



**SPECIAL FEATURE**  
OPPORTUNITY AND CHALLENGE:  
DEVELOPING INDIA'S  
ELECTRICAL INFRASTRUCTURE  
PAGES 16-29



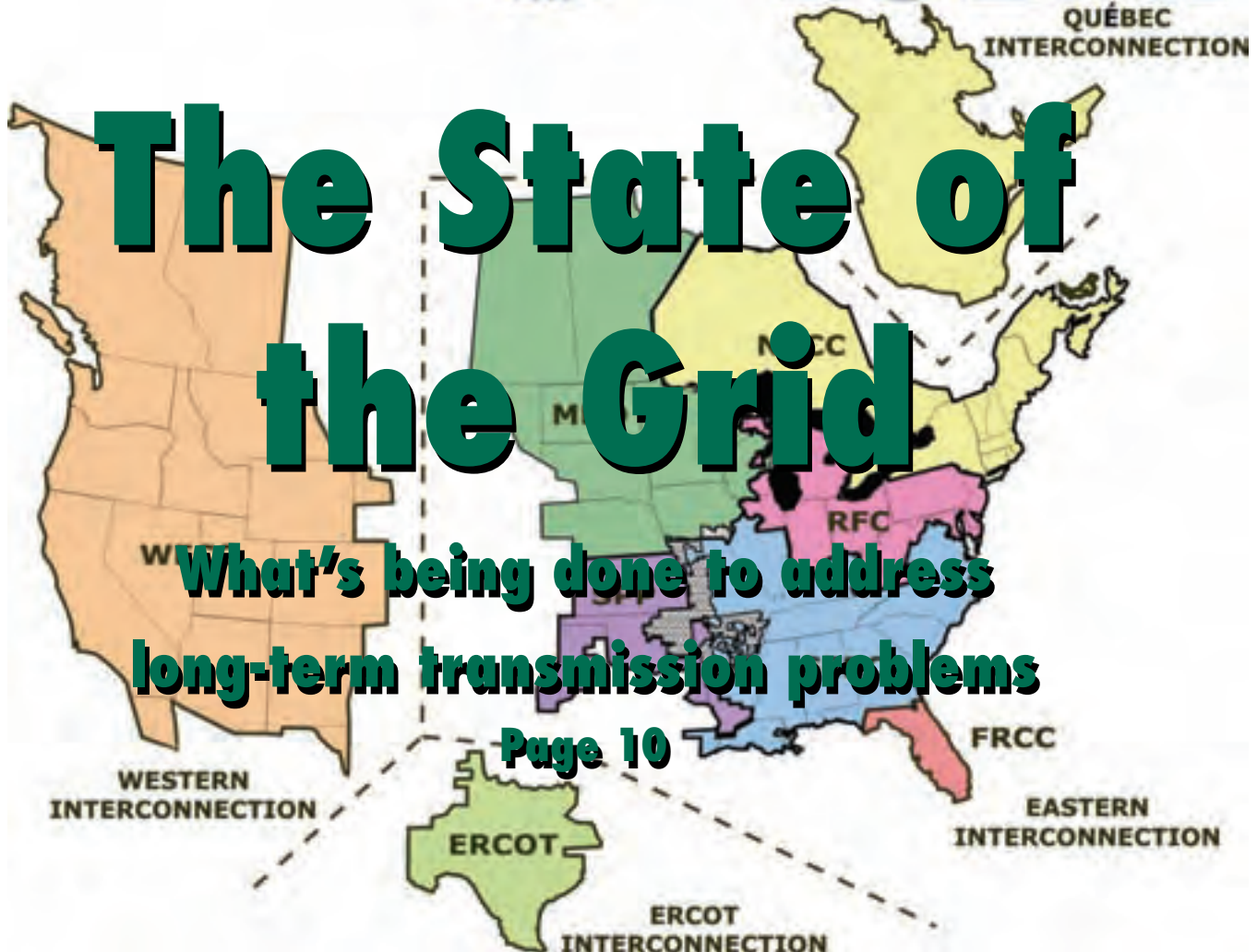
April 2007  
Volume 19, No. 3



# The State of the Grid

What's being done to address long-term transmission problems

Page 10



PUBLICATION MAIL AGREEMENT # 40051146

Electrical Buyer's Guides,  
Forums, On-Line Magazines,  
Industry News, Job Postings,  
Electrical Store, Industry Links

[www.electricityforum.com](http://www.electricityforum.com)



# Elster Integrated Solutions...

## Delivering cohesive, multi-utility AMR/AMI global solutions

Part of Elster Group, the world's largest multi-utility metering company, Elster Integrated Solutions (EIS) is a leading provider of both automated meter reading (AMR) and advanced metering infrastructure (AMI) systems and solutions for gas, electricity and water. We help customers worldwide adopt and integrate the latest smart metering systems solutions, enabling them to improve revenue cycle services, customer service, delivery reliability and workforce utilization, as well as implement demand response and conservation programs.

At EIS, we present a diverse, yet cohesive solution set to every customer. Core to our solution is the use of intelligent mobile and mesh network communications. Our system solutions deliver optimum performance and functionality today without impeding migration into new technology in the future.

Sharon Allan, president  
Elster Integrated Solutions

[www.elster-eis.com](http://www.elster-eis.com)



**Publisher/Executive Editor**  
Randolph W. Hurst  
randy@electricityforum.com

**Associate Publisher/Advertising Sales**  
Carol Gardner  
carol@electricityforum.com

**Editor**  
Don Horne  
don@electricityforum.com

**Web Site Advertising Sales**  
Barbara John  
forum@capital.net

**Circulation Manager**  
Colleen Flaherty  
colleen@electricityforum.com

**Production Manager**  
Alla Krutous  
alla@electricityforum.com

**Layout**  
Cara Perrier  
mac@electricityforum.com

**Visit our Web Site:**  
[www.electricityforum.com](http://www.electricityforum.com)  
**E-mail:** [hq@electricityforum.com](mailto:hq@electricityforum.com)

**Subscribe on-line:**  
[www.electricityforum.com/et/subscribe.htm](http://www.electricityforum.com/et/subscribe.htm)

**Phone:**  
905 686 1040

**Electricity Today** Magazine is published 9 times per year by The Electricity Forum [a division of The Hurst Communications Group Inc.], the conference management and publishing company for North America's electric power and engineering industry.

**Distribution:** free of charge to North American electrical industry personnel who fall within our BPA request circulation parameters. Paid subscriptions are available to all others.

**Subscription Enquiries:** all requests for subscriptions or changes to free subscriptions (i.e. address changes) must be made in writing to:

Subscription Manager, Electricity Today  
215-1885 Clements Road,  
Pickering, Ontario, L1W 3V4

or on-line at [www.electricityforum.com](http://www.electricityforum.com).

Canada Post - Canadian Publications Mail Product Sales Agreement 40051146

ISSN 0843-7343

Printed in Canada.

All rights reserved.

The contents of this publication may not be reproduced in whole or in part without prior permission from the publisher.

Member of:



## in this issue

### EDITORIAL

Investing in India Presents Great Hurdles, but Greater Rewards

### NEW TECHNOLOGIES

B&W Demonstrates New Carbon Dioxide Capture Technology

### TRANSMISSION

The State of the Grid:  
What's Being Done to Address Long-Term Transmission Problems

The National Grid - The Big Picture

### SPECIAL FEATURE

Improving Electricity Services in Rural India

AREVA T&D Steps Up to Meet India's Energy Challenges

Crumbling Roads, Jammed Airports, Power Blackouts Could Hobble Growth

Greenhouse Gas Implications in Large Scale Infrastructure Investments  
in Developing Countries

### YOU SAID IT

Our Readers Write In

### UTILITY INFRASTRUCTURE

Securing Critical Industrial Networks

### UTILITY MANAGEMENT

Why Are Electricity Prices Increasing?

### DEMAND RESPONSE

Examining Demand Response, Renewable Energy and Efficiencies  
to Meet Growing Electricity Needs

### PRODUCTS AND SERVICES SHOWCASE

### ADVERTISERS INDEX

6

8

10

15

16

22

24

28

23

30

34

41

45

46

# editorial board



**BRUCE CAMPBELL**



**JOHN McDONALD**



**BOB FESMIRE**



**CHARLIE MACALUSO**



**DAVID W. MONCUR**



**SCOTT ROUSE**

## **BRUCE CAMPBELL, LL.B., Independent Electricity System Operator (IESO)**

Mr. Campbell holds the position of Vice-President, Corporate Relations & Market Development. In that capacity he is responsible for the evolution of the IESO-administered markets; regulatory affairs; external relations and communications; and stakeholder engagement. He has extensive background within the electricity industry, having acted as legal counsel in planning, facility approval and rate proceedings throughout his 26-year career in private practice. He joined the IESO in June 2000 and is a member of the Executive Committee of the Northeast Power Coordinating Council. He has contributed as a member of several Boards, and was Vice-Chair of the Interim Waste Authority Ltd. He is a graduate of the University of Waterloo and Osgoode Hall Law School.

## **BOB FESMIRE, ABB**

Bob Fesmire is a communications manager in ABB's Power Technologies division. He writes regularly on a range of power industry topics including T&D, IT systems, and policy issues. He is based in Santa Clara, California.

## **CHARLIE MACALUSO, Electricity Distributor's Association**

Mr. Macaluso has more than 20 years experience in the electricity industry. As the CEO of the EDA, Mr. Macaluso spearheaded the reform of the EDA to meet the emerging competitive electricity marketplace, and positioned the EDA as the voice of Ontario's local electricity distributors, the publicly and privately owned companies that safely and reliably deliver electricity to over four million Ontario homes, businesses, and public institutions.

## **SCOTT ROUSE, Managing Partner, Energy @ Work**

Scott Rouse is a strong advocate for proactive energy solutions. He has achieved North American recognition for developing an energy efficiency program that won Canadian and US EPA Climate Protection Awards through practical and proven solutions. As a published author, Scott has been called to be a keynote speaker across the continent for numerous organizations including the ACEEE, IEEE, EPRI, and Combustion Canada. Scott is a founding chair of Canada's Energy Manager network and is a professional engineer, holds an M.B.A. and is also a Certified Energy Manager.

## **DAVID W. MONCUR, P.ENG., David Moncur Engineering**

David W. Moncur has 29 years of electrical maintenance experience ranging from high voltage installations to CNC computer applications, and has conducted an analysis of more than 60,000 various electrical failures involving all types and manner of equipment. Mr. Moncur has chaired a Canadian Standards Association committee and the EASA Ontario Chapter CSA Liaison Committee, and is a Past President of the Windsor Construction Association.

## **JOHN McDONALD, IEEE President**

Mr. McDonald, P.E., is Senior Principal Consultant and Director of Automation, Reliability and Asset Management for KEMA, Inc. He is President-Elect of the IEEE Power Engineering Society (PES), Immediate Past Chair of the IEEE PES Substations Committee, and an IEEE Fellow.

# 30 New Customers in 2006. 21 New Customers in 2005.



Orion5r 19-Inch Rack Mount

About every other week, Orion becomes another engineer's choice for Substation Automation.

User list available upon request.

Orion5 Transducer Mount



Visit [novatechweb.com/orion.html](http://novatechweb.com/orion.html) for complete information detailing the use of Orion in the following applications:

- Smart RTU
- Distribution Automation
- Alarm Annunciation
- Sequence of Events Recording
- Protective Relay Integration
- WEBserver™ HMI

 NovaTech®



Orion Automation Platform

Yeah. It'll do that.



Don Horne

# INVESTING IN INDIA PRESENTS GREAT HURDLES, BUT GREATER REWARDS

Within the next three decades, it will be the most populous nation on the face of the earth.

It has been a nuclear power since the 1970s and boasts one of the few vibrant, stable democracies in the Asian hemisphere.

It has launched several communications satellites, and is now on the verge of attempting its first manned space flights.

They are the next world superpower - yet they battle daily with maintaining an uninterrupted supply of electricity to their customers.

India is a giant that is hobbled by an overtaxed infrastructure. New businesses and industries are sprouting up across the entire subcontinent, eager to take advantage of a world market hungry for Indian products and services.

It is the second-fastest growing major economy in the world, with a current GDP of 9.2 per cent; but that growth is tempered by a per capita income of \$3,400, classifying India as a low-income economy in the eyes of the World Bank.

Although two-thirds of the population earn their livelihood either directly or indirectly from agriculture, the country is used by global companies for their outsourcing and customer service support. The Electronics City section of Bangalore is India's answer to California's Silicon Valley - the only difference being the major access highway, Hosur Road, is a potholed, four-lane stretch of uneven pavement.

But poorly maintained roads are just the tip of the iceberg as to the challenges faced by India to establish a solid infrastructure.

As a rule of thumb, major cities lose power one day a week just to relieve pressure on the grid. In the city of Pune, which has 4.5 million people, the lights go out every Thursday, forcing factories to maintain expensive backup generators.

It shouldn't have come as a surprise to Indian officials when Intel Corporation decided to locate its new computer chip



Powerlines can more resemble Christmas trees covered in tinsel as people attach their own lines to steal electricity.

assembly plant in Vietnam instead of India (although Intel wouldn't comment on the decision to choose Vietnam, industry insiders said the reason was mostly due to the lack of reliable power and water in India).

In Gurgaon (near Delhi), the average power cut in January 2007 was 7.45 hours and 5.07 hours per day in industrial and residential areas respectively. The longest recorded cut for that month was 11.10 hours on January 13, with an astounding 10-hour daily power cut from January 19 to 26.

What makes these January power cuts all the more ominous is that peak demand doesn't hit until the summer months.

One quick solution to the problem has been to introduce Captive Power Plants (CPPs), allocating dedicated generation to an industry for its exclusive

consumption. Although Indian Central Electricity Authority sources put a figure of 11,600 MW for CPPs, industry experts state that the figure is much closer to 20,000 MW.

More industries are avoiding the grid altogether, using their own generation (captive and cogeneration) rather than roll the dice on unreliable and poor quality grid supply (not to mention the high tariff resulting from heavy cross-subsidization).

For Indian officials, the growth of CPPs is a concern, as it leaves utilities in a position of having industrial load as their main source of revenue and limits their ability to manage the grid when there is a surplus of power.

Another concern of government officials is the widespread theft of power by residential consumers - a practice that has become so commonplace utilities have thrown up their hands and learned to live with it as the price of doing business. Officials estimate that as much as 42 per cent of the power supplied to India's capital of Delhi disappears through "transmission losses" (compared to 3 per cent in China). Serious yes, but better than in years previous, when transmission losses accounted for more than half of the electricity distributed in Delhi.

And this doesn't take into account the industrial power theft that occurs with the help of corrupt officials, or the power farmers' lobby that pushes hard (and often gets) free power or ridiculously cheap electricity.

Aside from the loss of revenue, it makes managing demand during peak periods virtually unmanageable for Indian utilities.

The promise of smart metering may hold the key for Indian utilities, allowing them to crack down on electricity theft and providing them with a more surgical option for cutting back on power, instead of having to resort to sweeping black-outs.

**Continued on Page 11**

# Brighter than ever.

Introducing our new  
package of smart energy  
automation solutions.



Cooper Power Systems is proud to present our new combined package of smart energy automation solutions. With the recent acquisition of Cybectec, Inc. and Cannon Technologies, we now offer built-in intelligence, best-in-class components, and expertise that spans from the meter to the substation to the operations center. At Cooper Power Systems, we're bringing our customers new ways to increase productivity, improve real-time operations, enhance reliability, and reduce the cost of delivering electrical power, now and in the future—a future that's looking brighter than ever.

 **COOPER** Power Systems

**Energy Automation Solutions**

 **cybectec**

 **CANNON**  
TECHNOLOGIES  
Powered by Yuba

• Automated Meter Reading • Load Management • Substation and Feeder Automation • Asset Monitoring • Data Management

[www.cooperpower.com](http://www.cooperpower.com) | 1-877-CPS-INFO

# B&W DEMONSTRATES NEW CARBON DIOXIDE CAPTURE TECHNOLOGY

The Babcock & Wilcox Company (B&W), in collaboration with American Air Liquide Inc., will begin testing a promising new technology to help coal-fired power plants capture emissions of carbon dioxide (CO<sub>2</sub>), a greenhouse gas.

The evaluation will occur at B&W's 30 megawatt Clean Environment Development Facility (CEDF) in Alliance, Ohio in June of this year. The CEDF, originally placed in service in 1994 by B&W, the U.S. Department of Energy and others, is a large-scale demonstration facility that has been used to develop emissions-control technology.

The CEDF will be used to validate a technology called "oxy-coal combustion" that utilizes pure oxygen for the combustion of coal in electricity generating plants. In this system, nitrogen that comes in with the air for the combustion process is eliminated. As a result, the exhaust gas is a relatively pure stream of CO<sub>2</sub> that is ready for long-term storage operations.

"Finding ways to capture and store CO<sub>2</sub> emissions from power plants is paramount if the United States is going to address greenhouse gas concerns and use our national energy resources," Don Langley, B&W vice president and chief technology officer said. "We see this major technology demonstration project as another step in B&W's plan to deliver CO<sub>2</sub>-capture technology to the electricity generating industry and make a significant impact on this global issue."

B&W's development efforts are being done well in advance of similar projects around the globe. "This is truly changing-the-world technology and we are pleased to be leading this research," Langley added. Because the oxy-coal technology builds on pulverized coal combustion technology, it would be complimentary to most of the world's coal-fired power plants.

B&W will work with American Air Liquide to modify the existing CEDF facility for the oxy-coal process and will begin proving the technology in June 2007.

American Air Liquide will provide engineering and chemistry know-how related to combustion, as well as proprietary equipment and sensors for the safe and efficient handling of liquefied oxygen.

In addition to American Air Liquide, several utilities will participate in an "advisory group" process that will help bring



the potential users of the technology into the development process.

B&W will evaluate several types of coal, including coal imported from Saskatchewan, Canada, and the site of a proposed near-zero emissions power plant that will use this technology at commercial scale.

Present in 72 countries, Air Liquide provides industrial and medical gases and related services and offers innovative solutions based on constantly enhanced technologies.

# **Finepoint's 14th Annual Circuit Breaker Test & Maintenance Training Conference**



**Join Us In Pittsburgh This October!**



- A day at the Pennsylvania Breaker and Pennsylvania Transformer Technology facilities
- Over a dozen useful substation and switchgear presentations
- An SF6 handling, management, and emissions reduction seminar
- A circuit breaker timing and analysis seminar
- Supplier exhibits every evening in the hospitality rooms

**October 1-5, 2007**

**Omni William Penn Hotel  
Pittsburgh, Pennsylvania**

For further information and on-line registration, please visit  
**[www.circuitbreakerconference.com](http://www.circuitbreakerconference.com)**



## THE STATE OF THE GRID: WHAT'S BEING DONE TO ADDRESS LONG-TERM TRANSMISSION PROBLEMS

By Drew Robb

In his State of the Union address, President Bush once again emphasized improving the nation's generating capacity and moving away from dependence on imported oil.

"It's in our vital interest to diversify America's energy supply - the way forward is through technology," he declared.

"We must continue changing the way America generates electric power, by even greater use of clean coal technology, solar and wind energy, and clean, safe nuclear power."

The \$4.3 billion authorized in the Energy Policy Act of 2005 (EPACT) for building new nuclear power plants will

help ease generation constraints, as will the other provisions covering wind, wave, clean coal, tidal, biomass, fuel cells and hydrogen production.

But boosting generating capacity is not the only problem that the nation

**Continued on Page 12**



## Investing in India

Continued from Page 6

The 2003 Electricity Act made power theft a criminal offence for the first time. Private utilities like Tata Power have cut transmission losses from over 50 per cent to a more manageable 30 per cent.

On the generation side, government planners are seriously looking at developing the massive hydroelectric potential in the north of the country, along with a significant expansion of the nuclear generation component.

Naturally, any new generation that is developed would require greatly

enhanced transmission corridors, concurrent to a strengthening and hardening of the distribution network.

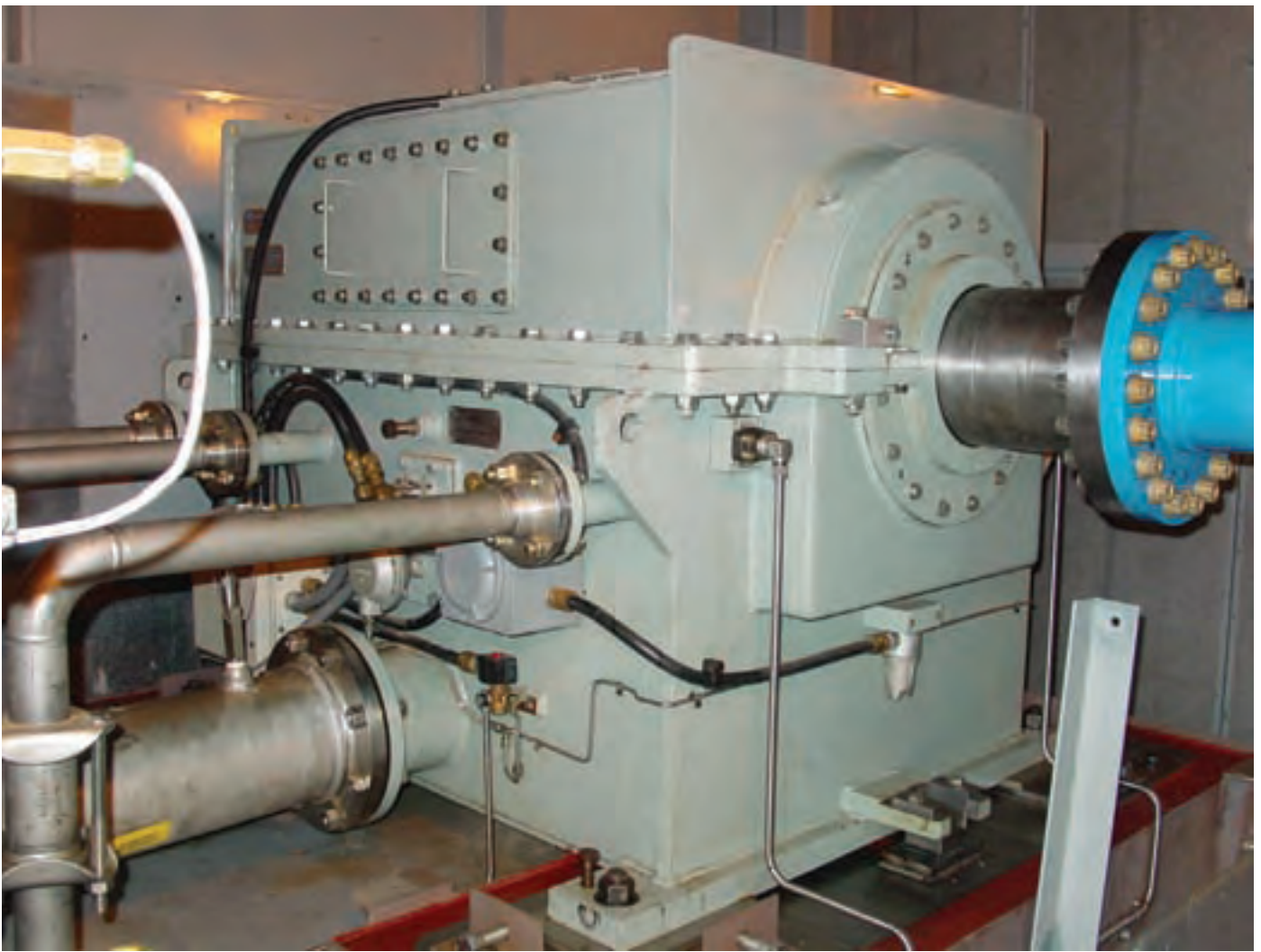
For foreign investors, like the French company Areva T&D, it is this commitment by the Indian government to expanding and improving the transmission and distribution network that has spurred their commitment to building factories in Pallavaram and Perungudi.

For Areva T&D, who held the 6th instalment of their Technical Days in India recently, building the transformers in India that are destined for that country's electrical grid is essential to developing that nation as a great power. Areva T&D, whose projects and investments

stretch from Russia to Brazil, sees opportunity - not obstacles - in helping nations strengthen and grow their vital electrical infrastructures.

Even the most inward looking North Americans have to admit that the global marketplace is forcing change. The obstacles of today - like those faced by India - can either be ignored by Western CEOs at their own peril or embraced and overcome, to the benefit of India, its people, and those companies who choose to invest and prosper with them.

See Special Feature "Opportunity and challenge: Developing India's electrical infrastructure" - Pages 16-29



A photo of one of the Size 260T SSS Encased Clutches that is installed at Lafayette Utilities.

## State of the Grid

Continued from Page 10

faces. That added power does no good if it can't get to where it is needed when it is needed. The aging distribution network is overdue for an overhaul. According to the U.S. Department of Energy (DoE), congestion charges will run \$8 billion for Eastern U.S. customers next year, and that doesn't count the congestion charges west coast residents in Southern California, the San Francisco Bay area, Portland and Seattle will have to pay.

The DoE, NERC and others are engaging in activities to address the long term state of the grid, but those don't address immediate needs (See related story: The Big Picture). So, let's take a look at what is happening in three areas to reduce transmission load and improve reliability using existing technology.

### RENEWABLES

President Bush isn't the only one talking about the potential of renewable energy. In January a DoE panel headed by MIT professor Jefferson Tester reported that investing \$1 billion over the next 15 years in geothermal could add 100

gigawatts of generating capacity. But, as with many renewable sources, the energy sources aren't near population centers. Or if they are, the citizens will try to block them, as occurred with the Cape Wind Project near the affluent Cape Cod region. Instead, wind farms are installed in places like West Texas or the Mojave Desert.

The former, for example, has become a huge player in the wind market, surpassing California as the biggest U.S. Wind region in 2006 when it added three new farms with a combined capacity of 430MW – the 225MW Horse Hollow Wind Energy Center, the 121 MW Buffalo Gap Wind Farm and the 84MW Red Canyon Wind Energy Center. This, however, has already placed a strain on the grid. In 2001, for example, ERCOT (Electrical Reliability Council of Texas) ordered a curtailment in wind production in one area because of overloaded transmission lines. In a white paper submitted to the Texas Legislature in 2005 (Transmission Issues Associated with Renewable Energy in Texas), ERCOT proposed spending a \$1.0 billion on upgrading 345 kV lines in West Texas to deliver 3,641 MW of wind energy, and two other options for delivering another 8,641 MW at a cost of \$2-3 billion. Similarly, San Diego/Gas and Electric want to build a new 500 kV transmis-

sion line to tap a potential 1000 to 2000MW of geothermal power from plants in the Imperial Valley.

Power generators and wind turbine manufacturers are also working to improve grid stability. Since wind turbines are large induction motors, they tend to pull reactive power from the grid which can cause instability and voltage collapse.

"Most types of wind turbine generators cannot do much to support grid voltage and they can even exacerbate voltage problems just like any other type of induction machine," says Yuriy Kazachkov, Ph.D. a consultant with the engineering firm Shaw Power Technologies. "Any wind plant that cannot support the voltage cannot be considered a sound generation facility."

The usual way to address this problem is to use capacitor and static VAR compensators to correct power factor. But GE and Clipper Windpower have both developed technologies to address the problem at the turbine. GE uses a central computer to monitor the power factor and then send a signal to processors within the nacelles to excite the generators as needed. Clipper's new Liberty turbines use permanent magnets so they operate at unity power factor, but the company also has a system to provide voltage correction as the power passes through the wind farm's transformers and collection system.

"Most types of wind turbine generators cannot do much to support grid voltage and they can even exacerbate voltage problems just like any other type of induction machine."

#### THINKING LOCAL

Grid support is not just a problem, though, for wind farms. According to the U.S-Canada Power System Outage Task Force's Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations, one of the major causes of the continent's worst power outage in three decades was "Failure to maintain adequate reactive power support."

The value of local sources for reactive power was further emphasized in the DoE study A Preliminary Analysis of the Economics of Using Distributed Energy as a Source of Reactive Power. According to that report: "Reactive power from DE offers the potential to provide reactive power compensation on a distributed and dynamic basis corresponding to the dynamic and spatial variation of reactive power needs. Intuitively, it seems there is a good match between the requirement for reactive power compensation to be provided adjacent or near to load pockets and the growth and availability of distributed energy located at or near customer loads."

When Lafayette Utilities System (LUS) in Lafayette, Louisiana recently added to its generating capacity, it also provided grid support. The utility gets most of its power from a 523MW coal fired unit at the Rodemacher Power Station, but rising demand and grid instability led LUS to add capacity locally.

"We added 200MW of generation capacity here to accommodate the growth of our community as well as give us some kind of insurance policy against the disruption of the transmission grid capacity," says LUS Director of Utilities, Terry Huval. "We have had some intense problems across the last five or six years and have had 290 TLRs (Transmission Loading Reliefs) since 2001. We believe it is important to ensure our customers have reliable power."

To address these issues, Lafayette Utilities built two new

plants in the city, each with two 50MW GE LM6000 simple-cycle combustion turbines to provide emergency or peaking power. The second of the two plants, the Hargis-Hebert Power Generation Plant, came on line in 2006. In addition to providing power, the generators can also provide synchronous condensing as a means of providing reactive power.

"Adding the synchronous condenser function allows the unit to absorb or supply more reactive power to the grid for voltage control purposes, by running the generator as a synchronous motor uncoupled from the gas turbine, than could be accom-

plished simply by varying the excitation of the generator operating as a generator," says Gregory Magarie, P.E., Executive Engineer-Electrical at R. W. Beck, Inc.'s Boston office and who served as the lead electrical engineer on the project.

He says that the LM6000s are ideally suited to synchronous condensing applications and that GE offers this as an option for the turbines. The difference is that, when a turbine is used for synchronous condensing, a clutch is installed between the turbine and the generator so they can operate independently of each other. The clutch selected was a model 260T from SSS Clutch Company, Inc. of New Castle, Del.

Continued on Page 14

## Why do more people buy FLIR infrared cameras than all other brands combined?



NEW! InfraCAM SD Thermal Imager

NEW! ThermoCAM P640 Infrared Camera

LOW COST! **INFRACAM SD**

With InfraCAM SD's Removable Memory Card, You're No Longer Tethered to Your Computer!

Plus, you'll get razor-sharp thermal image quality, 1000 Radiometric JPEG Images with a Removable SD/Memory Card, an ultra-portable design and exceptional ergonomics. Weighs just 1.2 lbs, long 7-hour battery life!

Get More Done With InfraCAM SD!

Call for a Free Demo! 1-800-613-0507 Ext. 25

Training Value Package Available!

Visit: [www.goinflracam.com](http://www.goinflracam.com)



Removable SD/Memory Card

HIGH DEFINITION **ThermaCAM HD**

The only High Definition infrared camera on the market today!

Superior image quality, spot size resolution, temperature measurement accuracy - the new standard for Professional Thermographers! Call 1-800-613-0507 Ext. 24

Training Value Package Available!

Visit: [www.highdefinitioninfrared.com](http://www.highdefinitioninfrared.com)

**FLIR SYSTEMS**

The Global Leader in Infrared Cameras  
+ Servicing Canada for 46 years

1-800-613-0507

Ext. 25 for InfraCAM SD  
Ext. 24 for P640 HD

IRCanada@flir.com

[www.flir.ca](http://www.flir.ca)

SSS has installed more than 500 clutches on GTs worldwide ranging up to 300MW.

“In operation, the combustion turbine generator is started in a normal fashion and synchronized to the grid at a very low power output,” he explains. “The generator is then uncoupled from the gas turbine and runs as a synchronous motor (with no shaft load); its excitation system adjusted to supply or absorb reactive power from the grid.”

Since the gas turbine is shut down, this saves on both fuel costs and turbine wear. Magarie says that using a turbine generator in this fashion provides a finer degree of control than other voltage support technologies.

“Unlike switching fixed capacitors or reactors on the grid to control grid voltage,” he says, “the synchronous condenser is, relatively, infinitely variable and can follow load automatically instead of in fixed steps using the generator control system.”

He says that other utilities could similarly benefit in the right circumstances.

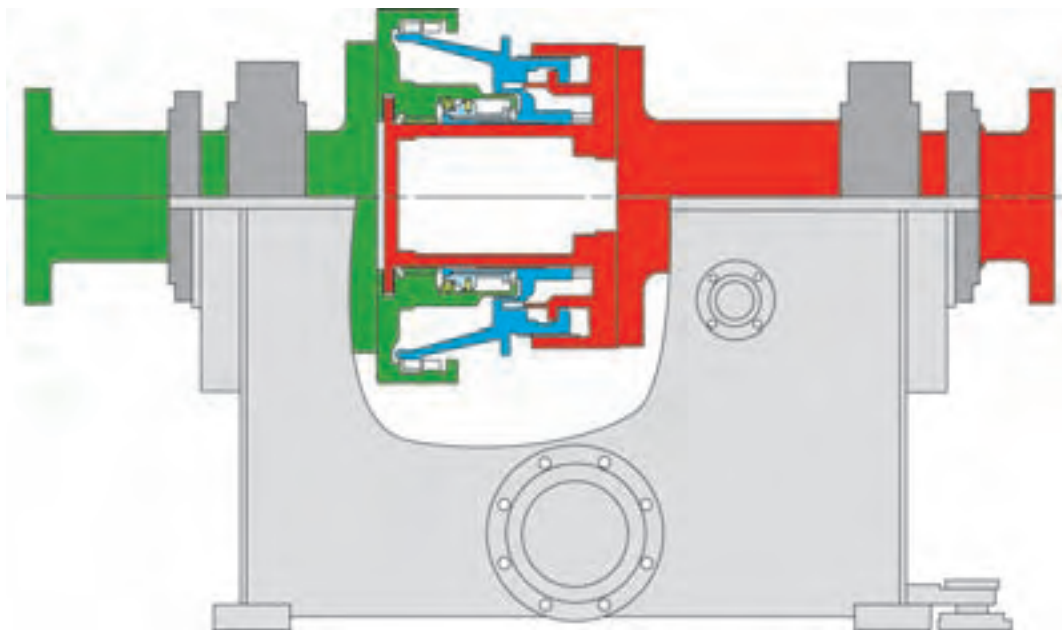
“An example would be where combustion turbines are being added to support new load growth in an area located at the far end of a radial transmission line,” he says. “Synchronous condenser conversion of retired generation could also be considered in areas where the reactive power requirements are high but other generation is available and the addition of new generation is not cost effective or precluded for other reasons.”

#### THE (VARIABLE) PRICE IS RIGHT

Finally, since congestion only occurs during peak usage, variable pricing offers local utilities a means to cut peak time usage and so reduce congestion. While commercial customers have had this option for years, EPACT Section 1262 gave utilities 18 months to study the effectiveness of smart metering for residential customers. Dr. Ahmad Faruqui of The Brattle Group in San Francisco was part of a two-year \$20 million dollar study of 2,500 California residential customers.

“There was skepticism that residential customers were too busy or don’t spend enough on electricity to care about prices,” he says. “That myth was shattered by this pricing experiment.”

The study found that when there was a five fold increase in



An illustration of the encased clutch. The green is the clutch output that connects to the generator. The red is the clutch input that connects to the gas turbine. The blue is the clutch sliding component that can move axially to engage the clutch teeth for power generation and disengage to allow generator synchronous condensing.

prices during critical peak situations, usage dropped by 13 percent, which was more than enough to balance the power supply. Following that study, the California PUC approved an application by Pacific Gas and Electric (PG&E) for advanced meters and dynamic pricing rates, and PG&E will install five million electric and four million gas meters in Northern California over the next five years. Those customers will then have the option of moving to critical needs pricing rates. Southern California Edison and San Diego Gas and Electric are pursuing similar plans to bring another five million customers under smart pricing.

“These three companies can set off a huge change in how metering is done in the United States,” says Faruqui. “If California pulls this off I am sure other states will give this serious consideration.”

#### NO SINGLE SOLUTION

People have a tendency to look for big, simple solutions to problems. We see this in the area of health where, almost daily, some new diet or food supplement is touted as the cure for what ails man, only to be replaced soon thereafter by the next fad. The fallacy is that health or obesity is a problem, rather than the a variety of problems each with its own cure. As with the human body, there is no single solution to fixing the grid because it is not a single problem, but a series of local ones.

Each of the steps mentioned above, as well as the longer-term DoE actions detailed in the sidebar have a role to play in curing what ails the transmission networks. By correctly identifying the local problems, the correct solution can be selected to improve grid health.

# THE NATIONAL GRID - THE BIG PICTURE

Let's take a look at the status of the national grid. The EPACT called for the Secretary of Energy to report to Congress on network congestion and propose a five year plan to address transmission issues. Pursuant to this Act, in August 2005 the DoE released its National Electric Transmission Congestion Study and a Five-Year Program Plan for Fiscal Years 2008 to 2012 for Electric Transmission and Distribution Programs.

The Congestion Study classified two areas as "Critical Congestion Areas" - Southern California and the New York-Washington corridor. Four areas were listed as "Congestion Areas of Concern" - New England, Phoenix-Tucson, Seattle-Portland and San Francisco Bay.

While those areas are currently the most congested, the study also found that other areas will face transmission congestion if significant new capacity was added, especially if there is a shift away from oil and natural gas. Some of the areas mentioned were wind power from Montana-Wyoming, Kansas-Oklahoma and the Dakotas-Minnesota regions; nuclear power in the Southeast; coal in Illinois, Indiana, and Upper Appalachia; and various types of renewable energy in Southern California.

The report also detailed the loads on specific lines in the Eastern and Western Interconnections. In the East, it found that "for the 2008 base case, the total cost of served load was about \$171 billion, and congestion rent totaled 4.7%; for the 2011 high case, the total cost of served load was about \$202 billion, and congestion rent totaled 5.1%." While these figures are small as a percentage, they do add up to \$8 billion for 2008 and over \$10 billion in 2011. The DoE found that targeting a few lines could relieve congestion and cut costs.

"Congestion is not evenly spread around the system, and a relatively small portion of constrained transmission capacity causes the bulk of the congestion cost that is passed through to consumers," the report stated. "This means that a relatively small number of selective additions to transmission capacity could lead to major economic

benefits for many consumers."

Problems were not as severe in the West, where the most congested line was the Bridger West line connecting coal fired plants in Southern Wyoming to customers in Utah and Oregon.

The DoE's Five Year Program lists its proposed actions in eleven areas delineated by the EPACT:

- Advanced energy delivery technologies including energy storage technologies, materials, and systems
- Advanced grid reliability and efficiency technologies
- Technologies contributing to significant load reductions
- Advanced metering, load management, and control technologies
- Technologies to enhance existing grid components
- High temperature superconductors
- Integration of distributed power systems including combined heat and power
- Small-scale distributed and residential based power generators
- Advanced grid design, operations, and planning tools
- Other infrastructure technologies
- Technology transfer and education

The projects detailed in the paper are interesting, but they are generally too long term to address immediate power distribution needs.

**Spring...**  
when a young man's thoughts  
turn to...

**Electrical Drawings  
and Schematics**

**Arc Flash and  
Electrical Safety**

**ON-SITE TRAINING AVAILABLE**

**THE ELECTRICITY FORUM**  
Since 1986

**CANADA'S LEADER IN ELECTRICAL TRAINING**

www.together (905) 686-1040 (905) 686-1078 The Canadian Electricity Forum  
Unit 215, 1885 Clements Rd.  
Pickering, ON L1W 3V4

[www.electricityforum.com/forums/reg.html](http://www.electricityforum.com/forums/reg.html)

# IMPROVING ELECTRICITY SERVICES IN RURAL INDIA

By Vijay Modi, Earth Institute at Columbia University

Excerpted from:  
CGSD Working Paper No. 30

Working Papers Series  
Center on Globalization and Sustainable  
Development

Editor's note: Of the two case studies cited at the end of the article, only the study of Madhya Pradesh district is printed here.

## INTRODUCTION

Expanding electrification and scaling up electricity services is critical to both the economic and social development of India. The current state of electricity services across India can be said to be acute, if not in a crisis mode. The immediate manifestations of this crisis are severe shortcomings in: a) access to electricity for rural and urban poor, b) generation capacity that cannot meet peak demand and c) reliability of supply, in terms of predictability of outages and quality of power supply. The goal of this report is to propose a set of policy levers that can aggressively reform all three of these issues at once.

National statistics tell a story of problems afflicting generation, transmission, and distribution of electricity. Shortages in energy demand and peak power demand have been around 8% and 12% on average between 2000 and 2003. Industry, farmers and households have invested in a substantial amount of equipment and capital in the form of captive power plants, generators, inverters, and voltage stabilizers to address issues of supply and its quality. India, with an average annual per capita electricity consumption of 400 kWh, is far behind countries such as China (900 kWh), Malaysia (2500 Kwh), and Thailand (1,500 kWh).

While large-scale reforms have repeatedly been attempted in the past, India's achievement in the field of rural access to electricity leaves much to be desired. India is home to 35% of the global population without access to electricity (Table 1) and only 44% of all rural Indian households are electrified. According to the 2001 Census, 6.02 crore

Country	Population w/out access to electricity (Million)	% of world total	Per capita electricity consumption (kWh)
India	579.10	35.44	393
Bangladesh	104.40	6.39	102
Indonesia	98.00	6.00	390
Nigeria	76.15	4.66	85
Pakistan	65.00	3.98	374
Ethiopia	61.28	3.75	24
Myanmar	45.30	2.77	74
Tanzania	30.16	1.85	55
Kenya	27.71	1.70	107
Nepal	19.50	1.19	61
DPR of Korea	17.80	1.09	1288
Mozambique	16.42	1.00	47
World Total	1634.20	100.00	2343

Source: IFA, 2002

Table 1. Countries with large population without access to electricity

households use electricity as the primary source of lighting out of a total of 13.8 crore households in the country.

Transmission and Distribution (T&D) losses in India have risen from 25% in 1997-1998 to around 30% in 1999-2000. In countries such as China, Malaysia, and Thailand, they are less than 10%. The State Electricity Boards (SEBs) that bear primary responsibility for distribution face irregularities in billing and rampant theft of electricity. It is estimated that of the total power generated, only about 55% is billed, and around 41% is realized. Cost recovery has declined from 82% in 1992-1993 to 69% in 2001-2002. The loss per unit of power sold increased from 23 paise in 1992-1993 to 110 paise in 2001-2002. It is ironic that over the period 1991-1992 to 2001-2002, when so many reforms were introduced, the gross power subsidy to agriculture, domestic consumers, and on inter-state sales has increased by 364% (or 4.6 times) – from Rs. 7,449 crores to Rs. 34,587 crores (or about 1.5% of India's GDP). While just about everyone agrees on the end-point, (restoring the financial health of the

SEBs and power utilities, increasing generation capacity, and lowering T&D losses) how to tread the narrow and difficult political path to achieving that goal remains a challenge.

The Kutir Jyoti Scheme released in 1989 connected nearly 60 lakh households in 15 years or at a rate of approximately 4 lakh households per year. The goal of the RGGVY scheme is to bring similar coverage to 2.34 crore BPL households (and an overall total of 7.8 crore households) within the next five years. This is equivalent to a rate of 46 lakh new BPL households per year (and a total of about 156 lakh households per year) for the next five years. This is a rate that is more than ten times the past rate of

electrification for Kutir Jyoti. The additional generation capacity that will be needed over the next five years if this accelerated pace (annual rural electrification rate ten times that of the past 15

years) of rural household electrification is maintained would require about 14,000 MW of evening hours capacity addition over the next five years. An additional 14,000 MW of required generation capacity in the next five years

Monetary units:  
1 crore = 100 lakhs  
1 lakh = 100,000 rupees  
1 rupee = 100 paise

amounts to about 2800 MW/year. This new capacity would have to be planned for, whether it comes from conservation, reduced losses, higher PLF, or new power plants. It is also worth noting that nearly half of this new capacity would be needed just in the three states of U.P., Bihar and W. Bengal. The additional capacity requirement from the RGGVY would be comparable to the capacity additions since 2002. These requirements would be over and above the additional generation that would be needed to fuel the increase in electricity demand that results from robust economic growth and the demand that would result if reliable 24-7 grid power were actually available.

### Why is rural electrification important?

Both the Government of India Planning Commission's strategy for the development of rural India as well as the United Nation's Millennium Development Goals (MDGs) for the next ten years are inherently dependent on the integration of electricity services to achieve a set of varied development goals. Viable and reliable electricity services result in increased productivity in agriculture and labor, improvement in the delivery of health and education, access to communications (radio, telephone, television, mobile telephone), improved lighting after sunset, facilitating the use of time and energy-saving mills, motors, and pumps, and increasing public safety through outdoor lighting. Rural electrification at a household level provides, at the very minimum, services such as lighting and communications (e.g. radio/television) and can increasingly meet the aspirations of the rural populations to own other household appliances. Household electrification also increases the likelihood that women will read and earn income.

Under the current 5-Year Plan, the Planning Commission states that rural electrification and power service reforms are high development priorities. The central government also recognizes that the current state of energy services could significantly impede India's economic growth on a national scale – beyond the rural and agrarian contexts. This realiza-

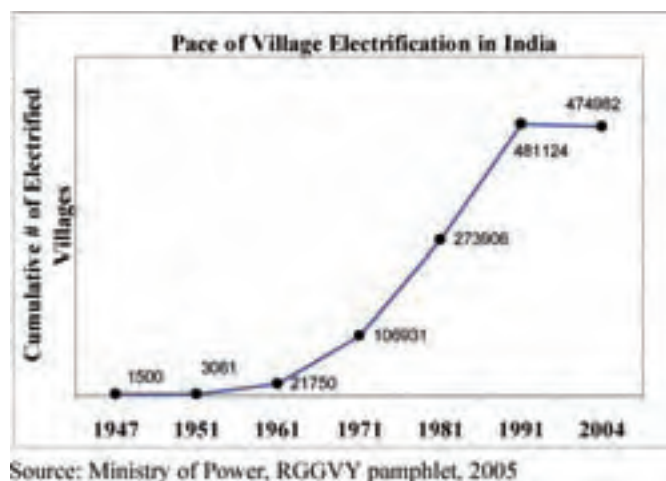


Figure 1. Decrease in number of electrified villages due to de-electrification

tion, along with India's gradual economic upswing, has brought the depressed state of energy service providers into the forefront of energy sector reforms. The failures of past Plans to revitalize power services (less than half of the goals of the Eight and Ninth Plans were implemented) underscore the sense of hopelessness

that surrounds discussions of the state of electricity in India today.

Successes in electrification and electricity services can be achieved, nonetheless, by boldly confronting the difficulties that have incapacitated the power sector for decades and by adopting a multi-pronged approach to re-vitalizing energy services in India. Future efforts must implement best practices and address setbacks in all of the following areas: distribution, power generation, tariffs, subsidies, monitoring and implementation of government schemes – in effect by addressing all aspects of energy generation and distribution. While electrification rates have generally increased over time (recent setbacks recognize that a village as "electrified" using a stricter definition of at least 10% hh as being electrified), as seen in Figure 1, household electrification nationally is still below 50% and the states such as Uttar Pradesh with signifi-

## THE WUNPEECE DUCT SPACER

### ONE PIECE DOES IT ALL!

- Replaces the Two Piece Base and Intermediate System
- Cuts Spacer Installation Time in Half
- Eliminates Weak Vertical Shear Plane in Concrete Encasement





**UNDERGROUND DEVICES, INC.**

**UNDERGROUND DEVICES**

INCORPORATED

2004 • 10000 W. 20th St. • Overland Park, KS 66213-2000  
Phone: (843) 205-9000 • Fax: (843) 205-9004

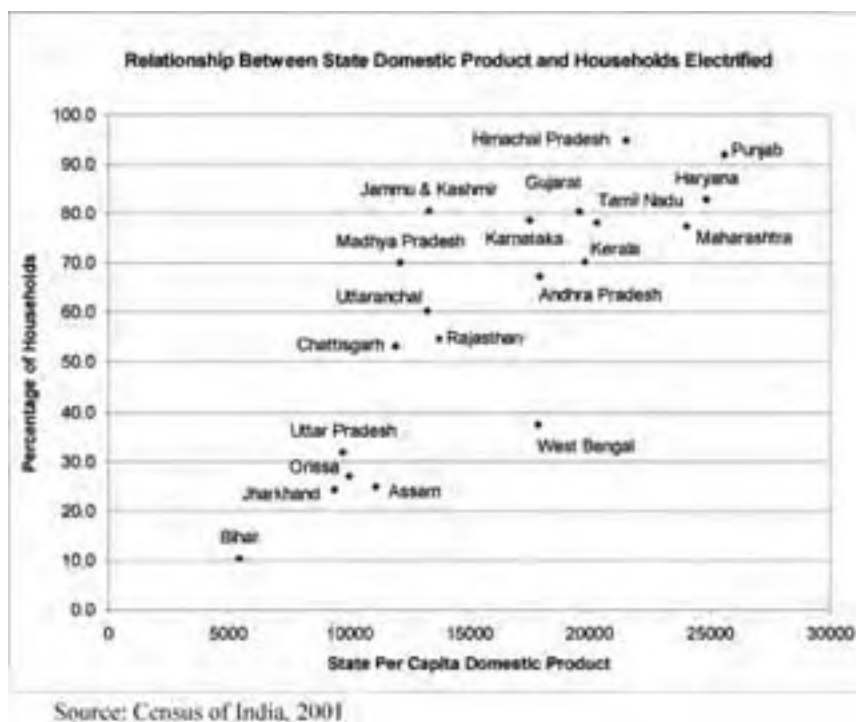


Figure 2. Domestic product and percentage of electrified households

cantly lower rate of electrification as measured by fraction of households that use electricity for lighting. The figure for U.P. is about 30% for rural households. The per capita GDP and electrification rates of all major states (population greater than 1 million) are shown in Figure 2.

#### HOUSEHOLD ELECTRICITY SERVICES AND THE RURAL POOR

A recent World Bank study articulates the inability of current methods of providing reliable and affordable electricity to the rural poor. Agriculture's mis-use of power and large government subsidies have frequently been blamed for the poor state of power supply in rural areas. While the agricultural sector has received the highest power subsidies (Table 2), blaming agriculture and particularly the rural poor for the failure of the SEBs is misleading.

Poor rural households and poor farmers are among the populations most in need of immediate relief. Currently, the vast majority of poor rural households do not have access to

electricity in India. Electrification rates vary dramatically between the urban poor (33% without connection) and rural poor (77% without connection), and obviously between the rural poor and the urban rich. This inequity impedes the development of poor rural populations and underscores the fact that India's rural electrification programs have not reached the most marginalized and needy sections of society. Because such a low number of rural households have grid connections, only a small percentage of rural poor have benefited from subsidies, with the majority of subsidies benefiting richer households. The GoI recognizes that for many rural households the only source of lighting is kerosene based and hence kerosene at subsidized prices is distributed through PDS in most states. Box 1 describes kerosene consumption of rural households in greater detail.

Irrigation pumping for agriculture has been cited by many as one of the principle causes of poor cost recovery of SEBs and a prime cause of the poor financial health of the SEBs. However, one needs to acknowledge that irrigation reduces poverty by increasing employment, incomes and real wages and by reducing food prices for rural and urban poor. In India, in un-irrigated districts (less than 10% area irrigated), 69% of people are poor, while in irrigated districts (more than 50% area irrigated), poverty level drops to 26%. Agricultural performance is fundamental to India's economic and social development and will critically determine the success of efforts in poverty reduction. Hence a sudden and substantial shift away from current pricing of electricity for agriculture could jeopardize agriculture, an activity that is the primary source of livelihood in rural areas, accounting for 72% of India's population. Irrigated areas in India contribute two-thirds of food grains output and provide livelihood and income to more than 650 million people in India. Of the 57 million net hectares of irrigated area, as much as 34 million ha is from private investments in tubewells, pump sets and water distribution channels. The poor frequently pay a high fraction of their gross farm income for irrigation as seen in Figure 3.

#### CASE STUDIES

To get sense of on the ground reality in the two states of Uttar Pradesh (UP) and Madhya Pradesh (MP), one district in each state and five villages within each of these districts were selected for field studies. The outline of the methodological approach for the study includes following major steps:

Selection of districts – Unnao district in Uttar Pradesh and Raisen district in Madhya Pradesh were identified by the Earth Institute at Columbia University for the purpose of the study.

Selection of villages – Attempting to capture the impact and attributes of energy services provision, the develop-

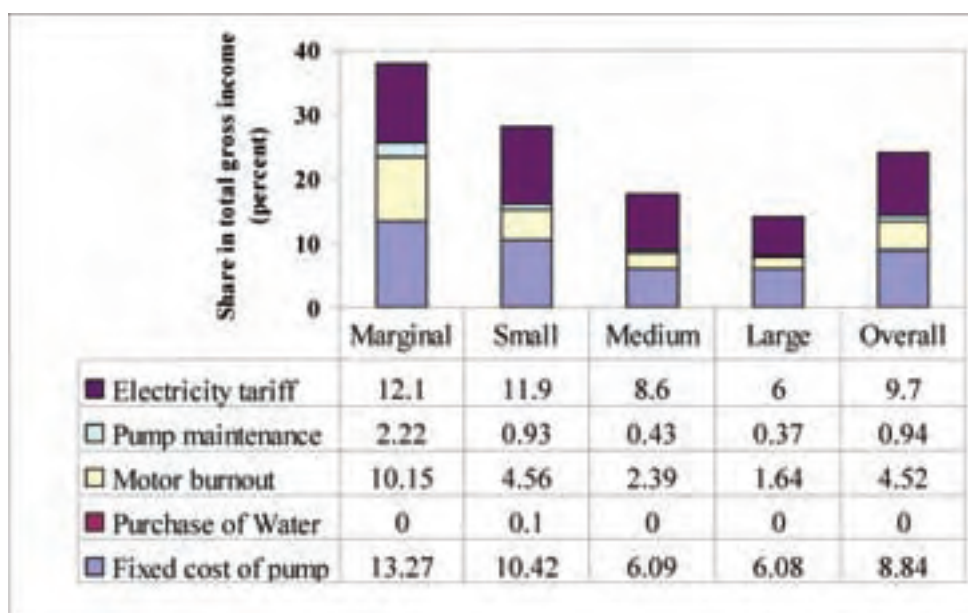
(ps/kVh)	1996-97 Actual	1997-98 Actual	1998-99 Actual	1999-2000 Prov	2000-01 Revised Est.	2001-02 Annual Plan
Domestic	105.7	136.2	139.1	160.7	183.1	195.6
Commercial	239.1	293.6	330.2	369.9	404.2	426.3
Agriculture	21.2	20.2	21.0	22.6	35.4	41.6
Industry	275.5	312.7	322.8	342	366.5	378.7
Traction	346.8	382.2	410.3	415.3	435.9	449.2
Outside State	151.4	138.1	163.8	190.1	187.9	194.4
Overall (average)	165.3	180.3	186.8	207	226.3	239.9

Table 2. Retail power tariffs by sector as per Planning Commission, 2002

mental indicators used for the purpose of village selection were:

- Percentage of SC/ST population in the villages;
- Percentage of literacy level;
- Percentage of marginal workers.

As per information available from the Census of India 2001, villages in both districts were ranked on each of the three indicators. The individual indicator ranking for each village was aggregated to develop a composite integrated rank indicator for each village in the district. The integrated rank indicators were statistically segregated over 4 quartiles. Ten villages were selected from each of the three inter-quartile boundaries and 10 each from the lowest and highest aggregated ranks. The final 5 villages were chosen to ensure that the villages were geographically spread across tehsils.



Source: World Bank, 2002

Figure 3. Irrigation costs as a percentage of farm income - Haryana electricity pumps.

#### DATA COLLECTION

Surveys were conducted in the ten sampled villages (five in each district). Focus group discussions were held in the communities to assess the status of services. The following sources were tapped to collect relevant information about electricity services in rural India:

Madhya Pradesh State Electricity boards, circle office Bhopal and Raisen.

Uttar Pradesh State Electricity boards, Unnao.

Public Health and Engineering Department, Bhopal and Raisen

Rajiv Gandhi Mission, Bhopal

District Agriculture department, Raisen

District water resources department, Raisen

Uttar Pradesh Jal Nigam, Unnao

District NIC office, Raisen and Unnao

Census of India office, Delhi

NSSO

Consultation with key stakeholders - The key stakeholders that were consulted for the purpose of the study are:

Chief Engineer, Madhya Pradesh SEB, Raisen

Chief Engineer, Uttar Pradesh SEB, Unnao

District Collector, Raisen and Unnao

PHED officials in Bhopal

UP Jal Nigam, officials, Unnao

Panchayat members- Sarpanch

Despite the fact that the team visited the PHED/Jal Nigam office several times, officials of the PHED / Jal Nigam, Raisen and Unnao were not available for discussion.

The primary data helped in assessing the current ground realities, quality of access and constraints faced at the field level. Data was used to identify gaps in planning and implementation. The secondary data and discussion with the utility officials has helped understand the point of view of end users and providers. While the sample size may be too small to

extrapolate, the village surveys and studies were instrumental in providing a snapshot of the conditions on the ground. Data was collected from various sources, which resulted in problems in comparing data sets that did not use the same scale.

#### ELECTRICITY SERVICES IN THE STATE OF MADHYA PRADESH

Madhya Pradesh was the largest state in India and had the fourth largest population until it was split into two states, Madhya Pradesh and Chattisgarh in November 2000. The state economy has shown robust growth averaging 4.4 percent since 1980/81, accelerating to 5 percent during 1990/96. The contribution of the primary sector in state domestic product has declined gradually over time and the contribution of services and industry has risen consistently. Similarly, the share of manufacturing and construction has risen from 21.4 percent to 23.0 percent during the same period. Despite its growth, MP is still one of the poorest states in India. In 1999/2000, the per capita annual income was Rs 11,244 as compared with Rs 14,682 at the national level. The percentage of the population living below the poverty line was 37.4 in 1999/2000, much higher than the national figure of 26.1 percent.

The 2001 census states that 97% of MP is electrified. The

Primary sources of energy for lighting.

National figures per 1000 distribution of rural households by primary source of energy for lighting shows 506 households use kerosene, 488 using electricity and 10 using other sources for lighting.

census data also shows that only about 70% of households across the state use electricity as a primary source of lighting - 90% in urban areas and about 60% in rural areas. Nearly 1.32 million pumps have been energized in the state, which constitute 9.6% of all pump sets energized across the country.

#### KEY ISSUES IN CURRENT ELECTRICITY SERVICES

Table 7 provides a snapshot of the state of the Madhya Pradesh State Electricity Board's (MPSEB) service capacity. The accompanying map (Figure 5) provides district-wise data on electrification.

#### LOAD RESTRICTIONS

The 2003-04 energy balance sheet shows that in addition to the load relief of 2,230 million units, the Madhya Pradesh State Electricity Board (MPSEB) undertook load shedding of 1,438 million units that year. Power demand grew by 6.4 percent in 1999-2000. According to the SLDC, while the registered maximum demand was 4,984 million units in January 2004, the unrestricted maximum demand would be 6,033 million units during the same period.

Despite the sound operating performance of MPSEB generating plants, the peak demand-supply gap in the state has been growing. This unserved demand results from planned (load relief) and unplanned (load shedding) cuts. In response to the shortage, MPSEB resorts to load restrictions for high tension, low tension, and rural consumers. According to the SLDC energy balance sheet for the year 2003-04, while average supply at divisional headquarters ranged between about 20 to 23 hours, supply at the tehsil level varied from about 14 to 23 hours per day. Rural 3-phase supply during the year, however, fluctuated from an average supply of 3.26 hours in January 2003 to about 23 hours in August 2003. Quality of supply has also suffered due to growing demand and overloading of the transmission and distribution network; the transmission system was operating at lower than normal frequency and voltage for over 50 percent of that year.

#### PRIVATE SECTOR PARTICIPATION

In response to growing supply gap, the Government of Madhya Pradesh (GoMP) initiated a policy to invite private power producers to enter into power purchase agreements with a total of 17 sponsors. However, the IPPs have been finding it difficult to achieve financial closure due to the insufficient escrow capacity of the MPSEB. The term escrow used here refers to the deposition of the revenue stream from a specific revenue collection center, e.g., a distribution unit, into a separate account in an identified bank, an escrow agent. In the power sector this mechanism is mostly used to guarantee payment of an independent power producer, to whom the primary claim on a revenue stream from a distribution zone is transferred or escrowed.

As per the MPSEB status on private sector participation in generation, of the 11 projects under consideration aggregating 3308.9 MW of capacity addition, only 4 projects aggregating 1426 MW have achieved closure. The MPSEB also acknowledges that 7 of the proposed 11 projects are likely to depend upon the future escrow capacity of the MPSEB.

#### TARIFF, SUBSIDIES AND FINANCIAL RESTRUCTURING

The immediate reasons for the financial problems of MPSEB appear to be an outcome of the GoMP policy to provide free power to single-point connections (un-metered con-

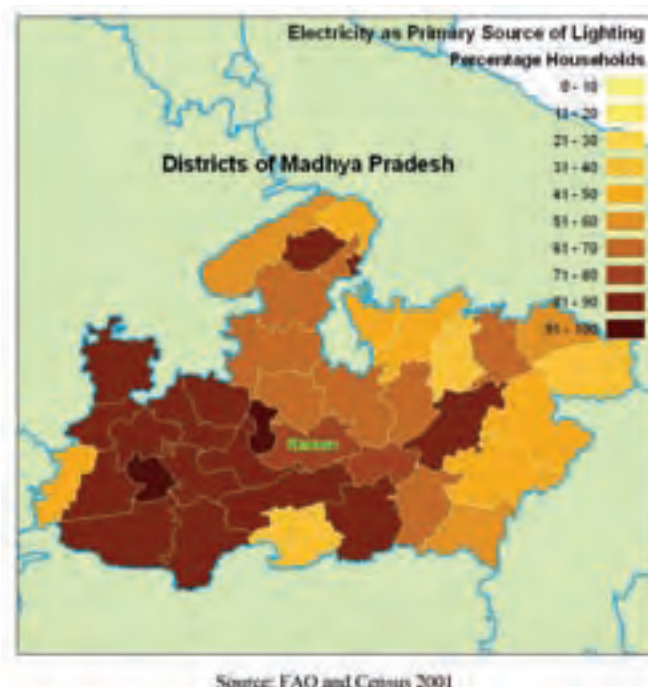


Figure 5. District-wise use of electricity as primary source of light-

Generation	
Installed Capacity <sup>62</sup>	Total (MW)
• Thermal	2272.5
• Hydro	835.0
• Mini/Micro hydro	5.45
• Total	3112.95
• Total generation in 2003-04 <sup>63</sup>	15801.214 M&Wh
Transmission <sup>64</sup>	
• Length of transmission lines in circuit kms	17951 Kms
• Number of substations	158
• Capacity in MVA	18801
Distribution	
• Total no of consumers <sup>65</sup>	6493541
• Total connected load	8897864 kW
• Total No of employees <sup>66</sup>	58774
• Weighted average distribution losses- half early up to June 2005 <sup>67</sup>	36.19%

Table 7. MPSEB figures

nections intended for operation of a single power outlet point only) in urban and rural areas and for agricultural pump connections of up to 5 horsepower. Moreover, GoMP instructed MPSEB to supply almost free electricity to rural electricity cooperative committees (Rs .07 per kWh) and to pursue a vigorous rural electrification program. This resulted in lopsided growth rates in the domestic and primarily agriculture sectors at the expense of the industrial and commercial consumer categories. Industrial consumption was 82.7 percent of total energy consumption in 1970-71, but dropped to only 20 percent of consumption in 1999-2000. During the same period, the percentage of agricultural consumption rose from 3.4 percent to 41 percent.

The situation has been corrected to some extent with the formation of the Madhya Pradesh Electricity Regulatory Commission (MPERC) in 1998 and the subsequent passage of 3 tariff orders emphasizing efficiency improvements and reduction in cross subsidy levels. The State Power Sector Rating

report of the MoP has highlighted the MPERC's latest tariff order (2005-06) as a key positive influence. The timing of such tariff orders, however, deprives the utility of the benefits of the revised tariffs for the full financial year. With low levels of subsidy payments in cash by the GoMP to the utility (about 45 percent) and estimated Aggregate Technical and Commercial (AT&C) losses of 46 percent, the finances of the restructured utilities are further strained.

Utilities that default on loan payments to both the state government and external agencies is a continuing cause for concern. The GoMP needs to resolve the issue of past liabilities as part of the restructuring and unbundling exercise. The financial restructuring plan for the restructured utilities, awaiting clearance from the GoMP, is expected to address a number of these issues.

#### SYSTEM LOSSES

From 1994-95 to 1998-99, transmission and distribution (T&D) losses have varied within the range of 19.6 percent to

20.9 percent. The State Power Sector Rating Report for 2005 has estimated AT&C losses in the state at 46 percent and assigned the utility a score of 3.25 on a maximum of 21 on T&D parameters. According to the tariff petition of 2005, the MPSEB has achieved 100% metering at 33 KV (2,791 nos) and 11KV (5,726 nos) feeders. Furthermore, in the fiscal year of 2004 the utility generated a total of 14,523.56 million units and purchased an additional 14,035.32 million units. Despite this, of the aggregated 28,559 million units input into the system during the year, sale was recorded for 15,996 million units, showing a loss of 44 percent.

The MPERC's multi-year goals for reduction in losses are unlikely to be achieved. In FY04, while the average cost of a unit sold was 4.03 Rupees, the average revenue excluding subsidy was only 3.42 Rupees. Because subsidized sale accounts for 61.8 percent of all electricity sold and 33 percent of all electricity sold is un-metered, collections are minimized. The 2004 Management and

Information Systems (MIS) report of the MPSEB estimates that 22.7 percent of all consumers are un-metered.

#### CONCLUSIONS

Despite noticeable progress, the sector's financial variability and sustainability remain an area of concern. The GoMP's commitment to reform in the sector has been consistent but progress on critical parameters including settlement of past arrears and unfunded pension liabilities requires immediate attention. In addition, the efforts of the MPERC to rationalize the tariff structure needs to be supplemented with the GoMP's commitment to timely release of the full subsidy in cash. The generation sector has shown the best performance since restructuring and the state government has supported the growth in state-owned generation capacity by 18 percent (base year 2002). However, in the absence of concrete actions to check the high AT&C losses, the desired impact of restructuring and unbundling the MPSEB may continue to elude the consumer.



**FLUKE**

## Plug and play power quality.

Analyze. Record. Predict.

The new Fluke 1750 Power Recorder lets you automatically record every power quality parameter and event, on every cycle. Long-term analysis. Power quality surveys. Quality of service compliance. Monitor from PDA, Bluetooth, it's all plug and play.

- Uncover hard-to-find or intermittent issues
- Quantify power quality throughout a facility
- Document results with professional reports
- Validate incoming power quality at the service entrance
- Monitor critical equipment

For more information call 800-36-FLUKE or visit [www.flukecanada.ca/PlayPQ](http://www.flukecanada.ca/PlayPQ)

**Fluke. Keeping your world up and running.™**

**Rugged and reliable power quality recorders, analyzers and troubleshooters. All in the Fluke family.**

Power quality loggers

Power loggers

Power quality clamp meters

Power quality analyzers

# AREVA T&D STEPS UP TO MEET INDIA'S ENERGY CHALLENGES

By Don Horne

AREVA T&D held its 6th Technical Days Conference in India recently, and after two days of presentations and discussions, one thing was abundantly clear - India is on the cusp of becoming an economic giant, and AREVA is at the forefront of making that happen.

The session, held April 5 and 6, brought everyone up to date on the operations of the Transmission and Distribution division and India's energy challenges, the T&D market and associated strategy.

A tour of AREVA's Chennai plants was included in the itinerary, underlining the commitment of the French company in developing India's transmission and distribution needs and with an eye to expanding their export market.

AREVA is renowned the world over for carbon dioxide-free power generation and electricity transmission and distribution. It is also a world leader in nuclear power and the only company to cover all industrial activities in this field - but as the Chairman & CEO of AREVA T&D Philippe Guillemot was quick to point out, the technical days were about transmission and distribution in India, not nuclear.

The transmission and distribution arm of AREVA is but one of four divisions. They are:

## NUCLEAR ENERGY

**Front-End Division:** involved in the nuclear fuel fabrication from uranium ore;

**Reactors & Services Division:** specializing in the design, construction and maintenance of nuclear reactors;

**Back-End Division:** dealing with spent fuel reprocessing and recycling operations, dismantling of decommissioned installations;

and separate from the nuclear divisions, the T&D Division: offering solutions for electricity transport.

The AREVA T&D division supplies products, systems and services for electricity transmission and distribution. They are used to regulate, switch, trans-

form and dispatch electric current in electric power networks connecting the power plant to the final user.

The division's customers are electric utilities as well as the oil, mining and metals, wind energy, paper and glass, transportation, and power engineering industries. This T&D division consists of the four following business units:

## PRODUCTS

The Products business unit designs, manufactures and delivers a complete range of products covering every stage of electric power transmission and distribution.

The business unit operates production units in 25 countries on six continents. The group serves more than 30,000 customers around the globe. The key strengths of the Products business are its research and development expertise, its understanding of changing customer requirements, quality management, and optimized production site operations.

## SERVICES

In addition to product-related services, the Services business unit provides network management services, operating support, and maintenance services to power companies.

The business unit offers medium- and long-term contracts covering the entire life cycle of its customers' electric power systems. These contracts allow power companies to optimize equipment costs and performance while ensuring operator safety.

## SYSTEMS

The Systems business unit offers turnkey projects and grid management systems, offering their substation engineering experience, electric power supply system expertise, command of advanced technologies, and project management know-how.

## AUTOMATION

The Automation business unit helps develop fully integrated energy management networks. The business is built around three main activities: automation and information systems, automation

products and application and support services.

The business unit supplies equipment and information technology systems, including computerized power management systems used to operate power transmission networks, determine customer needs and regulate the flow of power from power plants to the distribution network.

In Chennai, AREVA T&D has an automation plant in Pallavaram and a high voltage switchgear plant in Perugundi. Countrywide, AREVA T&D is looking to be a key player in developing ultra-high voltage in the Direct and Alternating Current fields.

A major component of the 6th Technical Days Conference was the input from local officials on the challenges that country faces (chronic power outages, rampant electricity theft and corruption, insufficient or aging infrastructure), and how best to overcome them. The massive \$12 billion Golden Quadrilateral highway express project in metro Delhi, the \$430 million International airport in Bangalore and Hyderabad's HITEC City are all examples of India's efforts to modernize its infrastructure - and ample evidence of the greater need to bring a stable supply of electricity to these areas.

A staggering 69,000 megawatts worth of projects have already passed the engineering and technical specifications for 2008-2012, with the majority of these projects already under construction (the remainder due to go to tender within the next nine months).

This Herculean increase in generation for India is indicative of the massive leap forward this country is taking as one of the premier nations of the world. AREVA's decision to invest and develop their transmission and distribution facilities in India made clear that the technical days were more than just talk, but a commitment of resources and expertise that will ensure AREVA will be a major player in what may very well be the world's next superpower in the 21st century.

# YOU SAID IT

Romulus Munteanu, a Manufacturing Engineering Manager with W.C. Wood Company Ltd. in Guelph, Ontario writes:

"I consider your magazine one of the best from all available technical publications."

Russell Power, an Engineering Planner with Serco in Happy Valley-Goose Bay Newfoundland-Labrador writes:

"Your publication has provided the company with valuable information and reference material in the past. Your magazine is passed down to the installers and maintenance people; they look forward to your magazines."

Scott Morris, a Technical Supervisor with Hydro One in Hornby, Ontario writes:

"I enjoy your magazine and find many topics applicable to my job. Thanks."

John Quartermain, Operations Supervisor with New Brunswick Power Corporation in St. Stephen, New Brunswick writes:

"I enjoy your magazine and so do the guys in the crew room. Keep up the good work."

Leslie Field, Senior Product Engineer with General Electric Company in Anasco, Puerto Rico writes:


"I would like to see more articles on Protective Relays, especially transformer and distance protective relays."

Lynn Wong, Electrical Discipline Manager with SNC-LAVALIN Inc. in Edmonton, Alberta writes:

"Excellent magazine; informative."


Philip Wood, Practices and Procedures Engineer with the Toronto Transit Commission in Toronto, Ontario writes:

"Electricity Today is a good reference for me. Every issue contains a lot of useful and practical information that is related to my work."



## Arc Flash Analysis in Real-Time

Reduce Risk  
Improve Safety  
Enforce Compliance



**Intelligent Substation**      **Labels & Reports**

ETAP automatically determines short-circuit contributions, primary protective devices, fault clearing times, and incident energies.

View real-time results/alerts and/or print labels & reports.

System Analysis • Device Coordination • Dynamics & Transients  
System Optimization • Distribution Systems • Control Systems  
Battery Systems • Panel Systems • Ground Grids  
Transmission Lines • Cable Systems • Power Quality  
Relay Test Set • Wind Power • GIS  
Real-Time Monitoring • Real-Time Simulation  
Energy Management System • Load Management System  
Intelligent Load Shedding • Substation Automation

**etap.com**  
OPERATION TECHNOLOGY, INC.

# CRUMBLING ROADS, JAMMED AIRPORTS, POWER BLACKOUTS COULD HOBBLE GROWTH

When foreigners say Bangalore is India's version of Silicon Valley, the high-tech office park called Electronics City is what they're often thinking of. But however much Californians might hate traffic-clogged Route 101, the main drag though the Valley, it has nothing on Hosur Road. This potholed, four-lane stretch of gritty pavement — the primary access to Electronics City — is pure chaos. Cars, trucks, buses, motorcycles, taxis, rickshaws, cows, donkeys, and dogs jostle for every inch of the roadway as horns blare and brakes squeal. Drivers run red lights and jam their vehicles into any available space, paying no mind to pedestrians clustered desperately on median strips like shipwrecked sailors.

Pass through the six-foot-high concrete walls into Electronics City, though, and the loudest sounds you hear are the

chirping of birds and the whirr of electric carts that whisk visitors from one steel-and-glass building to the next. Young men and women stroll the manicured pathways that wend their way through the leafy 80-acre spread or coast quietly on bicycles along the smooth asphalt roads.

With virtually no mass transit in Bangalore, Indian technology firm Infosys Technologies Ltd. spends \$5 million a year on buses, minivans, and taxis to transport its 18,000 employees to and from Electronics City. And traffic jams mean workers can spend upwards of four hours commuting each day. "India has underinvested in infrastructure for 60 years, and we're behind what we need by 10 to 12 years," says T.V. Mohandas Pai, director of human resources for Infosys.

India's high-tech services industry

has set the country's economic flywheel spinning. Growth is running at 9%-plus this year. The likes of Wal-Mart, Vodafone, and Citigroup are placing multibillion-dollar bets on the country, lured by its 300 million-strong middle class. In spite of a recent drop, the Bombay stock exchange's benchmark Sensex index is still up more than 40% since June. Real estate has shot through the roof, with some prices doubling in the past year.

But this economic boom is being built on the shakiest of foundations. Highways, modern bridges, world-class airports, reliable power, and clean water are in desperately short supply. And what's already there is literally crumbling under the weight of progress. Economic losses from congestion and poor roads alone are as high as \$6 billion a year, says Gajendra Haldea, an adviser to the federal Planning Commission.

For all its importance, the tech services sector employs just 1.6 million people, and it doesn't rely on good roads and bridges to get its work done. India needs manufacturing to boom if it is to boost exports and create jobs for the 10 million young people who enter the workforce each year. Suddenly, good infrastructure matters a lot more. Yet industry is hobbled by overcrowded highways where speeds average just 20 miles per hour. Some ports rely on armies of laborers to unload cargo from trucks and lug it onto ships. Across the state of Maharashtra, major cities lose power one day a week to relieve pressure on the grid. In Pune, a city of 4.5 million, it's lights out every Thursday — forcing factories to maintain expensive backup generators. Government officials were shocked last year when Intel Corp. chose Vietnam over India as the site for a new chip assembly plant. Although Intel declined to comment, industry insiders say the reason was largely the lack of reliable power and water in India.

Add up this litany of woes and you understand why India's exports total less than 1% of global trade, compared with 7% for China. Says Infosys Chairman



**wire**  
SERVICES

## Airborne LiDAR Data Solutions

- Thermal Rating Analysis
- Vegetation Management
- Digital Imagery & Video
- Upgrade Engineering

[www.wireservices.ca](http://www.wireservices.ca)

**Manitoba Hydro** POWERED BY A TRADITION YOU CAN TRUST **LSI** LiDAR Services International Inc.

N.R. Narayana Murthy: "If our infrastructure gets delayed, our economic development, job creation, and foreign investment get delayed. Our economic agenda gets delayed — if not derailed."

The infrastructure deficit is so critical that it could prevent India from achieving the prosperity that finally seems to be within its grasp. Without reliable power and water and a modern transportation network, the chasm between India's moneyed elite and its 800 million poor will continue to widen, potentially destabilizing the country. Jagdish N. Bhagwati, a professor at Columbia University, figures gross domestic product growth would run two percentage points higher if the country had decent roads, railways, and power. "We're bursting at the seams," says Kamal Nath, India's Commerce & Industry Minister. Without better infrastructure, "we can't continue with the growth rates we have had."

The problems are even contributing to overheating in the economy. Inflation spiked in the first week of February to a two-year high of 6.7%, due in part to bottlenecks caused by the country's lousy transport network. Up to 40% of farm produce is lost because it rots in the fields or spoils en route to consumers, which contributes to rising prices for staples such as lentils and onions.

India today is about where China was a decade ago. Back then, China's economy was shifting into overdrive, but its roads and power grid weren't up to the task. So Beijing launched a massive upgrade initiative, building more than 25,000 miles of expressways that now crisscross the country and are as good as the best roads in the U.S. or Europe. India, by contrast, has just 3,700 miles of such highways. It's no wonder that when foreign companies weigh putting new

plants in China vs. India to produce global exports, China more often wins out.

China's lead in infrastructure is likely to grow, too. Beijing plows about 9% of its GDP into public works, compared with New Delhi's 4%. And because of its authoritarian government, China gets faster results. "If you have to build a road in China, just a handful of people need to make a decision," says Daniel Vasella, chief executive of pharmaceutical giant Novartis. "If you want to build a road in India, it'll take 10 years of discussion before you get a decision."

Blame it partly on India's revolving-door democracy. Political parties typically hold power for just one five-year term before disgruntled voters, swayed by populist promises from the opposition, kick them out of office. In elections last year in the state of Tamil Nadu, for instance, a new government was voted in after it pledged to give free color TVs to poor families.

Then there's "leakage" — India's euphemism for rampant corruption. Nearly all sectors of officialdom are riddled with graft, from neighborhood cops to district bureaucrats to state ministers. Indian truckers pay about \$5 billion a year in bribes, according to the watchdog group Transparency International. Corruption delays infrastructure projects and raises costs for those that move ahead.

Fortunately, after decades of underinvestment and political inertia, India's political leadership has awakened to the magnitude of the infrastructure crisis. A handful of major projects have been completed; others are moving forward. Work on the Golden Quadrilateral — a \$12 billion initiative spanning more than 3,000 miles of four- and six-lane expressways connecting Mumbai, Delhi, Kolkata, and Chennai — is due to be completed this

year. The first phase of a new subway in New Delhi finished in late 2005 on budget and ahead of schedule. And new airports are under construction in Bangalore and Hyderabad, with more planned elsewhere. "We have to improve the quality of our infrastructure," Prime Minister Manmohan Singh told a gathering of tech industry leaders in Mumbai on Feb. 9. "It's a priority of our government."

Singh, in fact, is promising a Marshall Plan-scale effort. The government estimates public and private organizations will chip in \$330 billion to \$500 billion over the next five years for highways, power generation, ports, and airports. In addition, leading conglomerates have pledged to overhaul the retailing sector. That will require infrastructure upgrades along the entire food distribution chain, from farm fields to store shelves.

Envisioning a brand-new India is the easy part; paying for it is another matter. By necessity, since the country's public debt stands at 82% of GDP, the 11th-worst ranking in the world, much of the money for these new projects will have to come from private sources. Yet India captured only \$8 billion in foreign direct investment last year, compared with China's \$63 billion.

Just about every foreign company operating in India has a horror story of the hardships of doing business there. Nokia Corp. saw thousands of its cellular phones ruined last October when a shipment from its factory in Chennai was soaked by rain because there was no room to warehouse the crates of handsets at the local airport. Japan's Maruti Suzuki says trucking its cars 900 miles from its factory in Gurgaon to the port in Mumbai can take up to 10 days. That's partly due to delays at the three state borders along the way, where drivers are

<p><b>Featured Product:</b></p> <p><b>AEMC® DTR-8500</b></p>  <p>The DTR-8500 is a portable digital transformer ratiometer designed for on-site testing of power, potential and current transformers. When connected to a non-energized transformer, the DTR-8500 accurately measures primary to secondary turns ratio, while simultaneously displaying polarity and excitation current.</p> <p>Rugged and reliable, the DTR-8500 is built into an attractive, sealed structural polypropylene case designed to withstand the rigors of industrial and utility field use.</p>	<p>← <b>Transformer Ratiometer</b></p> <p><b>techniCAL</b></p> <p>...Power Analyzers→</p>	<p><b>Featured Product:</b></p> <p><b>RANGER PM7000</b></p>  <p>The new Ranger PM7000 power analyzer and logger sets new standards with over 500 logging channels, and it is waterproof and rated at Category IV for maximum operator safety. The PM7000 is used in a wide range of power measurement and analysis applications on industrial sites and by power distribution companies and regulatory authorities. Incidents such as motor start surges, transients, sag, flicker, notch, ring, negative sequence voltage, unbalance, etc. are easily seen and can be measured in detail for several weeks.</p>
<p><b>Test &amp; Measurement</b>      <b>www.technical-sys.com</b>      <b>Power Quality</b></p> <p>Tel: 905-575-1941 Fax: 905-575-0366</p>		

stalled as officials check their papers. But it's also because big rigs are barred from India's congested cities during the day, when they might bring dense traffic to a standstill. Once at the port, the Japanese company's autos can wait weeks for the next outbound ship because there's not enough dock space for cargo carriers to load and unload.

Companies often have no choice but to make the best of a bad situation. Cisco Systems Inc., the American networking equipment giant, has had a research and development office in India since 1999 and already has 2,000 engineers in the country. To supply the country's fast-growing telecommunications industry, Cisco decided last year to try its hand at making some parts locally. In December it contracted with another company to build Internet phones in the southeastern city of Chennai. Although Cisco says the quality of the workmanship is up to snuff, it has to fly parts in because the ports are so slow — and getting them to the factory right when they're needed is proving nettlesome. "We believe in manufacturing in India, but we don't believe in logistics in India — yet," says Wim Elfrink, Cisco's chief globalization officer. Elfrink adds that unless the Chennai operation demonstrates it can run as effi-

ciently as Cisco setups elsewhere, it won't go into full production this summer as planned.

Even the world's largest maker of infrastructure equipment is constrained by India's feeble underpinnings. General Electric Co. last year sold \$1.2 billion worth of gear such as power generators and locomotives in India, more than double what it billed in 2005. To meet that surging demand, it is scrambling to find a location where it can manufacture locomotives in partnership with India Railways. But when GE dispatched three employees to survey a potential site the railway favored in the northern state of Bihar, the trio returned discouraged. It took five hours to drive the 50 miles from the airport to the site, and when they got there they found... nothing. "No roads, no power, no schools, no water, no hospitals, no housing," says Pratyush Kumar, president of GE Infrastructure in India. "We'd have to create everything from scratch," including many miles of railroad tracks to get the locomotives out to the main lines.

But there is a silver lining for GE and other international giants: India's infrastructure deficit could yield huge opportunities. American executives who traveled to India last November on the

largest U.S. trade mission ever were tantalized by the possibilities. Jennifer Thompson, director of international planning at Oshkosh Truck Corp., viewed construction projects where swarms of workers carried wet concrete in buckets to be poured. That told her there's great potential in India for selling Oshkosh's mixer trucks. "There are infrastructure challenges, but we see a lot of opportunities to help them meet those challenges," she says.

That explains why so many multinationals are flocking to India. Take hotel construction: In a country with only 25,000 tourist-class hotel rooms (compared with more than 140,000 in Las Vegas alone), companies including Hilton, Wyndham, and Ramada have plans for 75,000 rooms on their drawing boards. Or consider telecom. Because of deregulation and ferocious demand, India boasts the fastest growth in cellphone service anywhere, with companies adding some 6 million new customers a month. No wonder Britain's Vodafone Group PLC just ponied up \$11 billion for a controlling interest in Hutchison Essar, India's No. 4 mobile carrier. U.S. private equity outfits also want in on the action. On Feb. 15, Blackstone Group and Citigroup announced they are teaming up

## platts 4th Demand Response and Energy Efficiency

June 15–15, 2007 • The Westin Grand • Washington, D.C.

**Register by May 4th and SAVE \$300!**

Platts 4th Demand Response and Energy Efficiency features speakers from the wholesale and retail level, as well as commissioners and other government officials, giving a complete picture of demand response and energy efficiency initiatives.

### Topics for this year include:

- FERC's support of demand response initiatives
- Achieving customer buy-in
- Coordinating wholesale and retail demand response efforts
- Financing demand response
- Large-scale demand response and energy efficiency projects
- Advances in smart metering and technology

### Gain insights from industry leaders including:

- Jon Wellingshoff, FERC
- Henry Yoshimura, ISO New England
- Peter Smith, NYISERDA
- Ed Myszkowski, Comverge, Inc.
- William Flynn, Energy Curtailment Specialists, Inc.
- Neal Dikeman, Jane Capital Partners LLC
- Jeff Bladen, PJM Interconnection
- Sean Brady, Ontario Power Authority
- Christopher Drake, Avista Utilities
- Joseph Van Den Berg, Booz Allen Hamilton
- Doug Smith, National Grid
- Rob Hartway, Elster Integrated Solutions
- Steven Mysholowsky, Con Edison, Inc.
- Gary Fescine, New York Post
- Steve Rosenstock, Edison Electric Institute
- Louis Szabalya, GridPoint
- Charles Parsons, Cannon Technologies/Cooper Power Systems

For a complete agenda or to register and SAVE \$300, please visit us at [www.events.platts.com](http://www.events.platts.com) or call us at 866-355-2930 (toll-free in the USA) or 781-860-6100 (direct).

Registration Code: PC742ET

The McGraw-Hill Companies

with the Indian government and the Infrastructure Development Finance Corp. to set up a \$5 billion fund for infrastructure investments in India.

But while the laws of supply and demand would argue that India's infrastructure gap can be filled, that logic ignores the corrosive effect of the country's politics. To gain the favor of voters, Indian politicians have long subsidized electricity and water for farmers, a policy that has discouraged private investment in those areas. That's what wrecked the now-infamous Dabhol Power plant. In the late 1990s, Enron, GE, and Bechtel spent a total of \$2.8 billion building a huge complex near Mumbai capable of producing more than 2,000 megawatts of electricity. But a government power authority set prices so low that it was uneconomical for Dabhol to operate, and the whole deal

**In the late 1990s, Enron, GE, and Bechtel spent a total of \$2.8 billion building a huge complex near Mumbai capable of producing more than 2,000 megawatts of electricity. But a government power authority set prices so low that it was uneconomical for Dabhol to operate, and the whole deal fell apart.**

fell apart. (The plant, taken over by an Indian organization, now runs only fitfully.) A 2001 law was supposed to create a framework to support private investment in power generation. But according to American construction company executives, it's not working well. "Everybody knows what needs to be done, but they have great difficulty doing it," says one of the Americans. "If the party in opposition offers subsidized power, the party in power has to give subsidized power to get reelected."

Politicians who refuse to play the game pay a steep price. N. Chandrababu Naidu, the former chief minister of the state of Andhra Pradesh, transformed the state capital of Hyderabad from a backwater into a high-tech destination by building new roads, widening others, and aggressively carving out land for factories and office parks. Google, IBM, Microsoft, and Motorola have all built R&D facilities there.

His reward? Voters tossed him out of office two years ago. During his decade in power, Naidu didn't do enough for rural areas, and his challenger promised to channel state funds into irrigation projects and electricity subsidies. "Naidu thought economics were more important than politics. He was wrong," says V.S. Rao, director of the Birla Institute of Technology & Science in Hyderabad. Naidu, 56, is plotting a comeback in elections two years hence. This time, he's

preaching a new gospel. "You can't just target growth," says a chastened Naidu. "You have to create policies that make the wealth trickle down to the common man."

But even when politicians say they're beefing up infrastructure, it rarely helps the poorest Indians. Agriculture is stagnant in part because of a lack of the

most rudimentary of roads to get to and from fields. N. Tarupthurai, for instance, scratches out a living from a five-acre plot in Jinnuru, a village in northeastern Andhra Pradesh. But his fields are more than a mile from the nearest paved road, so each day the 40-year-old Tarupthurai must carry his tools, seeds, fertilizer, and crops down a dirt path on his back or on his bicycle. "I have asked for a road, and the government

says it's under consideration," says the mustachioed, curly-haired farmer. Then he shrugs.

One reason little practical help makes it from the seats of power to India's impoverished villages is that so much money gets siphoned off along the way. With corrupt officials skimming at every step, many public works projects either go over budget or are never completed. "You figure that 25% of the cost goes to corruption," says Verghese Jacob, head of the Byrraju Foundation, which promotes rural development. "And then they do such a bad job that the road falls apart in one year and has to be patched over again," Jacob says as he jostles along in a car on a potholed byway outside Hyderabad.

None of the solutions to India's infrastructure challenges are simple, but business leaders, some enlightened government officials, and even ordinary citizens are chipping in to make things better. The most potent weapon India's reformers have against corruption is transparency. Last October a new right-to-information law went into effect requiring both central and state governments to divulge information about contracts, hiring, and expenditures to any citizen who requests it. The country is also putting to work its vaunted technology prowess to police the government. Officials in 200 districts are using software from Tata Consultancy Services

Ltd. to help monitor a government program that offers every rural household a guarantee of 100 days of work per year. Most of this labor goes into public works. To minimize "leakage", the TCS software tracks every expenditure — and makes all of the information available real-time on a Web site accessible to anyone.

Sometimes frustrated Indians take matters into their own hands. Tired of spending four-plus hours a day in traffic, Aruna Newton last fall helped organize something of a women's crusade to speed up infrastructure improvements. Nearly 15,000 volunteers now monitor key road projects and meet with state officials to press for action. They even enlisted the state chief minister's mother, who helped get his attention. "It's about the collective power of the people," says Newton, a 40-year-old vice-president for Infosys. "I just wish building a road was as easy as writing a software program."

Increasingly, companies trying to expand in India have the government as a willing partner rather than a roadblock. The state of Andhra Pradesh rolled out the red carpet last year for MAS Holdings Ltd. of Sri Lanka, South Asia's largest garment manufacturer. It promised subsidized electricity, new access roads, and even a deepwater port if the company would place a huge industrial park on the southern coast. Now MAS Holdings plans to build a cluster of factories that will eventually employ 30,000 production workers. And it chose India over China. "The government support was absolutely vital," says John Chiramel, India director for MAS Holdings. "If we can work together, there's no stopping growth in this country."

— Don Horne, Electricity Today

**Need Help?  
Need A Job?  
Contact Lisa—**



Call or send confidential resume to  
**LISA LINEAL: LINEAL** Recruiting Services  
MORE THAN 25 YEARS EXPERIENCE!

**TOLL FREE 877-386-1091**

**lisalineal@lineal.com**  
**www.lineal.com**

Electromechanical • Electronic  
Electrical Service & Systems Specialists

*Se Habla Español*

# GREENHOUSE GAS IMPLICATIONS IN LARGE SCALE INFRASTRUCTURE INVESTMENTS IN DEVELOPING COUNTRIES

By Mike Jackson, Sarah Joy, Thomas C. Heller, and David G. Victor

Meaningfully addressing global climate change concerns necessarily entails curbing the greenhouse gas (GHG) emissions of key developing economies. In 2002 China and India together accounted for roughly 18% of global CO<sub>2</sub> emissions, the leading human cause of climate change. These countries' growth in GHG contribution outpaces that of the U.S. and the European Union (E.U.), and by 2020 they will together account for one quarter world's CO<sub>2</sub> emissions (Figure 1). Engaging China and India in climate change agreements is difficult because climate concerns understandably take a backseat to the priority these countries place on development. Traditional approaches to involving reluctant countries in international climate policy have proven incapable of enticing or coercing the cooperation of these countries.

Presently, the Kyoto Protocol's Clean Development Mechanism (CDM) is recognized as the principal international apparatus for engaging developing countries in GHG abatement. However, poor oversight and governance, as well as gaming have plagued the CDM, and we anticipate that the mechanism's ultimate impact on developing countries' baseline emissions will be modest (Figure 2). Furthermore, those changes that the CDM exacts are marginal and do not create game-changing technology or infrastructure necessary to curb developing world emissions in the long run. For example, in practice, CDM projects have not adequately addressed developing countries' reliance on coal. And as of December 2005, less than a quarter of the CDM market was devoted to projects aimed at reducing CO<sub>2</sub> emissions (Figure 3).

## "DEVELOPMENT FIRST"

We assert that effectively engaging developing countries in climate change abatement regimes requires infrastructure investments that accommodate the high energy demands of economic growth and development. Espousing this theory of "development first", we formulate here two possible "deals" that could occur in China and India with assistance from the developed world. Both plans are built on the assumption that these countries will participate in a CO<sub>2</sub> abatement program only if the program assists (or at least accommodates) their unhindered procurement of the energy needed to foster economic and population growth.

## INDIA

India's total primary energy consumption was 376 million tonnes of oil equivalent (Mtoe) in 2004 and is expect-

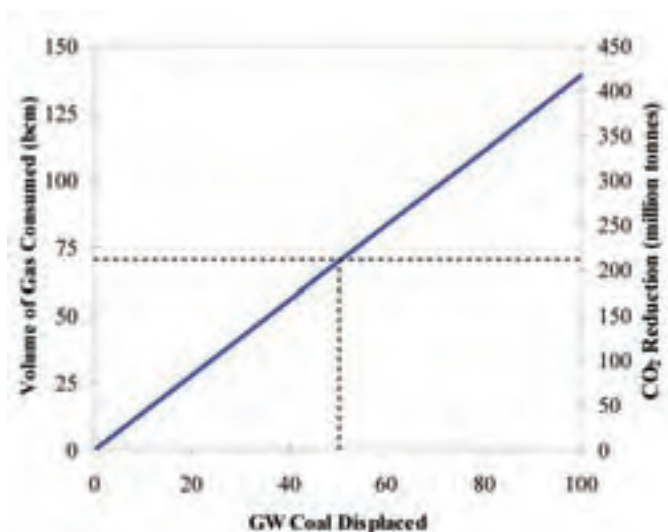


Figure 1: Implications of Coal Displacement in China in 2020

ed to reach 829 Mtoe by 2020. As with China, coal dominates India's electricity landscape, accounting for about 60% of total installed capacity. Table 1 details India's projected capacity.

We explore the carbon implications of the recent deal between India and the U.S. to share and implement nuclear energy technologies. While there are a range of assumptions of the amount of new capacity this technology transfer could provide by 2020, we analyze a middle-of-the-road estimate of 30 GW of new nuclear capacity. Under this scenario, nuclear would save 218 million tonnes of CO<sub>2</sub> if it displaced only coal capacity, and 83 million tonnes if it replaced exclusively gas. In practice, nuclear capacity would likely replace a mix of both coal and gas, and the emissions reduction would fall within this range.

We make the following assumptions about the load factor and carbon intensity of coal, gas, and nuclear plants in India (Table 2).

The carbon implications of new nuclear capacity are determined by calculating the annual energy produced by the nuclear plants and estimating the displaced CO<sub>2</sub> emissions from coal and natural gas. Note that 30 GW of nuclear capacity displaces 32 GW of coal capacity, owing to coal's

Table 1: India Reference Scenario

	Installed Capacity (GW) <sup>1</sup>	
	2002	2020
Coal	69	127
Gas	13	45
Nuclear	3	9
Total Capacity <sup>2</sup>	116	252

<sup>1</sup> Source: World Energy Outlook 2004

<sup>2</sup> Total capacity includes coal, gas, oil, nuclear, hydro, and renewables.

lower load factor (Table 3).

The CO2 implications of replacing coal or gas with a range of installed nuclear capacities are provided in Figure 2. Assuming nuclear will displace a mixture of coal and gas, the carbon reductions for any given nuclear capacity will fall between these two lines.

### CONCLUSION

The deals modeled in this paper are meant to demonstrate that well-structured investments in energy infrastructure in developing countries have the potential to bring about massive reductions in CO2 emissions (Figure 2). Such investment deals show promise not only because they represent viable means of carbon mitigation; we argue that, in helping these countries achieve their energy and development goals, these deals represent the only feasible way of engaging reluctant countries in emissions reductions.

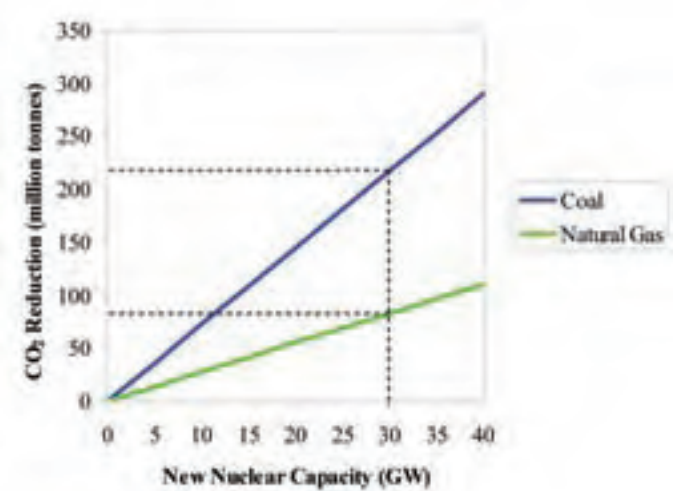


Figure 2: Carbon Implications for Indian Nuclear Deal

Table 2: India Nuclear Deal Load Factor and Carbon Intensity Assumptions

	Nuclear	*Subcritical Coal	CCGT
Load Factors	0.90	0.85	0.90
Emissions rate (tonne CO <sub>2</sub> /GWh)	0	920	350

\*CCGT: Combined Cycle Gas Turbines

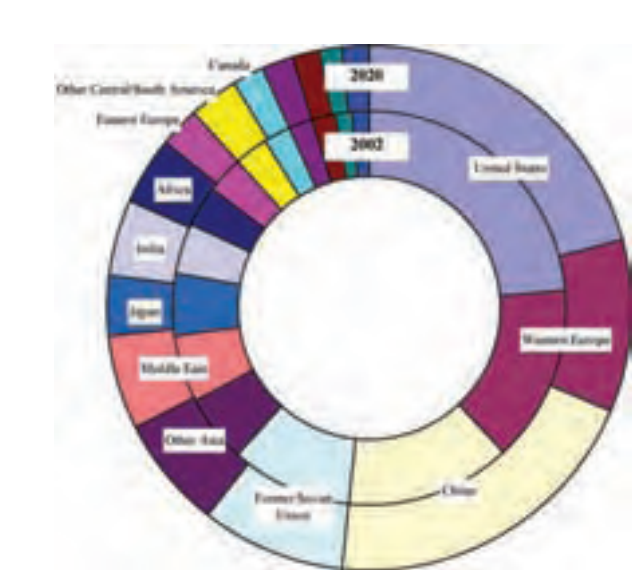
Table 3: Emissions Reductions Implications of India Nuclear Deal

	Nuclear Replaces Coal	Nuclear Replaces Gas
Displaced Capacity (GW)	32	30
Total Generation (TWh)	237	237
CO <sub>2</sub> Emissions Reductions (million tonnes CO <sub>2</sub> /year)	218	83

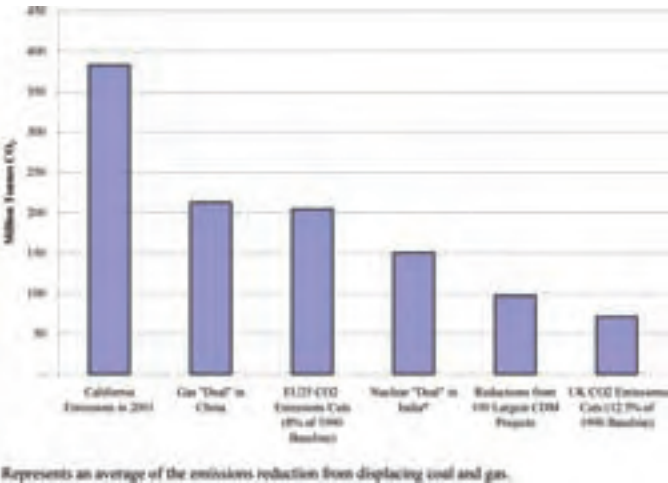
Successful implementation of these energy infrastructure investments requires attention to three general areas. Firstly, targeted developing countries need flexible, but credible policy, that can adapt to these energy infrastructure changes. Second, the right actors, including private entities adept at managing technical and political risk, need to be involved in these infrastructure deals.

Lastly, contextual changes in areas such as price formation and security concerns may be needed to accommodate newly established energy markets. Our institution, The Program on Energy and Sustainable Development, focuses on these issues in our other work and plans to examine them in the context of these deals.

The purpose of the analyses here is simply to provide a rough estimate of the magnitude of these deals’ potential CO2 savings. Our models’ implications underscore the need for further and more sophisticated analysis.



Appendix  
Figure 1: Global CO2 Emissions by Region (2002 and 2020)



Appendix  
Figure 2: CO2 Savings in Perspective  
\* Represents an average of the emissions reduction from displacing coal and gas.

# SECURING CRITICAL INDUSTRIAL NETWORKS

By Ron Derynck, Director of Product Strategies, Verano

Companies today – particularly those in critical infrastructure industries such as electrical power, telecommunications, water, transportation, and oil and gas – face a daunting and challenging environment. On the one hand there is a real threat of cyber terrorism, hacking, as well as both unintentional and malicious security breaches, and management must act to protect mission-critical assets, customers and employees.

On the other hand, pressure to improve financial performance is driving companies to improve efficiencies through tighter integration of operations, both within the facility and with supply chain partners.

How do companies deal with these two seemingly conflicting needs? Is it possible to go back to the good old days when automation systems were isolated from the rest of the world to protect them from cyber threats that way?

Not according to Bill Moore, Vice President of ARC Manufacturing Advisory Services, who wrote in a recent ARC Insight, “If we are to collaborate in manufacturing and wring out inefficiencies in our Supply Chain, we need to have our manufacturing operations connected to the outside world. Our communications and connections need to utilize standard protocols to facilitate the transfer of information between trading partners.”

If isolation isn’t practical in today’s world, how do companies protect their manufacturing and infrastructure assets while improving efficiencies?

The first step is to understand a facility’s vulnerability. For example, a major industrial company learned there were over 500 entry points to the corporate LAN and that two thirds of their process control networks were thereby connected to the outside world. As sobering as this is, cyber intruders may not even be the greatest threat. Malicious insiders armed

with specialized knowledge and privileged access are capable of doing great harm.

Faced with both external and internal threats, what steps are necessary to protect critical industrial control systems

with specialized knowledge and privileged access are capable of doing great harm.

MONITOR – An initial, comprehensive vulnerability assessment followed by continuous, automated monitoring.

DETECT – Recognition of unusual operational patterns indicating possible attack.

NOTIFY – Real-time notification and alert of appropriate personnel.

PROTECT – Effective neutralization and quarantine of cyber attackers.

RECOVER – Safe, timely operational recovery from successful cyber attacks.

Based on these five best practices, senior IT and management executives should consider the following blueprint to providing optimal security solutions:

1. Beef up the defenses of existing systems by conducting a vulnerability assessment, adding intrusion detection and real-time security event monitoring software.

2. Install a gatekeeper or guard that isolates the control network while supporting secure transfer of real-time information to corporate users and systems. To be an effective gateway, such systems must themselves be highly resistant to internal and external threats.

3. Deploy critical systems like SCADA or DCS control systems on operating systems that are specifically designed to provide a high degree of protection and integrity.

Steps one and two can be applied to existing industrial networks to strengthen their defenses, while the third step is most appropriate for new systems or a major upgrade. To avoid introducing new vulnerabilities, all three approaches should be based on a platform that is, itself, extremely secure. To achieve this high level of security, it’s necessary to look at the capabilities of the computer operating system.

SECURITY STARTS WITH THE  
OPERATING SYSTEM

The vulnerabilities of systems cur-

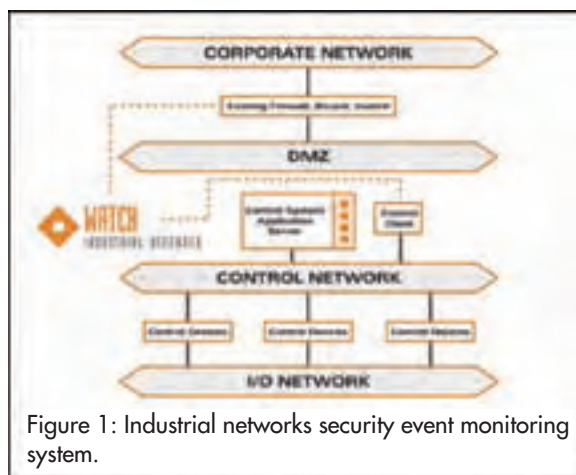


Figure 1: Industrial networks security event monitoring system.

and still allow them to serve real-time information to knowledge workers?

The risks of making the wrong decision are enormous. Consider the ramifications of two trains heading toward each other on the same track due to software hacked by a disgruntled employee. Or, the cost of a chemical plant spilling hazardous material because a worm disables part of a control system. Or, the result of a widespread power outage due to a coordinated cyber attack on multiple power plants.

## PROTECTING NETWORKS

Industrial networks utilize the same computers and communication technologies as the corporate network but also have unique equipment and operating constraints. It will take a marriage of control system expertise and cyber security knowledge to properly secure these systems. IT managers who are responsible for cyber security need to consult with their colleagues responsible for the control systems and find vendors that understand both domains.

Federal and state government agencies recommend the following best prac-

Continued on Page 32



# Electricity 2007

Denver, CO • June 17-19, 2007

**EEI** Annual Convention/Expo

## ***Dynamic New Directions***

This June, tackle the key issues that affect how you and your company invest in America's electric future—at EEI's Annual Convention/Expo in Denver. There, you can explore the most important topics at Critical Issue Forums—exciting executive panels with audience participation designed to give you insight from the highest levels.

- Federal and state regulation
- Electric companies and efficiency
- Greenhouse gas emissions reductions
- Strategic industry trends
- The smart grid
- Building new generation
- Outsourcing utility operations
- Industry workforce issues
- Fuel trends and generation choices
- Renewable portfolio standards
- Plug-in hybrid electric vehicles
- Carbon capture and storage

**Discover the industry's dynamic new directions . . .**

**At EEI's Annual Convention/Expo**  
**June 17-19, Denver, CO**

Plus, you'll hear high-powered speakers at the General Sessions... see the latest technologies, products, and services at the Expo... attend memorable networking events, where you can share ideas and socialize with industry leaders... and more.

**For more information, visit [www.eei.org/2007](http://www.eei.org/2007) today!**

If you have AMR, you can have

# Prepaid Without The Hardware!

## Increase:

- Energy awareness
- Payment options
- Ability to make smaller, more frequent payments

## Minimize:

- Disconnections
- Add-on charges
- Customer service calls
- Need for deposit

Prepaid ~~can~~ <sup>will</sup> impact your future

Call Today!  
972.852.2711

www.exceleron.com  
eMail: sales@exceleron.com



## Critical Networks

Continued from Page 30

rently deployed are well known. Trojan horses, viruses, worms, and other forms of attack are documented daily by the press. Most security efforts go into plugging these holes as they are discovered and erecting barriers around systems to shield them from attacks.

Barriers such as firewalls are, and will continue to be, important elements of a cyber defense plan. However, it's necessary to realize that unless a firewall is configured to block all incoming and outgoing traffic, it does not provide protection against data driven attacks such as a virus or trojan. And a firewall does not protect a network from an internal attack.

Indeed, the last line of defense is the security provided by the operating systems on which applications run. Most operating systems in use today, whether UNIX or Windows, base security on the concept of discretionary access control (DAC) and provide only two categories of user:

- An administrator who has full access to all system resources and
- Ordinary users who have full access to the applications and files they need for their jobs.

DAC, as the name implies, does not enforce a system wide security policy and all protective measures are under the control of individual users. Any program run by a user inherits all the permissions of that user and is free to modify any file that the user has access to. That's why a virus that infects an email program spreads so easily.

One can think of DAC as similar to a physical security system where there is only a lock on the front door of the building. If a person forgets to lock the door, or a thief, by trickery or force, gets past the front door, he has complete access to all the rooms and equipment in the building. No one would protect an important facility with such a simple physical security scheme. Instead, each room and critical piece of equipment would have its own lock and authorized personnel would be issued security cards granting them access to only certain rooms and equipment based on the nature of their jobs. With this scheme, whole sections of the building are off limits to individuals with low security clearance.

Is there a computer equivalent to the more thorough physical security schemes? Yes, highly secure computer systems are based on the concept of mandatory access control (MAC). Although the concept has been around since the 1980s, practical systems running on readily available hardware have only recently become available.

MAC provides the means for a central administrator to apply system-wide access policies which are enforced by the operating system. It provides individual security domains that are isolated from each other unless explicit access privileges are specified. It provides fine grained access control to programs, system resources and files. MAC supports a wide variety of categories of users and confines the damage that flawed or malicious software can cause to an individual domain.

DAC systems start with the premise that all system resources are accessible and security is added by restricting access to some components, MAC starts with the premise that no resources are accessible and all operations have to be explicitly enabled. With this difference in security philosophy, mandatory access controls represent the best available mechanism to protect critical systems from both internal and external

cyber threats.

But if most operating systems are based on DAC concepts, how does IT management deploy high security systems with mandatory access control?

#### LINUX AND SELINUX

Linux is a relatively new operating system that is gaining rapid acceptance in the IT community. Linux inherits many of its concepts, including security and access control, from its UNIX predecessors that have a long history in mission critical applications. Linux runs on commodity PC class hardware, yet delivers the robustness and reliability needed for the most demanding applications.

Linux is inherently less vulnerable to the viruses and other malicious code that can attack our home PCs. The basic structure of the operating system makes it more difficult to insert and run such code while the permission system minimizes potential damage. Disabling unnecessary services, to avoid their vulnerabilities, is also easy to accomplish in Linux.

Additional security software to protect password files, create Virtual Private Networks and embed a software firewall – protecting the machine from Denial of Service (DOS) attacks – are readily available for most Linux distributions.

Like their commercial brethren, standard Linux distributions utilize discretionary access control techniques. However, the U.S. National Security Administration (NSA) has enhanced Linux to create one of the most advanced security systems available today. Security Enhanced Linux or SELinux is designed to meet the NSA's stringent needs for a secure operating system and is available as a module for the Redhat 7.3 Linux distribution.

SELinux is the only operating system that can provide a high degree of internal protection and isolation for critical applications. Verano is adapting this technology as the basis for its

Industrial Defender product family because of its inherent ability to protect applications and information at the operating system level – the last line of defense.

#### REAL-TIME MONITORING

The process and utilities industries routinely use real-time computer systems to monitor the health and safety of their operations. But the health and security of these computer networks remains invisible. What if we could watch for or monitor security incidents in the same way as a SCADA system monitors flow rates and alerts an operator to a dangerous condition?

Security event monitoring systems (see Figure 1) are being developed for this purpose. They consist of security agents that are installed on existing computers to report on machine health, changes in security log files and application status. This information is sent to a security console where it is stored in a real-time database. From there, alarm limits can be set, alerts generated, incident reports created and trends displayed. The security console also runs network intrusion detection software and has the ability to monitor network equipment such as switches, routers and firewalls via the Simple Network Management Protocol (SNMP).

There is an old truism that a person

can't control what isn't measured and this applies to security as well. Security event management systems give organizations a better view of their vulnerability by aggregating information generated by firewalls, intrusion detection systems, switches and other network devices. In the industrial environment, information from plant computers and application programs needs to be added to the mix to ensure the availability and security of these critical systems.

Without security event monitoring, companies are flying blind and have no idea what their vulnerabilities are or even if they are under attack – until it's too late. In particular, industrial networks can benefit from this approach because some IT practices such as password lockout, frequent patch updates and periodic virus scanning don't translate well to the plant environment since they compromise the safety and integrity of the operation.

Installing a security event monitoring system at key facilities provides many benefits including:

1. A central view of industrial network equipment, applications and computers providing an overview of the current security status.
2. Key information to reduce or mitigate future security risks.
3. Satisfying emerging government, insurance and industry requirements concerning cyber security.

**Are you an expert in Arc Flash and Electrical Safety?**  
**Your talents are needed NOW!**

# ELECTRICAL TRAINERS

**NEEDED**

**If you have considerable working experience in any of these areas AND you have experience in instructing courses in these areas, then send your resume to:**  
**Randolph Horst, President.**  
**ruh@eforum.com**

**for a variety of subjects:**  
Arc Flash Analysis  
Industrial Electrical Safety  
Air Conditioning & Refrigeration  
Short Circuit Study  
Coordination Study  
Arc Flash Study  
Circuit Breaker Testing and Maintenance  
Electrical Relay Protection  
2006 Canadian Electrical Code  
Power Transformer Maintenance  
Programmable Logic Controllers  
Basic Electricity for the Non-Electrician  
Variable Frequency Equipment  
Test and Measurement Equipment  
Boiler Operation, Maintenance & Diagrams  
Generators & Emergency Power  
Motors, Controls and Starters

The Electricity Forum is one of North America's largest Electrical Training organizations. Since 1986, The Electricity Forum has trained more than 10,000 electrical professionals across North America on a wide range of subjects. Our company is seeking experienced electrical training instructors for our public enrollment and private training courses. We offer a competitive and innovative package of training fees and expenses.

The Electricity Forum publishes The Electrician, The Electrician's Magazine, and 12 Annual Technical Handbooks. The website is [www.electricalforum.com](http://www.electricalforum.com). We have over 20 million pages, 10,000 & 100,000 & 1 million member profiles.

# WHY ARE ELECTRICITY PRICES INCREASING?

By Gregory Basheda, Marc W. Chupka, Peter Fox-Penner, Johannes P. Pfeifengerger and Adam Schumacher of the Brattle Group

For more than a century, the electric power industry has supplied the United States with abundant and reliable electricity. The industry that brought “smokeless light” to American cities in the late 1800s now supplies the power for more than 176 million personal computers and a national network of 208 million cellular phones, contributing to both industrial productivity and consumer comforts that enhance our standard of living.

The power industry now faces an unprecedented challenge. At a time of record high fuel prices, historic environmental challenges, and industry structural change, the nation’s demand for reliable electric power continues to grow. While much of the nation’s power infrastructure is aging, the industry must keep up with the need for more capacity, increased reliability and power quality, and lower environmental impacts. Thus, the industry must invest in a new generation of power plants, environmental controls, transmission lines, and distribution system expansions and upgrades.

While these new investments will maintain reliability, diversify our fuel mix, and increase environmental performance, they come with added costs. Electricity price increases are occurring across the United States, among all types of electricity providers, to one degree or another. The extent to which increasing utility costs are recovered in rates will determine the financial condition of the industry and affect its ability to make future generation, transmission, distribution, and environmental investments in a timely manner.

With appropriate rate treatment, the industry will continue to provide reliable services at reasonable costs.

Conversely, if segments of the industry become unable to finance new investments in a timely or cost-effective manner, the ultimate costs will be borne by the local economies and consumers served by these utilities, as well as by utility shareholders. Failure to receive adequate rate treatment could impact the quality of service, impair the ability of the utility industry to meet growing demands for clean, reliable power, and undermine the financial health of the utility industry.

## Overview of Findings

**FUEL AND PURCHASED POWER COST INCREASES HAVE BEEN ENORMOUS AND ARE THE LARGEST CAUSE OF RECENT ELECTRIC COST INCREASES**

On an industry-wide basis, our analysis finds that fuel and purchased power costs account for roughly 95 percent of the cost increases experienced by utilities in the last five years. The increases in the cost of these fuels have been unprecedented by historical standards, affecting every major electric industry fuel source:

- Natural gas, which accounts for nearly 20 percent of all generation, experienced a more than 100-percent increase in spot prices between 2003 and 2005 and a more than 300-per-

cent increase since 1999. Real natural gas prices are now at their highest level in modern history. High and volatile gas prices have a particularly strong impact on electricity prices because gas-fired generators set the prices for a large percentage of the time in many short-term or spot power markets around the country.

- Oil, which is still a significant utility fuel in several parts of the country, is now at record price levels.

The prices of oil-based fuels delivered to electric generators rose about 50 percent between 2003 and 2005, and are now at the highest nominal levels ever recorded. Increased oil prices also have a significant impact on other fuel costs; for example, they drive up the costs of mining and shipping coal.

- Coal, which accounts for half of all power produced in the United States today, has risen 20 percent in delivered price in the last two years alone. In some areas, the increase has been much higher. For example, spot coal prices from the Powder River Basin have increased about 100 percent since 2003.

- The price of uranium, the primary component of nuclear fuel, which represents 19 percent of all generation, also has increased by about 40 percent since 2001.

These fuel price increases, in turn, have impacted the cost of power purchased by many utilities. The price of purchased spot power has increased between 200 and 300 percent in many power markets across the United States. Finally, the industry is using increasing amounts of renewable and distributed generation resources, which have valuable attributes but generally cost more than conventional energy sources.

## ADDITIONAL GENERATING PLANTS WILL BE NEEDED TO MEET DEMAND

The Energy Information Administration (EIA) and the North American Electric Reliability Council (NERC) both project that more than 50,000 megawatts (MW) of new power plants will be needed to meet demand growth through the year 2014. There are several aspects of the next wave of generation investments worthy of note:

- Prompted by recent natural gas prices and prospects for continued demand growth, new baseload coal plants are being proposed and/or built for the first time in more than a decade. More than a quarter-century after the last nuclear plant was ordered, new nuclear plants are under active consideration.

The Energy Policy Act of 2005 (EPAct 2005), in conjunction with other federal programs, will help reduce the costs and risks of building these generating additions, which are larger, are more capital-intensive, and have a longer lead time than the natural gas-fired units the industry built over the past decade.

- New generation investment varies substantially by region and by each utility’s present fuel mix. Some areas of the country remain chronically short on power and will need a variety of new resources to meet demand. Other regions are now strongly

reliant on gas-fired generation, and may add coal-fired capacity to diversify the fuel mix and reduce the total cost of electricity. Finally, nearly half of the states now require utilities to build or purchase energy from renewable electric generators, which will help diversify their fuel mix but add to overall costs.

- Uncertainties over future fuel prices, climate change policies, technological progress in all the major power technologies, and the impact of higher prices on power demand create substantial risks enveloping new generation investments. These risks add to the cost of financing these investments.

- The need for additional generation and transmission capacity will be mitigated by demand and energy reductions achieved through the price elasticity impact of rising prices and through a variety of conservation, energy efficiency, and demand-response programs. However, there still will be a need in the future for utilities to make major investments in generation and transmission capacity.

#### INCREASED TRANSMISSION INVESTMENTS ARE NECESSARY

After a long period of decline, transmission investment began a significant upward trend in the year 2000, totaling nearly \$18 billion in the period 1999 to 2003. A recent Edison Electric Institute (EEI) survey shows that its members have spent and plan to spend nearly \$29 billion on transmission over the period 2004 to 2008, a 60-percent increase over the previous five years. NERC projects that almost 12,500 miles of new transmission will be added by 2014, an increase of 5.9 percent of total U.S. circuit miles of high-voltage (230 kilovolts [kV] and above) transmission lines.

- These increased investments are prompted in part by the larger scale of the next wave of baseload generation additions and the fact that these additions are occurring farther from load centers. This is creating transmission projects that are larger and more costly than the average project over the past 20 years.

- New government policies and industry structures also will contribute to greater transmission investment. EPAct 2005 creates new incentives and siting processes that facilitate and promote transmission investment. In many parts of the country, transmission planning has been formally regionalized, and power markets create greater price transparency

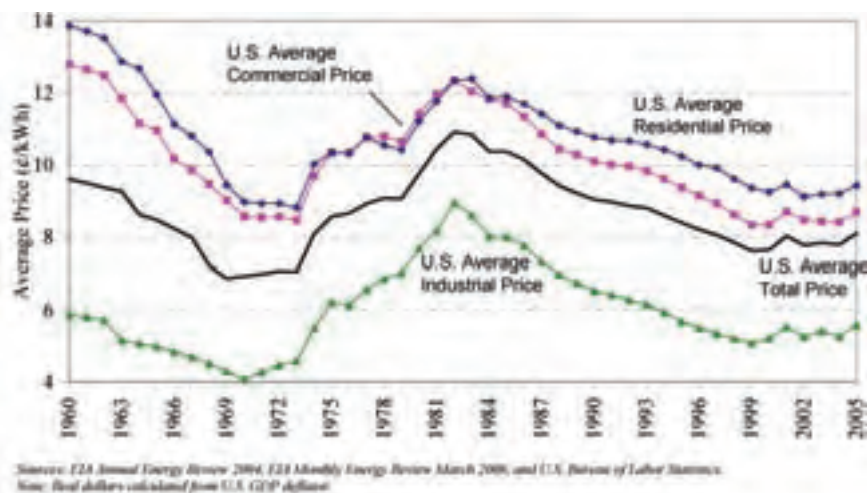


Figure 1-1  
U.S. Electricity Prices by Class of Customer (Real 2005 Dollars)

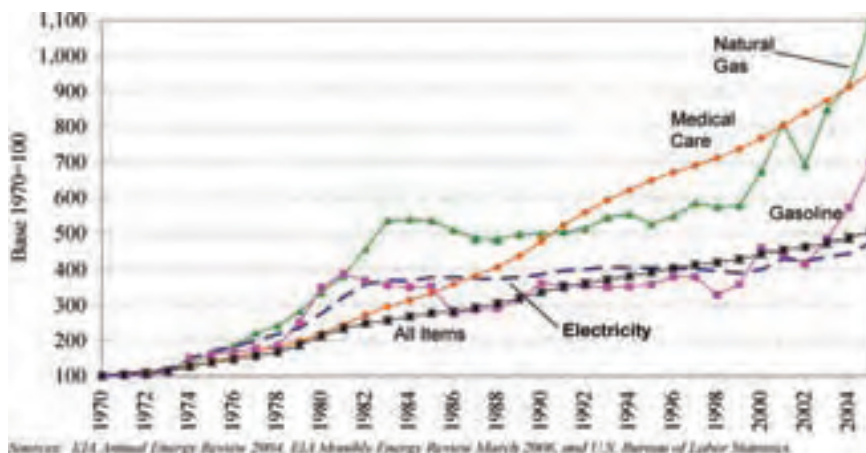


Figure 1-2  
Comparison of Electricity and Other Consumer Price Trends (1970 to 2005)

that highlights the value of transmission expansion in some instances.

#### SALES GROWTH, THE DEMAND FOR HIGHER QUALITY POWER, AND STORM RECOVERY COSTS ARE DRIVING DISTRIBUTION INVESTMENT

Industry spending on the distribution systems that deliver power to each customer has followed a generally steady upward trend for the past 20 years. Between 2000 and 2004, distribution investment increased from about \$10.5 billion to \$12.5 billion, a 19-percent increase.

- Many of these investments are in new technologies that increase the quality of delivered power to ubiquitous digi-

tal circuits. Other investments are being made to make the distribution system more automated, information-rich, and responsive to outages and customer needs.

For example, some automated distribution systems provide customers with the ability to monitor and control their energy usage on specific processes and appliances, depending on real-time prices and other factors.

- Additional large distribution system expenditures have been necessitated by widespread hurricane and storm damage experienced in the southeastern United States during 2004 and 2005, which impacted energy and materials costs across the nation.

## ENVIRONMENTAL INVESTMENTS ADD SIGNIFICANT COSTS

New environmental requirements, including recently finalized federal rules and state-level requirements that often are more stringent and less flexible, are prompting substantial environmental investments. These investments include more than \$43 billion in planned capital costs for emissions reduction technologies from 2005 to 2018, primarily retrofit equipment to further control air emissions from existing coal-fired power plants. These investments, while large, could be dwarfed by the costs of complying with potential mandatory carbon dioxide (CO<sub>2</sub>) emission reductions, as such policies have recently been proposed and considered in Congress.

## THE UTILITY INDUSTRY'S OVERALL FINANCIAL CONDITION IS SOUND, THOUGH NOT AS SECURE AS IT HAD BEEN BEFORE PRIOR PERIODS OF CAPITAL INVESTMENT

With reasonable cost recovery, the industry as a whole should have the ability to make the necessary, cost-effective investments. However, the industry has proportionately less “headroom” to make investments without rate relief, and certain portions of the industry are already below investment grade and therefore cannot weather greater financial impairment.

- The fraction of utilities rated BBB+ or above by Standard and Poor's, which was 75 percent prior to the 1990s, is now only about 40 percent. As of 2005, nearly 20 percent of all utilities were below investment grade. The credit ratings of independent power producers are significantly worse.

- Between 1999 and 2005, interest rates, allowed utility returns on equity (ROEs), and earned ROEs all trended downward at similar rates that enabled earned ROEs to remain reasonably close to allowed ROEs. However, the future prospects for earnings, absent adequate rate increases, are worse. Costs are rising much faster than revenues, and interest rates are no longer on a downward trend.

- The reduced financial stability of the industry is reflected in the “beta” of utility stocks — a measure of the proportionate riskiness of these stocks compared to the overall market. Value Line's estimate of the average industry beta has increased from 0.67 in 1995 to 0.87 in 2005, an increase of nearly 30 percent in a decade.

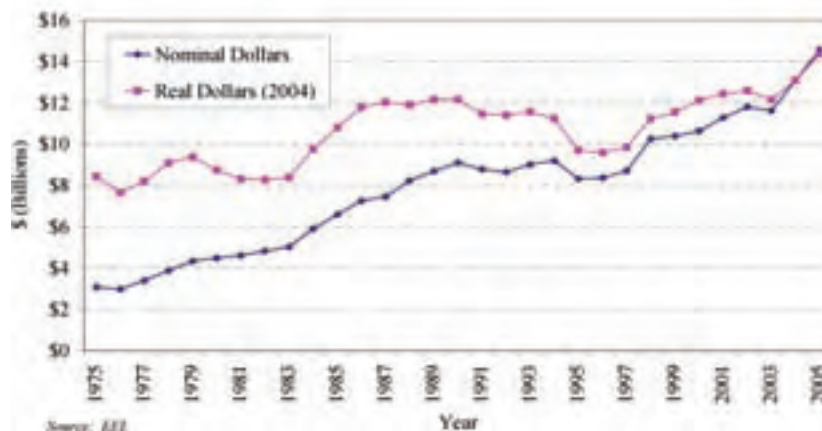


Figure 6-1  
Construction Expenditures for Distribution by Investor-Owned Electric Utilities

- The operating cash flows of utilities in 2005 were insufficient to cover their capital expenditures and higher operating costs. Utility cash flows were about \$10 billion less than the sum of operating and capital costs in 2005, and this gap could widen significantly during the next several years as regulated utilities undertake expenditures for infrastructure development and environmental improvements.

The overall picture emerging from these conclusions is that the electric power industry faces a situation in which significant investments are needed, and rate increases will be necessary to finance them. These investments will diversify supply away from natural gas, reduce future fuel costs, provide greater reliability and power quality, and lessen environmental impacts. Without these investments, one or more of these investment objectives will be impaired.

## ELECTRICITY REMAINS AN EXCELLENT VALUE

Even with price increases, electric power continues to grow in value to American consumers and the American economy. Since 1940, the percentage of U.S. energy consumed in electric form has quadrupled.

Electricity demand growth tracks Gross Domestic Product (GDP) growth much more closely than any other source of energy, highlighting its role as a key driver of economic growth and productivity.

As electricity use has grown in economic value, its inflation-adjusted cost has been declining. From 1985 to 2000, average electricity prices rose 1.1 percent

per year, less than half the average inflation rate of 2.4 percent. Figure 1-1 shows real electricity prices (in year 2005 dollars) by customer class over the period 1960 through 2005. After peaking in the early 1980s, average real prices had fallen by about 25 percent by 2005. And, compared with prices of other consumer goods and services, electricity prices have risen more slowly. This is shown in Figure 1-2, which uses 1970 as a base year for price indices for electricity, gasoline, natural gas, and medical care. Finally, despite increased household electricity consumption, electricity bills have become a smaller fraction of household budgets. American homes use 21 percent more electricity today than they did in 1978. Yet even with 21 percent greater use, the portion of our household budget that we devote to our power bill has declined, from 3.7 percent to 3.0 percent over the same period.

## DISTRIBUTION INVESTMENT Trends in Distribution System Investment

The transmission system delivers power from generators to local distribution systems which, in turn, deliver power to residential, commercial, and industrial customers. Specifically, the transmission system feeds substation transformers that reduce voltage and spread the power from each transmission line to many successively smaller distribution lines. The distribution system usually is considered to begin where voltage is reduced to 37 kV, but the important distinction is that distribution involves delivering the power to retail customers, while transmission involves moving bulk

power to distribution systems. The distribution system also includes metering, billing, and other related infrastructure and software associated with retail sales and customer care functions.

Continual investment in distribution facilities is needed, first and foremost, to keep pace with growth in customer demand. Figure 6-1 shows the pattern of investment in distribution assets over the last 30 years. In real terms, investment began to increase in the mid-1990s, preceding the corresponding boom in generation. This steady climb in investment in distribution assets shows no sign of diminishing. The need to replace an aging infrastructure, coupled with increased population growth and demand for power quality and customer service, is continuing to motivate utilities to improve their ultimate delivery system to consumers.

Continued load growth will require continued expansion in distribution system capacity. If recent investment trends persist, distribution investment will average \$14 billion per year over the next 10

years. This is almost triple the projected amount of annual investment in new transmission capacity and is likely to exceed capital spending on generation capacity over the next decade as well. This level of distribution investment would lead to a cumulative 3.5-percent increase in retail rates over the next 10 years.

Other factors apart from load growth, such as aesthetics, storm damage, and local land use, will spur spending on distribution infrastructure. In some cases, utilities are being directed to place new and/or existing distribution lines underground, particularly in urban areas. Placing existing power lines underground is expensive, costing approximately \$1 million per mile — a five- to ten-fold increase over the cost of a new overhead power line. Moreover, at a cost of \$1 million per mile, a new underground system would require an investment of more than 10 times what the typical U.S. IOU currently has invested in distribution plants and would compel the utility to increase its rates.

## Need to Modernize Distribution Systems

Distribution investment also will be needed to meet the greater demand for increased reliability. The impact of power disturbances on customers has grown steadily over time due to the increased use of digital technology. The current U.S. electricity infrastructure was designed to serve analog, or continuously varying, electric loads, and does not consistently provide the level of digital-quality power required by the nation's digital manufacturing assembly lines, information systems and, increasingly, home appliances.

Digital devices are highly sensitive to even the slightest interruption of power; an outage of less than a fraction of a single cycle can disrupt their performance. They also are quite sensitive to variations in power quality. Digital quality power has the same overall voltage as today's power and is indistinguishable from analog appliances, but has reduced levels of signal variations that adversely



**FLUKE**

### Point? Shoot? Predict?

Find it. Fix it. Fast.

Get the power of thermal imaging without specialist training. The Fluke Ti20 offers one-handed operation and intuitive on-screen guidance. Just point, focus and it automatically adjusts the temperature range to show a crisp image up to 350 °C (662 °F). It's the safe and easy way to identify problems and reduce unplanned down-time for:

- Electrical power distribution systems
- Electro-mechanical equipment
- Process instrumentation
- Facility maintenance

For more information call 800 36-FLUKE or visit [www.flukecanada.ca/point](http://www.flukecanada.ca/point)

**Fluke. Keeping your world up and running.™**

Rugged and reliable test tools for industrial predictive and preventative maintenance. All in the Fluke family.

affect digital circuits. An enhanced power system capable of delivering this higher quality power will stimulate faster and more widespread use of productivity-enhancing digital technology.

It is not an exaggeration to say that we are experiencing a “digitalization of society” — today, there are more than 12 billion microprocessors in the United States alone. For every microprocessor inside a computer, 30 operate in stand-alone applications. Digital-quality power now represents about 10 percent of total electric load in the United States. EPRI projects that digital-quality power load will reach 30 percent in 2020 under business-as-usual conditions.

Consistent with this trend, a recent study commissioned by DOE found that residential energy use on information technology (IT) applications increased substantially in the last few years, reflecting the dramatic increase in the use of personal computers and related devices. The study estimated that home IT equipment consumed about 42 terawatt hours (TWh) of electricity in 2005, compared to 16.5 TWh in 2001. That is, residential IT equipment accounted for about three percent of residential electricity consumption and one percent of U.S. electricity consumption in 2005. The study projects that, by 2010, residential IT energy consumption could rise to 101 TWh, under a scenario which assumes widespread high-bandwidth connectivity that enables effective exchange of large quantities of data and programs run on desktop computers.

Three new technologies already under development will enable utilities to provide digital-quality power and other enhanced distribution value. One is distribution automation. Distribution automation uses advanced sensors and control software to improve power suppliers’ ability to detect and correct disturbances more quickly, thus reducing customer outages and power quality problems. These capabilities lead to rapid disturbance isolation and restoration capabilities.

The second technology development path is custom power, a family of power electronic controllers designed for service on distribution systems. These devices and systems can provide real-time network control, protect sensitive customer equipment from network disturbances, and protect distribution feeders from power disturbances arising on the customer’s premises. Custom power

systems improve power quality for customers with special needs — for example, an industrial park with high technology companies.

The third path is the development of generation and storage technologies for distributed applications. These devices will move the power supply closer to the point of use, enabling improved power quality and reliability, and providing the flexibility to meet a wide variety of customer and distribution system needs.

This path is one of the main drivers of distributed generation.

Distribution systems will need to be updated to seamlessly integrate an array of locally installed, distributed power generation (such as fuel cells and renewables) as power system assets. In some cases, utilities will make the investments in these new technologies through their own programs or subsidiaries; in others, customers will invest in these technologies on their own.

Today’s distribution system architecture and mechanical control limitations

Today’s distribution system architecture and mechanical control limitations greatly limit the potential functionality provided by distributed generation.

greatly limit the potential functionality provided by distributed generation. In addition to improved hardware, improved tools will be needed for understanding and managing the interactions of distributed resources with existing distribution systems, as well as developing control systems for large grids with a mixture of distributed and central generation. As an example, to provide peaking power and premium power support for a distribution system, distributed resources must be dispatchable. This will require adding a variety of remote monitoring, communications, and control functions to the system as a whole. Moreover, distribution systems with mixed distributed and central assets are likely to require dedicated volt-ampere reactive (VAR) generation for system support and stabil-

ity. In general, distributed resources will not produce VARs in the quantity or location needed for grid stability. Distribution system operators will need the capability to produce VARs to balance the system, either through the “must-run” generators of today or the “silicon VARs” of tomorrow.

The latter can be produced by the emerging family of High Power Electronic Controllers, which will use power control devices to inject VARs into the system to stabilize voltage.

### Investments in Metering

Most electricity customers are served by conventional meters, which record cumulative energy usage and are usually read once each month by a utility employee. Replacement of today’s electro-mechanical meters with advanced “smart” meters will enhance customer service and customer options. Advanced, interval meters measure power use on a time-differentiated basis and report via phone, Internet, or wireless. These meters can track usage by the time of day, turn service on or off, diagnose problems, and react to price signals.

Digital power meters provide the ability to remotely monitor power usage and (increasingly) the ability to perform other functions such as monitoring power quality, voltage, theft detection, remote connect/disconnect, prepaid electricity purchases, and more. By collecting energy data on a real-time basis, they will enable power companies to better understand consumption patterns and to work with customers to cut energy usage.

As a result of this new technology, the meter will be transformed into a consumer gateway that allows price signals, decisions, communications, and network intelligence to flow back and forth through the two-way energy/information portal. This linchpin technology will help to create a more vibrant retail power marketplace, with consumers responding to price signals and a variety of product options and choices not previously available. The ultimate capabilities of an energy/information portal, in conjunction with an automated distribution system, include: (1) advanced pricing and billing processes that would support real-time pricing; (2) consumer services, such as billing inquiries, service calls, outage and emergency services, power quality, and diagnostics; (3) information for develop-

**Continued on Page 40**

5 to 10 arc flash explosions occur in electric equipment every day in the US\*

# Are YOU protected?



Everyday, workers in the electrical maintenance and utility industry work in environments that may expose them to hazards that could cause severe or fatal burn injuries. In the event of a momentary electric arc, everyday non-flame resistant work clothes can ignite and will continue to burn. Untreated fabrics continue to burn until the fabric is totally consumed and non-flame resistant synthetic fabrics will burn with melting and dripping causing severe contact burns to skin. The use of flame resistant clothing will provide a level of thermal protection, and after the source of ignition has been removed flame resistant garments will self-extinguish.

AGO INDUSTRIES INC. manufactures ARC/FR APPAREL to help protect workers in the electrical maintenance and utility industry from the hazards of electric arc flash exposures.

**Shirts • Pants • Coveralls • Coats • Jackets • Faceshields • Hoods**  
**Comply with NFPA 70E • Garments to ASTM F1506 Standards**

**AGO**  
**INDUSTRIES INC.**

PO Box 7132  
London, Ontario  
N5Y 4J9  
CANADA

PH: 519-452-3780  
FX: 519-452-3053  
EM: mail@arcfr.net

Featuring



\* CapSchell Inc.

**www.arcfr.net**

## Price Increases

Continued from Page 38

ing improved building and appliance standards; (4) consumer load management through sophisticated on-site energy management systems; (5) load forecasting; (6) long-term planning; and (7) green power marketing and sales.

Installing new meters will be an expensive undertaking, however. Some experts estimate that about 10 million of the 130 million residential meters installed throughout the United States are equipped with advanced technologies. Advanced meters cost approximately \$100 to \$150 per meter, so purchasing such meters for 120 million residential customers would be an investment of approximately \$12 billion to \$18 billion.

### Minimizing Outage Costs

Power outages are very costly to retail customers and will become increasingly so in the future as more and more applications require digital quality power. Even today, the nation's industrial sector has become quite dependent on

high-technology processes. Air conditioning and other building climate control systems have become more ubiquitous in the commercial sector, and the penetration of computers and other electronics has increased throughout the economy.

The value of electricity, or the cost of blackouts and other service interruptions, correspondingly has increased.

Various approaches have been used to determine the value of reliability to customers. One method of doing so is to assume that the value of having electricity is equal to the magnitude of the cost of not having it — i.e., the costs that a business incurs, in terms of lost sales, revenues, spoiled output, opportunity costs, etc. — as a result of a power outage. A recent report prepared by ICF Consulting estimated the value of reliability by computing costs of outages and other short-term reliability events. At an aggregate level, the study finds that the annual historical value of outages and other reliability costs exceeds \$20 billion per year and is much higher in recent years. Moreover, this estimate excludes the costs associated with the August 2003

blackout that affected much of the northeastern United States. This estimate also does not include the costs of very short-term reliability events, such as voltage fluctuations, as ICF found little empirical data on this topic.

However, the ICF study noted that some researchers found that momentary interruptions usually have a higher per event cost than sustained outages.


Hence, adding the costs associated with momentary outages would significantly increase the \$20+ billion estimated annual costs associated with sustained outages.

Indeed, one study estimated that approximately \$52 billion per year is spent on momentary interruptions.

Beyond reporting aggregate numbers, the ICF study also compared the value of electricity for residential, commercial, and industrial customers to their actual prices paid. Previous studies estimated that the value of electric service is approximately 100 times the price paid. The ICF report confirms this aggregate number, but also sheds light on which sectors are more impacted in dollar terms by outages.

# ...when you can have this!


Why this...?



- Voltages to 138 KV
- Standard Configuration to 10 MVA
- No onsite Erection or Oil Processing
- Savings up to 50% Over Conventional Designs

## HIGH VOLTAGE PADMOUNT SUBSTATION

[www.partnertechnologies.net](http://www.partnertechnologies.net) Contact: [ghgeall@ieee.org](mailto:ghgeall@ieee.org)  
Designed in partnership with Manitoba Hydro



# EXAMINING DEMAND RESPONSE, RENEWABLE ENERGY AND EFFICIENCIES TO MEET GROWING ELECTRICITY NEEDS

By R. Neal Elliott, Maggie Eldridge, Anna M. Shipley, John "Skip" Laitner, and Steven Nadel, American Council for an Energy-Efficient Economy; Alison Silverstein, Independent consultant; Bruce Hedman, Energy and Environmental Analysis, Inc.; Mike Sloan, Virtus Energy Research Associates, Inc.

The state of Texas is rapidly growing, with the state's population growing at a rate of 1.8% per year and the economy expanding at an annual rate of 3.8% from 2000 to 2006. It is projected that population growth will continue at a rate of 1.7% per year through 2023 (the horizon for this study), with the state's economy projected to grow at 3.2% per year.

The most pressing short-term policy concern in Texas is the rapid growth in peak demand. The Electric Reliability Council of Texas (ERCOT) reports that peak demand on the ERCOT system increased by about 2.5% per year between 1990 and 2006. The current forecast is for peak demand to increase by 2.3% annually from 2007 through 2012. ERCOT has raised the prospect that the state might be without sufficient generation capacity to meet peak demands as soon as 2009, creating images of a power crisis similar to that experienced in 2000 and 2001 in California.

The state's rapidly growing peak electric demand and electricity consump-

tion have led ERCOT and utilities to suggest that Texas should take actions to change the mix of electric generating

electricity from wind, so the state is on track to exceed the levels in the RPS. However, there is much more that can be

resources and lean heavily on building new coal-fired power plants. We suggest that demand-side and renewable resources, beyond conventional supply resources, should be considered as the state develops its near- and long-term energy plans. This report characterizes the potential for these key "alternative" resources and recommends policies to bring them on-line at the needed rate.

## ENERGY EFFICIENCY, DEMAND RESPONSE, AND ONSITE RENEWABLE RESOURCES

Texas has already taken progressive steps in the area of clean energy through its renewable energy portfolio (RPS) and its energy efficiency improvement programs (EEIP), which direct transmission and distribution utilities to serve 10% of load growth through energy efficiency. The utilities have easily met the efficiency target, and Texas already gets more than 4% of its

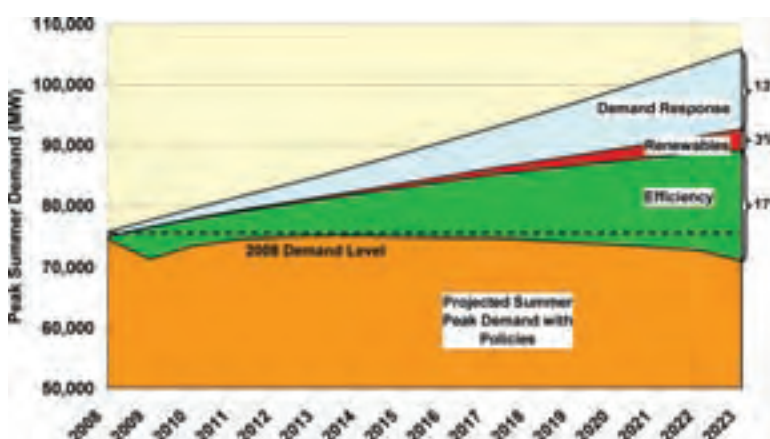


Figure ES-1. Fraction of Summer Peak Demand that Can Be Met with Demand Response, Efficiency, and Renewable Resources

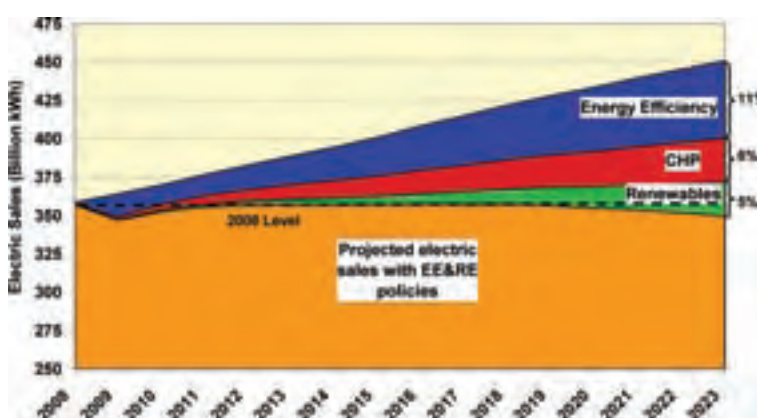


Figure ES-2. Share of Future Electricity Consumption that Can Be Met with Efficiency and Renewables Resources

achieved from energy efficiency and renewable energy resources. In particular, the level of savings that utilities can achieve through the EEIP can be greatly and cost-effectively increased. In addition, the EEIP does not apply to cooperative and municipal utilities in the state. While some of these utilities are already active in this area, all should contribute to meeting the state's needs. In addition to the EEIP, there are several other policies that could provide more energy efficiency resources.

The potential for onsite renewable energy generation (including solar photovoltaic generation systems) is very large in Texas. This report estimates the size of the energy efficiency and onsite renewable energy resources in Texas, and suggests a suite of policy options that the state can consider to realize their achievable potential.

In addition, a significant opportunity also exists to expand the state's "demand response" resources to reduce system peaks, as has been recommended by ERCOT. If initiated soon and pursued aggressively, the combined deployment of demand response and the other clean energy resources described above can address the state's reserve margin concerns while ensuring that the state has adequate, affordable electricity to sustain its economic growth. This report explores the opportunities in Texas for additional energy efficiency, demand response, and onsite renewable energy, and outlines the policies and programs necessary to harness these resources to meet the state's future energy needs.

Texas is growing: population grew at 1.8% per year and the economy expanded 3.8% annually from 2000 to 2006. This growth has been accompanied by rising electricity demand of over 2% per year. Population is expected to grow at a rate of 1.7% per year through 2023 (the horizon for this study), with the state's economy projected to grow at 3.2% per year (Economy.com 2007). This rapid growth has resulted in rapid increases in the state's electricity demands.

The key question is: how fast does electricity supply need to increase to serve Texas growth? The Electric Reliability Council of Texas, which coordinates grid operations for 85% of the state, projects consumption to grow at an annual 1.7% rate over the next 15 years. This report assesses the potential for Texas to meet its future energy service needs through energy efficiency, demand

response, and renewable energy.

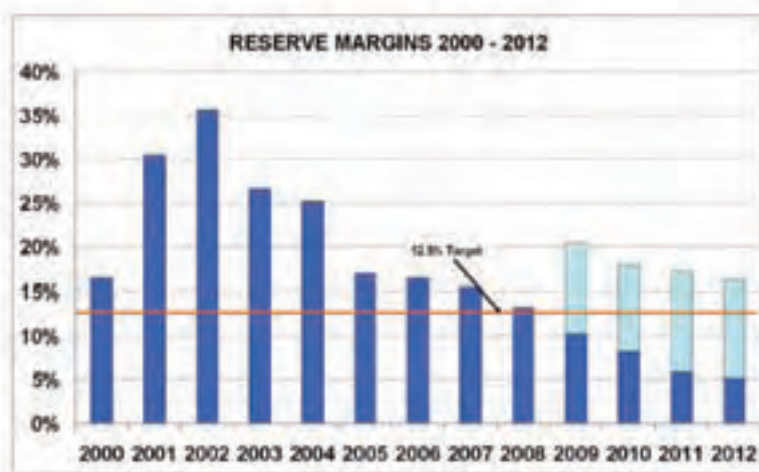
Texas's electricity outlook has been made more uncertain by the announced agreement by TXU to cancel plans for construction of eight new coal power plants, which has led the Wall Street Journal to suggest that "the plant cancellations, if they happen, could have an interesting effect. Proposals by other plant builders, which went dormant after TXU made its big splash, could be revived. If more plants aren't built, an equally troubling scenario may unfold: Power prices could spiral out of control in Texas because there aren't enough suppliers to meet the need and the state is so poorly connected to other states, by high voltage wires, that there's no ability to import power." (Kingsbury 2007) Our report suggests that efficiency and conservation, demand response, and onsite renewable energy can meet this growing need for energy services.

More problematic than the rapid increase in electricity consumption has been the even more rapid growth in peak demand. ERCOT reported that peak demand on the ERCOT system increased by about 2.5% per year between 1990 and 2006. The current forecast is for peak demand to increase by 2.3% annually from 2007–2012 (ERCOT 2006a). This level of growth is threatening Texas's ability to maintain grid reliability at reasonable costs in the coming years, which will affect the costs of electricity and the state's healthy business and investment climate. The mid-2006 report from ERCOT raised the prospect that much of

the state could lack sufficient generation capacity to meet peak demands as soon as 2008, creating images of a power crisis similar to that experienced in late 2000 and early 2001 in California (ERCOT 2006a). In February 2007, ERCOT suggested that the "reserve margin" shortfall would not occur until 2009, as can be seen in Figure 3 (Jones 2007). Even with this delay, it will be a challenge for new generation to be constructed in time to meet this forecasted need. On the other hand, as will be discussed later in this report, energy efficiency and demand response can be quickly deployed, meeting this need in the short time available.

Many groups have also expressed concerns about the diversity of fuel mix in electric power generation (see Figure 4), which is very highly dependent on natural gas. Within ERCOT, at present almost 70% of installed generating capacity is fueled by natural gas; 19% is coal (some mined in-state and some imported from the Powder River Basin); 6% is nuclear; and 4% comes from wind, the state's fastest-growing generation source. A third of ERCOT's current power plant fleet has been built since 1999, and almost all of that capacity is natural gas-fired.

The state's rapidly growing peak demand and electricity consumption, coupled with high electric rates, have led some of the state's energy planners to suggest taking actions to change the



Source: Jones 2007

Note: Lighter shaded bars represent "mothballed" units—generating units that are currently out of service but could be returned to service if conditions warrant as defined in ERCOT (2006a).

Figure 3. Actual and Projected ERCOT Reserve Margins

Continued on Page 44

## Arc Flash Evaluation

Design safer power systems while ensuring compliance with NEC 110.16, OSHA, NFPA 70E and IEEE 1584 standards.

- Save time with the fully integrated Short Circuit, Over-Current Coordination, Equipment Evaluation and Arc Flash Evaluation modules
- Provide a safer working environment by specifying the proper PPE level
- Evaluate alternatives quickly and easily to establish an optimal design
- Improve safety margins with user-definable arcing fault tolerances
- Save time by automatically generating arc flash labels and work permits
- Increase flexibility by creating custom labels in any size with user-defined logos, text, comments, and field placement
- Avoid potential fines, lost productivity, and increased insurance and litigation costs

### OVERSIGHT REPORT



## ArcCalc

### Arc Flash Hazard Calculator

**only \$995**



Calculate the incident energy and arc flash boundary for any point in a power system.

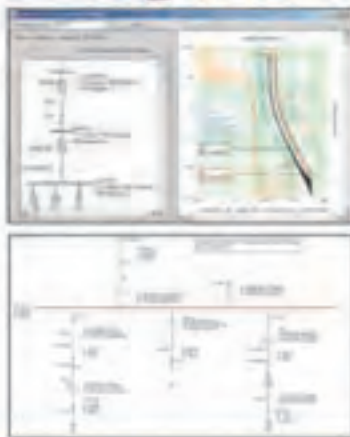
- Fast and Easy Standalone Solution
- Improves Safety and Reduces Liability
- Complies with NFPA 70E, NEC 110-16, IEEE 1584 Requirements
- Automatically Determines Fault Current & Protective Device Trip Time
- Includes Over 10,000 Validated Protective Device Curves
- Safety Tolerances Automatically Applied
- Custom Labels and Work Permits
- A "Must Have" for Every Consultant and Facility Engineer

## PTW Viewer

**only \$995**

PTW Viewer provides an interactive electrical model to your customers. You can display results on the interactive one-line, view time-current curves, print arc flash labels, and much more.

- Open, view, print, and export all study results from any project without a full version of PTW
- Create and expand one-lines from existing components
- Modify or create new datablocks and apply them to any one-line and TCC
- Adjust component position in existing one-lines and add annotations
- View and compare different scenarios created from the base project
- Create and print custom Arc Flash labels and Work Permits
- Access to the Component Editor to view specifications of every component



### Integrated Study Modules:

- DAPPER® Load Analysis & Equipment Sizing Load Flow & Voltage Drop Panel & MCC Schedules Comprehensive Fault Analysis
- Short Circuit Analysis (ANSI C37, IEC 60909/61363)
- CAPTOR® Time-Current Coordination
- Equipment Evaluation
- IEEE Wiring Regulation Sizing
- Unbalanced/Single Phase System Studies
- TMS - Transient Motor Starting
- I\*SIM - Transient Stability w/ Custom Models
- HIWAVE - Harmonic Analysis & Filter Design
- Distribution Reliability
- DC System Analysis
- Distribution Management System, Real Time Monitoring & Modeling, State Estimation, Optimal Power Flow
- Cable-3D Pulling
- Ground Grid Design
- Motor Parameter Estimation, Cable/Transmission Line Calculators

Arc Flash and Other Training Courses Available in Canada and U.S.



**Mention Code CE41 for \$50 off your order!**

**SKM**  
Systems Analysis, Inc.

P.O. Box 3376  
Manhattan Beach, CA 90266  
1-800-232-6789  
www.skm.com • sales@skm.com

resource availability, including more coal-fired coal plants (ERCOT 2006a; Jones 2007). We suggest that a broad range of resources beyond new, conventional fossil-fueled generation needs to be evaluated as the state decides how to meet its near and long-term energy needs. We will seek to characterize the potential for some of these key “alternative” resources in this analysis.

Energy efficiency, demand response, and renewable energy resources represent the low-cost energy and capacity resources available to the state. Recent polling suggests that over 70% of Texans would be willing to support increased spending on energy efficiency by the electric utility industry (WRS 2007). Almost two-thirds of the respondents were willing to pay more on their electric bills today if it avoided high cost electricity in the future, so a core of public support for policies such as we propose in this study clearly exists in Texas.

The DOE defines demand response as: “changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.” (DOE 2006b). Demand response measures include incentive-based programs that pay users to reduce their electricity consumption in specific times (such as load management and direct control to turn down customers’ heaters or air conditioners in an emergency situation), or pricing programs such as time-of-use rates, critical peak pricing, or real time pricing, where customers are given a price signal and expected to moderate their electricity usage in times when prices are high. Most early demand response programs were incentive-based and control-oriented, so the utilities could operate and con-

We suggest nine policies to build upon the foundation of energy efficiency and renewable energy policies that Texas has already laid. These policies are:

1. Expanded Utility-Sector Energy Efficiency Improvement Program
2. New State-Level Appliance and Equipment Standards
3. More Stringent Building Energy Codes
4. Advanced Energy-Efficient Building Program
5. Energy-Efficient State and Municipal Buildings Program
6. Short-Term Public Education and Rate Incentives
7. Increased Demand Response Programs
8. CHP Generation Target
9. Onsite Renewable Energy Incentives

trol the customers’ usage and tell exactly when and how much load changed; these are viewed as reliable, predictable programs that can be trusted as a resource to meet grid reliability needs.

Over the near term, given Texas’s tight capacity situation, incentive-based, emergency-oriented demand response programs will be most effective at lowering effective peak loads and moderating supply scarcity. Over the long term, however, once ERCOT’s nodal market is in full operation and many ERCOT retail electric consumers have advanced interval meters, more customers should and could take advantage of time-varying rates such as critical peak pricing, and price-responsive demand response should have a far greater impact upon peak loads and prices than incentive-based programs.

Today we have no data to estimate the possible impact of time-varying rates upon electricity consumption, and it will take years to collect and analyze such data; therefore, this study estimates only the potential for incentive-based, emergency-oriented demand response measures upon ERCOT’s supply-to-demand balance. By 2023, however, it is possible that the widespread availability of time-varying retail electric rates and complementary communications and control methods will have permanently changed the nature of Texas’s

electricity demand, making today’s forecasts for ever-increasing demands obsolete.

The ERCOT market began wholesale competition in 1995 and retail competition in 2002. Before the start of retail competition, Texas’s integrated utilities offered a variety of direct load control and time of use, curtailable, and interruptible rates, with almost 3,500 MW of loads participating (primarily from Texas’s base of industrial facilities). However, with the advent of retail competition in ERCOT and the structural unbundling of the investor-owned utilities, much of this demand response capability was lost to new market complexities and higher transactions costs.

There is less demand response available in ERCOT today, and in more limited forms than were available before competition. ERCOT has a real-time energy market (and no capacity market), and customers with loads at or above 700 kW have interval data recorders (meters that record energy use over time).

## SUMMARY AND CONCLUSIONS

Energy efficiency, demand response, and renewable energy resources can meet the increasing demand for electricity in Texas over the next 15 years. Efficiency and renewable energy resources combined with expanded demand response can avoid the reserve margin crisis that is forecast for the state, and actually reduce the overall summer peak demand over the same period. These goals can be accomplished at a lower cost than the construction of new conventional generation resources, thus enhancing the energy security and sustaining the economic growth of the state.

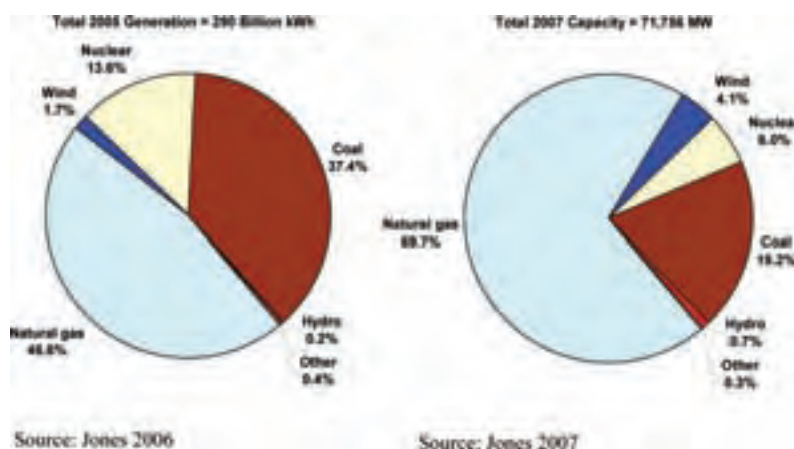



Figure 4. ERCOT Generation and Capacity by Fuel



## Test CT's and PT's

High performance at low cost. Model CT/PT is easy to use and super fast. Just connect and enter or retrieve the stored program. RCF and Phase will appear like magic. Prints certificates and multi-point reports.

**Special Features:**

- low cost
- high accuracy
- high speed, easy to use
- high power, to 8000A
- multi-point testing
- meets ANSI and IEC
- prints reports and certificates
- all solid state

**"The world's best systems"**  
Call for literature or demonstration

**OPTIMIZED DEVICES, INC.**  
220 Marble Ave. Pleasantville, New York 10570  
Phone: 914 760 6100 Fax: 914 769 6102  
Email: sales@optdev.com

## Solid Brass Padlocks and Accessories



**HERCULES INDUSTRIES, INC.**  
Manufacturer of HercuLock Padlocks  
P.O. Box 197 • Prospect, Ohio 43342  
Phone: (740) 494-2628  
Toll Free: 1-800-345-2590  
Fax: (740) 494-2274  
www.herculock.com

## ELECTRICAL SAFETY TRAINERS

We have an IMMEDIATE NEED for Electrical SAFETY trainers for a variety of subjects:

- NFPA 70E Arc Flash Standard
- Arc Flash Study
- Short Circuit Study
- Coordination Study
- Industrial Electrical Safety and OSHA Electrical Safety Existing and Proposed Standards
- Circuit Breaker Testing and Maintenance
- Electrical Relay Protection

If you have field-tested experience in any of these areas AND you have experience in instructing courses, then send a description of what course you would like to teach, along with your resume to:

Randolph Hurst, President,  
The Electricity Forum  
rwh@rogers.com

## Why do more people buy FLIR infrared cameras than all other brands combined?

**LOW COST! INFRACAM SD**

With InfracAM SD's Removable Memory Card, You're No Longer Tethered to Your Computer!

Plus, you'll get razor-sharp thermal image quality, 1000 Radiometric JPEG Images with a Removable SD/Memory Card, an ultra-portable design and exceptional ergonomics. Weighs just 1.2 lbs, long 7-hour battery life!

**Get More Done With InfracAM SD!**  
Call for a Free Demo! 1-800-613-0507 Ext. 25  
**Training Value Package Available!**  
Visit: www.goInfracam.com



**NEW!** InfracAM SD Thermal Imager  
**Removable SD/Memory Card**


**HIGH DEFINITION ThermoCAM HD**

The only High Definition infrared camera on the market today!

Superior image quality, spot size resolution, temperature measurement accuracy – the new standard for Professional Thermographers! Call 1-800-613-0507 Ext. 24

**Training Value Package Available!**  
Visit: www.highdefinitioninfrared.com

**FLIR SYSTEMS**  
The Global Leader in Infrared Cameras  
Serving Canada for 45 years  
1-800-613-0507 Ext. 25 for InfracAM SD  
Ext. 24 for ThermoCAM HD  
IRCanada@flir.com www.flir.ca



## Meet the PowerXplorer PX5.

The one solution for power quality and demand and energy analyzer needs.

The PowerXplorer PX5 is the first handheld power monitoring instrument that does it all. With its unique color touch screen and automated setups, this 8-channel workhorse measures at 50/60 and 400 Hertz, AC and DC, captures sub-microsecond transients, harmonics and much, much more.

Why carry around 5 or 6 instruments, when the PowerXplorer PX5 does it all?

**ON POWER**  
Power Quality Specialists

In Canada contact: On Power Systems Inc.  
Tel: 1-800-363-9133 or E-mail: jkerr@onpower.com

## LIZCOZ SALES

ELECTRICAL POWER EQUIPMENT SPECIALISTS

### WE HAVE THE ENERGY

CANADA's largest on-site inventory

- New/New Surplus/Rebuilt:
  - Oilfilled/Dry Transformers
- New Oilfilled "TLO" Substations
- New S&C Fuses/Loadbreaks
- High and Low Voltage
  - Vacuum/Gas Breakers
  - Air Circuit Breakers
  - Molded Case Breakers
  - QMQB/Fusible Switches
  - HV Toppers
  - Combination Starters
- Emergency Service
- Replacement Systems
- Design/Build Custom Systems

**1-877-842-9021**  
www.lizcosales.com

ADVERTISER	PAGE	CONTACT INFO
AGO	39	<a href="http://www.ago1.com">www.ago1.com</a> <a href="http://www.electricityforum.com/products/AGO_Industries_Inc.html">http://www.electricityforum.com/products/AGO_Industries_Inc.html</a>
Bulwark	47	<a href="http://www.vfc.com">www.vfc.com</a>
Cannon Technologies	7	<a href="http://www.cannontech.com">www.cannontech.com</a>
Circuit Breaker & Testing Maintenance conference	9	<a href="http://www.circuitbreakerconference.com/">http://www.circuitbreakerconference.com/</a>
Demand Response & Energy Efficiency conference	26	<a href="http://www.events.platts.com">www.events.platts.com</a>
Ecceleron	32	<a href="http://www.exeleron.com">www.exeleron.com</a>
EEI	31	<a href="http://www.eei.org/">http://www.eei.org/</a>
Elster Integrated Solutions	2	<a href="http://www.elsterelectricity.com">www.elsterelectricity.com</a>
ETAP	23	<a href="http://www.etap.ca">www.etap.ca</a>
FLIR Systems Ltd.	13, 45, 48	<a href="http://www.flir.com">www.flir.com</a> <a href="http://www.electricityforum.com/products/flir.htm">www.electricityforum.com/products/flir.htm</a>
Fluke Electronics	21,37	<a href="http://www.flukecanada.ca">www.flukecanada.ca</a> <a href="http://www.electricityforum.com/products/fluke.htm">http://www.electricityforum.com/products/fluke.htm</a>
Hercules Industries Inc.	46	<a href="http://www.herculock.ca">www.herculock.ca</a> <a href="http://www.electricityforum.com/products/hercules.htm">http://www.electricityforum.com/products/hercules.htm</a>
Lineal	27	<a href="http://www.lineal.com">www.lineal.com</a>
Lizco	45	Sales <a href="http://www.lizcosales.com">www.lizcosales.com</a> <a href="http://www.electricityforum.com/products/lizco.htm">www.electricityforum.com/products/lizco.htm</a>
Novatech	5	<a href="http://www.novatechps.com">www.novatechps.com</a>
Manioba Hydro International Ltd.	40	<a href="http://www.hydro.mb.ca">www.hydro.mb.ca</a>
On Power Systems Inc	45	<a href="http://www.onpower.com">www.onpower.com</a>
Optimized Devices	46	<a href="http://www.optdev.com">www.optdev.com</a> <a href="http://www.electricityforum.com/products/optimized_devices.htm">http://www.electricityforum.com/products/optimized_devices.htm</a>
SKM Systems Analysis Inc.	43	<a href="http://www.skm.com">www.skm.com</a> <a href="http://www.electricityforum.com/products/SKM_Systems_Analysis_INC.HTM">http://www.electricityforum.com/products/SKM_Systems_Analysis_INC.HTM</a>
Technical Systems	24	<a href="http://www.technical-sys.com">www.technical-sys.com</a> <a href="http://www.electricityforum.com/products/technical_systems2002.htm">http://www.electricityforum.com/products/technical_systems2002.htm</a>
Underground Devices	17	<a href="http://www.udevices.ca">www.udevices.ca</a> <a href="http://www.electricityforum.com/products/underground.htm">http://www.electricityforum.com/products/underground.htm</a>
Wire Services	24	<a href="http://www.wireservices.ca">www.wireservices.ca</a> <a href="http://www.electricityforum.com/products/wire_services.htm">http://www.electricityforum.com/products/wire_services.htm</a>

**3 New Exclusive Products from Bulwark®**

Visit us at [www.bulwark.com](http://www.bulwark.com) for more product information

**SEG6KH**

*Lightweight Flame  
Resistant Cotton  
Dress Shirt*



**SMW8HV**

*ANSI Compliant Flame  
Resistant Short Sleeve  
Work Shirt*



**SMW2HV**

*ANSI Compliant Flame  
Resistant Long Sleeve  
Work Shirt*



**LEADERSHIP. INNOVATION. COMMITMENT.**



**IT'S MORE THAN A SYMBOL. IT'S A PROMISE.**

# Why do more people buy FLIR infrared cameras than all other brands combined?



**NEW!** InfraCAM SD  
Thermal Imager

## LOW COST! **INFRACAM™ SD**

With InfraCAM SD's Removable Memory Card, You're No Longer Tethered to Your Computer!

Plus, you'll get razor-sharp thermal image quality, 1000 Radiometric JPEG Images with a Removable SD/Memory Card, an ultra-portable design and exceptional ergonomics. Weighs just 1.2 lbs, long 7-hour battery life!

**Get More Done With InfraCAM SD!**  
Call for a Free Demo! 1-800-613-0507 Ext. 25

**Training Value Package Available!**  
Visit: [www.goinflracam.com](http://www.goinflracam.com)



Removable SD/Memory Card

**NEW!**  
ThermaCAM® P640  
Infrared Camera

## HIGH DEFINITION **ThermaCAM® HD**

The only High Definition infrared camera on the market today!

Superior image quality, spot size resolution, temperature measurement accuracy – the new standard for Professional Thermographers! Call 1-800-613-0507 Ext. 24

**Training Value Package Available!**  
Visit: [www.highdefinitioninfrared.com](http://www.highdefinitioninfrared.com)



The Global Leader in Infrared Cameras

★ Servicing Canada for 46 years

**1-800-613-0507** | Ext. 25 for InfraCAM SD  
Ext. 24 for P640 HD

[IRCanada@flir.com](mailto:IRCanada@flir.com)

[www.flir.ca](http://www.flir.ca)