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Distributed Generation MONITOR

Protecting our Energy Infrastructure with DG

The September 11th attacks have heightened concerns about the security of the U.S. energy supply and energy infrastructures. Within hours of the terrorists attacks, the federal government ordered increased security for America's energy infrastructures. Private and public decision makers in the U.S. and around the world reevaluated their own energy systems. As these groups grapple with energy security issues, DG's role in providing solutions will likely expand.

A major concern is ensuring the safety of energy infrastructures. This is a daunting task- the U.S. energy infrastructure consists of hydroelectric, large nuclear and fossil fueled power plants, transmission and distribution lines, and nearly 400,000 miles of oil and natural-gas pipeline. Each of these segments, as well as the telecommunications, transportation, water and other infrastructures, is at a heightened stage of alert and security measures have been increased. For instance, pipeline companies are increasing on-site security by stationing guards at terminals and key pumping stations. Similar precautions have been taken at dams, water processing plants, generating stations, transmission lines, and elsewhere.

These key infrastructures are highly interconnected, and there is great concern about the potential domino effect that an attack on one can have on the others. Impairment of the communication system, for example, can impact the energy infrastructure, which uses communication infrastructures to manage remote power locations, monitor power systems, and control the transportation of energy. To protect energy security, the security of the entire network of infrastructures must be addressed.

Due to this priority, interest in new and supplemental backup and standby power applications is expected to grow. Many individual customers are also looking at these applications to provide for their own energy security independently of the grid. Companies with mission-critical electrical devices, such as data centers, are already using backup and standby power, and currently, building codes require the installation of standby electric generators in most office buildings, hospitals and some industrial sites. In light of recent events, however, many companies and individuals are reassessing their perceived vulnerability to power interruptions. Although this group may not generally be considered 'sensitive', they are definitely concerned with the possibility of power loss for hours or even days in the event of a serious compromise of the grid.

Backup and standby power applications for both these groups will generally be served by traditional technologies like diesel engine generators, but there is also room in this market for new DG technologies. DG can be used in many ways to enhance the security of key infrastructures, especially by building resilience into the power system. These systems are already designed to function after losing key components, but DG can help make them even more redundant:

- Large substations that serve long haul lines use DG to provide redundancy and power the local grid if transmission lines or central stations are down.
- Gas pipelines with backup power in place can function even when the grid is down.
- Central power plants may be an economic source of generating power, but DG, located close to the load,

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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 bi-monthly 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 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 contacting Jean Connors at 703/356-1300 x 208.

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

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:

- **Distributed Generation**
- **Marketing for Energy Businesses**
- **Strategies for Power Suppliers**
- **Strategies for Energy Purchasers**

RDC has entered its 21st year. Meeting our clients' needs has always been our top priority and we have consistently delivered outstanding consulting services to enable our clients to reach their goals. Clients include electric and gas utilities, energy companies and consumers, financial institutions, law firms, equipment vendors, trade associations, government agencies and international institutions.

For more information, see www.rdcnet.com.

DG Notes

Nov 13, 2001 - **FuelCell Energy, Inc**. successfully installed and tested the equipment necessary to produce 50 MW of fuel cells per year at the company's manufacturing facility in Torrington, CT.

Nov 8, 2001 - **Ocean Power Corp** subsidiary **Powerco US, Inc.** and **EPRIsolutions** formalized an agreement in which EPRIsolutions will test and validate Ocean Power's 3 kW Stirling engine for market readiness in the United States.

Nov 8, 2001 - **Southwest Research Institute** (TM) will demonstrate three **DCH Technology, Inc.** 3 kW proton exchange membrane (PEM) fuel cells at Brooks Air Force Base under a $500,000 contract from the U.S. Army Corps of Engineers Construction Engineering Research Laboratory.

Nov 7, 2001 - 73 percent of San Francisco residents voted in favor of a $100 million revenue bond that will result in the installation of 40 MW of renewable energy, of which 10-12 MW will be solar power, on city-owned facilities and schools.

Nov 6, 2001 - **Celerity Energy**, **Sixth Dimension**, and the **Bonneville Power Administration (BPA)** will launch a project combining demand management with new generation and communications technologies. The project will explore how DG can address key energy issues in the Northwest, and examine networking units into usable blocks of power.

Oct 31, 2001 - The largest commercial solar power installation west of the Mississippi was installed at the new headquarter of the International Brotherhood of Electrical Workers Union Local 332. The PV system generates 55 kW of power, and can provide for 70 to 80% of the building's total electrical needs. On weekends, power is sent back to the utility grid to earn credit. Forty percent of the $400,000 installation cost will be rebated by the State of California under their Rebate Program.

Oct 29, 2001 - **ABB,** a power and automation technology group, received an order from **Golden Valley Association Inc**., a nonprofit rural electric cooperative in Fairbanks, Alaska, for a Battery Energy Storage System. The $30 million project will provide continuous voltage during normal operation and backup power. The unit will consist of a nickel-cadmium battery, made up of 13,760 energy cells in four strings, power conversion modules, metering, protection and control devices, and service equipment.

Oct 2001 - The recirculation ballot vote on Draft 8 of the Institute of Electrical and Electronics Engineers (IEEE) P1547 Standard for Interconnecting Distributed Resources with Electric Power Systems achieved only a 66 percent affirmative vote. A 75 percent affirmative vote is required in order to proceed to the IEEE Standards Board. A new draft is expected to be ready in early 2002.

DG Market Assessments

The number of distributed generation applications is projected to grow significantly over the next few years. Resource Dynamics Corporation's (RDC) DG market assessments have provided energy companies, DG equipment manufacturers, government agencies, and research organizations with the market intelligence necessary to be successful in this changing market. These studies:

- ✓ Estimate the market size of the distributed generation market in the region of interest,
- ✓ Evaluate the technical and economic feasibility of serving different customer segments with distributed generation, and determine which DG applications, technologies, and sizes provide solutions to which customers, and
- ✓ Identify specific high value customers potentially suitable for distributed generation solutions.

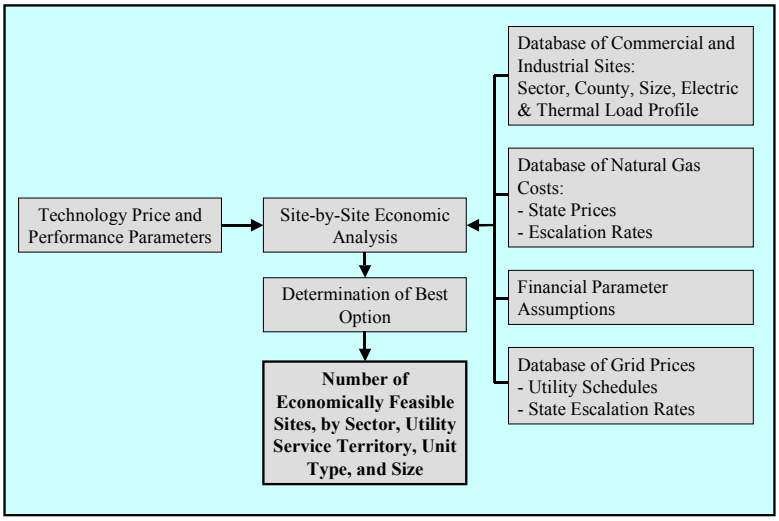
This critical information is generated using RDC's DIstributed Power Economic Rationale SElection (DISPERSE) model. DISPERSE, developed and improved over six years, estimates potential new DG applications by geographic region, SIC code, DG technology type, operation mode, and size. As seen in the figure on the right, a DISPERSE model run begins with a database of industrial and commercial sites. The model assigns electric and thermal load profiles specific to the application, region, and the size of facility.

For each site, the utilization of DG technologies in baseload electric, cogeneration, and peak shaving operating modes is compared to purchasing electricity from the grid. The model performs a life-cycle cost/benefit analysis based on site characteristics, DR unit life, cost and performance, fuel prices, and competing electricity price. The best DR options are selected based on fastest payback, highest NPV, highest ROE, or other financial measures. The results are then aggregated to obtain market potential. Sensitivity analysis on key variables can also be conducted.

Results from DISPERSE can help you determine:

- ✓ Which DG application types (e.g., baseload generation, cogeneration, etc.) are the most promising in your region,
- ✓ Which DR technology types have the most potential (this helps energy companies determine which manufacturers/distributors they should ally themselves with), and
- ✓ Which customer class offers the most potential (e.g., large chemical plants vs. small office buildings).

For more information on distributed generation market assessments, please contact N. Richard Friedman at 703.356.1300 ext. 203.



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can be used to counter the vulnerability of these facilities.

- Refinery outages can have major implications for many sectors of the economy. DG can provide power to refineries during grid outages and help keep the system flowing.
- DG can keep communication systems up and running, allowing for essential information exchange and coordination. Major components of the communication system were lost with the Towers on the 11th, illustrating the critical importance of dispersed systems.

DG is prudent because it can be put in place incrementally, mitigating the need for costly and unnecessary sweeping change, can be installed quickly, and is fuel flexible.

The events of September 11th highlighted the importance of backup and emergency power to provide for the safety of businesses and other individual customers during blackouts like those that occurred in Manhattan. Amongst other things, DG can be used by these groups to:

- Operate elevators, lighting systems and power other emergency equipment.
- Protect mission critical devices such as computers and other electronics.
- Keep banks, hospitals, airports, telecom facilities and other critical infrastructures running.
- In addition, mobile resources can be put in place quickly to help with emergency response.

Many companies and groups are conducting system vulnerability assessments anew, and some may explore using DG to generate all of their power. However, most will find they can address their security needs by supplementing grid power with first time backup installations or by adding to existing systems. Though the economic slowdown will limit many companies' ability to make large capital investments, security concerns may overcome many objections to backup power installations. Increased perception of risk may mean DG is more often seen as financially feasible.

Regulatory changes can also heighten this trend. Exit fees, stranded costs and stand-by charges are some of the issues that have discouraged DG installation. Now, a new emphasis has been placed on lowering regulatory and other barriers to DG technologies. In one example, on October 4th, the Environmental and Energy Study Institute gave a briefing on national energy security. One of the things Senator Susan Collins (R-ME), sponsor of the meeting, called for was encouragement of distributed energy resources. This includes funding for DG research, development, and testing.

DG has many barriers to overcome to reach its full market potential, but, as noted in an AFS Trinity Power Corporation National Security and Energy Infrastructure Risk Teleconference, in light of recent events, "[w]hoever comes in the door with solutions to critical problems is likely to find a much more open hand than there was previously." DG can provide those solutions, and therefore will be viewed with energy security in mind for years to come.

A substation may benefit from DG applications

CONFERENCES

Distributed Energy Resources The Power to Choose, 1st DOE Distributed Energy Resources Conference and Peer Review, 28-30 November, 2001, Washington, DC

The 12th National Energy Services Conference, The Association of Energy Service Professional International, 3-5 December, 2001, Ponte Vedra Beach, FL

Power-Gen International, Pennwell Energy & Utility Group, 11-13 December, 2001, Las Vegas, NV

Capitalization of DG Firms: Rough Roads Ahead?

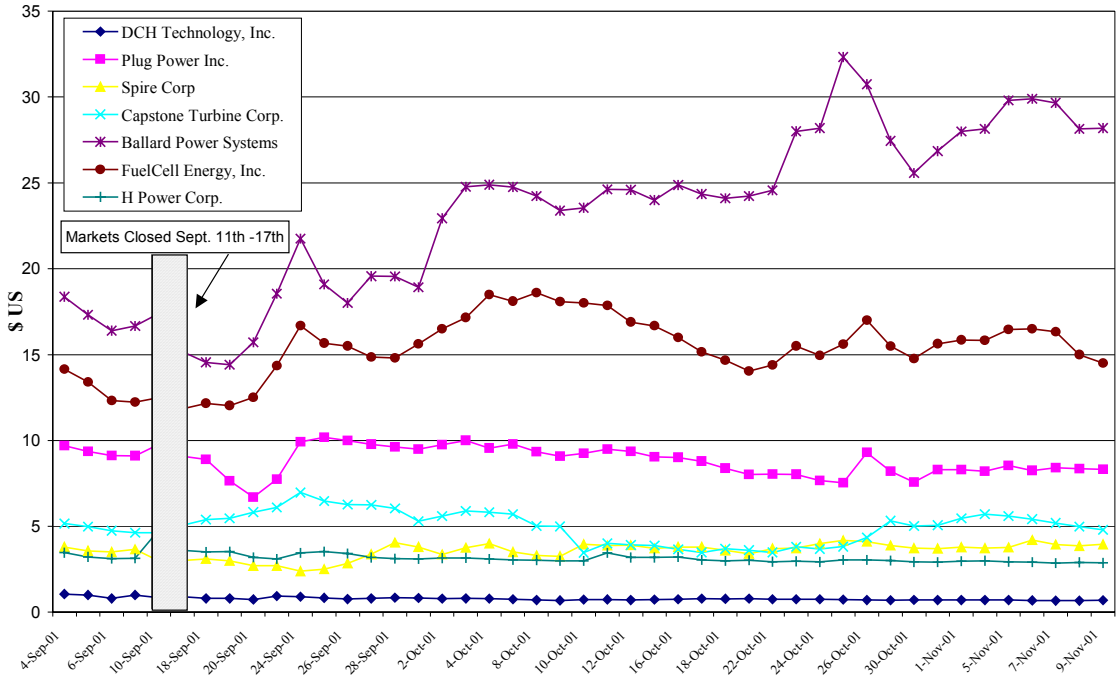
A week after the September 11th events, Nuvera Fuel Cells announced that due to unfavorable market conditions it would postpone its initial public offering. Mark Brodsky, President and CEO of Nuvera Fuel Cells said "…despite our successes, we recognize the difficulties of the IPO market at the present time."

His words echo a concern many are expressing. With the downturn in the market, will funding for DG be there now that it is critically needed? This is a crucial time for DG technologies. To overcome the final developmental and financial hurdles to commercialization, DG companies will need significant funding and support. However, though Nuvera's experience seems to indicate that the DG market has suffered a severe blow, the actual truth is mixed.

DG stock performance has varied greatly. In part because of a heightened emphasis on energy security, as the graph illustrates, many DG stocks, though suffering from an initial downturn after the 11th, have remained fairly steady. However, DCH Technology, Inc. dropped significantly, down 37 percent from September 4th through the 9th of November, while Ballard Power Systems' price increased 10 percent in the same period.

These mixed reviews illustrate that the current situation for DG technologies is an uncertain one. Certainly Nuvera's decision reflects an overall downturn in the stock market. As a result, though the market may continue to support even semi-established DG companies, there may be rough roads ahead for DG companies looking to go public. These mixed market responses will have long run implications both for DG commercialization and the technologies that will make up the DG market in the next several years.

Selected DG Stock Prices, Sept. 4, 2001- Nov. 9, 2001



DG Survey Results

Many DG Monitor readers have taken a minute to participate in our DG market survey. We've received some interesting initial responses to the question "How would DG technologies and their economics have to change for you to consider applying DG?"

General Views

Several views were repeatedly noted, such as:

- There needs to be a reduction in capital cost via improved technologies. Typical comments were "There is little incentive for people to go with DG unless the cost of power is less than is available from the grid." "Installed cost must be less than $1,000/kW for stationary applications while remote firm power applications might be acceptable at up to $4,500/kW."
- The counterpoint was also mentioned: "I don't think that the economics need to change at all… when the cost savings of the environment are measured against the production cost per kWh, renewables (excluding hydroelectric) are much cheaper than fossil fuels. Also, as the technology improves, the actual costs will become more comparable as well."
- "Manufacturers must provide evidence of the ability to run 24/7 if needed. Many of the smaller, high-speed generators are good for backup but woefully lacking when run continuously. On the other hand, larger turbines are either all or nothing; if you need less part of the time, the efficiencies go way down."
- "Companies that involve themselves in the DG technology product rush should do their best to make the most reliable and durable products they can. This will ensure that their products and their business remains reputable and economically viable in the future."

Residential Customers

Some respondents have already installed DG or are in the process of doing so. Others noted:

- "I'm just waiting for solid oxide fuel cells to be marketed in my city."
- "DG technologies would have to be environmentally benign and cost effective (even or slightly above current rates) to be applied. In addition, these technologies would have to be user-friendly, reliable, and durable. If DG technologies do not exhibit or promote any of the above characteristics, then they are not worth implementing on either a commercial or residential basis."

Commercial and Industrial Customers

A number of particular suggestions for DG manufacturers and installers have been made, including:

- "Simplify the interconnection with the utility and reduce the cost of the switchgear, synchronization, etc. for parallel operation."
- "Canadian interconnection roadblocks would have to come down."
- "I'd like to see availability of more standalone 'shrink wrapped' systems."
- "We need documented reliability and realistic economics. I am not impressed with low emission microturbines that indicate 650,000 hours of run time on 500 units! That is less than two months run time on average, for each unit. It seems like there is a whole lot more hype than proven performance. The reality is that DG needs to have multiple advantages to different parties to have the economic advantages to proceed forward."
- Projects are more successful when "the host facilities invest zero capital and achieve energy cost savings of 8 - 10% on their then current electric cost."

If you would like to add your viewpoint, please go to www.distributed-generation.com/survey.htm. More quantitative survey results will be summarized in a later edition of DG Monitor.

Your Thoughts About Distributed Generation?

The Resource Dynamics Corporation would like to know your thoughts about DG, its prospects, and what you might use it for. Your response will be anonymously compiled with other respondent's views and will be used to help shape the future of the DG industry. To complete the 60-second survey, please go to www.distributed-generation.com/survey.htm. We will publish the results to date in the next edition of *DG Monitor*. We appreciate your input!

DG APPLICATION SERIES: BACKUP POWER

The majority of DG applications in the U.S. were installed to provide emergency or standby power (known collectively as backup power). *Emergency Power Systems* automatically provide electricity to critical loads when the grid goes down. These systems power devices that protect human health and safety, or ensure the protection of property. Typical systems include battery-based lighting, uninterruptible power systems (UPS) for critical subsystems like communication equipment, and DG. *Standby Power Systems* allow the entire facility, or a significant portion thereof, to continue to operate if the grid fails, and usually allow for more extended operation. Standby systems almost always include DG units, and are usually sized larger than emergency power units relative to site peak demand, have larger fuel tanks, and allow the facilities to operate normally for hours or days.

Most of backup power systems are diesel-fueled reciprocating engines. Units designed for the residential sectors (less than 5 kW) often use spark-ignited gasoline engines. Natural gas-fueled reciprocating engines are also available for residential, commercial, and industrial applications, but cost more than diesel units. Emissions regulations are generally not a problem for any type of engine if it runs for less than 200 hours per year.

Microturbines can provide standby power, but are generally not suited for emergency power because most microturbines cannot meet requirements for dual fuel sources and because they have start-up times that are greater than 10 seconds. Because of this, microturbines will not meet many local or state codes for emergency power. Few microturbines have been sold to provide standby power, primarily because they cost more than similarly size diesel-fueled reciprocating engines.

In Europe and Japan, small combustion turbines (200 kW – 1 MW) are sometimes used for backup power. Turbines receive a tax credit in Japan, and they are also used in these two regions because of their small size (they can be roof-top mounted), the fact that they do not require cooling water, and because of manufacturers' claims of sure-start abilities (successful startup when requested compared to diesel engines). These units are available from companies like Daihatsu Diesel Manufacturing Company, Niigata Engineering Company, Yanmar, Kawasaki, Ebara, and Turbomeca Land and Marine Gas Turbines. Very few of these small turbines are used for backup power in the U.S. – diesel-fueled reciprocating engines dominate the market.

Backup systems are used to power critical loads such as this control center.

RDC DG News

Presentations

"Making Distributed Generation Choices" - N. Richard Friedman, at Capturing the New Customer Markets Created by Energy Deregulation, The Northeast Energy and Commerce Association (NECA), Boston, MA, Nov. 8, 2001.

"20% Goal for DER: Challenging or Business as Usual" – Paul L. Lemar, Jr., at Distributed Energy Resources: The Power to Choose, 1st DOE Distributed Energy Resources Conference and Peer Review, Washington, DC, Nov. 28-30, 2001.

Reports

DR Cost Impacts on T&D Systems - October, 2001 (EPRI).

Siting of DR Units: Process and Issues - October, 2001 (EPRI).

Application Guide for Distributed Generation Interconnection, The NRECA Guide to IEEE 1547 - September, 2001 (The National Rural Electric Cooperative Association (NRECA)).