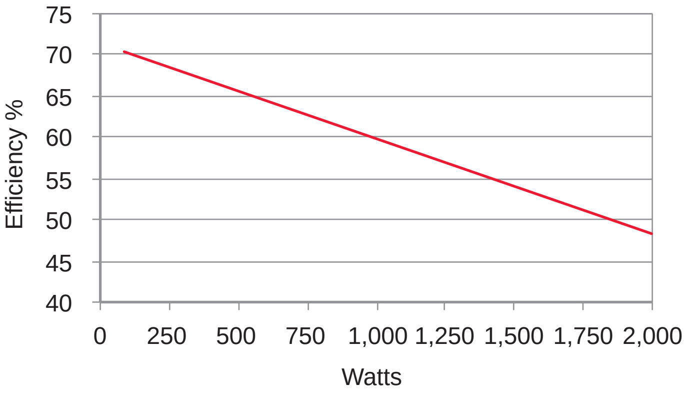
Edlund originally conceived of the concept for use on sailboats. Noisy generators are a great distraction to the purity of sailing, and he saw the quiet, small fuel cell generator as an answer to this problem. The real beauty of fuel cells for small systems is that the electrical efficiency of the fuel cell stack is actually higher at lower loads. Unlike an internal combustion power generator, whose fuel consumption remains high even at low loads, the fuel cell seems ideally suited for all phases of an efficient battery charging profile.

Fuel Cell Stack

The fuel cell stack converts hydrogen and oxygen into electrical power and heat energy. The typical PEM fuel cell operates at approximately 150° F (66° C). Hydrogen from the fuel processor and oxygen from the ambient air are combined to produce power. During my visit to American Fuel Cell Corporation in Boston, I got a close look at several fuel stack assemblies and their individual components.

The company's founder, David Bloomfield, explained to me that it's a long way from theory to a viable fuel cell. The hydrogen and oxygen must be delivered in a continuous and uniform way to the membrane. A second problem is maintaining the delicate humidity

Fuel Cell Stack Efficiency



balance in the cell. Much like a human lung, the moisture level has to be just right. Too much humidity can clog the membrane, inhibiting proton movement. Conversely, if the membrane dries out, breaches can develop, rendering the cell inoperable. The final hurdle to overcome, according to Bloomfield, was developing a mechanism to maintain the uniform cell stack temperature, allowing maximum electrical performance.

Each individual cell is made up of two flow field plates with a series of channels routed into the surface. The channels are designed to evenly distribute hydrogen and air to both sides of the proton membrane assembly that separates them. The membrane assembly consists of two porous carbon or graphite electrodes (cathode and anode) each with a thin layer of platinum catalyst. These are bonded to either side of the proton exchange membrane. Individual cells are assembled together to create the fuel cell stack.

Fuel cells react to loads much as batteries do. As the load is increased, the voltage drops to a point where there is no useable power. This is shown in a polarization curve that plots cell potential (volts) versus cell current density (amps/cell area).

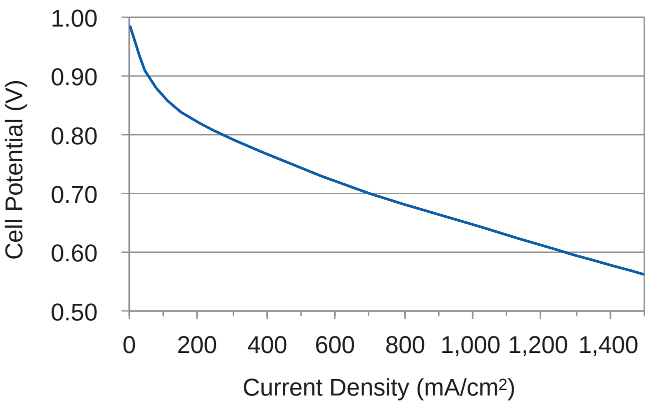
Typical fuel cell stacks convert hydrogen to electricity with an efficiency of approximately 55 to 60 percent. Other components within the residential fuel cell system further reduce overall efficiency to about 30 to 40 percent.

Thermal and Water Management System
This system maintains the fuel stack and fuel processor in thermal and mass equilibrium. It uses pumps, fans, heat exchangers, and controls, which create a constant power requirement on the fuel cell generator whenever it is running. The total parasitic load for existing residential fuel cell systems is about 250 watts. During my visit to American Fuel Cell, Bloomfield said that reducing this load by half is one of his highest priorities.

Cold startup of most fuel cell systems is a somewhat lengthy process. Up to twenty minutes is required to produce the steam needed and to bring the system into equilibrium. Because of this, fuel cell systems are designed to run on a continuous basis. For a typical system, this "phantom load" would consume about an additional half gallon (1.9 l) of propane daily, regardless of power requirements.

Power Conditioning System
Power conditioning in fuel cell systems is very similar to that of PV and wind systems that have been detailed in *Home Power* for years. DC power produced by the fuel cell stack is used for battery charging and for providing AC power through an inverter. A battery bank or some other storage mechanism is necessary because the fuel

Fuel Cell Polarization Curve



This polarization curve shows the relationship between voltage and current for an individual cell in a typical fuel cell stack.

processor cannot respond to instantaneous requirements placed on the fuel cell.

The fuel cell can respond very quickly to load demands, if provided with ample hydrogen and oxygen. But there is no way for the fuel processor to anticipate an upcoming need and produce and distribute hydrogen quickly enough. Although hydrogen could be produced in advance and stored in anticipation of a need, none of the systems I saw used this approach. Batteries also allow for load leveling so that peak loads can temporarily exceed the continuous maximum output available from the stack.

No Buyer's Guide Yet
When I set out to explore what was on the horizon with regard to residential fuel cell systems, I hoped to be able to present a nuts and bolts comparison of soon to be released products. I envisioned a chart that one could use in selecting a system for home use. Unfortunately, my research has revealed that most systems are still in the prototype stage.

While a number of companies have proven fuel cell designs, not many have developed viable fuel processing units. Even fewer have actually made prototype turnkey systems designed for residential use.

The Major Players
American Fuel Cell Corporation has probably done the most complete work toward development of a viable residential fuel cell system. During my visit there, I saw their prototype, the Residential Power Generator (RPG-3K). It was neatly packaged into a single case, able to process natural gas, and produced up to 10 KW. These folks have really done their homework and have an early lead on many fronts. They have designed and built their own fuel cell stacks and fuel processors. The unit I saw was being readied for shipment to a German natural gas utility for testing.

Fuel Cell System Components

Component	*Efficiency*	*Cost*
Fuel processor	79%	40%
Fuel cell stack	57%	27%
Power conditioning	95%	18%
Control	90%	15%
Overall	39%	100%

The company's projections show that new homes with natural gas available could easily use an RPG-3K in place of a furnace and have electricity and heating at less than current rates. Retrofits of existing homes were also competitive with grid-connected prices.

American Fuel Cell's president expressed an interest in developing even smaller units to work with PV and wind power systems. "The environmentally friendly nature of our fuel cells just seems to make sense as a way to augment renewable systems," he explained. "Fuel cells are plainly the cleanest way to produce electrical power from non-renewable fuel sources."

Northwest Power Systems has an innovative and apparently successful approach to the difficult problem of fuel processing. In October of 1998, they demonstrated their methanol-powered fuel cell system on a 2,250 square foot (209 m^2) residence that they disconnected from the grid. The additional heat co-generated during the test was utilized in heating a 460 square foot (43 m^2) attached garage.

Their demonstration unit is three feet wide by three feet deep and three and a half feet tall (0.9 x 0.9 x 1.07 m). It was taken on a road trip throughout the northwestern U.S. to conduct similar residential demonstrations. When I observed the unit operating in their lab, it was remarkably quiet, producing only a subdued hiss. They also showed me a similar processor in their lab, running on kerosene and producing similarly pure hydrogen.

Northwest Power System's David Edlund sees the small size of the company as an advantage during this period of residential fuel cell evolution. "If we come up with a better idea or a new way of doing something, we have a meeting in the morning, and by afternoon we're already moving in that new direction," he explained. It was obvious here, as at American Fuel Cell Corp., that people are excited about fuel cells.

Plug Power, near Albany, New York, has also operated a demonstration unit powering a home. They were joined in their development and marketing efforts by a major partner, General Electric. Plug Power claimed that the proprietary nature of their research would not permit them to allow me on their premises. Repeated attempts for an invitation to visit or a phone interview were declined. I could take a hint, and gave up.

Their press package was lacking any real technical details. Further investigation revealed that their much-publicized fuel cell demonstration home had been powered by hydrogen from a large truck parked nearby. Plug Power seems to be focusing its marketing efforts towards grid-connected customers. They promise to deliver residential electrical power at rates below those offered by the current utility companies.

Other Players

Government research grants have placed much of the focus in the fuel cell industry on automobile applications. Ironically, the technical problems of automotive fuel cells are great compared to those of stationary, residential applications. Only recently, as technological advances have lowered the price of fuel cells, has private investment shifted the focus towards the residential market.

There are a number of companies that I did not visit that are currently developing residential fuel cell systems. Avista Labs in Spokane, Washington has developed a unique approach to fuel cell design. Unlike traditional stacked-plate architecture, which requires the entire unit to be disassembled for repair, they have devised a modular design which allows "hot swapping" of individual modules while the unit remains online. These units use no expensive graphite plates in their manufacturing process which leads to lower costs.

Energy Partners, in West Palm Beach, Florida, has long been a leader in PEM fuel cell development. They have provided high-performance fuel cell stacks for research in the automobile industry. Recently, they began to produce composite graphite bipolar plates. Suited for mass production, this technology will reduce Energy Partners' cost for this major component from US$100 to less than US$2 apiece. Energy Partners is in the testing stage for their NuPower line of residential fuel cell power systems.

Ballard Systems, of Burnaby, British Columbia, Canada, is another company involved in development and testing. A large, well-capitalized company, Ballard has produced many fuel cell innovations for the automotive industry. They have also delivered large commercial fuel cell power systems for use by commercial utilities. According to their press package, their 250 KW PEM fuel cell remains the most powerful in the world.

Ballard has focused mainly on the automobile industry and large commercial applications. They have announced their efforts to develop residential power systems based on fuel cells but have not yet detailed any products. Their strong technological experience will guarantee them a position in the market if they pursue it.

H-Power, located in Belleville, New Jersey, was a pioneer in the commercialization of fuel cells. They presently have a manufacturing facility producing fuel cells for commercial sale. They have sold a number of hydrogen-powered fuel cell systems to the New Jersey Department of Transportation for use on portable highway warning signs. Though they have made public their intention to enter the residential fuel cell system market, they have not released specific details on any system.

Is There a Fuel Cell In Your Future?

Despite the intense development efforts, commercially available turnkey residential fuel cell power systems are still almost two years away. Considering the rapid pace of development, there may be substantial changes in the technology even in this short time.

Developers are forming relationships with utility companies and other investors to facilitate development and product launch. The electric companies, not wanting to lose out to a new competitor, are keenly interested. The gas utilities, seeing a huge new potential market, are likewise attentive. And the fact that industrial giant General Electric is involved is a sure sign that this industry will likely not go away. What does this all mean to those already involved in the renewable energy movement?

Legitimization

As onsite-produced power becomes commonplace, life will no doubt become easier for all RE users. As utility companies begin to routinely connect fuel cell units to the grid, it should be a lot more difficult for them to discourage wind and PV system connections.

We should pay close attention as laws are changed to accommodate this shift, and make sure no one gets left out. Costs for many parts already used in renewable energy systems—inverters, for example—could become much lower due to mass production as fuel cell systems proliferate.

Opportunities

As this technology blossoms, it will be full of opportunities for those currently involved in the renewable energy industry. Readers of this magazine have already solved many of the problems that residential fuel cell developers are just starting to discover. For example, I'm sure that fuel cell companies have a lot to learn about real world battery use.

As people become more accepting of off-grid life, sales of non-renewable systems to augment the new residential fuel cells should explode. I even expect that off-grid real estate values will increase substantially once this technology is popularly accepted.

Challenges

This new technology will provide exciting new challenges in the RE world. By their very nature, those currently involved in RE are inclined to be "early adopters" of this new technology. Many of you have already shown your willingness to experience the hardships (and joys) of independent power. Both of the companies I visited acknowledged that present RE users would likely be among the first to purchase their products. I'm excited to see how some of you will solve the problems that will undoubtedly arise.

I hope to become a beta tester for one of these new systems when they are ready for residential testing. If I'm successful, I promise to share my experiences with you. In the meantime, I am planning to install a wind turbine to meet my immediate power needs, and eagerly wait to see if the promise of residential fuel cells becomes a reality.

Access

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