

## An Emerging Issue We Cannot Ignore: Meeting the Twin Challenges of Education and an Aging Workforce in the Electric Power Industry

Michael E. Ebert, CIP Program

Within the span of the last few months, two reports have been issued – one by the US Department of Energy (DOE), the other by the North American Electric Reliability Council (NERC, its first reliability assessment as the new Electric Reliability Organization) that sound an alarm about the future reliability of the US – Canada electric power system. What makes these reports remarkable from a critical infrastructure perspective is that for the first time both DOE and NERC independently make an explicit linkage between critical “human infrastructure” – the men and women who have provided the North American electricity grid with engineering and technical expertise – and reliability.

This article examines the DOE and NERC reports through the prism of current and future workers. We also interviewed other experts, such as Professor Robert J. Thomas of Cornell University, founding director of the 11 university member National Science Foundation Industry/University Cooperative, the Power Systems Engineering Research Center (PSerc), and Wanda Reder, the president-elect of the IEEE’s Power Engineering Society (PES). Collectively, DOE, NERC, Thomas, Reder, *et al.*, point to an emerging issue of national importance: addressing the twin chal-

lenges of education and an aging workforce in the electricity sector.

While education and aging workforce concerns are not confined to the electricity sector but rather are part of larger national debates and “baby-boom” demographics, the available data and information suggest that education and workforce issues are more acute in this industry than others. Further, given the criticality of electricity to every other sector of the common North American economy, and its reliable supply vital to other essential public goods, it is important to elevate the public discussion using the solid evidence now available from NERC, DOE and other expert sources such as the PES.

As NERC Senior Vice President David Nevius suggested when interviewed for this article, it is important to consider balanced **approaches** to solve complex, multi-jurisdictional issues. As an example, Nevius points to some voices in the education – aging workforce debates who suggest that we can fix deficiencies in education inputs and outputs and knowledge attrition due to aging via “offshoring” – tapping into foreign sources of education and labor to fill looming workforce gaps, as the IT sector has done. Other voices, including NERC, urge solutions that would

require transformations of educational and political institutions using prescriptive formulas to churn out more American power engineers and technical workers. Still others believe we should “buy time” – and thus ignore the urgency of the data – by enticing a large number of the aging workforce to labor many years into retirement. NERC, says Nevius, recognizes that it is not practical or desirable for us to solve the challenges either by letting other countries solve the education – workforce gap for us, although attracting qualified and credentialed foreign engineers might be part of balanced industry – government – academia efforts. He also suggests encouraging electric utilities to better use their senior professionals to “mentor” younger workers to avoid the looming gap.

### DOE Report: Focus, Key Findings and Recommendations

In August, the Department issued a report to the US Congress, *Workforce Trends in the Electric Utility Industry*. This report is required by Section 1101 of the Energy Policy Act of 2005 (EPACT), and with its issuance DOE has fulfilled at least one of three explicit requirements of this provision (i.e., § 1101(b)(2), “report on trends”). There are two other requirements in *(Continued on Page 3)*

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 Section 1101 – one which requires the Secretary in consultation with the Secretary of Labor and using data collected by that agency, to “monitor trends in the workforce” for engineers, technicians and other “crafts workers.” The third requirement, §1101(b)(3), requires the Secretary of Energy, “as soon as practicable after the date on which the Secretary identifies or predicts a significant national shortage of skilled technical personnel in 1 or more energy technology industries,” to submit a report to the Congress describing the shortage. The August 2006 report does not appear to have triggered a §1101(b)(3) finding.

In its Executive Summary, the DOE report states:

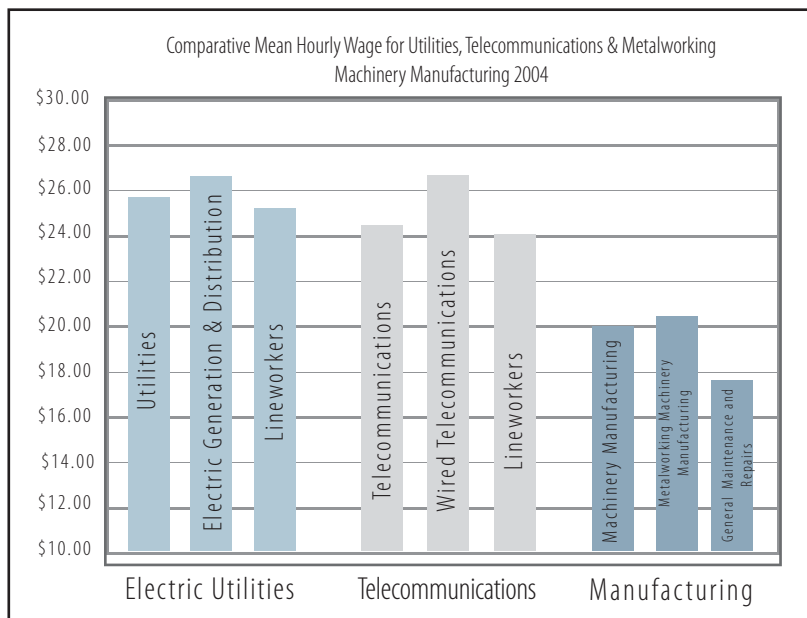
*Today, the power engineering education system in the United States is at a critical decision point. Without strong support for strategic research in power systems engineering and without qualified replacements for retiring faculty, the strength of our Nation’s university-based power engineering programs will wane, and along with them the foundation for innovation in the power sector to meet our energy challenges in the 21<sup>st</sup> century.*



Professor Robert J. Thomas  
 Cornell University

Professor Thomas takes issue with the theory that there is a lack of student interest in power engineering. He sees the problem as a lack of research funding which is necessary to support faculty hires. “University administrations need

to know there is a long term commitment to university research in the area. The students need to know there are high paying, interesting jobs.”



According to Wanda Reder, “a possible reason why the report did not trigger a §1101(b)(3) finding, besides the questions about how accurate the Bureau of Labor Statistics forecast is, is that the report assumed that in the near-term, power engineering programs would continue to be able to graduate power engineers in sufficient quantities to meet the demand. However, in five to ten years, that may no longer be the case.”

The major source of data in the DOE report comes from the Bureau of Labor Statistics (BLS). BLS data series on wages, employment and occupational classifications is an exceptionally rich source of information, particularly after BLS some years ago conformed its occupational series with the North American Industrial Classification System (NAICS) that is used by Census, the Bureau of Economic

Analysis and other federal statistical agencies (which allows researchers to link and cross-tab Census and BLS data, for example). Industry experts and academics, such as Wanda Reder, president-elect of the IEEE’s Power Engineering Society, and Professor Robert J. Thomas of Cornell’s School of Electrical and Computer Engineering, believe that the DOE has done a very good job mining BLS and other data. They have concerns, however, that while the DOE (and NERC) reports are the “best around given the available data,” there are fundamental knowledge gaps in the numbers. Some of the weaknesses identified by Reder and other experts we interviewed are future labor market demand data, hiring trends, and identification of new or emerging occupational skill sets that currently are not captured or correctly categorized by existing BLS codes.

The DOE report begins with an examination on electrical lineworkers and other electricity craft workers who typically enter the industry after high school via apprenticeship. (Continued on Page 4)

**Electric Power** (Continued from Page 3) ships, vocational education centers and/or community colleges. Often, the available literature on education and workforce issues in electric power has an emphasis on those workers who pursue BSEE degrees and specialize in Power Engineering both as undergrads and in graduate engineering programs. This report has a message for those six out of ten US high school graduates who do not enter 4-year college degree programs in its section on electrical lineworkers:

*Demand is expected to outpace supply over the next decade. As a result, [lineworkers] are one of the highest paid professions in the United States that does not require a post-secondary education. In May 2005, electrical lineworkers earned a mean hourly wage of \$25.14/hour or \$52,290 per year. Experienced electrical lineworkers earn well above \$32.54/hour and during overtime, based on this pay, could earn \$48.81/hour. So an experienced electrical lineworker working 20 overtime hours every month could earn over \$79,397.60 per year. However, companies have remarked*

*that they could grow immediately by 400 – 500 more people, if they could find the right candidates.*

But can such income potential market signals close the looming workforce gap in linemen and other technical craft occupations? The labor shortage and current workforce demographics are not encouraging. At one of the nation's largest public power companies, only 179 employees out of over 12,500 are between the ages of 20 and 24, whereas 2,891 employees are between the ages of 50 and 54.

The report does not provide similar encouraging income signals for future power engineers. The table below, taken from DOE's report based upon a 1000 IEEE publication, shows that average earnings for power engineers were dead-last compared with other electrical engineering specializations.

DOE's report makes two broad recommendations: The first is to foster better math and science education at all levels of education but particularly early-on and through the secondary level: Students need the right combination of math, physics and chemistry in order to pursue engineering in college. The second is to build interest in energy related careers: There is a perception that energy-related fields are obsolete and old-fashioned. However, there are some significant opportunities for creativity and innovation to meet the challenges of the 21<sup>st</sup> century. In addition, not all these positions require advanced degrees.

David Nevius, Senior Vice President  
North American Electric  
Reliability Council



"It is important to consider balanced approaches to solve complex, multi-jurisdictional issues."

Federal agencies, such as DOE and the Department of Labor, could work with the private sector to communicate what the energy industry is about and to build awareness for the careers of tomorrow.

**NERC/Electric Reliability Organization Reliability Assessment: Emerging Issues Identified and Recommendations**

On October 16, 2006, NERC published its 2006 Long-Term Reliability Assessment. While the organization has issued such reports in the past, the 2006 report was issued in the context of NERC's new designation by the Federal Energy Regulatory Commission (FERC) as the nation's first Electric Reliability Organization (ERO). What distinguishes the 2006 report from its predecessors is a new section, *Key Findings and Recommendations*. Within that section is a highly visible subheading, *Aging Work Force*. According to David Nevius, this topic was elevated as the report moved from draft to final. "When our board reviewed the draft, its members felt very strongly that the aging work force issue must be given high visibility and greater prominence," said Nevius. "We are giving this far greater attention not just in our report, but in our interaction with the media, government officials and academia." (Continued on Page 5)

Engineering Discipline	Salary
Solid-state circuits	\$93,500
Communications	\$92,900
Laser and electro-optics	\$91,000
Software, aerospace and electronics	\$89,000
Components, manufacturing	\$88,850
Signals and application	\$87,000
Antennas and propagation	\$86,000
Medicine and biology signal processing	\$85,000
Electron Devices	\$84,750
Network administration	\$81,000
Power Electronics	\$80,050
Circuits and systems	\$80,000
Instrumentation and measurement	\$76,000
Energy and power engineering	\$73,625

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Wanda Reder,  
President-Elect  
IEEE's Power  
Engineering  
Society

"Our industry is coming to the realization that recruiting and retaining the best people is top priority."

Read Ms. Reder's article on power industry demographics, "Look at the numbers," in *Transmission and Distribution World* ([http://tdworld.com/mag/power\\_look\\_numbers/index.html](http://tdworld.com/mag/power_look_numbers/index.html)).

NERC's report was able to draw upon the data and information similar to that available to DOE. NERC, however, also had access to surveys commissioned by industry where the microdata are not publicly available. One survey cited by NERC is a Hay Group study, which found that:

- forty percent (40%) of senior electrical engineers and 43 percent of shift supervisors will be eligible for retirement in 2009;

- two-thirds of the utility companies surveyed have no succession plans for supervisors and 44 percent have no succession plans for vice presidents;
- the problem is far more acute than professionals, engineers and managers: the skilled labor force will be severely affected; and,
- aggravating the problem of sustaining essential technical knowledge is the dwindling number of students in the power engineering programs of most universities.

NERC makes four key findings/recommendations to adopt "innovative measures to bridge this emerging knowledge gap."

- Establish needed cooperative programs with academia to reinvigorate power engineering education in North America.
- Identify key personnel approaching retirement and implement mentoring programs to impart the experience realized by these individuals.
- Reassess compensation and benefits packages to attempt to retain aging personnel, either part- or full-time.
- Hire engineers and other utility professionals from outside the United States.

**What are others saying and thinking about these challenges? Are there any new initiatives? Are there more specific recommendations?**

In conversations with Nevius, Reder, Thomas and other experts, it is clear that critical thinking in this space indeed goes back several years, especially within academia and organizations like IEEE PES and NERC. Ms. Reder provided CIP Program researchers with several of her articles, including a June 2006 slide show, *Managing the Talent Challenge*, an electronic copy of which is now available on the CIP Program website's library. Reder believes that one of the biggest challenges in higher education is on the demand side:

*We are getting to the point where the physical infrastructure and human expertise in the system are stretched to a critical point. We simply must rebuild power engineering faculty at US engineering schools and this cannot be done without addressing the current dearth of research money for power engineering. At this time, few senior executives in the electric utility industry make the connection between the education – workforce gap and much more robust research*  
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Similarities	Differences	
	Lineworkers	Power Engineers
Demographics - dominated by "Baby Boomers"	Industry very aware of retirement situation	Industry not completely aware of pending retirement impact
Loss of institutional knowledge as more retire	Short-term impact to utility operation	Long-term impact to national competitiveness
Mergers, cutbacks, and downsizing over the past two decades	Interest in field is growing	Interest in field is declining
In-house training programs being developed by industry to fill perceived voids	Training programs nearly doubled in last 10 years	University programs have declined over the past decade
Potential lack of qualified, interested replacements	High pay, especially for limited post-secondary education	Low pay, compared to other concentrations within electrical engineering

*Electric Power (Continued from Page 5) funding. There also are new technologies which either are stuck in the R&D stage or are developed and not being applied – a situation that more directed research could help alleviate. In addition, we also must develop better workforce supply – demand data, which IEEE PES hopes to do with a new recruitment website. We also must honestly confront the industry’s image challenge, which extends all the way down to students in middle schools and high schools . . . and also to teachers, guidance counselors and parents. Relative to hiring engineers from places outside of the US, there are visa limitations. If we are to tap this labor pool, Congress will need to change the current approach on visas for highly skilled and educated foreign nationals.*

While there are differences between the “power engineering gap” and the “lineworker/craft workers gap,” there also are important symmetries.

Cornell’s Thomas had several recommendations, including a need to examine apprenticeship and journeyman timeframes which run many years to see if time-savings can be made consistent with safety and security. Involving the International Brotherhood of Electrical Workers and other trade unions in reform is crucial. He sees a possible quick and somewhat inexpensive solution to a current knowledge gap by conducting a survey which examines trends in the number of electricity sector jobs advertised, but not filled due perhaps to labor shortages or skill gaps. Reder concurs, and says that even absent hard numbers, “my gut says there is a gap, not just for workers who’ve just

exited trades programs or universities, but at mid-career levels.” She suggests targeted surveys could help identify the nature and magnitude of education and aging workforce challenges.

New realities are pushing the industry, managers and workers, and academic institutions at all levels. Thomas says that “restructuring has caused some utility companies to wonder what their business really is . . . this is not just a problem in the US, but can be seen from studies and outcomes of restructuring in the United Kingdom.” Reder agrees that “market incentives often are short-term, whereas the time horizons for critical human infrastructure education and training are very long. Market dynamics will do what they will, but we need greater awareness of how markets are not just affecting investments in physical infrastructure but in education and research.”

Most of those who were interviewed for this article raised concerns about an undue reliance on “offshore solutions” or extending the number of years professionals and technical staff spend in the workforce. Electricity is a very unique commodity; off-shoring solutions and special visas may have addressed domestic workers and skills shortages in the Information Technology sector, for example, but offshoring many critical electric power jobs is not realistic, especially for lineworkers and control room operators. Security concerns will arise, as many jobs in the electricity sector increasingly require recurring background checks, substance abuse tests and security credentials – all of which are more costly and complicated with regard

to foreign nationals. Realistically, the politics of immigration have been difficult for both elected officials and citizens in the US.

There are bright spots amid the challenges. Professor Thomas says that it is very significant that “for the first time in my memory, NERC has flagged manpower as a major reliability issue. And this issue has not just found traction at NERC. It is surfaced in almost every utility boardroom.” Reder says that at local levels of government and education, positive change is rising to the challenge. For example, she notes that the industry, in cooperation with labor unions and some academic institutions, founded the Center for Energy Workforce Development (<http://www.cewd.org>) in March 2006. Located in Washington, DC, the CEWD will, in early 2007, launch a new initiative to better understand the electricity sector’s workforce gaps. According to CEWD’s Director, Ann Randazzo, “We are in the process of kicking off an industry study that will help us understand where critical shortages exist.” Ms. Randazzo, who previously worked in the electric utility industry for many years, says that her organization’s initial focus has been on lineworkers, powerplant operators, maintenance and repair workers, and pipefitters and pipelayers. CEWD’s strategic plan is to move into move into additional job categories where there are gaps, such as power engineering. An example of new curriculae that are being developed at the community college level can be found at the South Georgia Technical College’s electrical lineworker apprentice certification program, and CEWD’s “Get Into  
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**Electric Power** (*Continued from Page 12*) Energy” promotion is designed to confront the industry’s “image issue,” primarily targeted on pre-college age students and their teachers.

### Conclusion

Replacing or refurbishing aging electricity infrastructure is challenging, but long lead times required to effect input – output changes in the education-workforce supply chain are far more complex. Gaps in data and knowledge, particularly with regard to future demand forecasts and changing occupational skill-sets, make it difficult to construct a business case that withstands bottom-line pressures of financial markets, boardrooms and academic

institutions. It will take a balanced approach, cooperation and facilitation of dialogues which presently do not exist. Although industry has commissioned consulting firms to conduct targeted surveys of industry professionals to address identified or perceived data gaps, it may be more cost-effective and seamless if an academic institution develops and comprehensive survey instruments that bring educators, educational institutions and students into existing and planned surveys of utility managers and labor organizations. While capturing engineering schools, deans and faculty is essential, the ideal sample would include students and teachers at high schools, voc-ed centers, and 2-year community-technical colleges.

In speaking with professional engineers, concerns about “market realities” often surface, with experts such as Reder noting that in many past policy debates on industry restructuring, power engineers and other technical professionals “often were not at the table.” Expanding academic consortia that are engineering-focused to include economics, law and policy institutions might be a way to expand the table and facilitate richer policy discussions. ❖

*Wanda Reder (IEEE), Professor Bob Thomas (Cornell), Dave Nevius (NERC), Gil Bindewald (DOE) and Ann Randazzo (CEWD) made significant contributions to this article.*

The CIP Program is directed by John A. McCarthy, a member of the faculty at George Mason University School of Law. The CIP Program works in conjunction with James Madison University and seeks to fully integrate the disciplines of law, policy, and technology for enhancing the security of cyber-networks, physical systems and economic processes supporting the nation’s critical infrastructure. The CIP Program is funded by a grant from The National Institute of Standards and Technology (NIST).

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