TECHNOLOGY AT WORK

Member applications of EPRI science and technology

Utilities Use EPRI Analyses on the Effects of Climate Policy

Anticipating the effects of climate policy is problematic for utility planners for a number of reasons. Uncertainties about the structure and provisions of emerging legislation make it difficult to predict effective responses. Impacts may be far reaching, as significant constraints on CO_2 emissions will affect investment in new generation and control technologies, generation mix, plant dispatch schedules, purchase of energy and emission allowances, and customer service and pricing policies. Because utilities differ in their finances, physical assets, and operations, no single solution will be appropriate for all. Each company will need to fashion its own response to make the best use of its existing assets and business structures.

EPRI has developed various analyses that can give utilities critical insights into the potential effects of climate policy on their strategic, long-range plans. EPRI's seminal Prism analysis, for example, looks at the potential of a portfolio of advanced technologies to manage CO_2 emissions for the industry as a whole. Other analyses focus on the development of specific technologies and capital investment strategies and on the effects of carbon prices on new generation choices, power system operation, and customer response to electricity prices.

Two utilities with different business models—Tri-State Generation and Transmission Association and Consolidated Edison Company of New York—recently used EPRI analyses to assess the potential risks of emission constraint policies and analyze potential responses.

Tri-State Builds a Roadmap

Tri-State is a wholesale power supplier—a not-for-profit company owned by 44 distribution cooperatives in Colorado, Nebraska, New Mexico, and Wyoming. The utility drew heavily on EPRI work to develop a comprehensive systemwide greenhouse gas management roadmap that identifies technology strategies and compiles its various initiatives, assessments, and studies into a single plan. In addition to the Prism analysis and a site-specific greenhouse gas emissions inventory that EPRI completed in 2007, Tri-State incorporated the many collaborative projects in which it has been involved, including work on carbon capture and sequestration, generation and transmission efficiencies, and renewable technologies.

Tri-State completed the roadmap in June 2009 and submitted it to state policymakers, its member cooperatives, and external stakeholders. The analysis concluded that Tri-State's success in meeting emission reduction goals will depend heavily on developing cost-effective energy and environmental technologies and that this effort should be a major part of the company's resource planning. Tri-State intends to continue its analyses and make the roadmap a "living document" to help plan specific steps to implement technology options.

Con Edison is the primary electricity supplier to New York City.

Con Edison Assesses Its Business Model

In contrast to Tri-State, Consolidated Edison is primarily an energy distribution company that owns relatively little generation capacity. As such, it will face particular challenges if the price of carbon begins to substantially affect wholesale and retail electricity prices. Con Edison needed to examine whether its existing business model would be sustainable if greenhouse gases were regulated, and it asked EPRI to adapt and apply an electricity sector market-modeling framework to analyze the effects of climate policy on all aspects of its business.

EPRI began by focusing on the region in which Con Edison purchases wholesale electricity, determining the potential impacts on costs and generation mix of CO_2 prices ranging from $10 to $80/ton. From these results, EPRI calculated how changes in wholesale electricity prices would affect Con Edison's retail prices. Finally, the assessment examined demand response to determine how customers would likely conserve power in response to higher prices. The analysis concluded that the utility's business model would remain viable even under scenarios of extreme carbon price and customer response.

The EPRI assessment will allow Con Edison to demonstrate to investment and environmental organizations that its business model, strategic planning, and ongoing commitment to environmental stewardship are solid, and the study can serve as a valuable base for reviewing the impact of future legislative proposals.

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TVA Uses Evaluation Tools to Optimize Turbine-Generator Assets

Over its life, a steam turbine requires millions of dollars for maintenance, efficient operation, and routine repairs. As part of a cost-effective run/repair/replace strategy, operators must accurately assess the remaining life of a turbine's components and identify core weaknesses in parts likely to fail under normal operation. Tennessee Valley Authority recently used two EPRI tools to investigate such turbine issues in three of its steam power plants, enabling TVA to improve utilization of its turbine-generator assets and avoid the cost of replacement power.

Remaining Life of Rotor Disks

Cracking of low-pressure rotor disks has been a challenge for steam turbine operators for decades. Stress-corrosion cracking in a turbine's blade attachment area becomes more common as a turbine ages, due to local stresses, steam chemistry contaminants, temperature influences, operating conditions, and other factors. Cracking of the disk rim where the blades are attached can cause displacement of the blades and catastrophic failure of the entire rotor.

When the turbine manufacturer issued TVA a "duty-to-warn" letter regarding the health of its low-pressure rotor disks, TVA turned to EPRI to help assess the risk of continuing to operate a turbine at its Widow's Creek Unit 7 steam plant until replacement rotors could be procured. TVA engineers performed the analysis with LPRimLife, a computer program designed for this purpose. The code uses operating and design data, inpection results, and stress and fracture algorithms to determine a rotor disk's remaining life from both a deterministic and a probabilistic standpoint. The software also enables plant engineers to assess critical crack size and to more effectively plan maintenance and repair schedules.

Use of LPRimLife at Widow's Creek enabled TVA to more accurately estimate the rotor disks' remaining life and delay taking the turbine out of service, saving the company more than $500 million in replacement power costs.

Root Cause of Blade Failures

Blade failure represents the single greatest threat to the reliable operation of steam turbines, and given the high cost of unplanned outages and replacement power, operators can't afford to consider such a failure a random occurrence. Statistics and experience show that if the cause of a failure remains unresolved, problems are likely to recur following the initial repair. Accurate, timely diagnosis of root causes is fundamental to managing the

immediate problem and building a long-term strategy to protect other units of the same design. But investigating causes of failure is a complex challenge, involving the coordination of multiple activities and specialized engineering disciplines.

TVA faced this problem when it experienced unexplained blade failures in low-pressure turbines at its Colbert Unit 5 and Johnsonville Unit 7. For assistance in formulating an effective course of action, TVA used EPRI's *Steam Turbine Failure Root Cause Analysis Guide* (1014137), a concise reference document designed to help operators plan and conduct such investigations.

The guide provides a roadmap for a typical investigation, explaining when specialists should be involved, what they should contribute, and how the evidence can be used to establish corrective action. Providing both an overview and step-by-step procedures for identifying the damage mechanisms most common to blade failures, the guide clarifies how damage mechanisms relate to the unit's operating history and how to establish whether they constitute a principal (root) cause or merely contribute to the problem. The methodology is based on experience compiled from more than 350 failure investigations.

TVA used the guide to investigate the blade problems at Colbert and Johnsonville. Analysis results assisted investigators in understanding the factors and conditions that led to the failures, and equipped TVA to avoid future failures in these turbines and in sister units with the same blades.

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