Volume IV, Issue 2, March/April 2004

DG MONITOR[SM]

The Impact of Rising Natural Gas Prices on the DG Market

Wholesale natural gas prices have remained above $5/MMBtu since January, 2003, and are currently around $6/MMBtu. While recent prices have not reached the highs of early 2001 ($10/MMBtu), the U.S. has never experienced a continuous 15-month period with prices over $5/MMBtu. Wholesale natural gas rates did not exceed $4/MMBtu during all of 1998-1999, and were lower than $3/MMBtu for a few months during that period.

Earlier this week, Alan Greenspan, Chairman of the Federal Reserve, said that Americans will face persistent high prices for oil and natural gas in the future. He noted the U.S. needs to gain access to global supplies to keep volatile domestic natural gas prices in check, requiring *(continued on page 4)*

U.S. DOE's Hydrogen Posture Plan

In February, 2004, the U.S. Department of Energy published the *Hydrogen Posture Plan.* This document describes the Department's plan for successfully integrating and implementing technology research, development, and demonstration activities needed to cost-effectively produce, store, and distribute hydrogen for use in fuel cell vehicles and electricity generation.

The *Plan* outlines the Department's role in hydrogen energy research and development in accordance with the National Hydrogen Energy Roadmap released by Secretary Abraham on November 12, 2002, and lays the foundation for a coordinated response to the President's goal for accelerated research on critical path hydrogen fuel cell and infrastructure technologies. *(continued on page 4)*

COUNCIL FOR DISTRIBUTED GRID ENHANCEMENT UPDATE

The August 14 blackout starkly underscored the need to upgrade the nation's T&D system. However, a number of imposing institutional barriers to grid reform promise to delay any serious grid enhancement for many years. Perhaps more importantly, the hundreds of billions of dollars required to rebuild the T&D system will take decades to raise and apply. It is clear that since the grid was not designed for its current superhighway purposes, it requires significant modification and enhancement. Regulation has largely been state-by-state, and there will continue to be varying approaches to establishing reserve transmission capacity; management and operations; competition between IPPs and utilities; and risks of delays in siting. Experience teaches that even with a major legislative push to solve these problems, their actual solution and financing will be a lengthy process taking decades or longer to accomplish.

Against this backdrop, a near-term, stopgap fix to the system must be found. As the dollar value of reliability is just beginning to be appreciated and the need for security is just coming to center stage, there is a distinct need to find an immediate backstop. Distributed generation is uniquely positioned to bolster transmission and distribution system weaknesses through systematic and strategic deployment in potentially impacted areas. Instead of taking decades, however, as will major system upgrades, DG can be *(continued on page 7)*

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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.

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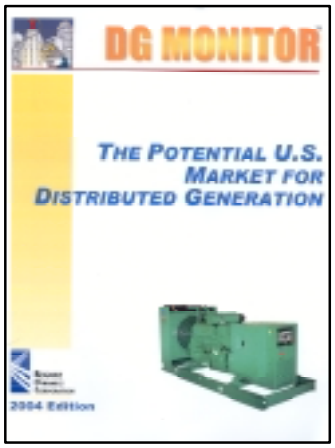
The **Resource Dynamics Corporation (RDC)** creates business solutions that empower clients to compete effectively in changing energy markets. Often, these involve evaluating the role of new technologies. All senior staff have both business and engineering backgrounds, with a distinct focus on strategy 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:

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

RDC has entered its 25th 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 big is the potential DG market in my state?

What are the leading DG technologies?

Which customer's are likely to adopt which sizes?

The Potential U.S. Market for Distributed Generation: 2004 Edition. The number of distributed generation (DG) units will grow significantly. Organizations seeking to be successful players in the DG market must have market intelligence – understanding the size of the potential new market and specifically where DG will be adopted. New DG technologies and recent changes in fuel prices will have a profound effect on the marketplace.

This report estimates the market potential for DG in the United States. This is the first published national assessment based on today's higher natural gas prices. The report examines fossil fuel-fired DG technologies and examines baseload, combined heat and power (CHP), and peaking applications. Results are available for each state, which helps identify specific market niches to pursue.

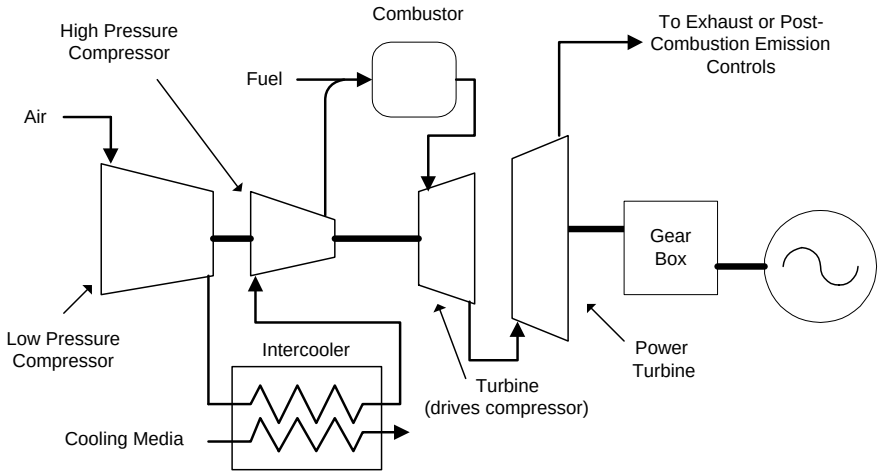
Market potential varies considerably depending on the underlying assumptions. To address this, five different cases were prepared, starting with the Base Case market potential given today's DG technology price and performance, current gas prices, and expected escalations in gas and electricity prices. Four additional cases examine the sensitivity to capital cost, gas prices and competing electric prices. Each case projects whether DG can economically beat the electric grid price for a particular user, including recovery of capital investment in the DG unit. The analysis considers actual tariffs from the utility where the user is located, and is not based on average electricity prices.

This report is 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: TYPES OF COMBUSTION TURBINES

A combustion (or gas) turbine is an internal combustion engine that burns a mixture of air and fuel to turn sets of blades attached to a shaft, converting the energy of the hot air into rotation of the shaft. For DG applications, this energy is then converted to electrical energy by turning a generator. Combustion turbines range in size from about 30 kW up to 50 MW for DG applications, and up to approximately 250 MW for central power generation. Combustion turbines are also used for transportation applications, and to directly power systems like gas compressors and pumps. Combustion turbines can be designed to use almost any liquid or gaseous fuel.



DG-sized combustion turbines can be divided into three classes; microturbines, aero-derivatives and industrial frame turbines. Microturbines are typically radial-flow designs, and resemble automotive engine turbochargers. Microturbines range in size from around 30 kW up to 500 kW. Aero derivative turbine gas turbines are "derived" from mature aerospace jet engine technology. Aero-derived, land-based engines sold in the U.S. start at around 1 MW and go up to 50+ MW. Industrial frame or heavy-frame combustion turbines are designed for stationary applications like power generation.

There is a diverse range of different varieties and types of gas turbines. Some common types are described below.

Unrecuperated turbines. With these simple cycle turbines, compressed air is mixed with fuel and combusted under constant pressure conditions. The resulting hot gas is allowed to expand through a turbine to perform work. Unrecuperated turbines are the least expensive and least efficient type of combustion turbines.

Recuperated turbines. Recuperated units use a heat exchanger that recovers some of the heat from the exhaust stream and transfers it to the incoming air stream. The preheated air is then used in the combustion process. If the air is preheated, less fuel is necessary to raise its temperature to the required level at the turbine inlet. Recuperated turbines are more efficient and more expensive than unrecuperated turbines.

Combined cycle turbines. Combined cycle turbines use both a combustion turbine and a steam turbine. Exhaust gas from the gas turbine is used to heat water to produce steam, which powers the steam turbine. Combined cycle units have the highest electrical efficiency of any type of turbine system with some reaching 60 percent.

Steam-injected turbines. With these turbines, exhaust gas is used to make steam, which is injected into the combustion turbine. Steam injected turbines are more expensive and more efficient than unrecuperated turbines.

Inlet air-cooled turbines. The intake air to combustion turbines can be cooled via refrigerated systems, media, or with inlet-fogging, resulting in increased capacity and efficiency, especially during periods of high ambient temperatures.

Intercooled turbines. Multi-staged turbines can use intercooling between stages, increasing efficiency and capacity.

CHAT (cascaded humidified advanced turbines). CHAT turbines use a cycle that includes reheat, intercooling, recuperation, and humidification. These turbines have the potential to be the most efficient turbine type, other than combined cycle.

As you can see, there are many types of combustion turbines available in the marketplace, each with its own strengths and weaknesses. ■

(High Gas Prices, continued from page 1) additional U.S. ports with facilities to handle shipments of liquefied natural gas.

Many current and potential DG applications are affected by high natural gas rates. For some baseloaded DG applications, fuel costs can represent the majority of annual costs.

Prices paid by residential, commercial, and industrial customers are higher than wholesale gas prices. U.S. residential prices have averaged around $10/MMBtu, commercial prices around $8/MMBtu, and industrial prices around $6/MMBtu for the past year.

The *DG Spark Spread* is defined as the difference between the price of electricity that can be obtained from the grid and the price of natural gas or other fuel used by the DG application, expressed in the same units.

Averaging the last 12 months of commercial sector natural gas prices and comparing it with state average electricity prices, California has the highest DG spark spread of any state (not including Alaska) and Kentucky has the lowest.

Another interesting way to look at DG and gas prices is the ratio of grid electricity prices over natural gas prices multiplied by DG efficiency. If this number is less than 1, then even if the DG capital and maintenance costs are zero, baseloaded, non-CHP DG does not make economic sense to operate. Again, using state average commercial sector natural gas prices compared with state average electricity prices and a DG efficiency of 40%, there are over 30 states with ratios of less than one. States with high ratios (where baseloaded DG makes the most sense) include Alaska, California, Maine, Michigan, Nevada, New Jersey, New Mexico, New York, and Vermont.

In areas with high natural gas prices and low grid prices, CHP and peak shaving DG applications may still make sense. CHP can overcome a poor spark spread because life-cycle economics need to take into account displaced thermal energy that would have been provided by a traditional source. Peak shaving applications run DG during on-peak hours, displacing electricity when it is most expensive to purchase. ■

(Posture Paper, continued from page 1) Key points of the *Plan* include:

- Producing and delivering hydrogen using various domestic resources (e.g., natural gas and coal using capture and sequestration of carbon dioxide; renewables including wind, solar, and biomass; and nuclear energy),
- Storing hydrogen,
- Converting hydrogen to useful energy through advanced fuel cells and other devices,
- Conducting limited "learning" demonstrations to measure technology progress,
- Addressing education needs,
- Developing and verifying appropriate codes and standards for a variety of applications,
- Developing a viable hydrogen infrastructure in achieving a successful FreedomCAR Partnership,
- Developing a government-industry initiative for the advancement of high-efficiency hydrogen-powered fuel cell vehicles, and
- Defining the important role of government policies in overcoming economic and institutional barriers to the development of a hydrogen infrastructure.

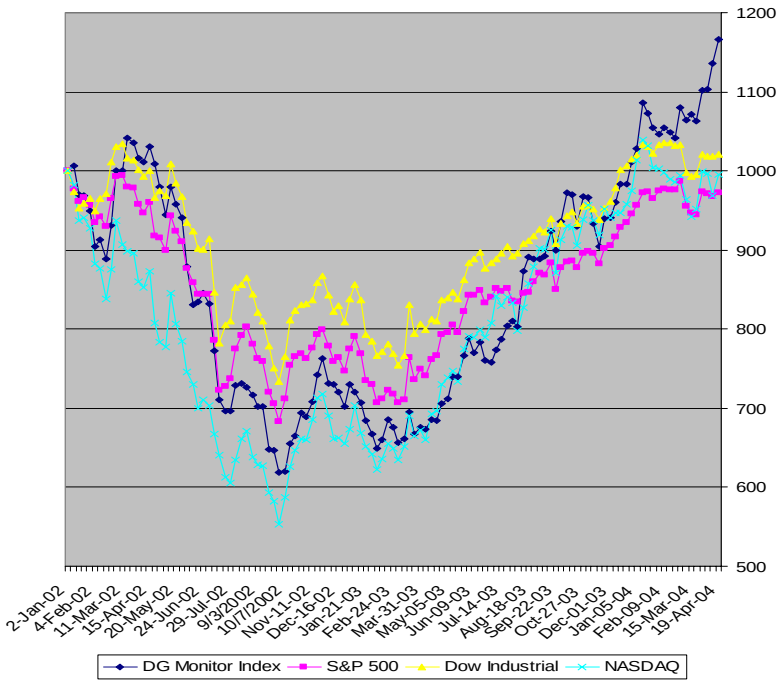
This document outlines the activities, milestones, and deliverables that the Department will pursue to promote a hydrogen-based energy system.

Secretary Abraham addressed the National Hydrogen Conference on this and related matters on April 28, 2004 noting the importance of DOE's hydrogen R&D efforts in helping move toward a hydrogen economy. ■

The DG Monitor Index℠

The DG Monitor Index℠ continues to surpass the returns of the Dow Industrial, S&P 500, and the NASDAQ indexes from January 2002 through April 19, 2004. Strong gainers over the last two months include.

- Spire Corporation (up 41%)
- Evergreen Solar (up 31%)
- PlugPower (up 29%)



Each of these companies is profiled below:

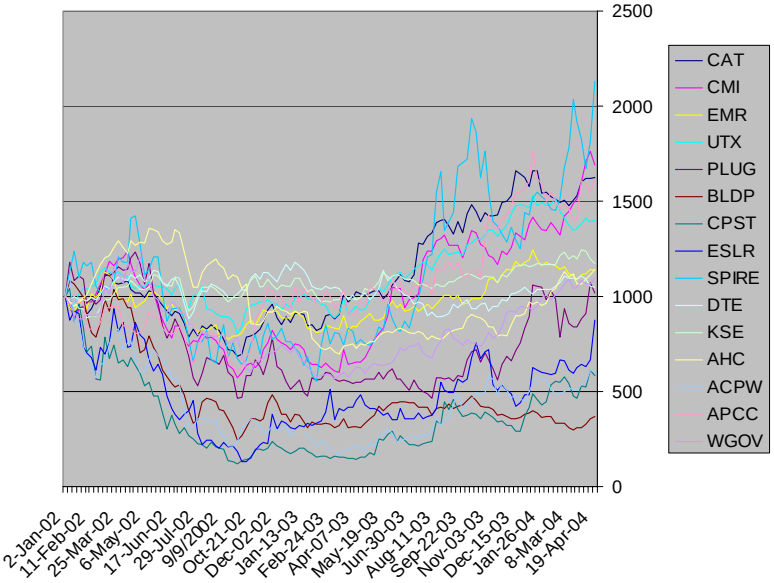
Spire Corporation
Spire develops and manufactures solar electric module manufacturing equipment and offers biomedical processing services and devices. Spire Corporation is the world's leading supplier of solar module manufacturing equipment, providing equipment to more than 150 facilities in 42 countries worldwide.

Evergreen Solar
Evergreen Solar is a developer and manufacturer of photovoltaic (PV) modules - the engines of solar electric systems - used in remote power and emerging grid-connected markets. The PV modules produced by Evergreen Solar incorporate a proprietary crystalline silicon technology known as string ribbon. This technology enables an innovative approach to manufacturing dependable and cost-effective PV modules. Earlier this month, Evergreen announced that it doubled its manufacturing capacity over 2003.

PlugPower
Plug Power develops and manufactures proton exchange membrane (PEM) fuel cells for stationary applications, primarily for the residential sector and for backup power applications. Plug Power acquired H Power Corp., another PEM fuel manufacturer, in March 2003.

Companies included in the DG Monitor Index℠ are:

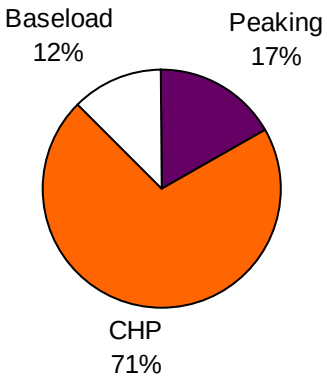
- Active Power (ACPW)
- Amerada Hess (AHC)
- American Power Conversion (APCC)
- Ballard Power Systems (BLDP)
- Capstone Turbine (CPST)
- Caterpillar Incorporated (CAT)
- Cummins Incorporated (CMI)
- DTE Energy (DTE)
- Emerson Electric (EMR)
- Evergreen Solar (ESLR)
- KeySpan Corp (KSE)
- PlugPower Incorporated (PLUG)
- Spire Corporation (SPIRE)
- United Technologies (UTX)
- Woodward Governor Company (WGOV) ■



West Coast CHP Use Volatile, May be On Increase

California has installed about 20 percent of the nation's interconnected DG, with a capacity of 3.5 GW (not counting emergency and other non-interconnected applications). Nearly three-fourths of this is deployed in combined heat and power (CHP) applications. Just over half this CHP use comes from combustion and recuperated turbines, while just under half comes from reciprocating engines. Figure 1 notes how this capacity was distributed by application as of the end of 2003.

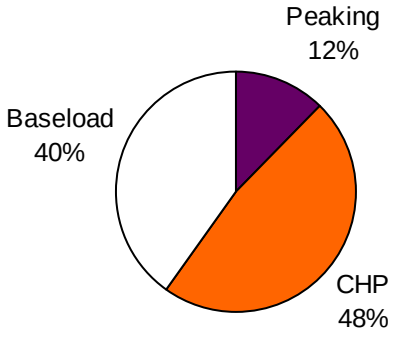
Figure 1. California Interconnected DG Capacity by Application



Source: *The Installed Base of U.S. Distributed Generation: 2004 Edition.*

Many historical CHP applications were deployed in the food processing, paper mills, and petroleum refining industries – future growth in these industries is limited. However, CHP use in recent years has been expanding into more commercial and small industrial sectors across the state. Long-term, the anticipated pattern is for considerable continued CHP use as CHP projects often offer the best market economics. Indeed, as noted in Figure 2, the market potential for CHP is nearly half of the projected 7.5 GW of new capacity that can be economically installed and interconnected in California, even given today's high gas prices.

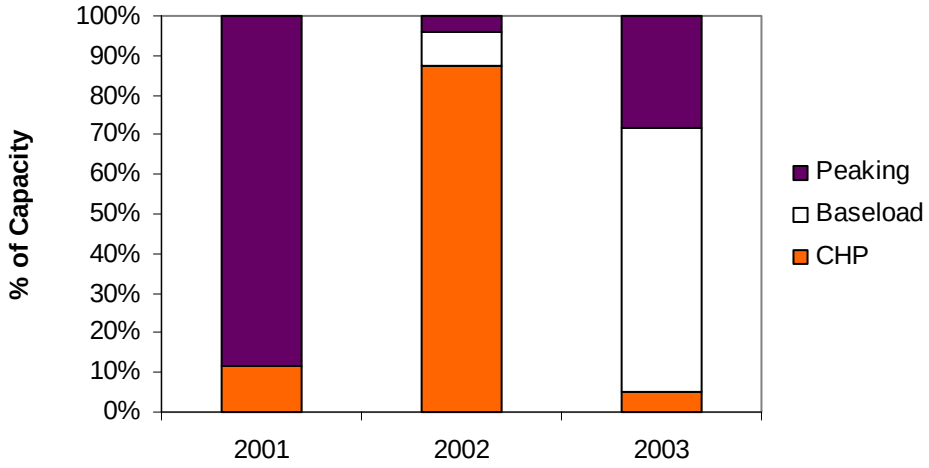
Figure 2. California DG Market Potential by Application, Base Case



Source: *The Market Potential for Distributed Generation: 2004 Edition*.

Short-term, the data indicate that developers are probably having a difficult time determining which market niches to pursue. End-user demands have changed wildly in the aftermath of the 2000 energy situation in California. Figure 3 depicts how the market share of interconnected California DG has changed over each of the last 3 years. Some years CHP is well above its historical 71% average, other years it is well below the average. What is clear is that the California market is quite volatile for developers. From year to year, not only the amount of DG installed, but also its application, varies significantly.

Figure 3. California Interconnected DG Capacity by Application and Year



Sources: Energy Information Administration Form 860 for interconnected units larger than 1 MW, and California Rule 21 quarterly filings by Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric for units smaller than 1 MW.

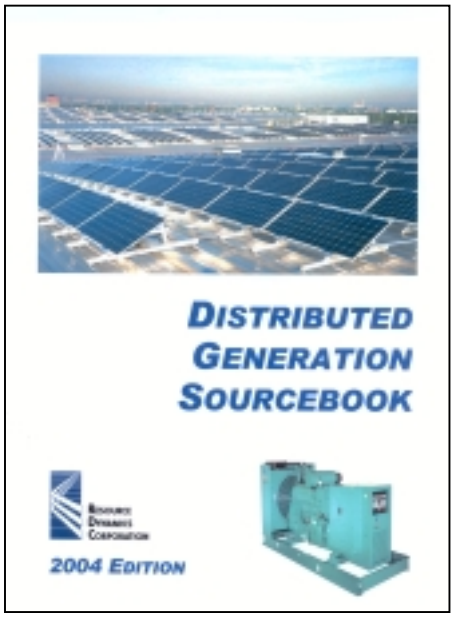
If you are a manufacturer, developer, or end-user on the West Coast, or if you see a similar or different trend elsewhere in the country, please drop us a line with your perspectives. We would like to share your comments with all our readers. ■

(CDGE, continued from Page 1) installed expeditiously; its costs can be allocated equitably; and its value added can be pinpointed and measured. To ensure that distributed generation (DG) becomes an integral part of the enhanced transmission and distribution (T&D) system in the U.S., the Council for Distributed Grid Enhancement (CDGE) was formed. The approach for CDGE centers on four key steps:

1. Build the membership base. Organize key DG stakeholders to support CDGE mission. Develop plans for membership enlargement. Regular communications for members only.
2. Establish a focused implementation and advocacy approach. Identify and promote workable DG solutions that can modernize and strengthen our grid in an equitable manner to all participants. Reach out to legislators, policymakers, regulators, the media and the public through white papers, other written materials and direct contact. Lower the barriers to stakeholder acceptance by pushing for the implementation of policy and financial incentives that ease the adoption of DG.
3. Establish equitable regulatory treatment for selected DG projects. CDGE will develop and promote breakthrough concepts that can revolutionize the role of DG in managing and enhancing the grid. One such concept is that of Qualified Reliability Facilities ("QRFs™"). To be accepted as an option that provides needed T&D relief, QRFs™ will need to demonstrate that they can alleviate congestion or security risks in terms of standardized metrics (e.g., substitution for ATC capability subject to shortfalls at certain times of day) and ongoing measurement. QRFs™ may be either direct sellers to end use customers, to utility distribution systems, or to wholesale transcos. Utilities therefore must be permitted to elect to own QRFs™ outside of the framework of their regulated rate bases. QRFs™ will be entitled to receive tax treatment comparable (but not greater than) that otherwise afforded renewables and alternative energy sources. QRFs™ will be entitled to expedited interconnection, and be exempt from bearing the cost of T&D system impact studies.
4. Develop innovative products designed to overcome market barriers to DG for grid reform. The first of these products is a financial/insurance offering tailored to utility distribution companies selecting DG as their near-term solution to distribution system upgrade.

For more information on the CDGE, contact Dick Friedman at (703) 356-1300 ext. 203 or nrf@rdcnet.com ■

Updated DG Sourcebook will be Available in Early May!



The rapidly developing Distributed Generation (DG) market is complex, with many players and stakeholders. The Resource Dynamics Corporation has developed the Distributed Generation Sourcebook: 2004 Edition to serve as both a learning tool and a handbook for those hoping to understand and benefit from DG. Updated for 2004, this edition features new sections, case studies and more. A brief outline of the comprehensive 210-page report is provided below.

Introduction

Chapter 1: Applications of Distributed Generation
This section summarizes different applications for DG technologies. A summary table comparing DG application types and their important characteristics is also included.

Chapter 2: Distributed Generation Technologies
This section provides a summary of each DG technology, including its history, current status, operation, development, emission controls and application characteristics. Also included are technology system diagrams.
New for 2004: Steam Turbines, Combined Cycle Turbines, and Stirling Engines

Chapter 3: The Distributed Generation Marketplace
DG marketplace structure dynamics and players are detailed, including go-to-market strategies.

Chapter 4: Distributed Generation Interconnection
Issues surrounding the connection of DG to the utility grid are detailed.

Chapter 5: What Makes Distributed Generation Applications Successful
For each DG application type, DG and site attributes that lead to success are described. Case studies are also included.
Featuring new case studies of successful DG projects

Chapter 6: Barriers to Distributed Generation
Barriers to the implementation of successful DG project are illustrated.

Chapter 7: The Installed Base of U.S. DG
New chapter giving an overview of the current installed base of U.S. DG

Chapter 8: U.S. Distributed Generation Market Assessment
New chapter providing a statistical breakdown of the current and future U.S. DG markets.

Appendix A: Glossary of Distributed Generation Terminology
Appendix B: Directory of Manufacturers
Updated for 2004 with new manufacturers and all the latest financial information, affiliations, and DG news

To order this report or other DG publications, go to

www.distributed-generation.com. ■

Ask the DG Monitor

Could you provide information about net metering for interconnected wind generation?

A.R., MIT, Boston MA

Dear A.R.

State regulators have been very active in the net metering world recently. Since 2000, 11 states have issued or updated net metering policies, and 9 states have developed net metering interconnection standards in addition to the 11 states that have issued new broader-based DG interconnection policies.

Net metering programs permit DG units to be interconnected with the grid and subsidize the installation by allowing DG generation to offset the use of grid power at a time of the energy user's (producer's) choosing. Because they subsidize the user, state law normally limits the technology, customer class, and size of the unit that can be interconnected under a net metering program.

As noted, more states are implementing new net metering programs or expanding the range of DG technologies to which these incentives apply. Most states at least have net metering rules for renewable technologies, which include photovoltaic and solar systems, wind turbines, hydroelectric systems, geothermal power systems, and units powered by traditional biomass fuels. 32 states presently have mandated net metering programs that specifically include wind-powered generation. The trend toward increased net metering means more small DG units can be economically deployed with lower siting costs.

For more information, a number of web based resources can help you understand current details about net metering. We suggest you look at:

- Database of State Incentives for Renewable Energy (www.dsireusa.org) which offers an updated comprehensive source of information on state, local, utility, and selected federal incentives that promote renewable energy.
- Bergey WindPower Company (www.bergey.com) which offers helpful advice about wind power with links to various state incentive programs.

Good luck as you pursue this opportunity!

Have a question for the Monitor?
Email: ejh@rdcnet.com. ■

DG NOTES

April 28, 2004 - FuelCell Energy, Inc. and Alliance Power have entered into an arrangement by which Sierra Nevada Brewing Co. of Chico, Calif. is expected to purchase four 250-kilowatt Direct FuelCell® (DFC®) power plants in late 2005 or early 2006. Until that time, a joint venture of FuelCell Energy and Alliance Power will supply electric power and heat to the brewery's production processes.

April 27, 2004 - STM Power, Inc., the world's leading manufacturer of commercial and industrial sized, on-site power generation systems utilizing external combustion (Stirling-cycle) engine technology, today announced the closing of $29.6 million in venture funding. VantagePoint Venture Partners led the funding round, which included Nth Power L.L.C., CDP Capital Technology Ventures, Sempra Energy, and Smart Technology Ventures.

April 27, 2004 - DTE Energy Technologies, a non-regulated subsidiary of DTE Energy, today announced the commercial availability of the ENI 140 (140 kW) and ENI 265 (265 kW) Lean Burn Biogas systems. Both new additions to the energy|now™ branded line of distributed generation products operate on waste gas from digesters or from other sources such as flare gas from landfills or oil and gas wells. The Menag Group AG of Switzerland manufactures the lean burn biogas systems.

April 15, 2004 - Distributed Generation Partners, LLC, a company jointly owned by Pepco Energy Services and CRM Energy Technologies, has signed an agreement with Laundry Capital Company, LLC to design and build small-scale combined heat and power systems in Laundry Capital's coin-operated laundries. The combined heat and power systems will incorporate microturbine technology provided by Elliott Energy Systems, Stuart, Florida and will be fueled by safe, reliable natural gas.

April 13, 2004 - DTE Energy Technologies, a non-regulated subsidiary of DTE Energy, has introduced the ENX 55, an external combustion engine utilizing Stirling Engine technology, rated at 55 kilowatts. As an addition to the energy|now™ product portfolio, this system is a source of highly efficient, reliable on-site power for a variety of applications. The fuel-fired ENX 55 can operate on a number of fuel sources including natural gas, propane, flare gas and coal bed methane. It also can operate on renewable energy sources, such as biogas from anaerobic digesters associated with agriculture and waste water treatment plants, and landfill gas and wood gas.

April 12, 2004 - Dairyland Power Cooperative and Eau Claire Energy Cooperative announce the operation of the ONYX Seven Mile Creek Landfill gas-to-energy facility in Eau Claire. The three unit, 3 megawatt renewable energy facility is now operational, with the ability to provide electricity to over 2,600 homes. Dairyland contracted with ONYX Waste Services, Inc., to purchase methane gas collected at the Seven Mile Creek Landfill, a regional collector of residential waste. They also contracted with Ameresco to design, engineer and construct this facility.

April 7, 2004 - General Electric Energy announced that it has acquired substantially all of the US business assets of AstroPower. AstroPower filed a Chapter 11 petition for bankruptcy two months ago to allow the sale of its assets and to meet other obligations. The transaction was subject to competitive bidding and approval of Bankruptcy Court, which were completed on March 12. AstroPower developed, manufactured, marketed and sold a range of solar energy products, including solar cells, modules, panels and pre-packaged systems for off-grid and on-grid applications. ■

CONFERENCES

DTE Energy Distributed Generation Group: DG Conference and Interconnection Workshop, Detroit Michigan. May 5-7, 2004.

5th Annual United States Combined Heat and Power Association (USCHPA) Conference, Washington, DC, May 10-12, 2004.

National Association of Energy Service Companies (NAESCO) Mid Year Conference, Seattle, WA, May 19-21, 2004.

New York State CHP Conference, New York, NY, June 23-25, 2004.

World Energy Engineering Conference and USCHPA meeting, Austin TX, September 22-24, 2004. ■