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Letter #58
Oct. 2008

THE ON-LINE GATEWAY FOR READERS OF PUBLIC UTILITIES FORTNIGHTLY MAGAZINE.



DEMAND RESPONSE

Going to Market

By Ali Vojdani, Ph.D.

Despite the October financial crisis, utility companies still must keep the lights on and plan for more demand in an environmentally-friendly manner as possible. Nuclear power is part of the answer and David Constable, Flour Corp. Group President, Power, gives an insider's view on how the challenges surrounding the next generation of nuclear power plants can be met. His company presently is partnered with Toshiba on construction of the South Texas Projects Units 3 and 4.

Another avenue is demand response (DR). Ali Vojdani, CEO of UISOL examines why DR is not widely implemented in most organized markets and how to address that situation.

L. A. Burkhardt
Editor

How can smart-grid technology reduce the carbon footprint while creating a more sophisticated delivery network?

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Demand-response programs increasingly are seen as critical to smooth and efficient functioning of wholesale markets – but their effective integration remains a challenge.

There is universal agreement among experts that demand-response (DR) programs are among the most cost-effective means of managing peak demand while reducing price volatility and improving grid reliability. Yet, with a few exceptions, wide-scale implementation of DR programs remains limited in most organized markets. Once the main obstacles are understood, they can be addressed successfully.

DR as Cost-Effective Resource

Numerous studies as well as empirical evidence agree that adding a relatively modest amount of DR programs to the resource portfolio of an organized wholesale market can have significant benefits. The principal benefits of DR may be grouped under three main headings:

- Cost savings by avoiding high-priced peak generation during high demand periods;
- Reduced price volatility by introducing critically-needed price elasticity in what would otherwise be an essentially inelastic demand in real-time or ancillary service markets; and
- Improved grid reliability and operability by adding flexibility on the demand side.

Grid operators who successfully have integrated DR programs into their wholesale market operations offer impressive testimonials on these beneficial aspects. For example, the PJM Interconnection LLC (see Figure 1), which has developed a successful market to »

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By Ali Vojdani, Ph.D.

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Nuclear Renaissance New-build Challenges

By David Constable



integrate DR into its operations, has documented cost savings of \$650 million during August 2006 when the region was afflicted by a prolonged heat wave.

On 2 August 2006 alone, when PJM set a new peak-load record of 144,796 MW, it reported DR savings of \$230 million. These savings were based on incentives paid to DR program participants vs. the cost for acquiring peaking generation as determined by the market on that day. According to Andrew L. Ott, PJM's Senior Vice President —

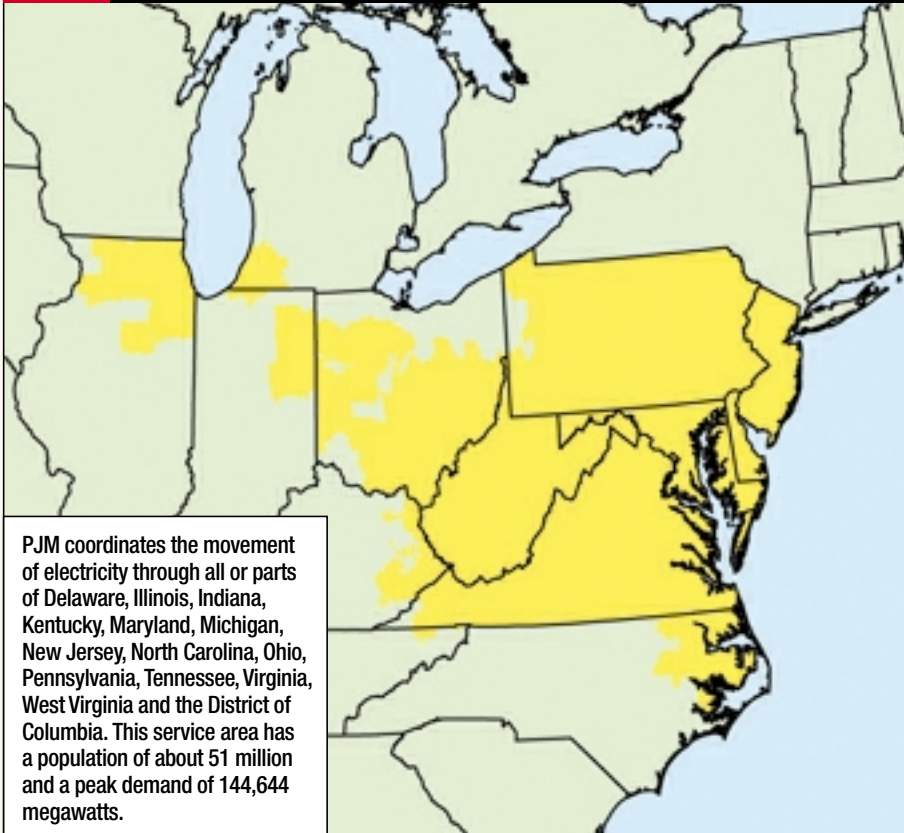
Markets,¹ "These (DR) voluntary curtailments reduced wholesale energy prices by more than \$300/MWh during the highest usage hours." Similar testimonials are available from other Independent System Operators (ISOs) around the country that have active DR programs.

Others, including utilities that have examined the benefits of DR, provide equally impressive cost-benefit figures. One recent study by Baltimore Gas & Electric Company, a unit of Constellation Energy, concluded that the capital



Fig. 1

PJM INTERCONNECTION



cost of DR, estimated around \$165/kW, is three to four times lower than the cost of installing new peaking generation, which costs in the range of \$600-\$800/kW.

DR Challenge: Scale and Effective Integration

Given such impressive results, why aren't we seeing wide-scale implementation of DR programs across the industry? One reason is that DR, like other demand-side options including energy efficiency programs, is still in its infancy relative to the industry's traditionally strong supply-side resources. A second and more important reason is that DR programs — by their nature — tend to be diffused and distributed among a potentially large number of participating customers. Aggregating and effectively bringing these distributed resources to wholesale markets to compete head on with traditional supply-side options is a complex process.

As DR programs grow in size and significance, the issues of scale (*See p. 5*)

FORTNIGHTLY'S

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Vienna, VA 22182
Phone: 703-847-7720
800-368-5001
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NUCLEAR RENAISSANCE

New-build Challenges

BY DAVID CONSTABLE

It is becoming increasingly evident that in order to provide cost effectively for the growing power demands of the U.S. in an environmentally-responsible manner, new power facilities using a broad mix of fuel types will be needed. There is no single magic bullet. However, it is clear that new nuclear-generated power will play a significant role in meeting these twin objectives, not just in the U.S., but globally as well.

As the largest publicly-traded U.S.-based engineering and construction firm, Fluor currently is partnered with Toshiba, and working on the South Texas Project Units 3 and 4, which will be among the first new nuclear plants to be constructed in the U.S. in nearly 30 years.

There are many unanswered questions surrounding the challenges for the next generation of nuclear power facilities. I will address two of the most vital from an engineering and construction firm's perspective.

Developing a Skilled Labor Workforce

Readers are certainly familiar with the fact that perhaps the key unknown for nuclear new-build involves the labor workforce. Power utility owners

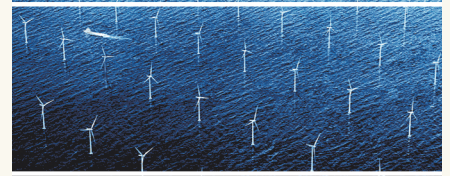


understand the challenges in labor availability, compensation and productivity when designing and constructing large fossil-fueled plants today. The added challenge for the first new-build nuclear plants will be deploying a skilled labor workforce with the extra level of expertise required for constructing these types of facilities.

There are currently no manufacturing facilities capable of forging the largest reactor components in the United States.

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One solution is to begin working now in the local high schools and colleges to inform the educators and students about the career opportunities available for skilled craft workers. Fluor is currently working with STP Nuclear Operating Company, Toshiba and Wharton County Junior College in Bay City, Texas, where we actively are educating students and faculty on the potential job growth in the nuclear industry. And these are good jobs, especially when compared to many entry-level white collar jobs that require a 4-year college degree.

The second step in the process is to train the new workers we attract. Our efforts already are underway in south Texas. These newly-trained craft employees will be hired initially to work on Fluor's regional projects in the oil, gas and conventional power industries, thereby gaining valuable experience and further training. Then, when the South Texas project is ready to ramp up in 3 years time, the craft workers will be available to productively build the nuclear units.

Furthermore, we believe that worker productivity will be improved due to enhanced computer and construction technologies, including modular construction techniques. It is estimated that only half the number of on-site construction personnel will be needed to build these new nuclear units when compared to the first »



generation plants of the 1970s and '80s.

Mitigating Manufacturing Supply Challenges

There are currently no manufacturing facilities capable of forging the largest reactor components in the United States. All of these components initially will come from Japan and/or Korea.

With numerous variables in play, it is difficult to precisely predict how soon new-build nuclear construction will occur. But if it takes off quickly with several units in the first wave, the sudden increased demand for major reactor component forgings could become a manufacturing supply-chain bottleneck.

For smaller components, manufacturers in the U.S. have been providing replacement and upgraded components effectively for the existing nuclear fleet since the 1970s. But again, if nuclear build-out occurs more rapidly than expected, we would expect to see many new manufacturers enter the marketplace to keep up with demand.

Fluor and the Nuclear Energy Institute (NEI) recently met with local area manufacturers in South Carolina to discuss the industry outlook, timing, and

codes and standards for the next wave of nuclear new builds. We also are working closely with NEI and owners on supply-chain initiatives to audit and qualify nuclear component manufacturers in preparation for future needs.

Taking Action Now

So the workforce challenges as well the potential manufacturing supply-chain bottlenecks can be mitigated if specific actions are taken now to prepare for the coming nuclear renaissance. The benefits to U.S. consumers will be the production of safe, reliable, clean electricity at affordable prices to meet increasing demands.

Again, nuclear alone is not a magic bullet. But together with electricity generated by new gas, renewable and clean coal plants, the nuclear option has a vital role to play in our country's energy security and standard of living. ■

David Constable is Group President, Power, Fluor Corporation.

Fluor originally designed and/or built 20 new-build nuclear plants in the U.S. in the 1970s and '80s, and subsequently provided engineering, construction, operations and maintenance services to 90 U.S. nuclear plants for the past 30-plus years.



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GOING TO MARKET

(Cont. from p. 2)

FIG. 2 THE GRAVEYARD OF STRANDED DR APPLICATIONS



Source: "California Demand Response Business Network", Final Report on California Energy Commission Project No. 500-01-043, DR-04-01, April 2005.

and effective integration become even more of a challenge. Beyond a certain scale, manual and haphazard programs — which typically rely on human interactions and processes — simply become impractical. To appreciate the significance of scale, consider PJM's current DR programs, which amount to roughly 6 GW of potential price-responsive demand-side resources in a 164-GW network. To aggregate this critical resource, some 50 curtailment service providers interface with over 7,000 participating DR sites.

To put things in perspective, PJM's 164 GW of supply-side resources are represented by approximately 2,000 generators compared to 7,000 participants to deliver a 6-GW DR resource. The scale on the demand side already is more than 3 times the supply-side in terms of number of resources that are managed. This is only the beginning of a burgeoning DR market, expected to grow in terms of number of participants and GW scale over time.

Clearly as we move forward, a higher level of sophistication and integration than traditionally has been applied in implementing DR programs is needed. Referring to the importance of scale and integration issues, PJM's

Peter Langbein² highlights several key requirements for successful DR programs:

- Ease of registration, simplicity of participation and standardized processes and transactions encouraging customer participation in DR programs in organized markets such as PJM;
 - Improved transparency in all aspects of notification, bidding, dispatching and settlement so everyone can see who did what, when and how;
 - Significantly reduced time and administrative costs for both market operators, curtailment service providers and DR participants;
 - Scalability of the scheme to handle higher volume of participation as well as larger number of transactions per participant; and
 - Ability to manage frequent changes in market rules, procedures, protocols and tariffs — a common occurrence in all organized markets.
- Such requirements — as straightforward and innocuous as they may appear — are not attributes that generally are found in many existing DR programs offered in many markets around the country. Nor is the underly-

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ing infrastructure generally capable of handling the frequent changes or the necessary interfaces with other subsystems within an operating grid, as described below.

Managing Complexity

Another difficult challenge facing DR programs is the sheer complexity of managing large numbers of transactions among a large and growing number of participants in a demanding working environment. To appreciate why, consider the following requirements of DR:

- Large numbers of participants must take part for DR to be of an effective resource;
- Complex network consisting of many entities, many processes within each entity, and many interface systems within and among these entities;
- Complex processes, many of which are not documented nor necessarily consistent, let alone standardized, streamlined or optimized;
- Frequent changes in market rules, tariffs and protocols aggravated by inflexible IT applications and interfaces; and
- Need for accountability and transparency to ensure the integrity of DR resources including supporting measurement and verification to avoid gaming and ensure program reliability. »



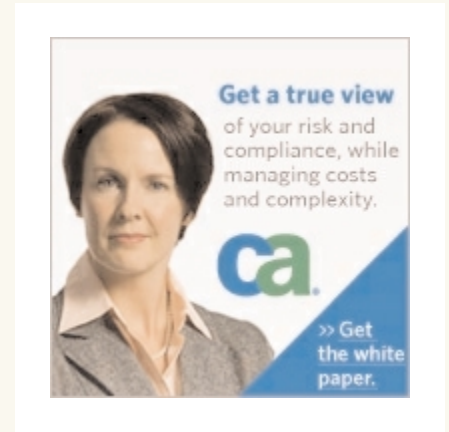
Need for Flexible Infrastructure

When markets operated by ISOs originally were organized, the principal focus was on managing the bidding and dispatching of supply-side resources and maintaining system reliability. It took a lot of ingenuity and resources to develop, test and implement the basic IT infrastructure to support a complex set of applications and sub-systems that are essential to operation of a centralized grid. DR programs were generally an afterthought, which means that these programs now have to be introduced and supported on top of layers of existing software and hardware, generally hard-wired and with little or no flexibility.

As the preceding discussion illustrated, managing DR programs is com-

plex in its own right due to a large number of participants, large numbers of transactions, and the need for transparency, scalability and the necessity to handle frequent changes in market rules and tariffs. The difficulties associated with superimposing this level of complexity on top of many existing applications so that DR resources can compete head on with supply-side resources cannot be overstated. This is a cause for concern, because as everyone in the IT business knows, it is often cheaper to buy a new and flexible application than to maintain an inflexible existing one.

Experience to date clearly suggests that managers in charge of DR programs must add flexibility to the long list of requirements for IT systems



and supporting applications. In fact, it may be wise to list flexibility ahead of other desirable attributes such as performance, usability, scalability, >>

Next Month's FORTNIGHTLY

The November issue of *Fortnightly* magazine delves into the minds of regulators. Editor-in-Chief Michael T. Burr investigates energy conservation in the "Regulators Forum: The First Fuel," looking into how, as saving energy becomes a policy priority, utility commissioners struggle to reconcile traditional revenue models with smart metering and smart pricing. Unlocking conservation potential will depend on transforming passive ratepayers into smart consumers. *Fortnightly* hosts a roundtable discussion with commissioners from six states.

Here is more of what you will find:

▶ **2008 ROE Survey—Rates, Risks & Regulators**

Economic uncertainties are raising doubts over utility returns. Will regulators feel the need to consider broader economic effects when engaging in ratemaking? While reporting on this year's rate cases, the author provides insight on what to expect as stock prices fall.

▶ **Memo to the President-Elect (Part 1)**

The new administration might be our last, best hope for recapturing America's technological and economic superiority. The time has come to institute an "Apollo Project" level of effort to convert to a carbon-free energy infrastructure while tossing aside the business-as-usual model. The future lies in nuclear power.

▶ **Rewiring America**

A massive T&D system build-out is starting, but more needs to be done. Executives from Northeast Utilities, Pepco Holdings and ITC Holdings discuss improvements needed for reliability, capacity, security, smart-grid and demand-response measures, as well as accommodating wind and green-energy quotas.

▶ **Carbon in the West**

Whether in the form of a carbon tax or cap-and-trade regime, climate-change policy is coming and will have a profound effect on electric suppliers and consumers. EPRI studied the effects of high carbon dioxide prices on nine diverse Western generation companies and provides insight into the expected major market responses.



reliability, and so on.

In this context, managers responsible for procuring IT infrastructure to support DR applications should consider flexibility as a predictor of future change order costs in answering questions such as: How fast and at what cost can I change an existing application?

While the industry has recognized the need for interoperability the hard way, the need for flexibility has yet to be widely recognized. Lack of flexibility can result in a short-life for DR infrastructure investments (see Figure 2). Fortunately some industry leaders such as PJM have recognized the need for flexibility and are proactively addressing that in the next generation of DR management systems. Such pioneering work could become a model for DR management infrastructure for the rest of the industry.

Way Forward

As the preceding discussion points out, management of large-scale, sophisticated DR programs with a large number of participants in an organized wholesale market is complex and can become a limiting factor in development of DR markets until we master it.

For DR programs to be effective, they must be able to support a very large number of participants with multitudes of transactions, which in turn must be supported by transparent accounting and settlement systems and interfaces with virtually every subsystem imaginable in a demanding busi-

ness environment — a real-time operating grid. Making matters worse, the requirements to support virtually all DR programs are likely to undergo frequent and significant changes, either because of new market rules, new tariffs or new regulatory requirements. In this environment, managers and IT professionals responsible for DR implementation must plan ahead and select with deliberation.

Foremost among the features of any DR program and supporting systems must be a flexible infrastructure that can cope with these challenging requirements. Meeting these challenges will not be easy, but the rewards available from increased DR energy, capacity, and ancillary services resources are worth the effort. ■

Ali Vojdani is the CEO of UISOL. He has over 27 years of experience in the application of IT in the utility industry as part of his professional career at UISOL, Vitria Technology, Perot Systems, EPRI, PG&E, and McGill University. Dr. Vojdani has a Ph.D. in electrical engineering and has authored over 60 technical publications. Contact Info: UISOL, 24 Benthill Ct., Lafayette, CA 94549. Phone: 916-247-5171.

Endnotes

1. PJM press release 17 Aug. 06.
2. Excerpted from presentation at Utility Integration Conference held in Phoenix, AZ, 16-17 Sept. 2008.



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