

## Energy/Power Systems Generation

*The technology findings here relate to alternative means of power creation, conservation or conversion against traditional gas, coal-produced electric, or nuclear-based power. This area of sustainable energy technology is at the forefront of a number of industries including housing.*

### Technology Scanning

One of PATH's major research support services is PATH Technology Scanning. *Technology Scanning* tells us about technology developments in other industries, from other nations, from federal laboratories, and from other building sectors. PATH looks for breakthroughs in other industries that could be transferred and applied to housing. *Technology Scanning*—published by the U.S.

Department of Housing and Urban Development/PATH and prepared by the NAHB Research Center, Inc.—are updated as technology developments dictate. The Research Center works to unite technology developers from outside of residential construction with manufacturers in the residential housing sector.

This issue of *Technology Scanning* is one in a series. Each issue in the series falls into one of the following categories:

- Design and Internet Tools
- Safety
- Surfaces and Interior Finishes
- Building Envelope Technologies
- Electrical
- Plumbing
- Heating, Ventilating and Air Conditioning
- Energy/Power Systems Generation
- Basic Materials
- Information Technology
- Sustainable Design Strategies
- Materials Recycling and Reuse
- Thermal and Moisture Protection
- Indoor Environmental Quality

Call the ToolBase Hotline at 800-898-2842 for information about other available *Technology Scanning* issues. Or, log onto pathnet.org and www.toolbase.org.

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## Fuel Cell Technology

Fuel cell technology combines hydrogen and oxygen to generate electricity and pure water. This technology is virtually silent and produces no pollution. Fuel cells can be used to power vehicles, homes, factories, and offices. They are modular in design, making them versatile in configuration.

### Fuel Cells Engineering Framework and Road Map

Pacific Northwest National Laboratory, Material Resources Group, is establishing a systems engineering framework for the development of fuel cells. They are defining barriers and mapping a plan for advanced fuel cell development.

#### Contact:

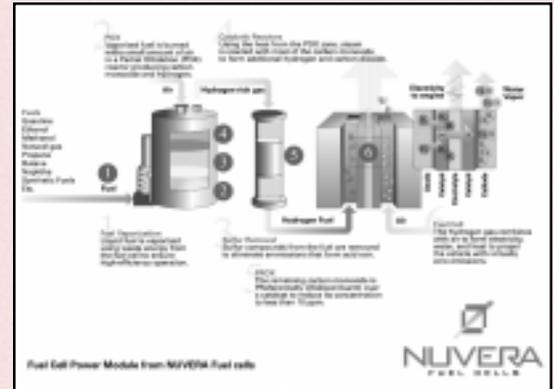
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### Nuvera Introduces Line of Residential Fuel Cell Modules

In response to a growing need for alternative on-site energy solutions, Nuvera is developing small-scale fuel cell power modules designed to provide a range of deployable power anywhere, anytime. The modules are flexible fuel cell technology that provide the user freedom of fuel choice from hydrogen, natural gas, or propane.

The units are intended for remote power use away from a power grid or as residential backup to traditional power sources. Three lines of compact, stacked fuel cells in aesthetically pleasing housing are under development:

- ▶ Premium Fuel Cell Module 1kW - Propane
- ▶ Premium Fuel Cell Module 1kW - Hydrogen
- ▶ Premium Fuel Cell Module 5kW - Natural Gas



Courtesy: Nuvera Fuel Cells

Nuvera intends to work with leading organizations around the world to demonstrate and test the commercial viability of small-scale power modules. The demonstrations will be designed to increase overall awareness and perception of fuel cells among consumers as viable clean energy alternatives. Nuvera was formed in April 2000 in a merger of De Nora Fuel Cells, Milan, Italy, and Epyx Corp, a fuel processing division of the American consulting firm of Arthur D. Little.

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### **World's Largest Fuel Cell Installation**

Middletown, Connecticut, USA Juvenile Training Center, has ordered a 1.2 MW fuel cell system for an estimated \$18 million. It is to be installed by Select Energy. This will be the largest single installation to date. When fully debugged and operational, it will provide a major portion of the facility's power.

### **Iceland to Demonstrate First Real Hydrogen Based Economy**

Iceland announced plans to start a fleet of hydrogen powered fuel cell buses and hydrogen filling stations to provide the world's first real demonstration of a hydrogen-based economy. A consortium of companies including Shell Hydrogen, Daimler-Chrysler, and Norsk Hydro, will spend about \$6.5 million U.S. dollars to start up the project. The four-year project will demonstrate the viability and implementation issues for a hydrogen-based economy. Three buses powered by fuel cells and a refilling station at an existing Shell retail site will be at the heart of the demonstration.

### **Fuel Cell Vacuum Cleaner**

Electrolux LLC has designed, and is ready to release with the assistance of Manhattan Scientifics, Inc., the first fuel cell powered vacuum. Using technology from NovArs GmbH, located near Passau, Germany, the stacked fuel cell is a composite material held together with sealants instead of bolts. The cells are lightweight and generate power of 1,000 watts. Electrolux will sell the backpack vacuum cleaner next year.

Passau, the fuel cell provider, feels it will help users get comfortable with fuel cells in and around the home and encourage greater use of fuel cell adoption for homes, cars, appliances, and outdoor power equipment. The VP of Marketing for NovArs GmbH said, "If people get comfortable with this technology on a small scale, they are more likely to have confidence with it on a larger scale."

MIT is currently performing tests on the new application.

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### ***Photovoltaic/Solar Technology***

Solar technologies have been around for a long time. However, our knowledge of solar technology has improved greatly over the past few decades. There are now better, more practical applications to harness the sun's power. Photovoltaic conversion occurs within solar cells made from silicon. Multiple cells are connected together and sealed to form solar power modules which collect the sun's energy and convert it into electricity.

### **Solar Dynamic Energy Conversion**

This conversion technology generates electricity/power with a small surface area. It is lightweight, and has a higher power-weight ratio than conventional photovoltaics. It can be applied to housing with a relatively small surface area and power generation units.

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### **Solar Cell Technology and Systems for Houses**

Sanyo, a Japanese maker of electronics, has developed a new structure cell, called HIT, with 17 percent mass production line cell efficiency. This new hybrid structure of a cell reduces energy loss and is the world's highest efficiency for a prototype cell at 20 percent. Sanyo's goal for the new process is a low-cost, large-volume production solar cell for housing. To date these cells have been applied in houses as shingles in Japan's test houses. The key technology breakthrough has been in the application of a thin film technology of Amorphous Silicon (a-Si:H cell) on a crystalline Silicon base. Pilot manufacturing lines have demonstrated mass production capability and potential efficiency.

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**Hpower's RCU 1-10 kW AC residential unit.**

Courtesy: Hpower



**The Georgetown University Fuel Cell Bus.**

Courtesy: Fuel Cells 2000

**SunSlates Roofing and Façade Systems**

Atlantis Solar Systems' strategy has been to incorporate photovoltaic technology into building products. In its first demonstration project installed in Switzerland one year ago, they used SunSlates photovoltaic, a thin-film solar cell roofing and façade product. Since then, it has been used successfully in Burgdorf Switzerland's Regional Hospital, along with 70 other applications across Germany and Switzerland. Solar Building Systems LTD, Exmore, VA, have installed some systems in the U.S.

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**Photovoltaic Cladding**

Located just outside London, the University of Southampton is the first building to have mono-crystalline vertically mounted PV arrays generating electricity. It is the most monitored, most watched installation of PVs. The goal is not only to collect performance data, but also reliability, durability, and economic data. A total of 96 modules are configured in sub-arrays divided across four levels of the building.

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**Photovoltaics Integrated into Windows**

The National Renewable Energy Laboratory has integrated a PV electrochromatic device into smart windows. Termed PV-EC Smart Window, this technology could derive better functional use of the window and reduce heating and cooling needs of the building by 25 percent, lighting demand by 50 percent, and peak power demand by 30 percent. A dye-sensitized solar cell electrode is the heart of the technology and can be used in conjunction with today's known window technologies of Low e coatings, gas fills, and space evacuation techniques. Making the cells thin enough to be semi-transparent to the human eye is one of the technical challenges being worked on. Another method of building the cells into the

window frame is being pursued as well. Reliability and durability will be key attributes to prove.

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**Solar-Shell Renewables**

Technology to turn the sun's rays into power on earth has been around for some time, but recent focused efforts around photovoltaics are forging new inroads. The energy conversion takes place within a solar cell manufactured from silicon. Multiple cells are connected together and sealed into solar power modules. Shell has recently opened a state-of-the-art solar cell plant in Germany. It is the world's most integrated plant and Europe's largest single solar cell line. With their size and technical know-how, Shell has produced cooperative efforts in Amersfoort, Holland, with 70 architects to bring about the largest solar residential development in Europe. Through a joint venture with a South African utility company, Eskom, Shell is bringing sun-derived power to 50,000 homes in remote areas not connected to public power grids. They



Credit: Jim Yost

**Mid-sized photoelectrochromic window turning dark under a voltage applied by two small PV cells attached to the side of the window.**



**The hybrid solar/wind project at Parker Ranch, Waimea, Hawaii, leverages daytime sunlight and warm Hawaiian winds.**

**Solar-Shell Renewables,**  
continued

have supplied Shell Oil's offshore drilling rigs with solar power in harsh conditions with special adaptations. They are supplying Sun Stations (combinations of solar and biomass) for village electrical needs in the Philippines. Solar power generation is expected to grow by 22 percent per year to a capacity of 1.5-2 Gigawatts by 2010.

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**Amorphous Solar Cells**

Amorphous silicon solar cells hold a number of advantages over typical crystal silicon cells. They can be manufactured using less energy and raw materials, which promises to be a lower cost and more environmentally friendly means to produce cells in mass production quantities. Also, their thin film design allows for physical flexibility and the ability to be fabricated into large-area cells, or wide varieties of shapes and sizes. Embedding them into other substrates is also easier due to their thin configuration. Manufacturers see great potential for integration of function and design.

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**DunaSolar-Amorphous Solar Cells**

Amorphous silicon solar cells provide 8-15 percent more energy than crystalline ones when illumination is low (scattered cloudiness). Dunsolar is one of the leading producers of these cells. They currently have U.S. test sites with UL-approved panels in Davis and Sacramento, CA, in industrial and public buildings. Their Sacramento sites will be the focus of a tour at the 6<sup>th</sup> annual UPVG Photovoltaic Conference in October 2001.

A company representative said DunaSolar has great interest in working with the U.S. building industry on solar photovoltaics and would be interested in further test installations or pilot applications. They also would like to work with some roofing manufacturers on integration.

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**Quick Connectors for Easier Installation Solar Cells**

Solel of Israel introduced a simple, innovative technology at Sustain 2001, which allows flexible, quick connection of solar cells to create large banks of cells. Efficiently connecting larger banks of cells results in lower costs, reduced thermal loss, and higher efficiency. Their system avoids harmful emissions and is maintenance-free once installed.

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**Photovoltaics and Wind Power Hybrid System Installed in Waimea, Hawaii**

One of the world's largest hybrid solar/wind energy power projects is up and running in Waimea, Hawaii, at Parker Ranch on the Big Island. The 175 kW's of PV panels are a ground-mounted tracker system that rotates to follow the sun east to west, capturing the maximum

**The hybrid solar/wind project at Parker Ranch features 175 kW of solar and 50 kW of wind turbines.**



amount of the sun's power, supplemented by 50 kW's of energy produced by five wind turbines. The combined system leverages clean renewable energy 24 hours a day providing power for the ranch's water pumping operations. The cost of the hybrid system is more than covered by the amount of reduced utility bills. The entire system was designed and installed by PowerLight Corporation of California.

**Contact:**

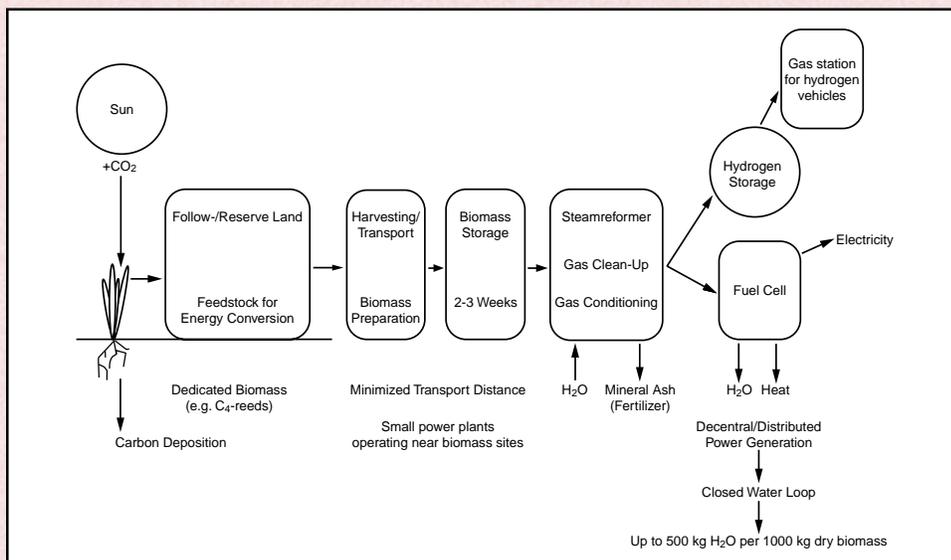
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**Italian Government Speeds Adoption Process for PV**

The Italian government allocated L60 billion (approx \$28 million U.S.) for a program to provide incentives for the early adoption of PV technology. Approximately \$9 million goes toward public, government, and municipal buildings' installation of PV, while about \$19 million will be used for private sector and households that wish to use PV to supply a significant portion of their power needs. Up to 75 percent of the cost of the system will be covered in the form of grants from this program. This is a good example of government providing funds to get technology adopted and in use in both the public and private sector.

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**The Electro-Farming™ Concept**

Courtesy: Dr. Wolf G. Johnssen

***BioMass Technology***

Biomass technology converts waste stream material or rapidly renewable plant material into useful heat and/or electricity. Some current applications in Europe take waste from wood processing industries or the agricultural sector and produce briquettes and pellets. These are then burned cleanly in specially designed units which can heat factories, offices, and even homes.

**BioMass = Chemically Stored Solar Energy**

Biomass Co-generation and Electro-Farming is a process to use and harness nature's power. BioMass for energetic conversion results from many sources:

- ▶ Waste material from forestry recultivation;
- ▶ Recycling from landscape conservation measures;
- ▶ Recycling from the wood processing industry;
- ▶ By-products from the agricultural sector;
- ▶ By-products from the food processing industry (olives, lemon peels);
- ▶ Specific cultivation of biogenic

energy carriers (perennial plants, rapidly growing trees, annual plants and grasses); and

- ▶ Natural building and packaging materials.

The patented Electro-Farming process enhances the role of biomass in future power supply via a new process for the thermo-chemical transformation of biomass. The biomass is broken down into its chemical components, and then cooked with high temperature steam. The water is cracked into its components, hydrogen and oxygen. This process results in a high conversion rate of energy/unit of weight. This process opens the door for the commercially viable production of hydrogen from biomass for fuel cells. Small or mini-plants can produce small batches for local consumption, even to the extent of a home producing and processing its own biomass into hydrogen for fuel cell use, thereby greatly reducing infrastructure and transportation energy envisioned for delivering biomass or hydrogen to individual customers. Electro-Farming has the capability to develop the smallest possible power plants with the highest possible efficiency levels and low operating costs.

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### **Biomass -Shell Renewables**

Shell Oil might change its name one day to eliminate the word "oil." The name of one of its fastest growing divisions, Shell Renewables, could be a leading contender. Biomass is in the commercially viable stage. The idea of its use is proven but the logistics and commercial selling of it is yet to be tried in large scale. Shell Renewables' goal is to develop a dedicated wood fueled biomass business on a worldwide scale with a 10 percent global share for Biomass by 2010, with several hundred megawatts of capacity in place by 2005. Already demonstration trials are underway in Chile and Uruguay, showing a scaled infrastructure producing (in conjunction with Shell Forestry) and using biomass to generate clean power with total regard for the environment. Larger scale capacity is being developed in Northern and Central Europe.

In Norway, biomass is in action providing energy to industrial and residential customers using bark residues from a nearby wood processing plant. Whitewood briquettes are being marketed to customers for heating alternatives to fuel oils, using specially designed units for residential homes. These commercial pilots are beginning to show competitive potential against gas, oil, and coal even in these early stages.

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### **International Awards for Residential Biomass Heating Unit**

OkoFen, a German company, has won several international awards for its innovative residential heating unit that runs off biomass pellets. Its powerful design and function were awarded the Energy Globe 2001 and the Innovation 2000 award by the world sustainable energy community. It provides heat for hot water systems and radiant heating systems. It is self-cleaning and automatically compresses the ashes produced. It delivers fully automated heating needs fueled by biomass pellets that burn clean. OkoFen is a pioneer in pellet burning systems and today's market leader. They were one of the most popular exhibits for residential energy systems at the Sustain 2001: Sustainable Energy Exposition. The unit is very well designed, compact and installation ready.

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