EPRI

TRANSMISSION AND DISTRIBUTION SECTOR

POWER DELIVERY NEWS

JUNE 2000

R_X for Stress: *Power Delivery Reliability Initiative*

The industry-wide *Power Delivery Reliability Initiative*, launched by EPRI in February 2000, is already delivering results to smooth the transition to an open energy marketplace.

While customers may or may not yet have noticed cost savings from electricity deregulation, some already have paid the price of increasing power problems. Power disturbances rose sharply between 1996 and 1998—shortly after restructuring legislation took force—and 1999 brought several highly publicized urban outages.

Long Hot Summer

The outlook for 2000 is no better, with record highs forecast for summer temperatures, electricity demand, and bulk power sales. Concern is rising about electricity service in the United States, traditionally among the most reliable in the world. "We are worried, quite frankly, about summer outages and the lack of capacity and distribution," says U.S. Energy Secretary Bill Richardson. "There is an increasing mismatch between capacity of the grid and demand," adds Karl Stalhkopf, EPRI vice president of power delivery.

EPRI's industry-funded *Power Delivery Reliability Initiative*, a two-year effort launched with the input of the North American Electric Reliability Council, IEEE, Edison Electric Institute, and other organizations, brings the electricity industry together to overcome the growing pains associated with the fast pace of deregulation and restructuring. Key to the Initiative are two parallel but separate programs that evaluate the transmission grid and distribution systems in detail, providing a "holistic look at the U.S. bulk power system," according to Stahlkopf. "The Reliability Initiative is the first comprehensive assessment of the reliability of the North American power grid that includes the probability of failure."

Solutions Now

More than a retrospective review of the power industry (as were recent outage studies by others), the Reliability Initiative is designed to provide solutions to today's emerging problems fast. For transmission: new understanding and tools that improve grid forecasting and operations for all three U.S. interconnections. For distribution: best practices for maintenance and operations as well as a standardized framework that distribution companies can apply to determine where they stand in terms of system preparedness.

Already the Initiative has identified key weak points throughout the North American transmission system, refined a unique probabilistic process for assessing grid security under deregulation *(see p. 4)*, and compiled lessons learned for urban distribution systems from the 1999 summer

outages in Chicago *(see p. 6)*. And newly introduced are several near-term operational tools that will help transmission providers and distribution companies better handle the coming hot summer.

Participants in the Reliability Initiative now number more than 30, and the number is growing.

For more information contact Karl Stahlkopf, (650) 855-2073, kstahlko@epri.com.

See www.epri.com for on-line Power Delivery news, calendar, and more!

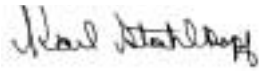
To Our Readers

The U.S. electric power industry is responding aggressively to the reliability problems that have arisen in the wake of deregulation. The extent of these efforts, however, has not yet been fully appreciated by either the public or government leaders. U.S. Energy Secretary Bill Richardson, for example, was recently quoted as saying: "America is a superpower, but it's got the grid of a Third World nation." Such hyperbole ignores both the challenges presented by rapid industry restructuring and the concerted effort being made by major segments of the industry to avoid further disruptions.

Following the mandates of the Federal Energy Regulatory Commission (FERC) four years ago to provide "open access" to transmission networks, the number of bulk power transfers has risen exponentially. Some 24 states are also in the process of providing more customer choice in retail electricity markets. Accompanying these changes have been a series of well-publicized outages, such as those last summer in New York and Chicago. And a May heat wave this year caused some utilities to reduce voltages and curtail service to interruptible customers.

In response, EPRI launched the *Power Delivery Reliability Initiative* and, as three articles in this issue of *Power Delivery News* describe in detail, results are already being applied to help reduce the number and severity of outages this summer.

Even broader support will be needed, however, if the Reliability Initiative is to fulfill its promise. Fresh insights on system operations must be fully observed and new technologies must be widely applied. The U.S. grid is not "Third World," but neither is it ready to meet the rising wholesale demand and heightened retail expectations of the new century. I would urge any utility, domestic or international, that wants to learn more about the potential benefits of participating to e-mail me at *kstahlko@epri.com*.



Karl Stahlkopf, Vice President, Power Delivery

EPRI NCI (Non-Ceramic Insulator) Program Goes Global

Long-term EPRI work to assess performance of NCIs gains international insight with a new global NCI program involving ESKOM (South Africa), Powerlink (Australia), and other energy companies around the world. In addition to new data, this program provides expert advice to participants about NCIs, which have been installed widely since the 1970s in place of conventional glass and ceramic insulators. *Ray Lings, (650) 855-2177, lings@epri.com.*

EIS Program Takes On "e-Risk"

Enhanced security for the critical interdependent systems that support the global energy infrastructure is the aim of EPRI's new Enterprise Infrastructure Security (EIS) program in light of continuing threats of viruses and hacker attacks. Energy companies are vulnerable to intrusion through their automated control systems, energy management systems, supervisory control & data acquisition (SCADA) systems, as well as new integrated enterprise resource planning software. *Charlie Siebenthal, (650) 855-2170, csiebent@epri.com.*

TCs to Demonstrate Home Fuel Cell Technology

As clean-running fuel cells approach the possibility of cost-competitiveness with grid power, a pair of EPRI TC (Tailored Collaboration) programs seek participants to demonstrate the potential of this technology. One TC will acquire and evaluate the performance of first-generation, semi-commercial residential fuel cells now being rolled out by Plug Power, Dais-Analytic, and others; the other TC will demonstrate community-scale (3-8 kW) fuel cell generation from natural gas or propane. *Brice Freeman, (650) 855-1050, bfreeman@epri.com*

Mexico and U.S. Grids Link Up at Eagle Pass

Entering service in June is the latest FACTS (Flexible AC Transmission System) controller, a 36 MVA back-to-back tie linking the United States and Mexico power systems at Eagle Pass substation, Texas. Greater electricity reliability for the Eagle Pass area is the reason for this bidirectional device, which enables switching between the U.S. and Mexican grids without the brief outage previously required. *Aty Edris, (650) 855-2311, aedris@epri.com.*

EPRI RTO Offering to Feature CIM-Based Applications

EPRI's upcoming offering to Regional Transmission Organizations (RTOs) will feature research and products based on the Common Information Model (CIM)—the standard power system model structure EPRI helped develop.

The goal of the offering is to provide a package of products across EPRI Targets that will enable RTOs to effectively meet Federal Energy Regulatory Commission (FERC) Order 2000 requirements and respond quickly and at low cost to changes in market, organizational, regulatory, and technical requirements.

RTO Challenges

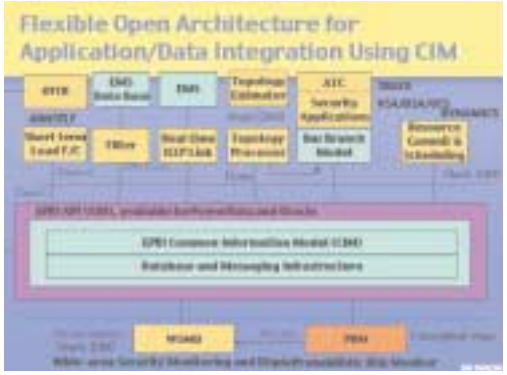
RTOs face a variety of challenges during their formation and as they begin operation. One way to summarize the tasks before RTOs is to examine the list of eight "minimum functions" that an RTO must satisfy, as specified in FERC Order No. 2000 issued December 20, 1999:

- Tariff administration and design
- Congestion management
- Parallel path flow
- Ancillary services
- OASIS, TTC, and ATC
- Market monitoring
- Planning and expansion
- Interregional coordination

In the Order, FERC establishes "an 'open architecture' policy regarding RTOs, whereby all RTO proposals must allow the RTO and its members the flexibility to improve their organizations in the future in terms of structure, operations, market support and geographic scope to meet market needs."

The control center Application Program Interface (API), including its Common Information Model (CIM), provides the open architecture RTOs need to comply with the FERC Order. In particular, the CIM defines a common language for power system information—a capability at the core of methods and tools needed to perform the Order's eight functions.

For this reason, CIM-based applications will be a cornerstone of the RTO offering EPRI is now assembling. To be available later this summer, the new package ensures that the diverse and wide-ranging needs of RTOs are addressed by integrating products in the areas of market assessment, transmission, substations, and distributed resources.



EPRI: CIM Pioneer

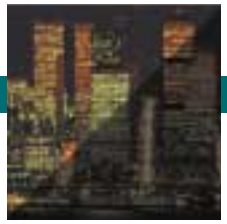
EPRI has been, and continues to be, at the forefront of the industry in developing the API and CIM, enabling its international standardization, implementing the CIM in applications, and helping CIM users best integrate applications in their energy management systems (EMS). As a result of this central role, EPRI is well suited to help RTOs perform their functions in a cost-effective, flexible, timely manner by helping them adopt systems based on open architecture.

EPRI has acted as an impartial, objective leader of broad-based project teams in this area. No other entity is more familiar with the CIM, how to manage development of CIM-based applications, and how to integrate these applications into open architecture EMS. EPRI can help RTOs in the following areas:

- Identify needed CIM-based applications, based on a detailed review of FERC 2000 and a review of individual RTO needs
- Develop high priority CIM-compliant static and real-time applications to enable RTOs to perform identified functions
- Integrate these applications into RTO EMSs

EPRI has already demonstrated its ability to perform these tasks for the energy industry. By identifying energy company information technology needs in the 1990s, EPRI began a process that resulted in effective standards. At the same time, EPRI developed static and real-time applications that are compliant with those standards, several of which are operational today in energy control centers.

For more information on CIM contact Stephen Lee, (650) 855-2486, slee@epri.com. *For information about the RTO offering contact Frank Burcham, (505) 856-8585,* fburcham@epri.com.



Empowering the Transmission Grid for Competition

EPRI's *Power Delivery Reliability Initiative* is delivering new understanding and tools that will enable the transmission grid to deliver both electricity competition and reliability.

The United States transmission grid, largely completed and in place by the 1970s, was not designed for electricity competition. Rather it was built to ensure electricity reliability in a regulated marketplace. Now competitive changes and exponential increases in bulk power transactions—up four-fold since 1995—are undermining the grid's ability to reliably deliver electricity.

Energy companies "who used to cooperate voluntarily under the regulated model are now competitors without the same incentives to cooperate with each other or comply with voluntary reliability rules. We are facing a real and immediate crisis," concludes a 1999 North American Electric Reliability Council (NERC) task force.

Mission: Transmission

The Transmission Project of EPRI's two-year, industry-funded Reliability Initiative is empowering the grid for competition by tackling critical long-and near-term needs. Looking long term, the program is developing a basis for sound planning and operations of the deregulated grid. Near term, new operational tools are being readied for 2000 and 2001.

Launched in February 2000, the Transmission Project is delivering results fast—in time to help manage the grid during this summer's load peaks.

To develop a basis for grid planning and operations under deregulation, NERC's latest regional reliability assessment reports have been reviewed for the complete North American network to identify transmission bottlenecks. Findings guided beta-testing on the Southern Co. portion of SERC (Southern Electricity Reliability Council) of an advanced probabilistic risk assessment (PRA) technique developed by EPRI that reveals grid physical and operating margins with much greater accuracy than present deterministic techniques. PRA is better because it accounts (probabilistically) for all possible system failures—as opposed to conventional security assessment tools that consider but a small, pre-selected number of possible contingencies. Consequently PRA will facilitate reliable grid operation under competition in spite of rapidly increasing load and power transactions and limited incentives for coordinating the grid's numerous control entities and power producers.

In the meantime, two web-based operating tools come on line for summer 2000: a real-time security data display (RSDD) and IDC (Interchange Data Calculator) "tag dump." RSDD, initially implemented for the Eastern Interconnection in collaboration with NERC, provides local operators with a first-ever interconnection-wide view of flowgate and voltage conditions. The tag dump automatically computes the impact of crossing transactions on a grid control area, a task previously done by hand. Both tools help operators optimize grid performance and stability.

And for 2001…

PRA for the complete North American transmission grid is an ultimate Reliability Initiative objective. To this end, the PRA technique has been enhanced after the SERC test to better reflect actual operating procedures and is now being validated at American Electric Power. Simultaneously, NERC is working with EPRI to prepare transaction, scenario, and failure probability data to enable PRA of the U.S. grid: the Eastern Interconnection, Western States Coordinating Council, and Electricity Reliability Council of Texas. PRA results will be published by early 2001.

National PRA results will provide a basis for reliable transmission competition by identifying weaknesses in grid operations and suggesting countermeasures. Recommendations will address business and regulatory practices as well as technical procedures. Additionally, new methodologies for transmission reservations, energy scheduling, congestion management, ATC (available transmission capacity) coordination, transmission pricing, and toll collection will be proposed for industry consideration.

"The effort to support operators with near-term tools will continue in parallel with national PRA analysis,"says Dejan Sobajic, EPRI Product Line Leader for Grid Operations & Planning. "Later in 2000, the RSDD will be enhanced with additional security data such as area in/out VARS and reactive reserve. And by summer 2001, real-time CIM (Common Information Model) will be implemented for security coordinators, fulfilling a long-term industry goal to facilitate communications and transfer of grid data."

For more information contact Dejan Sobajic, (650) 855-8537, dsobajic@epri.com.

UCA Saves at Substations

EPRI's Utility Communications Architecture (UCA™) continues to penetrate the substation communications market based on advantages of plug-and-play installation and open (non-proprietary) standards.

UCA-based equipment for substation control and protection is now available from more than 10 vendors worldwide. GE alone has orders for more than 1200 UCA-based "Universal Relay" (UR) units, examples of which are already in use around the globe. A UR recently performed a protection trip at a substation in Nelspruit, South Africa, validating network-based UCA control concepts.

"Neslpruit had a two phase to ground feed cable fault and the UR system performed perfectly," said Peter Warner of Drivecor Pty. Ltd.

Commanding Savings

UCA saves at substations because it offers a common language for communications all the way from the control center to the meter, thereby eliminating the need for costly data gateways and bulky converters at substations. And because UCA is a non-proprietary specification issued by the IEEE—and is in line to become an IEC Standard—users are assured of maximum upgrade flexibility and competitive equipment costs.

Savings potential was demonstrated by a recent feasibility study undertaken by Duquesne Light Company (DLC), which recently sold its Phillips Power Plant to a third party but retained ownership of a switchyard (but not its controls) at the power plant. The study found that for new control and protection facilities for the switchyard, use of UCA would enable a mobile, modular control facility costing several million dollars less than a conventional control house—all while providing greater control capability and flexibility.

"Based on what has been learned in our feasibility study, only UCA technology would enable such a reduction in the costs of monitoring and control at this substation," says Joe Koepfinger of DLC.

For more information contact Bill Blair, (650) 855-2173, bblair@epri.com.

Cathodic Protection Fights Corrosion

NYPA's installation of a cathodic protection system for a submarine circuit protects the cable from corrosion and helps ensure the future reliability of the power system serving Long Island communities.

Anode beds were lowered to the sea floor to counteract the effect of the stray currents.

In 1987, the New York Power Authority (NYPA) installed a Y-49, 345-kV self-contained fluid-filled (SCFF) submarine cable circuit across Long Island Sound. The length of the cables is 13.3 km, and to prevent mechanical damage, the cables are buried in the sea bottom to a maximum depth of 3 m. During design and installation of the cable circuit, corrosion was identified as a possible problem.

Unique System

With EPRI funding support, NYPA initiated an investigation of the cable and its environment, and designed a cathodic protection system with a number of unique features. The system includes 12 anode beds placed along the cable at either end of the circuit and covered in a layer of coke to improve sensor longevity. Current from these anodes cancels, or counterbalances, the effect of stray currents in the water. The protection system also includes real-time control, which uses reference electrodes to measure the potential difference between a point at sea and a point on the cable return conductor on shore.

According to NYPA, the cathodic protection system defers cable replacement by at least five years, for a cost savings of $23.1 million. In addition, the results obtained in this projectoffer others important information for evaluating site-specific corrosion processes and designing effective protection.

For more information contact Tom Rodenbaugh, 650) 855-2306, trodenba@epri.com.

NYPA Saves with EPRI

NYPA saved an estimated $27 million in O&M and avoided costs in 1999 with EPRI projects, including:

- Convertable Static Compensator

- Daytime corona camera
- SF_6 leak detection system

- Insulator integrity assessment

Helping Distribution Companies Respond to Change

The Distribution Project of EPRI's new *Power Delivery Reliability Initiative* is already delivering distribution companies tools they need to evaluate their own systems and take measures to avoid outages in today's changing business and regulatory climate.

Electricity distribution systems are the most diverse, costly, and exposed part of the power delivery system. They are the part most sensitive to change—in business or regulatory climate as much as in the weather. As such, power industry deregulation in the United States has had an increasing impact on distribution system problems and outages in the late 1990s. Problems have been exacerbated because the design and upgrading of distribution infrastructure has not kept pace with growing needs for flexibility and reliability. Moreover the emergence of distributed resources introduces a new "wild card" for distribution systems.

The Distribution Project of EPRI's industry-funded Reliability Initiative is helping distribution companies adapt to change in the business and regulatory climate, just as other EPRI efforts have helped companies handle the weather. The two-year Distribution Project will unearth the root causes of recent distribution outages, identify underlying problems, and recommend ways to improve distribution system reliability under competition. This is a fast-track project, and the first results have already been delivered to participants.

Best Practices, Self-Audit Tools

Because different distribution companies use widely differing distribution architectures, equipment, and operating practices, the Distribution Project relies on analysis of representative distribution systems using deterministic methods. This case-study approach contrasts with the regional probabilistic assessment used in the Transmission Project, where the interaction of linked, largely similar systems is of critical concern.

For distribution, five representative types of systems are being analyzed:

- Urban radial, largely underground (Commonwealth Edison)
- Urban network, largely underground (Consolidated Edison, Duquesne)
- Urban radial, largely overhead (Oklahoma Gas & Electric, MidAmerican)
- Suburban, combined overhead and underground (Duke Power)
- Rural (to be determined)

Under review at each are critical aspects of distribution O&M and planning, including contingency criteria, substation design/automation, equipment condition/maintenance, loadforecasting/relief procedures, human factors, procedural compliance, and root outage causes. Suggestions for improvements are provided to each representative system participant.

Analysis results will be integrated with industry surveys and data from other companies to create the first industry-wide "best practices" for distribution. A comprehensive self-audit template for each of the five distribution systems types will permit companies to evaluate their own system and practices.

Ready Results

Results of the individual system reviews will be provided to participants through the spring and summer of 2000; one is available now. A final report summarizing all results, the best practices documentation, and self-audit template will be presented in January 2001.

April 2000 saw release of the first system review report, on the Commonwealth Edison distribution system. The review identifies issues contributing to the 1999 outages, including O&M procedures, budget constraints, communications between management and staff, and the effects of weather projections on design and planning criteria. Recommendations address lessons learned about system and capacity planning, engineering and design, relay protection, underground and substation maintenance, and system operations.

The remaining review reports are in preparation, and additional information is being compiled to develop industry best practices.

"This unique effort funded by the participating utilities demonstrates a proactive approach to improving distribution system reliability throughout the nation," says Bill Donohue, Senior Vice President of Electric Operations at Consolidated Edison and Chairman of the EPRI Distribution Project. "By quickly compiling lessons from 1999, the Distribution Project provides participants a forum to learn valuable information about industry best practices that can be applied directly to their system, which will improve distribution reliability in 2000 and beyond."

For more information contact Bernie Ziemianek, (650) 855-2857, bziemian@epri.com.

Progress on Premium Power Park

The EPRI-sponsored project team managing development of the world's first premium power park has completed the first of three project phases—developing an application methodology—and is now soliciting bids for implementation.

Phase one work involved benchmarking the power quality requirements of the participants and developing an application methodology to meet these needs. As it happened, several premium power methodologies were identified, based on different combinations of power quality devices (PQDs) and local energy storage. Multiple

design alternatives maximize vendor competition, promising a highly cost-effective installation.

The Premium Power Park project is a two-year effort to retrofit Ohio's Delaware Industrial Park into a facility capable of supplying customers with high-quality power based on their individual needs. A distributed (as opposed to substation-based) approach is planned, with shunt and series PQDs connected at customer locations. The host utility and subcontractor is American Electric Power, and the system integrator is Siemens Power Transmission & Distribution.

Powerful Concept

EPRI customer surveys validate the premium power park concept, indicating that industrial and commercial customers will pay to avoid production downtime and improve process stability. Energy companies benefit from improved customer satisfaction and a reputation and increased customer base for premium power services.

At the Delaware Industrial Park, four of 11 customers are project participants. The two largest represent 9.2MW of the park's 14.4MW load.

Equipment bids are expected by mid-summer, with installation in early 2001. After commissioning, the project will conduct performance monitoring to assess power quality improvement and will evaluate customer satisfaction and economic benefits.

For more information contact Larry Carmichael, (508) 358-4959, lcarmich@epri.com.

Combating Underground Fires and Explosions

EPRI workshops seek effective solutions for mitigating fires and explosions in underground structures such as vaults and manholes.

Although underground fires and explosions are relatively rare, they are recurrent, and recent events in urban areas have raised their visibility with the public. To help energy companies understand and mitigate such events, EPRI is holding a two-part workshop series. The *Underground Explosion Event Summit Meeting* was held May 11-12, 2000, in Washington DC, with Potomac Electric Co. (PEPCo) as co-host. At the meeting, energy company decision-makers described their underground events, detailed community and public utility commission responses, and discussed event prevention and explosion mitigation technologies.

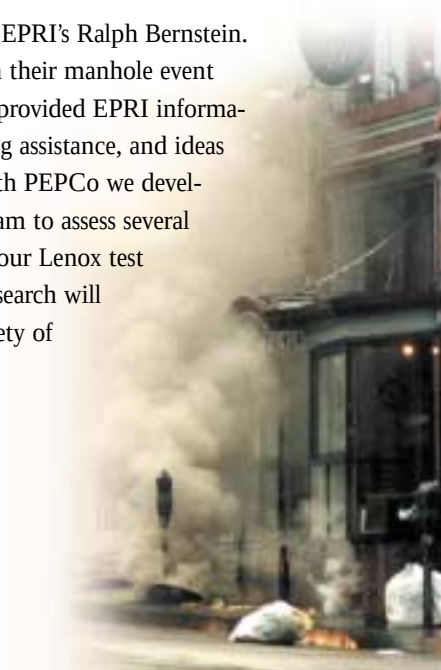
Dino Basile, PEPCo Distribution Product Line Advisor, has been addressing this issue in Washington DC. "We have had several events recently, and need to know what causes them and how to prevent them. We look to EPRI for assistance in this important problem that faces all urban utilities."

Timely Workshop

The *Underground Explosion Event Workshop*—for energy company engineering staff—will be held August 17-18, 2000, in Lenox, MA to plan how to implement summit meeting recommendations. The workshop will also include presentations on recent events, their causes and consequences, and EPRI and industry research. Explosive gas detection systems, explosion modeling, and mitigation technologies will be described, with industry representatives on hand to provide product and technology information.

"The meeting series is timely," says EPRI's Ralph Bernstein. "In April EPRI helped PEPCo with their manhole event response and hearings. We quickly provided EPRI information and results, mitigation planning assistance, and ideas for mitigation implementation. With PEPCo we developed an experimental testing program to assess several proposed mitigation approaches at our Lenox test facility. We hope our continuing research will aid utilities in dealing with the variety of underground issues that they face."

For more information contact Ralph Bernstein, (650)-855-2023, rbernste@epri.com.



DR in the Field: Performance and Siting Studies

Complementing EPRI's lab-based validation studies for microturbines and other emerging distributed resource (DR) technologies, a new Tailored Collaboration (TC) program is evaluating the performance of promising DR devices in the field—and what it takes to permit and install them.

The program, launched in January 2000, involves EPRI, San Diego Gas & Electric (SDG&E), and other electricity industry partners in a collaborative effort to address key field issues for DR, specifically 1) interactions between DR technologies and the existing distribution system; 2) permitting, siting, and installation; and 3) the adequacy of the existing gas infrastructure.

Initially, four DR technologies will undergo comprehensive field testing at real-world industrial and commercial facilities on the SDG&E system:

- 1,600 kW trailer-mounted Caterpillar diesel with ENCORP solid-state interconnection equipment
- 30 kW natural gas Capstone microturbine
- 100 kW natural gas Engine World (automobile engine conversion) system
- 2 kW flywheel storage system

DR performance and interactions with the existing electricity distribution system will be evaluated for each installation. Critical mechanical, electrical, and emissions parameters will be monitored, as well as operational experiences using remote operation/start-up equipment and the impact of ambient weather conditions.

Specific testing activities for each installation remain flexible. "We want to supply the information that utilities and end-users need today to make informed decisions about DR in the future," says Al Figueroa of VFL Energy Technologies, Inc., who is overseeing the program for SDG&E. "We know each participant has unique needs and we will be working to accommodate them."

Siting and Gas Supply Studies

Along with the performance tests and evaluation of each individual technology, the program will document the lessons learned about DR siting, from contracting with site hosts to site location and preparation, permitting, liability issues, installation, local utility interconnection, staff training, and operation.

"A real value of this field program will be to supply for the first time an understanding of the work necessary to implement a DR technology today," says Figueroa.

A companion study will examine if the existing natural gas infrastructure is adequate to support DR in the marketplace.

EPRI's DR field evaluation project systematically evaluates the performance, siting, and gas supply considerations of diverse new power generation and storage technologies.

Initial plans are now being made for continuing the project into 2001 and beyond. Technologies being considered for future tests include a 370 kW dual fuel (diesel/natural-gas) conversion of a reciprocating engine, 70 kW microturbine, 1500 kW gas turbine, and a fuel cell.

To encourage the evaluation of many different DR technologies, this program is available to additional parties via EPRI TC or co-funding arrangements. Present participants include the California Energy Commission, Idaho Power, First Energy, Southern California Gas, California Independent System Operator, and American Electric Power, among others.

For more information contact Brice Freeman, (650)-855-1050, bfreeman@epri.com.

5MW Turbine Demo

In a related field program, New York State Electric & Gas Co. and EPRI are demonstrating a transportable 5MW gas turbine for grid support. Additional participants are wanted for the program, which will provide lessons learned and early insight into the viability such units to alleviate summer peaks and T&D bottlenecks in 2001. *Dan Rastler, (650) 855-2521, drastler@epri.com.*

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