Reliability Issues in a Restructured Electric Industry

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I have been in the business for a long, long time. In fact when I started in Load Research, we were still collecting data on wax charts and paper tape, and entering the data into a mainframe computer using data cards. We had just retired the stone tablets and chisels.

My first project in Load Research was a commercial time of day rate. In those days the thought of a residential time of use rate was absolutely unheard of. After all, residential customers were not about to alter their lifestyle to save a few pennies. Only commercial customers, whose electric bill represented such a large portion of operating costs, were sophisticated enough to modify their usage patterns by planning and adjusting the running of certain processes. My job was not to design rates to be charged but to determine rating periods to be considered peak, off-peak and shoulder, and to develop a scheme for editing any lost data that would accurately depict customer usage during the unrecorded period. Remember, in many cases the recording methods were not exactly state-of-the-art, and there were many gaps in the data. It was, to say the least, a tedious task.

As time went on the data collection evolved from magnetic tape and chip memory and computers got smaller while handling greater amounts of data. Once we were convinced that time of use worked for commercial loads, we experimented with residential loads. By performing end-use surveys to determine appliance mix and load research on end-uses, we were able to determine the time and duration of appliance use and contributions of each appliance to peak. We all know that a single residential load may not be that significant, but in Washington, D. C., I surveyed some homes that used as much power as a small business. Consider this -- a wine cellar, a tropical garden, a heated swimming pool, eight bedrooms, and an art gallery all under one roof. Obviously this was not a candidate for time of use and the residents didn't really care how much money was spent to keep all their thermostats happy. But there were others who, through education, could definitely benefit from load controls and wiser use of electricity.

For years, we assumed residential customers would use their electricity indiscriminately, believing there was nothing they could do to reduce the bill and knowing there would always be an adequate power supply at the flick of a switch.

When I introduced a real time pricing rate to the large industrial customers in New York State, they were all skeptical. First of all, we only talked to customers who were on the time of use rate. One customer, through intense negotiations with the labor union, had shifted most of their crew to night work to take advantage of off peak rates. The off-peak rate more than made up for the night shift pay differential, particularly in an industry where more than 75% of their operating costs are for electricity. The real time rate would allow the workers to return to day work, and the company could take advantage of lower costs, by using forecasted rates to plan their operations.

The residential time of use rate I introduced in New York drew a lot of flak from dairy farmers, who complained that their cows would object to being milked off-peak, according to the time of use schedule. Residential customers could readily adapt to the new rates. My response was to design a new rate for farmers (and their cows) to better their commercial operations.

This discussion of load research, rate design and forecasting may seem irrelevant to reliability and restructuring of the electric industry, but knowing your system, your customers, and your future energy needs are highly relevant to maintaining a healthy electric system. Load research provides information about usage and exposes opportunities; rate design provides incentives to shift loads, and forecasting is a major planning tool. While these functions are integral to system reliability, they could also become victims of competition.

Now we are moving into a new era. Competition and deregulation have become the new buzzwords. While electric utilities have competed for years with other fuels, they will now compete with one another.

Over the past two decades there has been a great deal of talk and movement towards competition and the restructuring of businesses and services traditionally considered natural monopolies. Technological advances, providing the means to break down barriers to competition, have been greatly responsible for this movement and a changing attitude about natural monopolies. Trucking, airlines, long distance telecommunications, natural gas and now electricity have all been de-regulated to varying degrees.

Following close on the heels of FERC's orders to open transmission (FERC Orders 888 and 889), is the current push to break up or restucture electric utilities into their functional parts: generation, transmission, distribution and customer service.

Today I want to talk a little about electric reliability and the possible impacts of restructuring and competition on reliability. We have just gone through a year-long exercise to test the reliability and Y2K readiness of the nation's electric grid. Manual workarounds and contingency plans were examined and rewritten to deal with computer misread problems. Systems and plans were examined so carefully that unrelated problems were discovered and solved. By comparison, this was only a pop quiz, for competition will, I suspect, test our ability to make the most of precious resources.

Competition, whether implemented on the state or federal level, will lead to restructuring of electric utilities. As they evolve into leaner, meaner, more efficient organizations, cutbacks to improve bottom line and cut costs, may additionally compromise customer service and reliability. The biggest question will be who is responsible and accountable to ensure customers continue to be served as well as they have in the past? How can this be enforced? In the vertically structured utility the responsibility was well defined, but in the new structure with so many new players, the lines of responsibilities may become blurred.

How is reliability defined -- how is it measured -- who oversees the reliability of the national grid?

Reliability is the delivery of power, safely, efficiently, with a minimum of fluctuations and outages. Reliability is monitored by the North American Electricity Reliability Council (NERC) which is made of geographic subgroups of electric utilities, many of which are electric cooperatives operating in rural America. NERC, under the U. S. Dept. of Energy, along with NRECA , APPA and EEI, played a major role in the monitoring and testing of Y2K readiness in the United States during the last two crucial years. While most electric utilities in the United States and Canada are members of NERC's sub-councils, membership is strictly volunteer and NERC has no means to penalize utilities for infractions of reliability standards, even though members are expected to follow the stardards developed by NERC. Basically, this is a self-regulating system. In many States, even the public service commissions have limited authority to enforce standards, even though they recognize them and require reporting on such actions as outages and accidents. Otherwise the Councils work together to forecast energy needs and keep the grid secure.

In 1996 the National Association of Regulatory Utility Commissioners (NARUC) surveyed its State commission members to determine their position on what constitutes reliability issues and standards and their authority over those areas. In light of restructuring, many standards currently under the jurisdiction of the State commissions could be left to the individual companies at the expense of the consumer. In that survey, less than one-third responded that they were updating their standards, some were adopting NEPOOL standards, but most were taking a wait-and-see approach. Most commissions have incorporated standards in their rules or in administrative code (law). (A complete list of reliability issues addressed by Commissions is found at the end of this paper.)

Over the years, State public utility commissions have developed definitions of reliability to include those areas which contribute to the delivery of reliable electric service. For the most part it is understood that good engineering practice for plant construction, operations and maintenance must be exercised at all times. NESC, NEC and ANSI, and OSHA safety standards as well as Federal, State and local standards and ordinances must be followed. ANSI includes standards for construction, meters and transformers, and voltage standards for variation and quality.

Other important reliability issues currently addressed by State commissions include outage reporting, including frequency and duration; voltage studies; safety programs, inspections, protective measures, and tree trimming; procedures for handling complaints; and emergency operating and contingency plans. Many commissions have developed indices for monitoring interruptions and standards for frequency and voltage fluctuations. (A table of these indices is found at the end of this paper.)

Under a competitive structure, including further reduced State oversight, it is likely that, in the interest of maintaining revenues, the reliable electric service could become a scarce commodity.

As conscientious engineers, we would say this is impossible, but in the new environment, energy will be bought, sold and moved around by small businesses more interested in improving their bottom line than making sure that the power lines are equipped to carry the power being forced onto them.

BIOGRAPHICAL SKETCH

SHARON E. ASHURST

Sharon Ashurst is currently a Senior Power Requirements Officer in the Energy Forecasting Branch where she reviews load forecasts of some of RUS' largest borrowers. Most recently, she coordinated the Electric Program's efforts to assist borrowers in Y2K compliance. Sharon started her career at Potomac Electric Power Company (PEPCo) in Washington, D. C., where she held various positions. Her last eight years with the utility were in load research, where she performed class and end-use studies, including appliance saturation and a study of non-response bias with EPRI. After PEPCo, she worked for Niagara Mohawk Power Corporation in Syracuse, New York, where she assisted in the installation of a data base and load analysis package and trained a load research staff. Additionally, she performed cost of service studies for both gas and electric sectors of Niagara Mohawk and designed real time and time of use rates for electric customers and gas transportation rates. She has testified before the New York State Public Service Commission on gas and electric issues and has ten published reports, including her Masters thesis on competitive strategies for rural utilities.

Reliability Issues -- Required by Utilities

Exercise good engineering practice for plant construction, operations and maintenance

Follow National Electrical Safety Code

- National Electrical Code
- ANSI standards for meters and transformers
- ANSI standards for construction
- Grounding standards for industrial and commercial power systems
- Other appropriate Federal, State and local standards and ordinances

Reduce life hazards

Maintain records of accidents

Report to commission on death and injuries

Permit formal investigation

Written program for inspection of system

Checks of poles, wires, distribution system

Implement safety programs

Tree trimming programs

Verify satisfactory meter location

Check circuit and secondary grounding

Miss Utility programs -- call before you dig

Performance based mechanisms

Generation or power supply:

- Provide adequate power supply
- Provide for reserve power supply

Transmission and distribution:

- Design, construct, maintain and electrically reinforce system to perform reliably, considering storm and traffic hazard environment
- Maintain residential and underground lines

Preventive maintenance schedules

Emergency repair procedures

Plant and equipment inspections

Meter testing, accuracy and records

Frequency standards, including variation and quality

Example: 60 cycles per second, maintain within +/-2%

ANCI standards on voltage standards, variation and quality

Example: Maximum voltage deviation +/- 2% for retail and +/- 7.5% for wholesale loads

Perform voltage studies

Rules for equipment testing and recordkeeping

Reasonable care for avoidance of outages

Speedy restoration of power, consistent with safety considerations

Calculation of indices

Maintain records on interruptions

Distribution outage reports

Adequate notice of planned outages

Protective measures; health and safety measures

Records on worst performing circuits

Emergency operations plan -- contingency plans or manual workarounds

Load research

Procedure for handling complaints

Forecasting and resource planning

Records of sales and purchases

Parallel generation source

EMF protection

Calculation of Indices -- adopted by EEI, IEEE, EPRI

SAIFI -- System Average Interruption Duration Index -- The number of times the average customer's service is interrupted in a year. Minimum and Objective levels are established by service area. Calculated by dividing the total annual number of customers interrupted by the average number of customers served in a year. (10,000 customers out of 100,000 experience five interruptions each = .5)

CAIDI (SAIDI) -- Customer (System) Average Interruption Duration Index -- The average number of hours required to restore service to a customer whose service is interrupted or the average amount of time a customer is without service during the reporting period.. Minimum and Objective levels are established by service area. Calculated by dividing the annual sum of all customer interruption durations by the sum of customers experiencing the an interruption. (i.e., 100,000 customers experience one interruption lasting one hour = 1.0)

MAIFI -- Momentary Average Interruption Frequency Index -- The average number of momentary interruptions that a customer experiences during the reporting period.

CIII -- Customer Interruption per Interruption Index -- The total number of customers interrupted divided by the number of interruptions. The index measures the average number of customers without service per interruption.

TLPI -- Transmission Line Performance Index -- Transmission line insulation failures for the period divided by the miles of transmission line at the end of the period.
Worst Performing Circuits -- Circuits, which for each reliability index, are among one percent of all circuits in an operating area with the highest achieved values (lowest performance levels) for a specific reliability index.

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Advances in Technology

- Load data recording
- Meters & meter reading
- Computerized monitoring systems
- Distributed generation
- Renewable energy sources

Ensuring Reliable Power Delivery

- Knowing your customers
- Knowing your system
- Forecasting future needs
- Maintenance programs

Competition

- What does it mean to electric utilities?
- What does it mean to electric coops?

Reliability Defined

- Delivery of power: safely, efficiently, with a minimum of fluctuations and outages

Some Acronyms

- NERC - North American Electric Reliability Council
- NARUC - National Association of Regulatory Utility Commissioners
- NAERO - North American Electric Reliability Organization
- FERC - Federal Energy Regulatory Commission
- RTO - Regional Transmission Organization

Reliability Issues

- Good engineering practice for plant construction, operations and maintenance
- Follow standards: NESC, NEC, ANSI, OSHA, as well and Federal, State and local standards and ordinances
- Voltage studies
- Outage reports
- Safety reports

Reliability Issues

- Meter and transformer testing
- Scheduled outages
- Protective measures
- Tree trimming
- Emergency operations
- Contingency plans

Conclusion

- Knowing your customers
- Knowing your system
- Knowing your competitive environment
- Forecasting your customers needs