

## Electric Andrew

Andrew Carnegie founded Carnegie Tech and Andrew Mellon the Mellon Institute, and the two merged to form Carnegie Mellon University (CMU). Now that you know that, let's move on to business.

Carnegie Mellon held its "Third Annual Carnegie Mellon Conference on the Electricity Industry: Ensuring that the Industry Has the Physical and Human Resources Needed for the Next Thirty Years" on March 13-14, 2007, an event co-sponsored by the Carnegie Mellon Electricity Center, Department of Electrical and Computer Engineering, Department of Engineering and Public Policy, and the Tepper School of Business. The sponsorship indicates the breadth and depth of the undertaking. Full texts of all remarks are available on the conference website. Here's a summary.

Everything works so well that people assume that no problems remain in the electricity arena. Not so, said Ed Schlesinger (CMU). The public needs to know.

Studying the industry requires a multidisciplinary approach, as Lester Lave (CMU) and Marija Ilic (CMU) noted, as they pointed out that their program operates out of engineering and business departments. At deregulation, economists didn't understand the system and engineers didn't understand the market. Implementation of public policy required more than economics 101 skills. It required power engineering as well.

Under regulation, according to Lester Lave (CMU), utilities had an incentive to over invest, but spent little on R&D. Under deregulation, they shed jobs, cut investment and spent even less on R&D. Half the workforce is close to retirement, which makes retention of knowledge a key issue for the industry. Will the industry get needed capacity in place, and will the suppliers to the industry have the capacity to meet the industry's needs? Nobody knows for sure. The industry has to plan for and respond to uncertainty.

Speaking of planning, Goran Andersson (ETN-Zurich) argued that the industry's existing system is not suitable to meet future requirements. The industry has to forecast technology and build a system flexible enough to incorporate whatever comes along. A common carrier device could transport gas and electricity to energy hubs, for instance, which could distribute the appropriate product to consumers. The key problem is to find a way to develop; a network that does not get locked into particular technologies that could become obsolete.

The electric network requires reactive power, but, said Greg Reed (KEMA), under deregulation it is difficult to plan or schedule reactive power. The existing plant was not designed for markets. New technologies, however, can be viewed (and should be paid) as generators of VARs. Furthermore, while they may look expensive compared to conventional equipment, they may cost less than other solutions, such as building transmission lines.

Pricing and metering can make a difference, according to Ahmad Faruqui (Brattle Group). Customers do respond to pricing, and tests indicate that the right combination of metering, control and prices could shave 5% off peak load. Under traditional ratemaking, though, a change in pricing leaves too many customers worse off, and does not provide sufficient benefits to attract participants. The utility should take into account its risk in selling to customers at a fixed price. The customer who accepts the time of use pricing takes on the risk from the utility, and should receive compensation for doing so. After payment for risk, 97% of the customers come out better off under the new pricing scheme.

Industry structure creates all sorts of complications that affect results. Edvaldo Alves de Santana (Fedl. U. of Santa Catarina) and Andre Luis da Silva Leite (Southern U. of Santa Catarina) did not get to the conference but submitted a paper that looked into the motivations behind bidding and contracting procedures, mistrust of markets and hybrid structures, in the Brazilian electric industry and how those factors produced predictable results. Policy makers seem to march ahead unreflectively everywhere.

Jason Makansi (Pearl Street) argued that we should view emissions as signs of inefficiency, and we had to analyze and monetize global warming, vulnerability to attack and energy independence. Once done, private investors could drive the goals.

Jack Casazza (American Education Institute) claimed to be the only qualified lineman in the room, which nobody disputed. He narrowed the problem to how to get adequate capacity with the right technology for the next three decades. The single most important reliability problem is gas transmission: lose a pipeline and face a major electrical blackout. As for the emphasis on a national grid, he thought better of the idea of splitting the grid apart, and connected the parts with DC transmission. And he advocated more attention to distributed technologies. The market will not produce a solution. The country needs a goal, and then should organize to achieve it.

The industry's structure is more complicated than ever, according to Marija Ilic (CMU), involves the need for multiple tradeoffs and products, and all that requires a transparent exchange of information. The industry may not have the resources to provide the same reliability to all customers, but does not have information about what customers need or want, just an obligation to serve. The time has come for new regulations and definition of performance.

With terrorism on the front pages, Granger Morgan (CMU) took a look at the electric industry as a target. Back in 1990, the Office of Technology Assessment said that terrorists could inflict massive damage. A National Research Council (NRC) report in 2002 said that terrorists could do the greatest damage by hitting the electric system. Well, another NRC report is on the way. As for targets, nuclear waste storage looks tempting, but the substations look the juiciest: thousands of them protected only by chain link fences, and it takes a long time to get replacement equipment for a damaged substation. More attention should go to rapid service restoration, which requires the stockpiling of equipment, portable transformers, batteries and other local solutions.

The Department of Energy (DOE) has joined with NERC to create reliability tools, according to Phil Overholt (DOE). People working on the electrical network need to know what is happening on it, and phasor measurement technology will keep them informed. Reliability markets, market design demand side response and new technologies must be integrated into the operation of the network.

Jose Antonio Vanderhorst-Silverio (Grupo Millennium Hispaniola) asserted that industry restructuring went in the wrong direction. What is missing is interaction between the industry and customers. The end state should be retail competition and ultra quality service, which means electricity without price controls served up on an integrated high quality transportation system.

Of course, a high quality transportation system for electricity must mean more than what we have now. Customers have to call the utility to tell it that something is wrong. Laurentiu Nastac, et al., (Concurrent Technologies) unveiled an intelligent operational fault analysis system than can locate the problem.

Suriya Ruangpattana, et al., (Purdue U) tackled the risk of the fuel portfolio, using financial procedures, looking at price variability as a measure of risk, and cost. The utility needs to trade off the cost vs. risk when choosing a particular fuel.

Frequency response on the electric system requires rapid rebalancing after a disturbance in order to prevent system failure. Howard Illian (Energy Mark) believes that frequency response standards have declined since 1992. Poor response endangers the network. The network has to respond automatically when quick response is required. No existing market in the world could provide the required response.

Jay Morrison (NRECA) took a look at the Federal Power Act Second 217(b)(4), which requires transmission entities to “facilitate planning and expansion of transmission to meet reasonable needs of load serving entities” which includes providing them with “firm transmission rights or equivalent ... on a long term basis.” NRECA translates “facilitate” to mean “make it happen.” Morrison’s organization, which represents rural electric cooperatives, doesn’t view FERC as being enthusiastic about this injunction. FERC had already concluded that the transmission entities can’t plan the network in a way that puts their interests ahead of that of their customers, but that customers don’t have an equal weight in decision making. Is FERC focused on the long term? Congress is. FERC does the bare minimum

Managing assets requires a balanced perspective, according to Larry Dickerman (American Electric Power). Utilities have to improve the cost / quality balance for customers, improve earnings and keep regulators in mind. Twenty years from now , AEP might have to integrate end use activities, demand side management and distributed generation. ( As an example, consider a plug in hybrid vehicle that could charge its batteries off the grid as well as provide storage to the grid.) That integration requires a clear strategy.

Tim Mount (Cornell U) described capacity markets, designed to assure that generating capacity will be there when needed, in terms of the rise and possible fall of a dubious regulatory strategy, which seems to involve paying out a lot of money and getting little in return. In the old, traditional arena, planners worked to keep a steady margin of extra capacity. In the unregulated market, high prices at peak was supposed to provide the incentive needed to keep in service or bring on line plants that do not operate often. Once the regional organizations decided to “mitigate” high prices at peak, that created a problem, and it led to complicated mechanisms (capacity markets) that don’t necessarily lead to low costs or the necessary plant.

Boris Defourny and Louis Wehenkel ( U of Liege) proposed that policy should be based less on approximation, that it needs methods to deal with uncertainty, and that assets have to be valued better, in a way that considers their peculiarities or advantages. That is, policy makers must identify trends, and consider the probability and volatility of future events.

Lynne Kiesling (Northwestern U) described a potential future for the industry, Gridwise Interoperability, something akin to a global ATM network. The existing network is linear. Power flows to consumers, and money flows from consumers. The consumer is passive. With information technology, the network could become more transactive.

China is in the midst of an ambitious electric integration program as well as a gas pipeline expansion, according to Robert Blohm and Hui Ren (North China Electric Power U), although rivalries between various state controlled entities seems to stymie progress at times. China wants to establish power markets, too.

Adam Newcomer and Jay Apt (CMU) examined the economics of adding a gas storage unit to an IGCC plant, and concluded that doing so would improve IGCC economics. Right now, coal goes to the IGCC to produce gas that goes into the generator to produce electricity. The unit could produce gas in off peak periods, and store that gas, for use in peak periods with an additional generator added on to the plant. The added facility would sell output at peak prices.

Kathleen Spees (CMU) returned to the topic of peak load, this time at PJM, where 15% of generation runs 11.1% of hours in the year or less (not counting the 17% reserve margin that doesn’t seem to run at all). Furthermore, a shift of 0.12% of all hours consumed would obviate the need for those facilities. The wholesale market treats load as unresponsive to price, but studies show short term price elasticity of demand at -0.25 and long term elasticity at -0.80. Even assuming lower elasticity, price response would reduce peak price 20-30%.

Jhi-Young Joo, et. al. (Seoul National U) outlined a critical peak pricing policy, perhaps required for use three times a month, statistically administered ahead of time. A dynamic administrator ( an energy service provider) sends a signal to the customer with

a smart meter. Will the user turn off as requested? If the answer is yes, the administrator cuts the service. The incentive to the energy service provider is the profit.

Dalia Patino- Echeverri, et al. (CMU) proposed that the retrofit of an old coal plant with emissions controls required an investment strategy based on uncertainties. The average US coal fired power plant is 38 years old, and 10% of the plants are over 48 years in age. Investing too much in additions to an old plant may not make sense. What is the planning horizon? View the decision to install pollution control facilities as an option on emission allowances.

Aurelian Craciunescu ( U Politehnica of Bucharest) , the last presenter standing between the conferees and lunch, made a virtue of brevity. Cable motors pump the cooling fluid in electric cables. He has developed a new, brushless, long lived cable pump motor. That's it!

Putting it all together, the conference paints a picture of the electric industry that resembles the financial industry. Old players take on new forms (the demutualization of the exchanges), trading in derivatives often exceeds that of the underlying instruments, investors do not know what risk they incur (collateral based obligations), principals become agents and dump risks on unwitting consumers (sub prime mortgages), financial engineers buy whole companies and sell them later (do they improve company performance or just strip assets?), and regulators have no clue as to whether the new instruments and players make the financial system safer or less safe.

Electricity restructuring seems to have separated physical, financial, commercial and regulatory decision making, and, inadvertently, left consumers at risk. We need physical plant to deliver the goods, and putting that plant in place requires planning and long term incentives, but those in charge of the new market place seem to have only the vaguest notions of how to bridge the gap between the day ahead market and planning for three decades ahead. Regulators may stymie the development of market oriented procedures that could reduce costs and improve reliability. Furthermore, reliability seems to have deteriorated. Yet, as the presentations demonstrated, there are a lot of ideas out there that would sharpen decision making, reduce costs, align incentives with desired goals and even bring to market new products and services.

Henry James wrote of “the *constant* force that makes for muddlement. The great thing is indeed that the muddled state ... is one of the very sharpest of the realities...” So, will we muddle through the coming three decades, or will we do better than that? That's the question that the conferees really asked. We need an answer.

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