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Program on Technology Innovation: Executive Workshop on the Aging Workforce in the Utility Industry

April 2006, Carnegie Mellon University, Pittsburgh, Pennsylvania

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PRODUCT DESCRIPTION

The *EPRI/CMU Executive Workshop on the Aging Workforce in the Utility Industry* brought together 40 utility operations and human resource executives in April 2006 to address the foremost concern of utility human resource managers: the impending wave of the aging workforce reaching retirement age. The intent of the workshop was to identify workforce needs and explore tactics and actions to address problems that may ensue when as many as 60% of today's experienced utility workers retire in the next five years. The needs addressed included how to prevent high turnover, capture knowledge that is "walking out the door," foster increased knowledge transfer between retiring and incoming workers, and generally bolster the educational and training mechanisms that help supply the pipeline of skilled workers for utilities.

Results & Findings

The workshop featured both presentations and interactive working sessions in which utility executives helped frame short- and long-term solutions to problems that are expected to be encountered because of a significant loss of experienced older workers. This report documents results of participant working group discussions along with their recommended actions. Highlights of plenary session addresses with selected accompanying graphics from PowerPoint slides provide background data and insights and an outline of potential future research activities.

Working Group Sessions and Results

These sessions focused on answering the following questions:

1. **What will the industry workforce look like in the next 5 years—and the next 10 years?** What factors related to the customer, the economy, technology, strategic management, and the workforce will shape the industry landscape? Will it change? And how much?
2. **How will the workforce change in the next 5 years—and the next 10 years?** What are forecasts, and what do current trends portend?
3. **What actions can be taken to address both workforce and industry needs?** What efforts for shaping the utility workforce will help utilities create the future they want?

Summary findings from interactive working groups include the following:

- *The supply of skilled workers will remain lower than the utility industry's needs*. Collaborative support of educational programs at all levels and for all types of jobs are needed to bridge this gap. In-house training programs also are recommended, allowing for cross training and enhanced workforce flexibility and mobility.
- *The utility infrastructure will be largely the same as it is today, with the major change being an increase in use of digital technology*, including advanced meters, smart grid technology,

and automated diagnostic equipment. This may mean more automated, unmanned functions, but it also will require a workforce well trained in use of such technologies.

- *Knowledge capture and transfer programs will need considerable development and leadership*. Examples include systems for greater documentation of both explicit and tacit worker knowledge and budget allowances for overstaffing to fund a period of overlap during which retiring employees can help transfer critical knowledge to incoming replacements.
- *Greater investment in efficiency and technologies such as renewable and nuclear power will likely increase operating costs, and may have some effect on type of workers needed*. Although clean coal technology such as integrated gasification combined cycle (IGCC) plants will be tested, deployment will have very little effect on workforce needs within the next five to ten years. The need for skilled nuclear workers may increase, however.
- *An aging infrastructure and likely continued under-funding of physical asset replacement will require a workforce with considerable analytical ability* for determining when and how maintenance and replacement must be performed.
- *Meteorological events that engender floods, heat waves, droughts, hurricanes, and other severe storms will result in consumer desire for higher reliability* and, thus, greater need for skilled mobile restoration crews.

Challenges & Objective(s)

The workshop was conducted to identify both short- and long-term actions to take advantage of the coming utility workforce transformation. The aging workforce is one of the most pressing issues in the electricity industry. A recent Carnegie Mellon University (CMU) study found that 80% of utility human resource executives rank the aging workforce as the number one concern they have, even above health care costs, which tops the list in every other industry.

Applications, Values & Use

Addressing the aging workforce situation is critical to utilities' ability to perform well in the near term and offers a rare opportunity for innovation in shaping future utility operations and technology for the longer term.

EPRI Perspective

This workshop helped detail the challenges utility management and the future workforce must address, including aging infrastructure assets, the increasing need for advanced communications and computational ability to be built into new infrastructure, maintaining and enhancing levels of reliability and customer service, and pressures to keep costs low.

Approach

The project's goal is to impart information on the status of retirement and attrition of workers in the utility industry and convey the perspectives of the workshop participants regarding actions to address workforce attrition that would be of greatest use to the industry.

Keywords

Aging, Human resources, Knowledge capture, Knowledge transfer, Retirement, Workforce

ABSTRACT

The intent of the EPRI/CMU Executive Workshop on the Aging Workforce in the Utility Industry was to envision workforce needs and examine tactics and actions that could address problems likely to result when upwards of 60% of today's experienced utility workers retire in the next five years. The workshop featured both presentations and interactive working sessions in which utility executives helped frame short- and long-term solutions to problems that could occur with the attrition of experienced older workers. This report documents results of participant working group discussions along with their recommended actions. Prior to the working sessions, industry experts and researchers from EPRI and Carnegie Mellon University and Erroll B. Davis, retired chief executive officer of Alliant Energy Corporation, briefed participants. Their presentations featured data and insights on the current utility workforce situation, including results of a survey of utility operations and human resources executives. This report, in its entirety, is intended as a reference and source of ideas to utility executives and managers, including senior management and human resource personnel.

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CARNEGIE MELLON ELECTRICITY INDUSTRY CENTER

The **Carnegie Mellon Electricity Industry Center** served as co-sponsor and host of the Executive Workshop on the Aging Workforce in the Electric Utility Industry as part of its mission for the interdisciplinary study of significant business and technology issues related to the electricity industry. The Center is probably one of the largest of its kind in the world.

The Center:

- Is one of the Alfred P. Sloan Foundation's 26 Industry Centers of Excellence situated in 19 universities nationwide
- Involves 17 faculty and 22 Ph.D. students at CMU
- Engages closely with industry stakeholders including utilities, regulators, government agencies, consumer groups, labor groups, and national laboratories
- Focuses scientific knowledge on issues of mid- to long-term importance, including recent projects on
  - market structure and performance
  - distributed energy resources
  - advanced generation and transmission technologies
  - environmental and sustainability issues
  - reliability and security

One of the research projects of the Center was to identify issues, challenges and opportunities presented by an aging utility workforce, which entailed a survey of human resource executives at U.S. utilities with more than 100 employees. Results of this study as well as ongoing research on potential scientific solutions to the threat of knowledge loss are highlighted on in this report in the summary of the presentation by Michael Ashworth.

A selected sample of other recently completed research includes:

- Should we transport coal or electricity?: Cost, efficiency, and environmental implications
- Are renewable portfolio standards cost-effective emissions abatement policy?
- The costs of wind's variability: Is there a threshold?
- Environmental effects of interstate power trading on electricity consumption mixes

- Learning curves for environmental technologies and their importance for climate policy analysis

For more information on the Center, including descriptions of research, publications, events, people involved, and funding, please visit http://wpweb2.tepper.cmu.edu/ceic.

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KEYNOTE ADDRESS OF ERROLL B. DAVIS, JR.: THE GRAYING OF THE ELECTRIC UTILITY INDUSTRY

Erroll B. Davis, Jr. served as chief executive officer and chairman of the board of Alliant Energy Corporation—an energy holding company with $8.3 billion in total assets and annual operating revenues of $3 billion. Alliant Energy currently has more than 1.4 million customers in Iowa, Illinois, Minnesota and Wisconsin. Davis is also a former chairman of the Edison Electric Institute.

Davis retired from his dual roles as Alliant Energy president and CEO in July 2005 and now serves as chancellor of the University System of Georgia, responsible for the state's 35 public colleges and universities. The University System has 253,500 students, 35,000 faculty and staff, and an annual budget of $5 billion.

Erroll B. Davis, Jr. set the stage for the workshop with an address that characterized the current utility workforce, what this means for utilities, and what utility executives should consider in dealing with the loss of half or more of their experienced staff and technicians.

"We are in an interesting, yet startling period."

Facts and statistics help define the magnitude of the aging workforce problem.

- The U.S. Bureau of Labor reports that the U.S. will face a shortage of 12 million qualified skilled workers by 2010.
- The oldest Baby Boomers—including George W. Bush, Cher, and Dollie Parton—are turning 60 this year. The number of people reaching retirement age during the next 5 to 10 years is unprecedented, and this will affect electric utilities more than any other industry. The average age of the utility worker is 48 years old, 3 years older than the average worker in the U.S.
- What a few specific utilities are facing in respect to the aging workforce offers a glimpse of a problem that is industry wide.
  - **Dominion Resources**, which is headquartered in Richmond, Virginia, reports that 25% of its workforce will be eligible to retire by 2007.
  - At **Duquesne Light** in Pittsburgh, Pennsylvania, 50% of line technicians will be of retirement age in 5 years.

– At **Alliant Energy** in the Midwest, more than 40% of the workforce is over 50.

"We're building power plants again. We need more people."

The wave of expected retirements is occurring as the electric utility industry is entering a phase when power plants are being constructed again, and work needs to be done to upgrade an aging power delivery system. This creates a "double whammy" of sorts, as even more workers will be needed, not just replacements:

- By some projections, the industry will need 9% more line technicians a year—or about 10,000 more per year.
- More than 1,000 new plant operators will be needed each year over the next decade.

"There is little or no pipeline."

Davis noted a number of exacerbating and contributing factors to the challenge of replacing retirees in the utility workforce. For example, most all positions increasingly require computer proficiency, suggesting that more computer training is needed today. Moreover, the supply of skilled workers is insufficient.

The short supply of skilled workers is part of a larger, societal and educational system problem: 35% of seniors in high school score "below basic" in math, and 45% score below basic levels in science.

"It's clear younger people want different things than their elders wanted."

Davis posited that part of an upcoming potential recruitment problem is that utilities have an image problem and may not be offering the types of jobs or work flexibility that have cachet with younger generations of workers.

- Job security is not as important as it used to be. "They have never gone hungry," noted Davis.
- Utilities are not seen by younger workers as particularly attractive places to work. They are not viewed as glamorous or adventurous, or as conferring the same status as some other industries. "'I got an offer from a utility' is not something graduates brag about like they would if getting an offer from Microsoft or GE."
- The demanding nature of many utility jobs may affect recruitment. Davis quipped, "All of you with kids know they are dying to work in a hot steamy power plant; or go out in the rain to work on wires that may be hot."
- Younger people are likely to want more flexibility for a life/work balance. Davis noted that younger people don't necessarily build their lives around work the way previous generations have.

"Executives should be losing sleep over this. But it is solvable."

Davis noted several options and actions that utilities should consider for tackling the problem of acquiring and retaining a workforce with the skills and knowledge needed.

- An assessment of each utility's needs and a comprehensive workforce plan is called for. He exhorted companies to identify what knowledge is being lost, and when it is likely to be lost. "You have to have data."
- Consider offering more money. "No matter what age, money is always of interest," stated Davis.
- Examine the flexibility offered to workers: consider family-friendly policies, such as men getting paternity leave.
- Work with unions, especially when you need to "backfill" skills.
- Retain or rehire older workers. Consider motivating older workers to stay on the job with financial incentives, health care that is superior to Medicare, flexibility to work part time, or perhaps do job sharing. This may require altering pension rules.
- Capture the older workers' knowledge before they leave. This might be achieved by pairing older and younger workers, and documenting knowledge more effectively.
- Utilities need to partner with each other and with schools and universities. There are insufficient trainers and educational programs operating to meet the workforce needs of utilities. "Most industries have tighter bonds with educational institutions than utilities do," Davis pointed out. He did note an example of a collaborative effort for technical training for entry-level utility positions. In October 2004, the Utility Business Education Coalition (UBEC) set out to create Centers for Excellence for utility job training in partnership with the American Association of Community Colleges. Twenty-five sites have applied for the designation as a Center for Excellence, and the UBEC's goal is to have a minimum of 10 sites by 2008.
- Get the word out. "Shout from the rooftops" that utilities provide good and interesting jobs.
- Get moving. "Utilities have long decision-making processes appropriate for making multi-billion dollar investments, but we shouldn't use this for every decision."
- Give younger people greater responsibility and opportunity. "Take more risks—every mistake doesn't turn off the lights," contended Davis. "How many utilities have any vice presidents in their early 30's?" he asked, pointing out that he served as a vice president at Alliant Energy at that age.
- Develop and improve technology. This is not just for cost cutting or environmental reasons, but also to reduce manual labor, and make it safer for workers (and extend the capability of older workers). It may also enhance the attractiveness of utility jobs to the pool of recruits who want the latest high-tech tools.

2
PLENARY SESSIONS: POSSIBLE FUTURES, MAINTAINING A SKILLED WORKFORCE, AND HUMAN RESOURCE SURVEY RESULTS

Building on Erroll B. Davis, Jr.'s introduction to the aging workforce dilemma, Lester Lave and Michael Ashworth of Carnegie Mellon University (CMU) and Clark Gellings, Vice President—Innovation of the Electric Power Research Institute (EPRI), offered results of research on the status of the utility workforce, ideas on what might affect or emerge in the future to affect the ability of utilities to maintain a skilled workforce, and information on how their respective institutions may assist utilities in addressing these issues.

Lester Lave, Carnegie Mellon University: The Electricity Industry in 2011? 2021?

The **Carnegie Mellon Electricity Industry Center**, which applies interdisciplinary research to electricity industry problems, co-sponsored the *Executive Workshop on the Aging Workforce in the Electric Utility Industry* because of the timeliness and strategic importance of the aging workforce issue. Lester Lave presented both conclusions and possibilities for the future of the electric industry, which he asked participating utility executives to consider during the course of the workshop.

His main theme was that although we need to rely on existing infrastructure assets in the near term, and thus need to have a replacement workforce with the same skill sets as are presently required, the world is changing. Utilities should consider their long-term workforce needs as well. "You have to turn on the power tomorrow morning, but you also have to plan for the future," contended Lave.

He presented his outlook on what change factors utilities and the participants in the workshop should consider, and recommended development of a more flexible workforce that is not an exact replica of the existing one.

What will the future be?

Lave helped put the workshop in context with discussion of what the future might hold for utilities, but urged caution about speculating too far out into the future, say 15 years from now.

For example, he asked, "What would you have predicted for 2006 in the year 1991? Would you have gotten it right?":

- In that time of cheap natural gas and coal, would you have predicted today's prices or volatility?
- Or in a period when there had been no large blackouts since the 1970's, would you have predicted the Northeast blackout?
- Would you have predicted the state of restructuring of the electric utility industry?

Then why worry about 2021?

"A fifteen year perspective is nonsense," said Lave. But he noted that certain facts will affect the direction of the electric utility and related workforce issues, most notably growth in demand, and the potential need for new technologies and processes in response to fuel prices and emission control policies. These include:

- Demand is likely to grow by 37% through 2021, requiring new capacity to be built.
- Pulverized coal plants have a very long life (today's are 30–60 years), and may be millstones around your neck if stringent CO_2 emissions are in place by 2036.
- A trained worker for a nuclear or coal plant is a long-term investment.

Forecasting 2011

The short term is easier to deal with, since inertia rules, and little of the infrastructure or operations will change by then. However, technology developments in the next five years may indicate some changes in longer-term workforce needs:

- We will likely have a better idea of how well some new technologies, such as coal gasification plants now being built, will work.
- What are today just warning clouds may prove to be facts of life; e.g.,
  - greenhouse gas emissions control
  - more stringent air pollution controls for ozone, heavy metals, etc.
  - natural gas scarcity

Moreover, market structures may change. This leads to some challenges and opportunities—and alternative futures—that are presented by new technologies, changing economic and political conditions, and market responses. For instance, energy demand might change.

Forces that Could Cut Electricity Demand Substantially by 2036

- Demand could be lowered substantially within 30 years through much greater efficiency and lifestyle changes.
- Cheap, small fuel cells could emerge.
- A U.S. economy in a recession and decline would need less electricity.

- Population growth could slow (no immigration)
- Or conditions may prevail that instead of cutting demand for electricity, increase it.

Forces that Could Increase Demand

- Plug-in hybrid vehicles
- Everything stationary runs on electricity; everything mobile runs on hydrogen
- Rapidly increasing income and population

Challenges and Opportunities for 2011

According to CMU research, several options including demand response, distributed generation, renewable resource development, and coal gasification merit attention when considering what the utility world will be focusing on within the next 5 years:

- The wind resource is large, and "deserves a second look," per Lave. This resource may be a key component for meeting state renewable portfolio standards. And the standards may change within 5 years.
- If the price of natural gas is not too high, distributed generation such as internal combustion engines and other technologies may play a bigger role in the next 5 years, boosting reliability.
- "If you make electricity demand responsive, the world changes," per Lave. Although some participants raised objections to the viability of demand response efforts, citing previous erroneous expectations about its cost effectiveness, Lave asserted that "It is nonsense to say whatever demand is, that's okay."
- Coal gasification with carbon separation and sequestration may be a factor in 5 years and this may have implications for the workforce. For instance, CMU research on a project for using Wyoming coal for California electricity revealed that moving gas (from coal gasification) instead of transmitting electricity would be the better option.

Should we replicate the current workforce?

Although the utility infrastructure will not change significantly within 5 years, utilities have an opportunity to shape the replacement workforce and they should do this by examining future needs, not simply replicating the past.

Lave contends that design can eliminate some jobs and devices may improve productivity. For example, perhaps a few linemen will be able to do the job of many. Is it true that we'll always need linemen? Although conventional wisdom is that we will, Lave asked participants to consider ice delivery in the past. If you had been assigned to change it, how would you do it? Robot delivery? No. What you need is a refrigerator/freezer that eliminates delivery altogether. Although existing infrastructure assets mean we will continue to need linemen many years out, he encouraged participants to consider how technology could change the workforce needs in the

longer term. For example, in a hydrogen economy in which each house has a fuel cell to produce electricity and provide thermal energy for space conditioning and water heating, transmission and central station power could be eliminated, making distribution less important.

Some potential technological changes that might affect the utility workforce include:

- Robotics
- Underground superconducting cable
- Moving energy by pipeline, not wire
- Greater reliance on distributed generation such as fuel cells
- Broadband communication that allows for remote trouble-shooting

Policy and market issues could also affect tomorrow's workforce, including:

- Ability to outsource almost all white collar jobs
- Outsourcing engineering, software, product design and manufacture
- Reform of public utility commission regulation
- Industry consolidation through mergers & acquisition
- More variable precipitation, meaning hydro resources could be problematic
- More & more violent storms leading to more frequent and greater infrastructure damage
- An aging population, which can lead to demand changes

Conclusions

Lave advised that the workforce depends on the company strategy. First, utilities must decide what they want to be and design the workforce and the infrastructure accordingly. He recommended:

- Design your workforce to fit the company. Don't just replace your current workforce.
- Figure out how to train skilled workers and retain them; e.g., $12,000–20,000/yr. in training plus a forgivable loan.
- Buy more flexibility by cross training workers.

Clark Gellings, Electric Power Research Institute (EPRI): Maintaining a Skilled Workforce

The Electric Power Research Institute co-sponsored the *Executive Workshop on the Aging Workforce in the Electric Utility Industry* in order to determine if there are opportunities in the future development of science and technology which could help address workforce issues. At present, EPRI has three related areas of activity:

4. **Technology**—this is the primary focus of EPRI research and has several dimensions related to maintaining a skilled workforce. How should technology evolve and how will this affect workforce needs? For instance, noted Gellings, "Instead of working on a relay, set it remotely." Can remote monitoring or robots that 'walk' the transmission line automate functions? Such technological approaches could have an enormous impact on workforce needs.
5. **Learning**—education and training, such as training of plant operators, is a significant element of EPRI's work. Knowledge capture is of particular interest as it relates to downsizing, retirements and attrition, as is knowledge transfer, performance improvement processes, sharing of best practices, and just-in-time information.
6. **People**—EPRI, as a key industry institution, has a stake in the broad issue of creating and maintaining a positive image of this industry overall. While not a research question, the need to constantly communicate technological opportunities is critical.

Gellings stressed that EPRI is primarily interested in technical issues related to the aging workforce going forward, and outlined multiple dimensions in which technology impacts the workforce, including making technology easier to install, maintain and use by reducing its complexity. In particular, in the realm of information technology (IT), application and integration could have a significant impact.

Information Technology (IT) Issues

- Integration of decision tools, business processes, and customer relationship management systems.
- Access and control of intellectual property, document management, indicators, etc.
- Search and retrieval issues related to unstructured data, agents, portals, spiders, taxonomies, data mining, and text mining.

Knowledge capture and knowledge management systems are especially critical with so much of the workforce retiring in the next few years, said Gellings. He noted, "How often do you have people walk around with drawings that are out of date? How unusual is it for someone to say, 'Oh, that pipe doesn't run there anymore. We moved it." Such information needs to be documented.

Undocumented Knowledge Capture

Gellings identified a three-phase process resulting in valuable and usable documents, as shown in the chart in Figure 2-1.

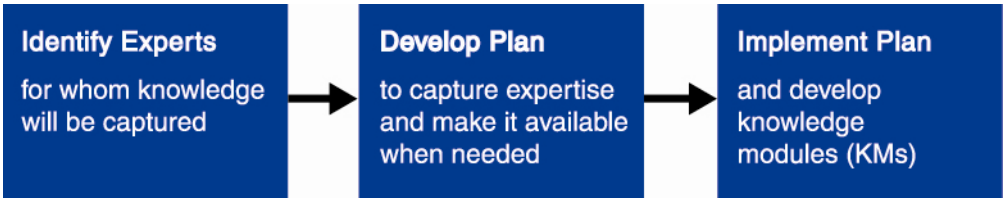

Figure 2-1
What is Undocumented Knowledge Capture?

Gellings also discussed the importance—and difficulty—of capturing tacit knowledge; i.e., the knowledge the person relies on to do a job, but which has not been expressed and documented. Such tacit knowledge is typically the core of job competency and quality, as illustrated in Figure 2-2.

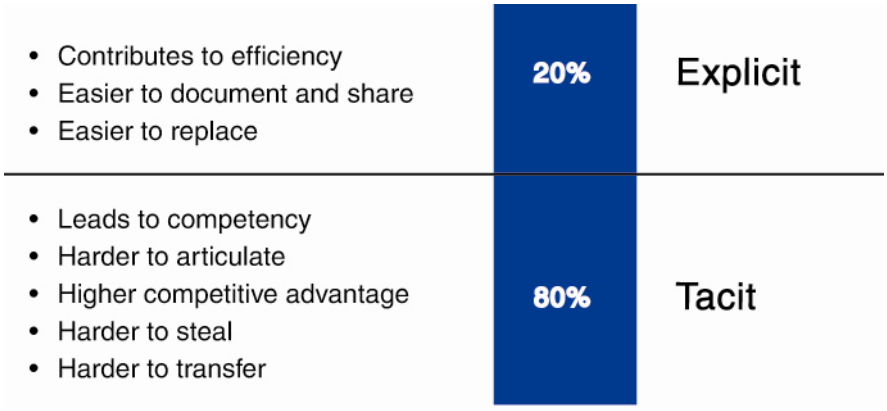

Figure 2-2
Tacit Knowledge Capture is Difficult but Rewarding

EPRI has found that capturing such knowledge has led to success in nuclear plant operation and in power system protection engineering. "You need to know what decision rules a person uses, and what kind of decision rules are needed for a particular position. Perhaps different individuals with the same job have different methods. It can be inconsistent from person to person and varies from job to job."

Technical Issues Affecting the Workforce

In a discussion following Gellings' presentation, a number of technology issues were brought up by participants and Gellings:

What is the next bucket truck? *Joe Belechak* of Duquesne Light noted that the last big technology breakthrough for linemen was the bucket truck. CMU's Lester Lave commented that since linemen are getting older, perhaps one approach would be to remake the bucket truck with mechanical assists. Making equipment for older workers would not require breakthrough technology. He noted how hot and exhausting hurricane restoration work was for the linemen who worked 12 hours a day after Katrina.

Communications and diagnosis systems were mentioned by Gellings as an area that could affect field technicians, enabling remote monitoring so that failures could be predicted. He cautioned, however, that the utility industry uses 152 different communication protocols, with any individual utility using as many as18-20 different ones—and on top of that, the building industry uses another 28 different protocols. Convergence is clearly needed, but could be complex. However, he did see some standardization beginning to take place.

Will distributed generation be a major factor in workforce change? One participant wondered if there wouldn't be a big difference between the skill set needed to service a fuel cell versus a transmission line, and what the role of an electrical worker and a third party might be when distributed generation became more mainstream.

Gellings emphasized that getting to a point where having even 20% of new power needs in the next 10 years generated via distributed resources would be "a lot," and that **the need for central power will not go away**. He stated that there will, however, be a need for more people who can integrate, operate, and maintain distributed resources, and it is not clear whether they will be new entrants or third parties. He mentioned that how this might play out is one of the issues being explored in the *Galvin Electricity Initiative*, an effort to engender practices and technology that will create perfectly reliable power for U.S. consumers and businesses (See http://www.galvinelectricity.org for more information.)

Another participant commented that given the uncertainty of the technological changes, **"investment in human capital is called for to foster development of the right skill sets that can morph into what is needed."**

The pace of technological change was questioned by some, with *Steve Hickok* of Bonneville Power Administration mentioning that he knows of only one or two coal integrated gasification combined cycle (IGCC) plants that will come on line in the next 5 to 10 years, and stating "I have heard that 95% of the world will be the same in 10 years as it is now. But one-third to half of the utility workforce will be gone." He noted that **"Responsibilities of workers will change, not necessarily their needed skills."**

Several attendees mentioned that outsourcing, using consultants (including retired utility workers) and more centralized functions or use of supervisors with special skill sets are options for utilities. References to the transportation industry, where airlines and trucking companies use outside companies to maintain equipment, might be a model for the utility industry.

Michael Ashworth, Carnegie Mellon University: Workforce Aging in the U.S. Electric Power Industry

Michael Ashworth presented results of his research conducted in conjunction with the Carnegie Mellon Electricity Industry Center, providing participants with background on the aging issue, along with results of a survey of human resources executives and a discussion of "how to drive the future, rather than just react."

Ashworth's presentation captured the magnitude of the transition in the utility workforce that will occur in the next few years, with a substantial portion of the workforce planning to retire, and an anticipated increase in turnover rates.

A Stable Industry Facing Change

Traditionally, the electric power business has been one of the most stable employers in the world:

- As of 2000, the average tenure of employees was 15 years—"not only the highest in the U.S.—but in the world."
- Employment has been characterized by high job satisfaction and generally low turnover rate, which Ashworth pegs "in the low single digits."

A Decline in the Size of the Workforce

"We're doing more with fewer people," reported Ashworth. Employment levels have declined by nearly 25% to pre-1975 levels, while output continued to grow by 30% over the same time period. See Figure 2-3.

The size of the industry's workforce has steadily declined because of:

- Deregulation-driven downsizing
- Low rates of replenishment due to technology implementation and work practice design
- A shrinking skills base

The decline in the size of the workforce is worsened by large numbers of impending retirements. Ashworth noted that the percentage of workers nearing retirement varies by location, but numbers are generally high: "In some places everyone on the lineman crew is set to retire in a year or two."

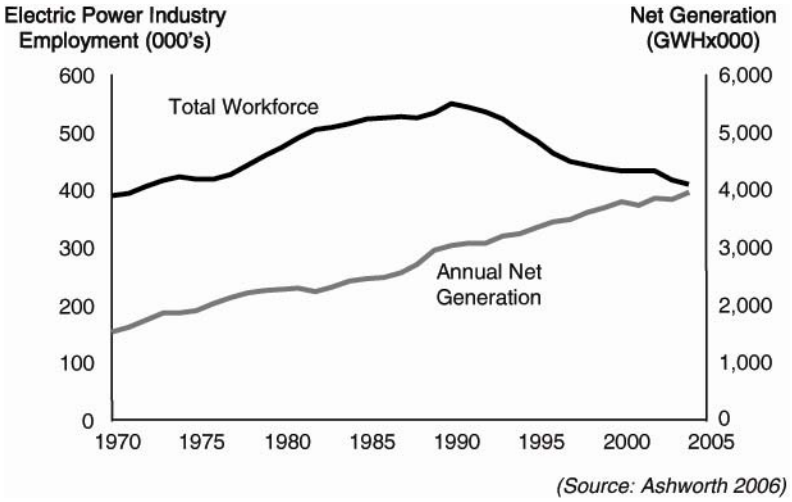

Figure 2-3
Doing More with Fewer Workers

"A lot of knowledge is walking out the door."

Relevant knowledge and experience of substantial numbers of retiring workers may have to be replaced according to Ashworth, and his research has shown that knowledge loss is a productivity and quality-of-service issue resulting from impaired organizational learning capability.

The Age Cohort Has Shifted

The average age of the utility worker is 48. As electricity industry employment has fallen over the last decade, the largest age category has moved from the 35-44 cohort to the age 45-54 cohort, as shown in Figure 2-4.

"This is a demographic issue that is particularly acute in the utility industry," said Ashworth. "Worker age is higher than among government workers."

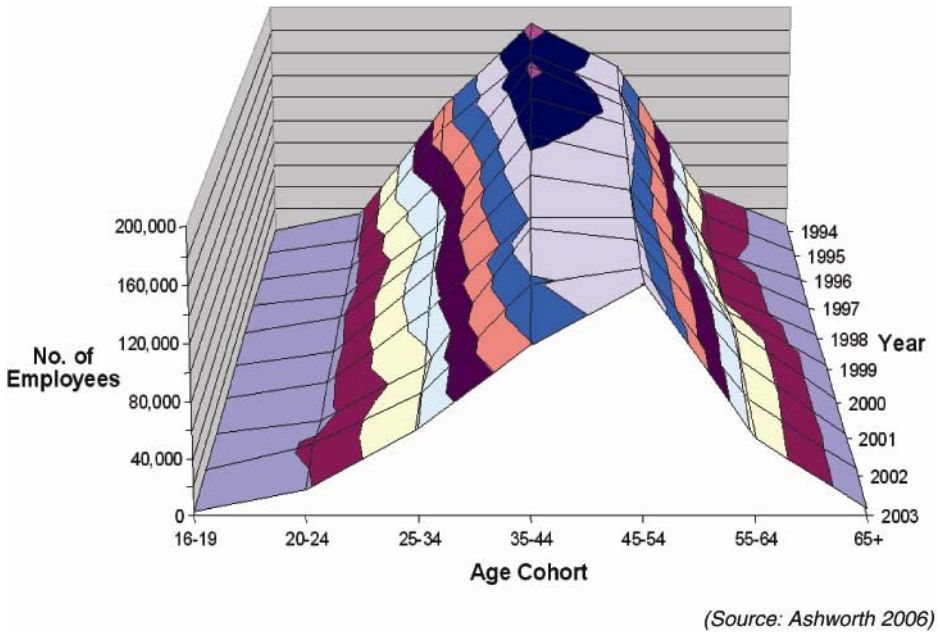

Figure 2-4
More Utility Workers in 45-54 Age Cohort

The Utility Industry is Facing the Aging Issue First

The electricity industry is not alone in facing an aging workforce issue, as Table 2-1 illustrates—but it is among the first to have to address consequences. "Other industries see it coming and are watching what we do. At Carnegie Mellon, we get calls from the steel, chemical and other industries about what utilities are doing."

Table 2-1
Worker Median Age by Industry

Industry	Median Age
Electric power	43.9
Public administration	43.8
Education & health services	42.1
Manufacturing	41.9
Mining	41.8
All workers in U.S.	40.4
Professional services	40.2
Finance & insurance	40.1
Information	39.1
Wholesale & retail sales	38.4

The Increased Age of Workers Will Continue to be an Issue

Based on current labor demographic forecasts, the rising age of the U.S. workforce will continue to be an important human resources issue in all industries. The coming humps in the 24–29 and 45–54 age cohorts; and the drastic increase in 55–64 age group is illustrated in Figure 2-5.

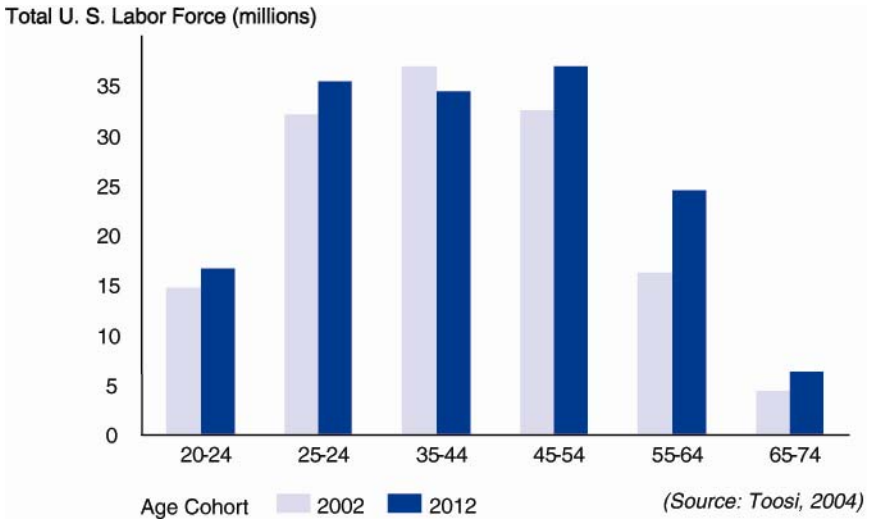

Figure 2-5
Workforce Demographic Forecast

Carnegie Mellon Survey of HR Executives

The Carnegie Mellon Electricity Industry Center conducted a survey targeting the top-ranked executive at each of 97 U.S. private and public power providers with more than 100 employees:

- Out of the 97 executives surveyed, 65 responded (67% response rate). Only one executive from each participating organization was surveyed.
- 74% of respondents were vice presidents of human resources (including executive and senior vice presidents of human resources).
- 26% were CEOs or executive/senior vice presidents of operations.

The Aging Workforce is the Number One HR Issue

As Table 2-2 reveals, among the issues identified in the survey, the aging workforce was ranked as the number one concern by 48 out of the 65 respondents, vastly exceeding benefit costs at number three, which typically is ranked as number one in other industries.

Table 2-2
Results of HR Survey

	HR Issues Identified	Response Rank (*n* = 65)					Total	Rank-Weighted Index
		1	2	3	4	5		
Top-Tier	Aging Work Force	48	8	4	1		61	88
	Skilled Work Force	11	18	16	6	1	52	58
	Cost of Employee Benefits	11	18	16	2	3	50	56
	Leadership Development	2	11	4	3	6	26	24
Mid-Tier	Transition to Performance Culture	1	2	9	9	5	26	19
	Increasing Work Force Diversity		4	2	10	4	20	14
	Constructive Labor Partnerships		1	1	8	5	15	9
	HR Technology & Management			3	5	3	11	7
	Work Force Engagement			4	3	2	9	6
	Organization Design/Alignment		1	2	2	2	7	5
Lower-Tier	Productivity Improvement			1	2	4	7	3
	Governance and Compliance				2	2	4	2
	Labor Cost Control			1		1	2	1
	Homeland Security				2		2	1
	Other				1	1	2	1

Retirement Statistics from Participating Utilities

Survey participants shared results of internal surveys of workers at their utilities, revealing why the aging workforce is the dominant issue:

- 57% of respondents voluntarily reported that the average age among their operations employees is 47–49.
- 52% of respondents indicated that a sizeable percentage of existing employees are already eligible for retirement. They reported that employees who have reached retirement age and continue with the utility stay for a variety of personal reasons, such as supplementing retirement income and retaining medical insurance coverage.
- Several respondents stated that internal surveys showed that despite having a significant number of people already at retirement age, most people who are approaching retirement age intend to retire when eligible to do so.
- Most (74%) respondents said that 40–60% of their employees will be eligible to retire after the next 5 years.

High Turnover, Knowledge Capture Major Concerns

Why is the aging workforce the dominant issue among utility HR executives? Because the majority (71%) of the executives surveyed link loss of older workers to some combination of workplace concerns, including:

- High turnover
- Extended learning curves for newcomers
- Knowledge replacement
- Knowledge transfer between retiring and incoming workers
- Replenishment of team-level leadership

In addition, nearly half (48%) expressed concerns about how to manage cultural transitions as a younger, more diverse, and more tech-savvy generation of employees replaces aging workers over the next 5–10 years.

The Bottom Line

For Ashworth, the aging workforce presents both challenges and opportunities for utilities, and his assessment of the challenge boils down to "How will utilities drive the future rather than just react?" Elements of the challenges and opportunities the industry faces are shown in Figure 2-6.

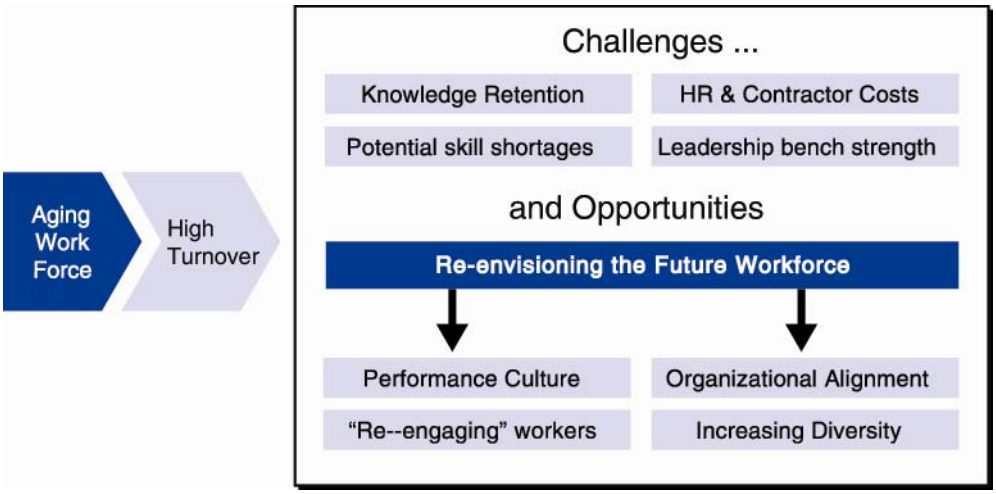

Figure 2-6
What Utilities Face

Discussion

Ashworth's presentation stimulated discussion on several elements related to recruitment needs, including an inquiry about the **whether the trend of "doing more with less people" would continue, or have we reached a peak**? Ashworth said that although his information on this is

anecdotal, he believed "In the last few years utilities have focused on cost reduction. I think the pendulum is beginning to swing another way." *Steve Hickok* of the Bonneville Power Administration (BPA), corroborated this with data from his own company, noting that BPA peaked at 3,800 employees, bottomed out at about 2,400 and was now at about 3,000.

Clark Gellings offered some U.S. Bureau of Labor statistics to help quantify the national picture on the increased demand for workers of various types, as outlined in Table 2-3:

Table 2-3
U.S. Bureau of Labor Projections on Increased Demand for Workers

Profession	Increase in numbers needed (percentage)
Civil engineers	>21%
Electrical engineers	>17%
Mechanical engineers	>17%
Linemen	> 9%
Electricians	>42%
Boiler makers	>46%

Robert Schainker of EPRI asked what portfolio of technological capabilities will the future workforce need, especially given an uncertain future. *Jim Hunter* of the International Brotherhood of Electrical Workers (IBEW) commented that "In 1994, no one in the relay department could even sign on to a computer, but today everyone uses one." He contended that what is needed is the **ability to learn**, more than anything else.

Ashworth urged utilities to pay attention to **how positions are packaged**. He thinks cross training and "multi-skilling" are key for the future workforce. Also, he cautioned that positions could not be presented as being dumbed down or they would backfire. "To have a generalist that can fit into a number of positions requires a smarter person."

Joe Belechak of Duquesne Light noted that the type of person recruited should be considered. For instance, perhaps companies should replace the workforce "with people who don't necessarily want or need stability, but rather who thrive on change. That would be a good strategy."

Clark Gellings championed the concept of **providing digital and other technology resources to workers** to enhance quality performance and to help attract them to the position as well. "Ford auto technicians have PDAs [personal digital assistants] and can drill down and get a lot of information. We need to consider similar tools for the utility industry. For example, if asked to measure impedance, the worker could access a video explaining what impedance is and how to measure it."

Granger Morgan of Carnegie Mellon University mentioned **development of a small computer for field workers** that allowed them to work on schematics in the field. "And you could wear it and operate it with gloves on."

Steve Hickok of BPA championed the concept of cross training in the crafts, and providing workers with a broader set of responsibilities and skills so they are just **not repeating the same task over and over**.

Ashworth closed the session with comments on the need for knowledge capture and transfer, citing his current research study on how group memory is structured in organizations. He believes one the keys to successful transition of the workforce will be related to so-called "transactive memory," which reflects the extent to which team members are aware of the knowledge of other team members and is thought to be a primary mechanism underpinning organizational learning and knowledge transfer. To capture the attributes of group transactive memory along with other social and knowledge network structures, Ashworth is conducting extensive field surveys of power industry work groups in companies in several different regions of the U.S. Ashworth expects the study to verify how the structure of transactive memory can be fostered to help organizations reduce the effects of both systematic and non-systematic turnover on performance. Results of the study are expected to be completed and published sometime in late 2007.

3
WORKING SESSION OUTCOMES

The Process

Executives attending the *Aging Workforce in the Electricity Industry Workshop* formed small groups to explore likely workforce needs in the next five year and ten year periods. The intent of these working sessions was to identify potential future industry conditions and directions—and generate ideas on how best to deal with loss of retirees. Two working sessions with four groups of 10 executives each were held, with members of groups scrambled between the first and second sessions to foster innovation and participation. Each session was facilitated by a Carnegie Mellon University or EPRI representative.

The working groups were asked to discuss and answer two primary sets of questions:

1. What will the electric utility industry look like in one to five years? In five to ten years?
2. Given the aging workforce and the working group projections of industry direction in the next five to ten years, how will the workforce need to change, and how can this be accomplished?

Participants were asked to explore major influences on the industry, with particular attention to what might affect workforce needs. Factors discussed included consumer attitudes and energy demand, technology, infrastructure assets and needs, environmental policy, demographics, regulatory issues, homeland security, economic conditions and other elements that would have a significant impact on the electric utility of 2011 and 2016.

At the end of the break-out sessions, all workshop attendees reconvened to review the results of the small-group discussions and develop a list of elements for a utility industry action plan.

Session Results: What will the electric industry look like in five years?

Although participant views varied, considerable consensus developed in working groups regarding what the utility world will be like in 2011. Several common elements emerged among each of the executive working groups, with emphasis on factors that will change or affect workforce needs.

In 2011 the electric utility industry will be largely like today's. Change will likely be incremental, leading from forces already in play. This means that the electric utility industry will need to have workers mostly of the same type and with the same level of skills and knowledge that are now in place, although there will likely be an increased need for workers skilled in use of computers and advanced digital equipment.

The aging workforce and competitive pressures will likely keep the supply of skilled workers at lower-than-needed levels. The skills gap could rise to the level of enterprise risk given the large percentage of workers reaching retirement age (up to 60% in five years). The shortage of mid-career workers that resulted from downsizing and lack of hiring in the 1990s will stymie leadership development as well.

The attrition rate at utilities over the next five years was a topic of less agreement. By and large, executives expect higher turnover among newer employees than those of longer tenure, but participants had contrary views on whether those of retirement age would continue working. Their perspective on this issue was dependent largely upon expected human-resource policies. For example, if companies offer greater flexibility, attractive financial and medical insurance packages, and the option of part-time work, some believed many older workers would keep working. On the other hand, if policies such as mandatory overtime continue, they believed workers would retire as soon as they become eligible. This could determine whether or not there will be a short-term workforce crisis.

No new generation technologies or major infrastructure changes will occur, although there will be increasing reliance on digital equipment. Deployment of advanced meters, smart grid technology, automated diagnostic equipment, and other digital equipment will increase. With an aging physical infrastructure to deal with as well, this could lead to greater automation and more unmanned operations. However, whether there will be sufficient staff with the technical skills and training to use new digital systems is of concern.

Time-of-use rates will likely increase. Encouraged by legislation and greater availability of more advanced metering technology and communications, more utilities will offer price signals to consumers to help manage peak demand.

Fuel costs will continue to be high, and capital expensive. The economic environment will be shaped by higher costs, keeping up cost-reduction pressures in the industry. Rates for electricity will be higher and more variable. This in turn could erode compacts between consumers, regulators, and utilities.

Global warming concerns will lead to caps on greenhouse gas emissions, resulting in higher costs. Along with higher prices and uncertainty of foreign fuel supply, carbon caps will translate into higher operating costs.

High costs of fuel, environmental controls, and security will foster development of nuclear and renewable power generation and investment in demand-side efficiency. Nuclear, wind, and demand-side resources will likely attract greater investment, but construction, licensing and decision-making time are sufficiently long that the existing infrastructure and workforce needs will remain largely the same during the five-year horizon, although some believe the need for skilled nuclear plant workers will increase by 2011.

New coal technologies such as integrated gasification combined cycle (IGCC) plants will be tested, but won't affect near-term workforce needs. At least one or two plants are slated for development and testing in the five-year time frame. But such plants are so few in number that they will not have much effect on the electric utility industry workforce needs in the five-year time frame.

More severe weather events, natural events, or other disasters are likely. If predicted meteorological trends continue, hurricanes, floods, droughts, heat waves and other catastrophes could affect the utility workforce needs. Hydro power resources could be unavailable; need for craft workers who make up the teams for storm restoration and infrastructure repair and replacement could be greater.

Outages and brownouts will increase because of an aging infrastructure and more meteorological events. Customer demand for higher reliability and shorter outage restoration times will increase as a result. Maintaining quality of service and a positive public image will be a challenge, and consumer goodwill toward the industry could further erode.

Mergers and acquisitions in the industry will increase. The repeal of the Public Utility Holding Company Act (PUHCA), which restricted the geographical territories and ownership of utilities, will engender a major increase in industry mergers and acquisitions (M&A). Increased M&A activity will in turn create greater cost pressures, corporate culture clashes, multi-state utilities, or, as one executive suggested, the ultimate realization of Ed Tirello's legendary prediction of "50 utilities in 5 years."

Economies of scale resulting from mergers may allow more centralized work, such as creation of maintenance "shop" facilities, and may also lead to more in-house research and development.

A large number of chief executive officers will retire in the next five years. What effect this will have on industry strategy, knowledge transfer, and leadership is uncertain. Coupled with increased M&A activity, however, it could mean a time of organizational instability for utility companies.

Certain utility jobs will be increasingly demanding and stressful, especially crafts. Restructuring and downsizing have created an environment that will continue to demand considerable worker competence and diligence in many job categories. Besides danger to life and other physical safety, financial costs can be great when a worker makes a mistake. As one participant noted "In a restructured regulatory environment, if a generation plant is shut down for 24 hours, it could cost $1.5 million." With the consequences of mistakes so large, "There is a stress level on certain workers that wasn't there before."

The Sarbanes-Oxley Act of 2002, which requires greater accounting responsibility and transparency among company directors and executives, could also lead to greater risk in decision-making for workers. Consequently, top management will likely give less discretion to engineers and other staff to make decisions.

The education and training pipeline will remain inadequate. The general math and science capabilities of elementary and high school students has eroded—along with analytical problem solving ability according to some--and will probably not change sufficiently or quickly enough to change the caliber of graduates within the next five years. One individual predicted that "There will continue to be low rates of passing grades—20 to 40 percent of applicants—on relatively simple pre-tests." Moreover, vocational and university-level programs geared to utility careers in both the crafts and professions will slowly re-appear over the ensuing five years.

Utilities will continue to offer well compensated jobs, but retirement and other benefits as well as job security will change. Cost pressures as well as mergers and acquisitions will likely lead utilities to offer new employees retirement plans that are limited to defined contribution plans, 401(k) plans, or some variation consistent with the reduced retirement packages offered by other industries. The stability of jobs will also change, with less ability by utilities to make commitments for long-term or lifetime employment. The effect this will have on recruitment of the younger person is uncertain, although some executives have concerns it will make attracting and retaining the best candidates even more difficult.

Outsourcing and use of contractors will increase. Cost pressures and management's desire to move away from centralized technical expertise will cause greater reliance on external resources such as contractors and consultants. This will cause increased stress on the internal workforce.

Session Results: What will the electric utility industry look like in ten years?

Participants agreed that moving further into the future makes conditions more difficult to predict with any level of confidence. And one group simply focused on the nearer term period of five years. However, all had some ideas on what might occur, and virtually all agreed that some unforeseen external factor could have a huge influence.

As such, the perspective here is less a consensus and more a brainstormed list of what some of the possibilities for the utility industry in 2016, and an add-on to the five-year forecast.

Generation will still be largely what is in place today, but new central plants will be needed. What type of generation will be built is unclear. Aging plants will be an issue. Nuclear will either increase (up to 12 plants in construction), or disappear due to an accident or external factor. Coal will either increase greatly because of the success of cleaner technology such as integrated gasification combined cycle plants, or be reduced because of new coal technology to meet market needs.

Siting of new plants will be an issue. Although "not in my backyard" will still exist, huge tax benefits for bringing new power plants to a location will likely mean some locales will want them, while others will not.

New technologies such as plug-in hybrid vehicles or superconductivity could be common.

Distributed generation may be increasingly deployed, affecting transmission and distribution companies and the reliability and security of power supply in case of a terrorist attack or natural disaster.

Transmission technology and transmission operation may change. Greater reliance on high voltage direct current (HVDC) transmission to enhance system reliability, and an operational mode similar to the National Grid in the United Kingdom, which is driven by reliability and security, will prevail.

Continued high fuel prices and high cost of environmental controls will drive up efficiency on the generation and transmission side of the business, as well as in end use.

Utility management and ownership will change. Mergers will be a big driver for change, and business, not technical, people will likely make more the decisions. Entities from outside the industry will enter the power generation business, with investment banks serving as operators. Reliable power will take a back seat to financial performance. Deals will be highly leveraged, putting more pressure on financial performance.

Flatter, more nimble utility organizations will emerge. A performance-based culture will replace the "entitlement culture" beginning to change in 2006.

Cost of capital will likely remain high. This will mean a risk-averse industry that needs to increasingly strike a balance between being cost driven and innovative.

Because of training lag times, even in ten years there will be a huge gap between the supply of skilled workers and their availability. The industry-wide skilled labor requirements will are so phenomenal that community colleges and other institutions are not going to provide enough graduates. And in ten years, all eligible workers in the current older cohort will be retired.

Outsourcing will increase, as will the current trend away from use of union labor. This may present reliability, response time, and in-house core functionality issues, and greater outsourcing may pressure new college graduates to take more blue-collar jobs.

The workforce will be more mobile and more likely to change companies. Utilities will no longer have lifetime employees and will need to learn to better accommodate workers moving from company to company.

4
HOW WILL WORKFORCE POLICIES NEED TO CHANGE?

Participants agreed strongly on the need for investment in education and training, including greater standardization and collaboration among utilities to enhance recruitment and retention. A number of action items and tactics suggested during small working groups and the final workshop discussion session are combined below, summarizing the possible elements of an action plan.

1. **Rebuild the pipeline.**
   - Increase outreach to schools/colleges at all levels. Help to upgrade/restore vocational education in public schools.
   - Become proactive and do your own vocational education with unions and associations.
   - Develop collective strategies to upgrade and restore vocational and technical education at the junior college/community college level. For example, create a summer intern program, complemented with two-year vocational education, then provide a job to the graduate. Funding or financial support may be an element of such programs, but require ongoing evaluate of cost/benefits.
   - Consider regional industry initiatives for training electrical engineering and craft workers.
   - Continually upgrade skills of existing employees by instituting on-going training programs.
   - Improve training procedures to reduce the timeframe required for reaching the next level of proficiency or responsibility. This will need to be done with a testing process to demonstrate experience and ensure readiness to proceed to the next level.
   - Cross train new and existing employees so they are more nimble and flexible, enabling one person to move between various jobs.
   - Work with contractors who provide skilled labor on a seasonal or as-needed basis for rarely needed projects such as building transmission lines to ensure adequate capacity to meet industry needs.

- Consider having EPRI create a "worker clearinghouse" —i.e., a pool of skilled and knowledgeable workers who can work on an as-needed basis on seasonal or rarely needed jobs.

Several executives commented on programs now in place that are related to rebuilding the pipeline:

- **Southern California Edison** has partnered with **San Diego Community College** to *train health physicists for nuclear plants*. San Diego Community College had been a feeder for health physicists, but discontinued the program. It is getting back in, reinvigorated through a network of employees who maintain ties with the college.
- The **National Rural Electric Cooperative Association** (NRECA) has expanded its *leadership program* at the University of Wisconsin business school, extending a program that had been aimed at middle management training into the highest executive levels. The latest is a chief financial officer training program. *Bob Palton* of NRECA noted that the NRECA performed a needs assessment for training for each type of position, and developed a program with industry experts to provide curricula in areas of needed competencies, including how to deal with new workplace issues and technologies.
- **Hawaiian Electric Company** sponsors a successful *"school to work" program* that entails recruiting and sponsoring teachers who bring students to the utility during the summer for a six-week program consisting of full days observing projects like plant overhauls. According to CEO *Mike May*, "The intent is to get students interested in working at the utility while they are still in high school, between their junior and senior year. We often attract youth at a point where they could break one way or another, and we have had people decide to become a HECO worker who have become some of our best employees."
- **The San Francisco PUC** in California has developed a *program for people who are traditionally underemployed or undereducated*, creating an internal pipeline in which workers can move from station to station to get exposure to different jobs at different locations.
- **The Center for Energy Workforce Development** was recently created as an industry center and online clearinghouse to document utility best practices for workforce planning, training and certification as well as identification of model curricula in secondary schools and community colleges. The Center is co-sponsored by the Electric Edison Institute (EEI), the American Gas Association (AGA), the International Brotherhood of Electrical Workers (IBEW), and the Nuclear Energy Institute (NEI).
- A number of training programs are available in community colleges and universities across the U.S. For example, **Bismarck State College** offers online degrees and certificates at http://epceonline.org.

2. Establish knowledge capture and retrieval programs that enable transfer of knowledge between more experienced and younger workers.

- **Standardize knowledge across jobs to increase worker portability.** The nuclear industry is a model for this; for example, at every Exelon nuclear plant the organizational chart is the same. The company can easily move people from one plant to another.

- **Also standardize training across the industry** so that workers have greater ability to relocate not only within their own company's territory, but also within the industry.
- **"Proceduralize" the work environment, instituting a knowledge capture and retrieval system.** As Clark Gellings described in his plenary presentation summarized on pages 2-5 to 2-7, establishing a process to upgrade maps, manuals, and other materials is vital, in addition to capturing tacit knowledge of workers. To achieve this, managers and information technology departments must be empowered.

Programs reported by participants that are related to knowledge capture and retrieval:

- The California Public Utilities Commission helped **Southern California Edison** (SCE) develop such a program by making *a favorable ruling allowing SCE* to overstaff so a new employee could be trained by the outgoing employee for about 3-4 months before that person retires.

  SCE also has its nuclear plant *employees document processes* and knowledge. The utility provides a template to the employee to complete.
- **TXU** institutionalizes procedures for fossil plants, and in nuclear pla*nts has* staff dedicated to learning and documenting what works and what doesn't related to multiple operations including frequency of repairs, inspections and the like.

3. **Engage in industry-wide and local marketing, communications and brand image programs to ensure the public understands the benefits of working for an electric utility.**
   - "Employment markets don't work without good information," and utilities need to collaborate and work individually to *publicize the positive features of utility employment* and overcome perceived negatives associated with utility work.
   - *Unique, localized opportunities should be promoted*, such as being able to remain in a rural area where farming is no longer economically viable.
4. **Consider a "retire/rehire" program to retain or transfer retiree expertise.** This can be done to the extent allowed by the Employee Retirement Income Security Act of 1974 (ERISA), a federal law that sets minimum standards for most voluntarily established pension and health plans. Individual utility company pension rules must also be considered, some of which do not currently permit rehiring.

   Several utilities and agencies have examined this issue and noted
   - The **San Francisco PUC** adhered to federal ERISA rules and rehires retirees to work for up to 960 hours in each fiscal year.
   - The **American Public Power Association** (APPA) shared results of a member survey, which revealed that 46% could rehire on a full-time basis, and 81% could rehire on a part-time basis.
   - **Alliant Energy** is conducting a pilot retire/rehire program in 2006. So far the program has been successful and it is being rolled out for linemen.

- Although **Bonneville Power Administration** does not have a retire/rehire program, they use contractors who have BPA retirees on staff.

5. **Enhance the diversity of the workforce.**
   - Reinvigorate diversity programs to increase the number of women in utility positions.
   - Consider redoubling efforts to enhance diversity, to reflect demographics in territories served. This should be done in both crafts and the management ranks.
6. **Make pay and benefits competitive**, and consider other compensation currencies besides money. All agreed that compensation is an essential part of attracting and maintaining a skilled workforce, adding that effectively communicating that utilities offer attractive compensation opportunities is also crucial. Benefits other than financial ones, including opportunities for professional development, job variety, and a schedule and culture that enables work/life balance were also suggested.
7. **Assess and implement retention policies** so new recruits will want to remain with the company. Understand the desires of potential workers.
8. **Foster change in the way company leadership thinks so they can be more innovative.** Perhaps introduce people from the outside.

5
AN EPILOGUE ON THE FUTURE ELECTRIC UTILITY WORKFORCE

Clark Gellings, VP—Innovation at EPRI, believes that there are a number of issues and opportunities the industry faces in the years ahead that could effect the skills, abilities and composition of the electric utility industry's workforce.

Nuclear Power

The segment of the industry under most pressure in the conflict between retirement, retention, and recruitment is the nuclear sector. Sustaining the existing fleet and extending its life is paramount to meeting the nation's need for electricity. In addition, it is obviously inevitable that our next generation nuclear plants using the advanced light water reactor, will need to be widely deployed. Neither the engineering talent nor the skilled craft workers, nor the manufacturing capability exist to support this build out.

Clean Coal

Since more that half of U.S. electricity is generated from coal—and since there is a 250-year supply of coal in the country—there is a compelling argument that we will need to find new ways to burn coal cleanly and to enable carbon capture and sequestration. The skills for developing and implementing these technologies are not based in the traditional electrical engineering discipline; they are in the chemical engineering field among others. People in such disciplines will need to be recruited and retained in electric utilities.

Environmental Regulations

Regulations will continue to tighten, ratcheting down levels on every pollutant and eventually on CO_2. Increasing, this will impose pressure to increase the skill sets of all utility engineering personnel.

Renewable Portfolio Standards (RPS)

Now in more than 20 states, renewable portfolio standards, which require utilities to provide a specified percentage of generation from renewable resources, are likely to proliferate and become more stringent. Accordingly, skills regarding the performance and integration of renewal energy resources will be in increasing demand.

Gas Supply

As domestic national gas supplies continue to decline and liquefied natural gas (LNG) imports increase, planners and engineers who understand LNG market dynamics and the technical issues of transport and storage will be increasingly valued.

Energy Efficiency

Regardless of any scenario for the future that we wish to assume, efficiency in generation, delivery, and utilization will likely be the best investment the nation has. While the industry has continually honed its skills in improving the efficiency of generation and delivery of electricity, it has all but abandoned its expertise in utilization. Today, professional engineers with that expertise are few and far between. It is inevitable that this need will re-emerge.

New Technology

With demand growth at over 1.7% per year and capacity additions <0.5%, it is likely that there will be increased pressure for technology to fill the gap. New technologies will be needed in generation, power delivery, and utilization. Power delivery technologies are need to increase power flow, enable improved asset management, and automate the power system. Generation technologies are needed to capture transport and sequester CO_2 as well as to extend the life of nuclear plants and enable the deployment of advanced plants. Utilization technologies are needed that enable demand response and that greatly enhance the efficiency of end-use devices and appliances. Each of these require skills beyond any now present in the industry.

Demand Response

In 2006, reaction to the concept of demand response is almost euphoric. The idea that giving consumers the right incentives and price signals will lead to a nearly instantaneous change in the pattern and extent of their energy purchases is very appealing—and has been widely researched. As in many other areas, experts in this realm are reaching retirement age and needs to be re-established for the future.

Aging T & D Infrastructure

The fact that much of the U.S. T & D infrastructure is greater than 40 years old and is at the end of its life highlights the state of the industry's moderization. Nearly every industry in the western world has modernized itself through the deployment of sensors and the use of communications and computational ability—except one—the electric utility industry. The technology platforms to support this integration will require skills that are beyond the capabilities of today's engineers.

Complexity

All of the issues elucidated above point to the establishment and maintenance of a skilled workforce—one that is not only carefully selected after recruiting, but one that is eager to learn, re-learn and re-invent itself as the demand for critical skills accelerates.

Taken as a whole, these factors translate into the need for substantial development of engineering and other professional talent needed to meet the electricity industry's needs.

A
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Tracy Elich	AEP
Mark Flaherty	Constellation Energy
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