Volume III, Issue 5, September/October 2003
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DG MONITOR℠

Blackout Creates Local Water Supply Concerns

During the blackout of 2003, millions of people in the Northeast lost electric power, but some of the most damaging effects came when water treatment plants and pumping stations were shut down. In Cleveland and Detroit, the water supply was severely diminished and contaminated because of inadequate emergency and back up power generators. The cities had not planned for an event where power was lost at every water pumping station and treatment plant in the area. In the face of a citywide blackout with potential looting and riots, Cleveland mayor Jane Campbell said, "The biggest crisis we have is water."

While one can get by without electricity, clean water is a necessity for survival. Within hours of the blackout, water pressure in Cleveland had diminished and over one million customers were left without access to water. At the downtown pumping station, which is below sea level, water pressure remained for some time. However, treatment plants were still in the process of switching over to backup power, and they could not clean the water that was available. A boil order was placed advising people to boil their water for at least 3 minutes to kill any bacteria or other potential contaminants. The Detroit area's water supply was also affected, and a similar boil advisory was put in place. These advisories remained in effect for days after power was restored.

In addition to the inconvenience and health problems associated with a diminished and unsanitary water supply, harmful effects to the environment were also endured. Without adequate backup power, the pumping stations and (*continued on page 5*)

New Business Plans Help Crack DG Market

A recent RDC study prepared for the U.S. Department of Energy and the Oak Ridge National Laboratory, entitled *Integrated Energy Systems (IES) for Buildings: A Market Assessment*, shows the potential market for Integrated Energy Systems (IES), which combine on-site power or DG technologies with thermally activated technologies, in office buildings is over 10 GW.

Several companies are working to achieve some of that potential. However, the DG siting process from start to finish can be long and complicated, and can curtail DG project development. Over the last few years, organizations have found ways to overcome many of the challenges to DG siting in order to tap into office building DG potential. One such organization is Equity Office, the largest publicly held office building owner and manager in the U.S. The company recently entered the DG market and expects to invest $15 million in distributed generation in the next year. The DG Monitor spoke with Frank Frankini, senior vice president of development and energy operations about Equity Office's DG siting experiences. With 12 installations completed or underway, and potentially as many as 100 total sites, Equity Office's experience offers some insight into the siting process.

A major challenge for DG developers is identifying the potential site and then convincing the building owners that DG is a good idea. Equity Office is able to circumnavigate site (*continued on page 6*)

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RESOURCE DYNAMICS CORPORATION

To view earlier editions of the DG Monitor or to begin receiving the publication via email please visit: www.distributed-generation.com.

About the DG Monitor. The DG Monitor is a bimonthly publication of the Resource Dynamics Corporation covering the many facets of the emerging Distributed Generation marketplace. Articles both report and interpret the most important items. In addition, the Monitor includes special series on DG technologies, applications, manufacturers, and other issues, providing the reader with a complete picture of these topics over several issues.

Comments or requests for additional information can be addressed to DGMonitor@rdcnet.com, through our website at www.distributed-generation.com, or by calling 703/356-1300.

Executive Editor…….. Paul L. Lemar, Jr.
Editor……... Elizabeth A. Kime
ekime@rdcnet.com

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Resource Dynamics Corporation
8605 Westwood Center Drive
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The **Resource Dynamics Corporation (RDC)** creates business solutions that empower clients to compete effectively in changing energy markets. Often, these involve evaluating the role of new technologies. All senior staff have both business and engineering backgrounds, with a distinct focus on strategy implementation. We combine these strengths to create innovative business solutions for energy technologies and markets. **RDC** utilizes an extensive set of tools including proprietary databases and models to develop these solutions.

We develop business solutions in four areas:

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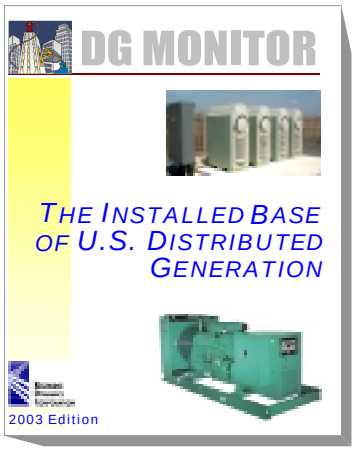
RDC has entered its 23rd year. Meeting our clients' needs has always been our top priority and we have consistently delivered outstanding consulting services that enable our clients to reach their goals. Clients include energy companies, consumers, financial institutions, law firms, equipment vendors, trade associations, research organizations, government agencies and international institutions.

For more information, see www.rdcnet.com.



How much DG is there in my state or region?

What is their aggregate capacity?

Where are these units located?

The Installed Base of U. S. Distributed Generation 2003 Edition helps decision makers at all levels answer these questions and make informed DG policy, regulatory and market decisions by providing detailed estimates of the total number of DG units installed in the U.S. as of 2001, and their capacity by 19 size ranges from less than 15 kW to 60 MW. Breakouts are made by technology, application, primary fuel consumed and year of installation. Additional regional and industrial breakouts are provided for a subset of the larger generators.

Additional reports are also available:

With the new IEEE 1547 DG Interconnection Standard likely to be released this year, the ***DG Monitor's Directory of Interconnection Technologies and Equipment*** helps decision-makers quickly develop a short list of potential interconnection solutions. This publication lists the equipment and technologies necessary to interconnect all kinds of DG applications, and provides contact information for manufacturers and distributors.

Evaluating DG technologies or markets? Check out the ***DG Monitor's 2004 DG Sourcebook!*** Available in November 2003, this report is a compendium of information on virtually every aspect of distributed generation technologies, applications, and markets - right at your fingertips!

These reports are part of the DG Monitor™ publication series produced by the Resource Dynamics Corporation (RDC).

To order this report or other DG publications, go to

www.distributed-generation.com.

TECHNOLOGY SERIES: DIESEL TO NATURAL GAS ENGINE CONVERSIONS

With environmental regulations becoming stricter in many areas, diesel engines are facing increasing challenges. In many parts of the country, diesels engines, based on their environmental permits, are only allowed to operate a few hundred hours per year. Some engine operators are looking at cleaner technologies, and others are employing more emission controls on existing units. However, another option, converting their diesel engine to run on natural gas (NG), can prove economic in some situations. Natural gas can be less expensive, and some engines operate more efficiently when converted to NG. In addition, NG engines run more quietly and produce significantly fewer emissions.

Complete diesel-to-natural gas conversions are quite expensive and the benefits do not always outweigh the costs. Changing the compression properties, fuel injectors, heads, and pistons of a diesel engine can be an expensive process, and sometimes the operator faced with increasingly strict emissions regulation is better off buying a new NG engine. However, converting a diesel engine to a dual-fuel engine that runs on a combination of diesel and natural gas is a relatively easy and inexpensive task that can significantly reduce the emissions and noise associated with diesel engines.

In a dual-fuel engine, the diesel fuel becomes the pilot ignition source for the natural gas/combustion air mixture. The basic diesel engine design is not changed, except for where the natural gas/combustion air is introduced. At low power outputs and engine start-up, diesel fuel is used in higher quantities, but when the engine is running at a high power output, natural gas dominates and the NG/diesel ratio reaches about 80 percent. At 80 percent natural gas, the engine usually has a higher efficiency and produces far fewer emissions than a single-fuel diesel engine (NO_x emissions are usually reduced 50-70%). Even when the engine is running at a lower power output, with the ratio at about 50 percent, the difference is still highly noticeable. In addition, dual-fuel engines need fewer oil changes, run more quietly, and can last longer than 100 percent diesel engines.

Companies such as the Innovative Technology Group Corporation claim that they can convert any diesel engine to run on a diesel/natural gas combination and on any form of natural gas (pipeline, wellhead, biogas, digester gas, landfill gas, etc). Another company, Energy Conversions Inc. offers diesel-to-dual-fuel conversion kits. For example, for the General Motors EMD 645 series of turbocharged diesel engines, a dual-fuel conversion system will allow the retrofit engines to run on up to 90 percent NG, while the more expensive dedicated natural gas conversion system completely retrofits the system to run on 100 percent natural gas. Dual-fuel kits for Caterpillar engines are also available, allowing a CAT 399, 389, or 378 diesel engine to run on up to 80 percent natural gas.

While 100 percent diesel-to-natural gas engine conversions are rare, converting an existing diesel engine to dual-fuel has nearly all of the same benefits and is more easily accomplished. For diesel engine operators facing strict environmental regulations, a dual-fuel engine conversion can be a cost-effective solution. Even for those in areas where emission regulations are not so strict, dual-fuel engines offer enough benefits to warrant consideration. ■

Congress Examines DG

In September 2003, the Congressional Budget Office (CBO) released a report entitled *Prospects for Distributed Electricity Generation.* This paper was prepared at the request of the Senate Committee on Energy and Natural Resources to provide information on the status of DG and its benefits and drawbacks. In addition, the paper looks at the barriers to DG and discusses the policy actions that could help lower these barriers.

Currently under consideration in Congress is energy legislation that supports the use of DG. DG is being examined for its role in increasing energy reliability, a major topic at present due to recent blackouts. Congressional interest in DG has widespread implications for the energy market as a whole, and the CBO report seeks to provide an overview of DG for policymakers.

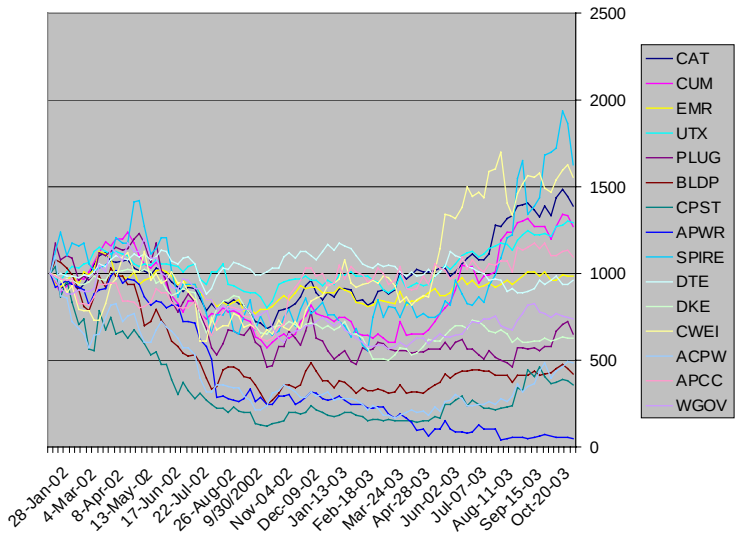
For more information, and for links to this paper, go to www.cbo.gov/ftpdoc.cfm?index=4552&type=3 ■

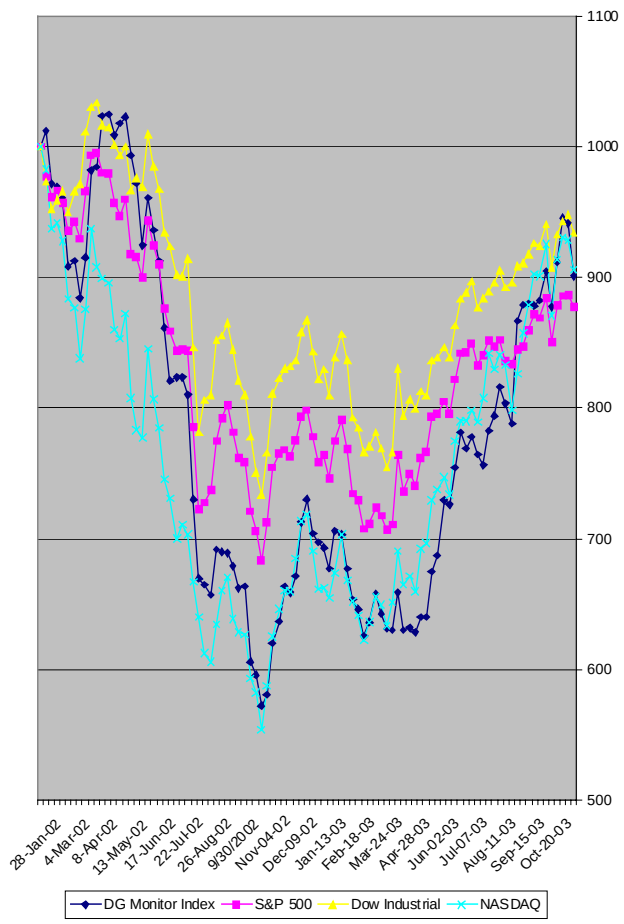
The DG Monitor Index℠

The DG Monitor Index℠ continues to lag the Dow Industrial and NASDAQ indexes, but now has surpassed the returns of the S&P 500 from January 2002 through August 18, 2003.

Top-performers since January 2002 include Spire, Clayton Williams Energy, and Caterpillar. Caterpillar Inc. has three lines of business: machinery, engines and financial products. The machinery division manufactures construction, mining, agricultural and forestry machinery. The engines division makes reciprocating engines and combustion turbines, and the financial products division offers financing to customers and dealers.

The poorest performers continue to be emerging technology manufacturers. Laggards from January 2002 include Astropower, Ballard, and Active Power. Ballard Power Systems Inc. develops proton exchange membrane (PEM) fuel cell technology for stationary and transportation applications. It also supplies subsystems and components for fuel cells to other developers.





Companies in the DG Monitor Index℠ include: Active Power; American Power Conversion; AstroPower Incorporated; Ballard Power Systems; Capstone Turbine; Caterpillar Incorporated; Cummins Incorporated; DTE Energy; Duke Energy Corp; Emerson Electric; PlugPower Incorporated; Spire Corporation; United Technologies; Clayton Williams Energy; and the Woodward Governor Company. ■

RDC DG NEWS

Iowa Contract. The Resource Dynamics Corporation was recently awarded a contract by the Iowa Department of Natural Resources to investigate questions and issues surrounding interconnection in Iowa and develop a comprehensive assessment of current interconnection procedures, including existing barriers and potential solutions. This report will lay the groundwork for streamlining Iowa's interconnection process.

NYSERDA Contract. The Resource Dynamics Corporation was recently awarded a contract with New York State Energy Research and Development Authority (NYSERDA) to assess the feasibility of DG as a grid support option. In cooperation with EPRI and several New York utilities, the Resource Dynamics Corporation will evaluate specific DG projects that have been or are being considered as options to traditional transmission and distribution (T&D) investments. In addition, the factors that promote the feasibility of DG in this type of application will be evaluated statewide to assess the potential for DG to serve as cost effective system management tool. ■

(*Blackout, continued from page 1)* treatment plants could not pump or treat their sewage, and many were forced to dump untreated wastewater into local basins. Three major treatment plants in Cleveland discharged millions of gallons of sewage into the Cuyahoga River and Lake Erie, polluting the beaches and causing serious environmental damage. New York and other areas faced similar problems and had no choice but to dump raw sewage into local waterways. While New York's gravity-fed drinking water system fared well, the wastewater treatment system spilled nearly half a billion gallons of untreated effluent into New York Harbor over two days because pumps were offline. The overall effects on the environment are still unknown.

The great blackout exposed the vulnerability of the U.S. electric grid, and planning for future blackouts, whether caused by system failures or terrorist attacks, has become a top priority. Aside from better recovery plans and stronger preventative measures, the situations in Cleveland and Detroit showed that local water systems must be adequately prepared. In a sustained blackout, emergency and backup generators must be capable of pumping and treating enough water to support the populace. While many cities believe they have adequate backup power in the case that one or two of the treatment plants and/or pumping stations are down, they need to be prepared for large-scale blackouts that cut off the whole city's power supply. Cleveland water commissioner Julius Ciaccia Jr. stated "We had what we thought was a good reserve plan in the event that one of Cleveland's four treatment plants were struck by terrorists. We didn't anticipate all four treatment plants and 12 pumping stations going down at the same time."

The answer for treatment plants and pumping stations could be either more powerful backup generators, or on-site power generation with no reliance on the local electric grid. In the areas where backup generators and DG systems were capable of handling the task, water supply was simply not an issue. To be successful in a large-scale blackout, the generators must be capable of running entire stations, at least at partial load. In Cleveland and Detroit, most pumping stations did not have enough power to operate their pumps, and treatment plants took up to 15 hours to fully restore their power. In these cities, more powerful backup generators and/or DG systems will likely be installed to prevent this from happening again. At wastewater treatment plants and pumping stations, on-site power generation has become more important than ever, and the market for DG among these facilities is expected to grow.■

Update: Hurricane Isabel Knocks Out Power, Water for Millions of Customers

On September 18, Hurricane Isabel hit the Mid-Atlantic with heavy rain and 100 mph winds. As it made its way up the coast it weakened, but still managed to disrupt power for over 5 million people. Three days after the storm, over 1.5 million people, many in the heavily populated D.C. metro area, were still without power. Some had to wait for a week or more for their power to be restored.

Like the power outages in Cleveland and Detroit, the Hurricane knocked out power for many water pumping stations and wastewater treatment plants. In the D.C. metro area, as well as the Virginia Beach area, millions were left without clean water. A boil advisory was put into effect in these areas and was not recalled for up to a week after the storm. If the treatment plants and pumping stations had sufficient backup power generators, or produced their own power, the large water problem could have been averted. ■

Anaerobic Digester Gas: A Free Fuel Source for Wastewater Treatment Plant DG

Many wastewater treatment plants are looking at on-site power generation options to avoid power failure in case of another blackout. Regardless of whether the facility currently utilizes anaerobic digestion, anaerobic digester gas can be considered as a potential fuel source for on-site distributed generation equipment. For treatment plants that already house anaerobic digesters, the gas is a free fuel source, and works almost as well as natural gas in most applications.

Several microturbine, fuel cell, and reciprocating engine gensets that run on anaerobic digester gas have been installed successfully at wastewater treatment plants throughout the country. Most treatment plants produce enough gas to power a large portion of the facility, and dual-fuel gensets (with natural gas as the secondary fuel) can be built to power the entire facilities. While some treatment plants do not have anaerobic digesters installed, they are generally superior to aerobic digesters and other treatment methods, and the cost of installation is relatively small when compared with the potential benefits.

(*New Business Plans, continued from page 1)* identification road blocks faced by many DG installers by the fact that it owns and operates the buildings in which it installs DG. As such, the company is in a unique position when it comes to identifying potential DG sites. Equity Office own 721 buildings throughout the U.S. and as the company's DG team handles energy procurement for these buildings, they have an intimate knowledge of each building's electric, heating and chilled water loads. This information, combined with knowledge of the applicable rate schedules, helps them narrow the field down for DG potential.

Once a site has been identified, DG developers must consider other aspects of the installation. Other factors that determine whether Equity Office selects a building include whether the existing system can be easily interfaced with a DG installation. Ease of siting in the building is also considered. Though they have backup, peaking shaving and cogeneration strategies, the company is currently focused on CHP applications. This is in line with results from the IES study, which shows much of building DG potential is in CHP applications. As such, Equity Office looks for buildings with high heating load and water or steam based heating systems.

The DG technology chosen can dramatically impact the economics of a project. At Equity Office, a simulation program is utilized to assess the economic feasibility of different technologies. The company considers itself "equipment agnostic," but has found that thus far natural gas reciprocating engine generators are the best option. Turbines have shown themselves to be unsuited for building load profiles, fuels cells just are not economic, and PV systems are expensive, though incentives do help make them more economic in some situations. Technology costs are a major component of the DG siting decision process. IES study sensitivity analyses showed that improvements in the installed cost and efficiency increases market potential dramatically. Both future scenarios examined increase the commercial building potential market from 35 GW to almost 70 GW, nearly doubling the market size.

DG projects must gain the approval of the investment committee. Equity Office's tenants do not pay for the installations. Rather, the company assumes all the risks of the DG installation, and then provides power to the tenants at a slight discount. There must be economic reasons for these DG installations, which include access in some instances to better rates. The company is pursuing DG for a number of additional reasons, including improved power factor and the opportunity to provide backup opportunities for what the company calls "special need customers."

In general, once the project has gained approval, Equity Office starts with a 9-10 month schedule, though siting can end up taking as long as 15-16 months. Engineering issues such as sounds levels, unit sizes in an existing building, access for combustion air, exhaust, access to natural gas, and the building distribution system are all things that must be considered and can add time and expense to the project.

What Mr. Frankini deemed a "pleasant surprise" has been the relative ease of the air permitting process. The company chooses low emission technologies, and the use of CHP has also helped in this area. The interconnection process, on the other hand, differs greatly depending on the location of the potential site. Currently most of the company's sites are in their Chicago market, though they are also working in or examining the Boston, New York, Los Angeles, San Diego, Orange County and San Francisco markets. At present, interconnection and safety issues represent a roadblock for some DG installations. However, Mr. Frankini added, the process is in its infancy on both sides of the equation - for the DG installers and for the utilities. For example, the company has a project in the siting process that will be the first electric interconnect in the downtown San Francisco network distribution system. Mr. Frankini added that he anticipates a stronger DG developer/utility partnership will evolve over time.

The blackout in August 2003 and recent weather relates outages may increase office building interest in DG. Once the DG unit is installed, it can be used in many different application, depending on what makes economic sense. Thus far, Equity Office has two installations in Chicago, one of which has been online since October of 2002. The project provides both electricity and steam and is also used to provide backup power for Fidelity National Financial, the building's largest tenant. The remaining projects, expected to come online over the next year, will also be used for CHP and backup applications. Although the company has been involved in demand response programs in the past, they have not yet done so using DG, but they may explore this option in the future. ■

Ask the DG Monitor

The new column responds to reader's questions about the DG market and DG technologies. Have a question for the Monitor? Email: askthemonitor@rdcnet.com.

Reader Question:
Can you describe the emission unit of gm/bhp-hr? *- E.S. in Jakarta, Indonesia*

DG Monitor Answer:
The unit you ask about is grams of pollutant per brake-horsepower per hour. This rather odd and somewhat archaic unit is used to describe the level of air emissions of NO_X, SO_X, CO_2, or CO output by a DG device. A related unit is ppm, or parts per million, of an effluent in the total air emission stream. The gm/bhp-hr measurement is based in part on how long the DG device operates but does not consider efficiency in converting fuel to useful output energy.

The significance of air emissions is considerable in regions where government regulations restrict the level of air emissions from stationary power sources. In the U.S. this includes many Environmental Protection Agency regions known as non-attainment districts, including among others Southern California, parts of New York, and parts of Texas. Similarly there are regions in Europe and elsewhere where air emission standards must be complied with. Often these are the very regions where the relative price of electricity and fuel (the spark spread) indicates DG might be operated profitably. Thus air emission standards can and do prevent some DG units with relatively high effluent (e.g. diesel reciprocating engines) from being operated.

There is a trend in the U.S. toward output-based air emission levels. Some states have established, or are now promulgating in draft form, emission levels that depend on the electric and possibly the thermal output of the DG device. A typical level would be measured in pounds of effluent per kWh produced, or pounds of effluent per Btu produced. These output-based measures consider the efficiency and size of the DG device, so they create a better basis for comparison between DG technologies, and between DG and central-station power generation technologies.

One thing is clear. More standardized measurement units, probably output-based, would help regulators, manufacturers, utilities, and end-users compare technologies and establish more meaningful air pollution policies. The current mixture of air pollution measurement units, which often vary by state/region, by type of effluent, and even by DG technology, do not improve the debate about where, when and how many hours per year to apply DG. With a current rise in demand response programs that dispatch backup reciprocating diesel engines this issue becomes more critical.

- DG Monitor Staff

RDC Speaks at EPRI's DG Conference

October 15-17, 2003, EPRI sponsored their 8th DG conference. New this year was specific inclusion of renewable technologies. Several presentations focused on wind and PV installations. The conference was attended by just over a hundred people, well down from the attendance levels of past years. However, those in attendance were well-versed in DG issues and had practical DG experience. Participants included a mix of utilities, regulators, manufacturers, developers, and consultants.

Mr. E.J. Honton of the Resource Dynamics Corporation addressed the conference on "Interconnection Experience in the U.S. – Is It Working?" This presentation reviewed utility and state approaches to interconnecting DG with the grid, highlighting utility experiences, typical process flows and options for streamlined interconnection approval in some areas. A lively discussion resulted, and the underlying controversy surrounding interconnection emerged.

At the conference, a total of thirty speakers offered practical perspectives on how DG is evolving. Real world examples of DG installed by utilities, developers and end-users were highlighted. Case studies illustrated both the strengths and weaknesses of DG today. Many participants remain hopeful of a bright future for DG, especially considering new technology developments. Niche market businesses were described which clearly illustrated ways in which DG can be an economical solution.

Overall this EPRI conference benefited from its focused on real-world DG solutions while providing sufficient opportunities for participants to share and learn. For those readers interested in attending the next meeting, EPRI is considering holding their 9th conference between 18 and 24 months from now. ■

DG NOTES

Oct 24, 2003 - New Jersey Natural Gas (NJNG), the principal subsidiary of New Jersey Resources, installed a photovoltaic cell system at its service center in Wall, New Jersey. NJNG will receive a rebate of $106,520 from the New Jersey Clean Energy Program for the system, which cost $195,117. NJNG also offering customers the option to contribute to the New Jersey Clean Energy Program through their natural gas bill. Through the Program, rebates are available for up to 60% of the cost of eligible renewable energy systems..

Oct 23, 2003 - **Hydrogenics Corporation** is partnering with IdaTech, the fuel cell subsidiary of IDACORP, Inc., to develop a 50 kW fuel cell system using newly developed component technologies, including Hydrogenics' fuel cell power module technology, and IdaTech's fuel processing technology. IdaTech was recently awarded $9.6 million as part of a U.S. Department of Energy solicitation. Three 50-kW systems will be field-tested, one each with Sempra Utilities, Puget Sound Energy and Marriott International.

Oct 21, 2003 - **Advanced Energy Technology (AET)** was awarded two cash grants totaling $1.4 million from the State of Ohio to support two fuel cell development programs. Approximately $800,000 will be used in a program to develop high volume manufacturing processes for PEM fuel cell flow field plates. The second program, costing $600,000, will develop a fuel cell testing system. AET is partnering with both the University of Akron and Lake Shore Cryotronics to develop and commercialize the fuel cell testing system.

Oct 7, 2003 - **DTE Energy Technologies** will install 10 kW natural gas fueled standby power systems in more than 50 new condominiums built by Windmill Homes LLC of Michigan. DTE Energy Technologies offers residential units ranging from 6 kW to 100 kW, so customers can power partial loads or their entire home or small business. *September 30, 2003* it was announced that **DTE Energy Technologies** will participate in a project funded by the U.S. DOE entitled “Advanced Aggregation and Control of DG.”

Sept 29, 2003 - **Microgy Cogeneration Systems, Inc**. executed a Memorandum of Understanding with the City of Lodi, California which contemplates a further agreement for the development of an initial group of projects designed to provide up to 20 MW of renewable generation capacity based on Microgy's proprietary anaerobic digestion technology. The first phase of development would focus on a project designed to produce up to 10 MW.

Sept 29, 2003 - **AmericanDG** signed an agreement to provide electricity and hot water to the Aishel Avraham Residential Health Facility in Brooklyn, NY using a 60 kW cogeneration facility that AmericanDG will operate at the site. The installation will feature natural gas-driven cogeneration modules from **Tecogen**.

Sept 18, 2003 - **Chapeau, Inc. dba BluePoint Energy, Inc.** received final approval for UL listing of its proprietary Lean-One(TM) 260 kW Combined Heat & Power Module for "Engine Generator for Co-Generation Use", #46XT; Standard 2200.

Sept 17, 2003 - Rodney Strong Vineyards signed an agreement with **Powerlight Solar Electric Systems** of Berkeley, California to install a 766 kW solar electric system in early October of 2003.

Sept 2003 - **Caterpillar Inc.** and **FuelCell Energy Inc**. announced the first joint sale of 250 kW Direct FuelCell® power generation plant in the state of California. The power plant will be used by the Los Angeles County Sanitation District.

Sept 2003 - **Capstone Turbine Corp**. began shipping a new combined heat and power product based on its 60 kW microturbine power system.

CONFERENCES

IEEE 1547 Series of Standards Meetings, Nov. 12-14, New Orleans, LA.

The 16th NREL Industry Growth Forum: Financing the Path to Clean Energy and a Hydrogen Future, Nov. 17-19, Austin, TX.

Second DER Peer Review. U.S. DOE Office of Distributed Energy Resources, Dec. 2-4, Washington, DC.

Power-Gen International, Presented By: Power Engineering, Dec. 9-11, Las Vegas, NV.