# Electricity Advisory Committee

MEMORANDUM

TO: **Honorable Patricia Hoffman, Assistant Secretary for Electricity Delivery and Energy Reliability, U.S. Department of Energy**

FROM: **Electricity Advisory Committee**
**Richard Cowart, Chair**

DATE: **October 17, 2012**

RE: **Recommendations on Electricity Workforce**

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## Overview

The energy industry is undergoing a significant transition, described by some as a revolution. Driving this change are many technology breakthroughs aimed at addressing a growing and aging population, rising cost of energy, increasing environmental awareness and concerns and escalating cybersecurity needs. Advancements have been realized and are continuing to facilitate carbon management, electric transportation, sustainability and increased system reliability and flexibility. There are now more renewable generation and storage options coming, with the promise of increased ability to control and manage electric systems, and demand-side capabilities. Much of this progress was has stemmed from market developments and a wide-range of technical advances in the areas such as electric machines, power electronics, batteries, photovoltaics, controls, communications, and embedded intelligence. Workforce requirements and competencies are evolving to successfully innovate, plan, design, operate and maintain reliable, secure, and safe systems in the future. There is more uncertainty, advanced threats, increased complexity and a need to involve those with a wide variety of capabilities and backgrounds than ever before.

As new technologies come online, power may be generated and managed at new scales (at the home, local/ distributed, and large-scale levels).The intersection of the power and transportation sectors will likely grow with increasing electrification of the auto fleet, and more individuals, small-businesses and private entities will play important roles in changing how people interact with the energy system on a daily basis. This will lead to a larger number of individuals, with a broader and diverse range of skills and interests interacting with the energy system and markets.

The workforce that currently serves the industry is shrinking and continues to mature. According to the Center for Energy Workforce Development (CEWD) 2011 Gaps in the Energy Workforce Pipeline survey, the US electric and natural gas utility workforce dropped from 535,000 in 2009 to 525,000 in 2011 primarily as a result of reductions and delays in hiring due to the economy. While engineers slightly increased during this period (3.9%), the number of line-workers, technicians and plant operators all decreased. Whether this trend will continue is a factor of the pace of economic recovery, technology advances and productivity gains.

Further, the Electric and Natural Gas Utility workforce is maturing. The average age increased from 45.7 in 2006 to 46.1 in 2010: employees between the ages of 18-27 decreased while the number of employees age 53 and above increased over the same time period. The CEWD survey concluded that almost 62% of the industry has the potential to retire or leave for other reasons over the next decade. Furthermore, it concluded that 36% of the utility technicians and engineers (excluding positions in nuclear), may need to be replaced due to retirements or attrition by 2015. Because the electric system is so complex, the pending loss of related expertise needs to become a more significant planning consideration to ensure continued reliable operations.

In addition to changes in technology and an aging workforce, there will be significant investments in the grid over the upcoming years to modernize it, both by the power sector and by consumers who integrate new technology in their homes and businesses. EPRI has estimated $338 - $476 billion will be needed through 2030; the Brattle Group predicts the investment will be $880 billion. This significant capital outlay and the types of investment being made will certainly increase the demand for skilled workers well beyond the levels needed in recent years.

NERC recognizes that electricity reliability is in large part dependent upon the workforce: reliability is at risk if the workforce lacks the necessary skills and knowledge or if workers are overtaxed by their responsibilities. Furthermore, the success of grid modernization will require a well-trained, professional workforce to build, operate, and secure it, as well as discover and implement innovations.

Across the industry, new technologies in training, computer usage and internet based simulations and delivery systems are meeting changes in talent management and career development head on. Prolonged economic difficulties have left many energy organizations resource short, with insufficient supply of ready internal talent to replace pending attrition in a timely fashion. Specifically, many energy organizations are finding themselves in situations where key positions historically filled from promotion are now increasingly difficult to source internally.

Another emerging Electricity Workforce challenge centers on the dearth of skilled cybersecurity resources necessary to support grid modernization and reliability. The

Center for Strategic and International Studies (CSIS) captured the magnitude of these challenges in their November 2010 Report "A Human Capital Crisis in Cybersecurity" as part of the CSIS Commission on Cybersecurity to the 44th Presidency. According to interviews conducted with Jim Gosler, NSA Visiting Scientist and founding director of the CIA's Clandestine Information Technology Office, there are only about a 1,000 security specialists in the United States who the specialized to operate effectively in cyberspace however, the United States needs about 10,000 to 30,000 such individuals[1]. These are the same security specialists who will be required to design network architectures, establish security processes and practices, and secure infrastructure design and operation that defend, monitor, and respond to cybersecurity threats facing the grid. As such, cybersecurity workforce development and maintenance must become a top priority to meet future needs and threats with the same level of urgency as non-cyber workforce requirements.

Some have said that Energy Technology (ET) will change the world more in the next 2-3 decades than Information Technology (IT) did in preceding generations. The convergence of Energy Technology (ET), Education Technology (EdT) and Social media hold the promise that the next generation of energy workers will be trained, developed and deployed as never before. However, it will take proactive and targeted government policy and actions to best catalyze that transition, and the recommendations in this paper indicate the measures that the Department of Energy (DOE) could take to do so.

Thus, this paper recommends that DOE's Office of Electricity Delivery and Energy Reliability (OE) continue its involvement with the electricity delivery workforce because doing so is critical to maintaining a safe, secure, and reliable electrical infrastructure to serve the nation's current and future needs. Efforts are needed to better understand the workforce implications of industry drivers such as retirements, technology advancements, and policy changes. OE actions are recommended to facilitate the development of necessary competencies and readiness of skilled workers.

This paper provides two categories of recommendations for OE, with the first category in section 1 of the paper, and the rest in section 2. The EAC believes that the first category of recommendations is relatively straightforward for OE to implement on its own, and that OE should adopt these recommendations before the second category. The second category of recommendations may be more challenging. Throughout the document, a background statement is paired with a corresponding recommendation. These strategies are listed in roughly the order of priority that the EAC recommends they should be pursued. We briefly summarized our work force recommendations as follows:

[1] "Cyberwarrior Shortage," https://www.npr.mobi/templates/transcript/transcript.php?storyId=128574055.

First-Tier EAC Recommendations - Easier for OE to Implement

1.1 Identify scalable solutions from ARRA electricity delivery workforce training grants.
1.2 Identify workforce lessons from ARRA-funded smart grid investment projects.
1.3 Incorporate workforce elements in future OE technology development efforts.
1.4 Develop a set of criteria and a recognition program to acknowledge the best worker training and education programs at the state and city levels
1.5 Review current state of benchmarking / metrics on workforce needs. (Phase 1 of 2.1 below)

Second-Tier EAC Recommendations – More Challenging for OE to Implement

2.1 Facilitate regulator / industry dialog and establish metrics on workforce needs.
2.2 Increase coordination between NSF and OE to address workforce issues.
2.3 Improve coordination and communication with other agencies.
2.4 Perform workforce scenario planning.
2.5 Identify best practices to accelerate transition into the workforce.
2.6 Retain experienced workers.
2.7 Increase the visibility of career opportunities to build awareness
2.8 Develop an educational road-map that aligns with industry needs.

**First-Tier Recommendations: Category #1 – Easier for OE to Implement**

**Background #1.1: Identify scalable solutions from ARRA electricity delivery workforce training grants.**

The American Recovery and Reinvestment Act (ARRA) provided DOE with $4.5 billion to fund projects that modernize the Nation's energy infrastructure and enhance energy independence. Of that amount, the OE awarded nearly $100 million to 54 workforce training projects that will help prepare the next generation of workers to help modernize the nation's electric grid. The grant recipients estimate that the projects will train approximately 30,000 Americans.

The 54 projects are focused on two main areas – workforce training and curriculum development for community colleges and other institutions to train line workers, electricians and others. Curricula will also be developed for university-level programs in interdisciplinary power systems to give power engineers a better understanding of areas that they will need to address and the R&D challenges of the future – areas such as cyber security, policy, economics and IT. All projects were not to exceed 3 years; making a targeted project end date of September 2013. The awards were divided into three topic areas as described below.

**Topic A: Developing and Enhancing Workforce Training Programs**

- 22 awards Totaling $13,849,875
- Provides new strategies and programs for industry
- Addresses the entire electricity delivery system: transmission, distribution and electrical equipment manufacturing

**Topic B: Smart Grid Workforce Training**

- 19 awards totaling $54,820,263
- Targets power sector personnel directly related to smart grid
- Increases workforce capacity and capability of electric power companies and smart grid technology manufacturers
- Addresses skills shortages in a variety of power sector disciplines

**STEPS: Strategic Training and Education in Power Systems**

- 11 awards totaling $27,646,317
- Supports Colleges and Universities in developing new curricula
- Addresses building, operating, and maintaining a modern electricity system
- Courses target power electronics, information and communications technologies, policy, economics

**Recommendation #1.1: OE should evaluate the ARRA electricity delivery workforce training grants with the objective of identifying scalable solutions and results to be distributed to the greater education community. Leverage the results of each project to the maximum extent possible.**

- In cooperation with the performers, disseminate results of the evaluation, lessons learned, materials, on-line resources, curriculum, competency requirements, Developing a Curriculum (DACUM) and learning objectives for developing curriculum, simulations, training activities, training delivery methodologies and any other knowledge developed using grant funding.
- Identify the competencies that each project was seeking to address and find out to what extent the projects' evaluations demonstrated achievement of those competencies.
- Ascertain the sustainability of the project/program without additional OE support.
- Assess the value of continued networking among the grantees and the OE support that would be required to do so.
- Determine how to make the results from the training grants available to the education communities, and whether broader networking should occur within the various education communities. Explore coordination with professional societies and associations.

Because these projects are nearing completion, the EAC recommends that OE act quickly to work with the award recipients to collect the necessary information, since it will be much easier to gain the cooperation of those involved while the projects are active. OE should make specific efforts to collect information on what worked well in these projects to develop real employment and hiring.

**Background #1.2: Identify workforce lessons from ARRA-funded smart grid investment projects.**

As authorized in the EISA (2007) and ARRA (2009) legislation, the DOE's smart grid programs (the Smart Grid Investment Grant Program and the Smart Grid Demonstration Program) are $9.0 billion public-private partnership to accelerate investments in grid modernization. The Federal government's contribution to this initiative was $4.0 billion from ARRA funds, with industry providing the rest. DOE selected 99 grant projects covering almost all states through a merit-based competitive selection process in the grant program. The smart grid demonstration program, consisting of another 32 projects, added another $770 million in storage projects and $876 million in regional projects to DOE's smart grid efforts. Many utilities and other organizations have spent billions in funds to match DOE grants, and on smart grid programs initiated without DOE support. These projects were initiated approximately three years ago and are in various stages of implementation with most scheduled to complete in two more years. There is an opportunity to understand the workforce skills, competencies and process enhancements that have been required to successfully implement these projects.

**Recommendation #1.2: OE should obtain feedback on workforce needs from smart grid demonstration and investment projects in order to successfully plan, install, maintain, and operate a high penetration of these technologies in the future.**

- Convene a panel to identify the workforce impact, to communicate successes and explore widespread deployment and use of the smart grid technologies of demonstration projects
- Link workforce impact (actual hiring) to results of workforce training grants to identify further potential for scaling training and curriculum solutions.
- Disseminate results.

**Background #1.3: Incorporate workforce elements in future OE technology development efforts.**

OE regularly invests in technology development as part of its mission. For technologies to successfully be deployed and scaled, it is critical that the workforce is trained to appropriately apply them. Often processes are also changed as a result of technology development, which can save costs, increase organizational efficiencies and impact the workforce competencies.

Anticipating future workforce needs of the 21st century electric grid community and future issues in the technology of training design and technology should be factors in designing technology research and development plans. New technology adoption by the electric grid could influence the type of workforce skills needed to design, build, operate and maintain the future electric grid infrastructure. For example, a research and development plan heavy in "smart grid" technologies should recognize a likely need for new electronic communications, computing and large data analytic skill for the electric grid. Conversely, an expected shortage in certain workforce skills could call for the development of new technology as surrogates for those particular workforce skills. As another example, an expected shortage of certain maintenance work skills might be met with the development of robotic or automated technologies. Similarly, some future "workforce" needs might be too dangerous for worker health and safety, such as outage prevention or more rapid outage recovery in extreme weather events; or beyond human capabilities, such as detecting, diagnosing and taking action in very fast operating situations. Again, a new technology might be the "workforce" solution, and web and mobile based training tools and just-in-time job aids may be found to be the most effective investments in training technology.

There are two aspects to consider regarding the integration of workforce and technology development needs. One is the impact that new technologies might have on the skill sets required for the future workforce. For example, the deployment of some smart grid technologies that lead to more system automation could require that the operators become less technician-like and more systems supervisory. The other aspect is the changing conditions that a future workforce might face in which new technology might be needed for economic efficiency, effective training, physical activities or workforce health and safety. An example might be faster system restoration in hazardous conditions that might call for the use of robots. Incorporating the competency requirements, processes changes and workforce efficiency improvements from technology adaptation is an essential consideration to forecasting workforce needs, training requirements and curriculum design.

OE has an opportunity to systematically collect workforce implications for each of the technology projects that are pursued. They also have an opportunity to factor the workforce benefits into the R&D portfolio decisions. By considering workforce aspects systematically in the R&D portfolio assessment, a process emerges to methodically define emerging workforce development requirements and continually apply criteria to technical development efforts to improve labor efficiency, "foolproof" designs, improve safety-related conditions and streamline operational activity.

**Recommendation #1.3: Incorporate workforce implication elements or statements in technology development, demonstration, and deployment projects funded by DOE going forward**.

- Implement a process to systematically identify workforce implications for all OE projects. Pilot the process within OE with the goal of implementing it across DOE.
- Coordinate within DOE and with other agencies (like NSF and DOL) to adopt best practices and metrics for identifying and recognizing high-quality programs that address workforce issues.
- Identify opportunities to improve workforce effectiveness and factor these into the planning and design of DOE R&D plans.
- Support Small Business – by integrating distributive technology grants and programs (e.g. PV/EV – SBTTR Technology – SBIR Innovation Research programs) in a way to support small business growth and employment in small businesses related to Energy Technology.
- Identify application-oriented workforce development needs and the role that the National Labs should have in filling the gap. If feasible, pursue jointly to advance the skills of incoming and existing workforce ensuring that tools and skills are developed to incorporate technologies necessary for grid modernization.

**Background #1.4: Develop an annual OE-sponsored recognition program on excellence in the state of power system education and training.**

There has been much publicity around the idea that many critical technical jobs remain open even as unemployment among veterans, college grads and experienced professionals remain too high. These reports make the case that employers need critical skills that are often missing in job seekers. Across the states, many utilities, colleges, universities and public power entities are already collaborating and cooperating in real time to build and develop programs to find solutions assuring workforce readiness. Some have been quite successful. This recommendation is to encourage those successful private public programs born out of collaboration and cooperation across the states be celebrated and communicated in a highly visible way to encourage more innovation, more cooperation and more success. While what works in Cincinnati may not work in Tucson, a DOE sponsored initiative that seeks successful efforts to tell their story will yield more than fell good PR – it may well provoke innovation in problem solving across communities to meet critical training and development needs.

Energy Organizations like educational institutions are often resistant to change – often for good reason. This recommendation creates a forum for those energy organizations, communities and educational institutions that have overcome barriers and resistance to change to share their success and broadcast what is working so others may learn from their stories.

**Recommendation #1.4: Develop an OE-sponsored annual recognition program on excellence in the state of power system education and training for engineers, technicians and operators in power systems – perhaps called the OE**

**FARADAY Recognition Program. This program should seek out and celebrate excellence in private – public – educational institution partnerships**.

The DOE OE should establish a FARADAY Recognition Committee to establish the criteria, rules and a timetable for communicating and establishing this Annual Recognition program. This committee of industry experts, governmental representatives, academics, regulators, community leaders and practitioners will make recommendations for an event or series of regional events to celebrate the successes that pursuit of the FARADAY Recognition engender. These may take the form of a series of TED Talk like events in various regions of the country with a major event in or around Washington, DC. The Recognition Committee may seek out appropriate private or grant funding to reward winners and publicize success.

The criteria to be considered will include: the numbers of students/employees trained, and the numbers of veterans, disabled, graduates and unemployed developed for real energy roles. Some consideration may be weighed for extending jobs to women and minorities in non-traditional roles that break barriers and those programs that extend Energy Technology (ET) training into K-12 programs as well as higher level retraining for veterans and experienced mid-career professionals into energy careers. Time to readiness; costs, creativity and effectiveness of the programs; long term value and repeatability of success may also be considered.

**Background #1.5: Review current state of benchmarking / metrics on workforce needs. (Phase 1 of 2.1 below).**

Measuring the size, competency and need for the energy workforce is a complex undertaking that must take into account the uniqueness of the industry including the obligation to serve, the geographic differences in the deployment of energy generation, transmission and distribution, and the availability of workforce in every community in the country.

Workforce development activities are often viewed as a management prerogatives not needing the direct attention of regulators. Furthermore, new workforce development actions could necessitate increased workforce costs in the short-run so regulators not wishing to make decisions that raise costs are further motivated to not raise questions about the workforce development planning.

OE is uniquely positioned to facilitate discussions among industry, regulators and other government agencies on the implications of state and federal regulatory policies and on advances in technology that impact workforce development actions. Understanding current practices in measuring workforce is a critical step in identifying metrics that can guide regulators and industry in planning for the future workforce.

**Recommendation #1.5:**

- Convene a cross functional group of experts to include industry, government agencies (DOL, DOE, NSF, DHS) and regulators for the purpose of reviewing current practices in workforce benchmarking and metrics
- Identify short and long term recommendations for OE consideration (Phase 1 of 2.1 below)

## Second-Tier Recommendations: Category #2 - Recommendations That May Be More Challenging for OE to Implement

### Background #2.1: Establish metrics on workforce needs.

There is a workforce crisis coming that could affect customer services and costs so it is in the public interest that regulators increase their oversight of workforce development. For example, in its 2007 Long-Term Reliability Assessment, the North American Electric Reliability Corporation (NERC) stated that "*The loss of industry workers and their years of accumulated expertise due to retirements is a serious threat to the bulk power system reliability…*"

In 2010 webinar, the National Regulatory Research Institute (NRRI) asked some important questions:

- What are utilities doing to address these (workforce) issues?
- Are state commissions fully informed about (utility workforce) efforts, which have direct implications for the ability of utilities to provide safe, reliable, and cost effective services to customers?
- Do state commissions have the authority to inquire about these issues, the expertise to assess progress, and the ability to establish standards and assign consequences if performance falls short?

In January 2010, the NRRI published "Are Utility Workforces Prepared for New Demands? Recommendations for State Commission Inquiries" describing the regulatory authority for regulatory inquiries on utility staffing issues. In its February 2010 resolution entitled "Resolution on State Commission Involvement in Utility Workforce Preparations", the National Association of Regulatory Utility Commissioner's (NARUC's) Board of Directors endorsed the NRRI report and its emphasis on cooperative approaches that regulators and utilities can take in addressing future changes in the industry workforce. Information is needed on the status of actual regulatory inquiries and actions on utility workforce development actions along with discussions of what actions are needed to avoid the situation where regulators have to react to a crisis that has actually occurred. Reliability of is a fundamental focus of utility regulators and they need awareness of the relationship between the utility workforce and reliability to ensure that adequate resources are available to the utility for reliability-related personnel and necessary workforce development.

### Recommendation #2.1 Facilitate dialog among state regulators and industry on workforce needs, establish metrics and identify policies that facilitate necessary workforce development activities by the regulated companies.

- Develop a forum to educate regulators and compare best practices and use of metrics for hiring, retirements and other forms of attrition, based on stakeholder input, that will assist regulators, policymakers, educators, etc. in determining workforce needs to maintain reliability. Initially the focus should be on the workforce whose performance is most directly connected to reliability, such as operators, linemen, and planning engineers. Engage regulators through NARUC forums to educate and inform them of the metrics and supporting data.
- Work with the industry to create metrics to quantify the threat posed to the electric grid's performance by insufficient replacement workers, due to retirement or other attrition.
- Identify, with stakeholder input, those regulatory policies and practices that are directly or indirectly affecting a utility's ability to engage in best practices in workforce development, succession planning, education and training. Collaborate with stakeholders to explore alternative policies, practices and / or incentives, which could enhance or remove barriers to workforce development activities.
- To facilitate regulator / industry dialog, design and hold a workforce workshop for NARUC that creates situational awareness for state regulators. Use this as a platform to identify the information needed to convey workforce readiness to guide related policy development and develop a process to convey an on-going understanding of workforce preparedness.

**Background #2.2: Increase coordination between NSF and OE to address workforce issues**

The National Science Foundation (NSF) serves as the Federal government's principal steward of research and education across the broadest range of scientific and engineering endeavors. NSF integrates research and education to support the development of a world-class scientific and engineering workforce as well as nurture the growth of a scientifically and technologically aware public. There are several programs at NSF that have some grantees with research interests in power and energy and thus the students they educate will be prepared for the power and energy sector. The best example of this is the Energy, Power, and Adaptive Systems (EPAS) program, which specifically emphasizes research in electric power networks and grids. For other programs that focus more broadly, there are typically a few grants at any given time in the power and energy sector. For example, there are programs that focus on human resource development in general, for example the Graduate Research Fellowship Program (GRFP) and the Research Experiences for Undergraduates (REU) program, where NSF supports students in a broad range of science and engineering disciplines.

There are also programs that focus on curriculum and program development such as the Advanced Technology Education (ATE) program aimed primarily at two year institutions, and the Transforming Undergraduate Education in Science, Technology,

Engineering, and Mathematics (TUES) program to improve the quality of undergraduate curricula and programs. In addition, there is the Engineering Education program that supports research in education methodologies and pathways as they relate to engineering. There are also Centers programs, such as the Engineering Research Center (ERC) program and the Industry/University Cooperative Research Center (I/UCRC) program to support a larger community of researchers and students to conduct research on a complex topic in an interdisciplinary environment. Two of the currently funded ERCs, including one co-funded by OE, and two of the I/UCRCs, focus on electrical transmission and distribution research. Within DOE, EERE is funding new technology integration efforts in generating technologies (solar, wind, geo, biomass, industrial cogeneration, etc.), storage technologies (hydrogen, batteries, etc.), energy efficiency, demand response and transportation (vehicle technologies). Multiple offices in DOE including EERE are also supporting NREL's ESIF (Energy Systems Integration Facility) that can potentially coordinate to support workforce development efforts.

**Recommendation #2.2: Increase coordination between NSF and OE to address workforce issue.**

- Understand the linkage of research funding grants and university education efforts for workforce development. Can university research grants be better leveraged to impact workforce development?
- Explore possibilities to fund or co-fund proposals submitted to existing NSF programs that support OE interests. In this way, existing NSF programs and merit review and grant administration processes can be leveraged.
- Make lessons learned from NSF and OE grants in curriculum development and engineering pedagogy widely available.
- Continue collaboration on grid-related Engineering Research Center and other Center education efforts to find lessons learned / best practices.
- Ascertain issues that may exist in increasing the number of community college students who pursue power and energy engineering courses at a university

**Background #2.3: Improve coordination and communication with other agencies.**

There are opportunities to develop cooperation and sharing of information between federal agencies and also at the state level. For example, there are existing cross-agency working groups that could potentially incorporate a subgroup on workforce development. One example is the Interagency Advanced Power Group (IAPG), a Federal membership organization initiated in 1958 to facilitate exchange of information in the area of Advanced Power at the technical level of research and development programs in the member organizations (Army, Navy, Air Force, NASA, DOE, and NIST). The purpose of the IAPG is to increase effectiveness of

research efforts by sharing information, avoiding duplications, and identifying gaps. This could be extended to include workforce issues.

The tracking and associated demand requirements for power and energy workforce are often lost in the Department of Labor and Department of Education. The number of people required to educate, train and build, operate and maintain the electric infrastructure has not been uniquely highlighted through SOC codes, perhaps because this labor pool is not of the size to command attention for this critical resource. The CEWD survey has been useful at understanding the workforce changes for electric and gas utilities in the US (see section 2.6) and yet, as an industry there is very little information on the trends for service providers, manufacturers, contractors, and other related groups. Without this information, it is very difficult to identify trends for utility insourcing / outsourcing and quantify the manufacturing workforce needs both of which are needed to build a case with tangible actions to balance workforce supply and demand.

OE is ideally positioned to work with the Department of Education and the Department of Labor to re-define the SOC codes, which occur every ten years, so this critical workforce can be tracked. This information will be useful for scenario planning, competency development, and implementing efforts to balance the supply and demand to meet electricity delivery workforce needs. OE can also convene agencies to track workforce changes, develop appropriate curriculum and share best practices so programs and initiatives can be leveraged.

**Recommendation #2.3: Improve coordination and communication with other agencies at the federal and state levels and with other schools to leverage research, share programs / curriculum, track trends and balance the workforce supply and demand to meet electricity delivery needs.**

- Leverage existing working groups in the electrical power and energy area, such as the IAPG, as opportunities to discuss and coordinate workforce needs and initiatives as a part of regular meetings.
- Establish a standing cross-government working group, formed through Memoranda of Understanding between the participating agencies, with the primary purpose of sharing best practices, lessons learned, and current initiatives related to electrical energy workforce development. This group would meet regularly (e.g. quarterly). In addition to OE candidate agencies, include the Department of Labor, Department of Education, Department of Defense, NSF, DHS and others with interests and/or programs in workforce development.
- Partner or provide information to state Departments of Commerce / Economic Development, higher education, Labor, etc. so that states can develop and integrate recruitment, training, employment placement programs in concert with electric utilities and community colleges.
- Sponsor a joint workshop to share lessons learned, identify collaborative activities and make initiatives transparent across agencies. Consider developing

a best practice matrix to make programs and initiatives more transparent and visible. Seek opportunities to leverage and consolidate where feasible using web based methods like TED talks to publicize successes.

- Advocate the use the Energy Industry Competency Model developed for the skilled trades to create programs that will reduce the skill gaps in applicants and provide quantifiable benefits to the companies.
- Adjust the SOC codes to increase the visibility and measurement capability to better understand risks, improve forecasting and better predict industry demands.
- Assess and develop a K-12 program consistent with National efforts at new CORE Curriculum efforts by 46 states with secondary and post-secondary programs that are specific to developing interest in and competencies for skilled energy positions, and explore innovative ways of publicizing and piloting this work.
- Develop an initiative with the Departments of Education and State Departments of Education encouraging Utilities and Public Power entities to sponsor, support and provide leaders and judges to Science Fairs in K-12 in school districts across the country focused on Energy Technology.
- Collaborate with others to understand the development of energy-related education offerings such as EPRI's Energy Systems Engineering Institute Program. An input to monitor this activity is through the IEEE Power & Energy Society's annual Power Engineering Education Committee survey data which captures power system and energy-related higher education offerings. This can be used to understand trends for related curricula, faculty demographics and enrollment in the United States.
- DOE engage with DOD and higher education to determine how military certificate training translates into traditional academic degree programs.

**Background #2.4: Perform workforce scenario planning.**

Forecasting the longer term development needs for the workforce for the electric grid depends on how its infrastructure and operating requirements will change to meet the needs of future electricity users, markets, regulators and the like. At the moment, the future beyond the next few years is quite uncertain. There are a number of drivers for change facing the electric grid owners, designers, planners and operators, some of which are particularly influential and uncertain:

- What new technologies will be developed and commercialized, and which ones will and can be adopted by the electric grid industry for operations and training?
- How will tariff regulations and market forces affect energy and demand market structures and practices, and grid operations?
- How will siting and permitting processes affect how much and what kind of new grid infrastructure will be built?

- How will requirements for environmental protection affect not only the design and operations of the electric grid per se, but the type of generation and end-user services it will have to provide?

In responding to these and other drivers over the next decade or so, will the electric grid architecture be just more of the same, or become radically different? The answer will determine the type and size of workforce needed.

Given this great uncertainty, a deterministic approach to forecasting and planning longer term future workforce development is not particularly useful. It's likely to be wrong. In this type of circumstance scenario planning can be helpful in facing a very uncertain future. Scenario planning develops plausible "stories," or hypotheses, about the future in which today's decisions can be tested. They highlight risk and opportunities of strategic issues. They are not predictions or strategies for the future. [Source: "Plotting Your Scenarios," Jay Ogilvy and Peter Schwartz, Global Business Network (GBN) a Member of the Monitor Group, 2004.]

Scenarios are tools for better understanding and preparing for the future. They might be used for:

- Corporate or institutional learning
- Testing robustness of strategies
- Generating ideas for strategies
- Identifying plausible disrupting events and discontinuities
- Integrating team based simulations in effective readiness and preparedness events
- Identifying key "sign posts" of what future is evolving

Scenario planning is recommended for any group, e.g., DOE, DHS, developing plans for regulations or investments regarding workforce development for the electric grid of the 21st Century.

**Recommendation #2.4: Convene a group to do workforce scenario planning utilizing the tools that are available to improve the understanding of workforce risks given the inherent uncertainty. Results will be useful to communicate challenges and plan mitigating strategies. This effort could be done in conjunction with the Department of Labor, Department of Education, NSF, DHS and other interested stakeholder groups.**

**Background #2.5: Identify best practices to accelerate transition into the workforce.**

There are large pools of individuals, such as military personnel and engineers without knowledge of power systems engineering, who could contribute sooner to meeting workforce needs if programs for accelerating their education on electric

power workforce skills could be more widely available at the Joint Force Staff College, Military Academies and Military Operational Specialty/ technical schools, community college programs and/or advertised such as by adult career counseling. These individuals could enter the workforce more ready with relevant job performance skills and abilities that reflect higher levels of performance ability than entry-level workers. The leadership of the IEEE Power and Energy Society and IEEE-USA often hear from engineers, many of whom are unemployed or underemployed in other disciplines, asking how they can become qualified for jobs in power engineering. At the same time many industry professionals admit it takes years to make new college educated engineers effective in utilities. Moreover, while there are existing programs addressing retraining needs, it appears that many individuals are having difficulty finding them, and the best practices in accelerating the transitions to electric power jobs are not well known.

**Recommendation #2.5 Identify and embrace best practices that effectively accelerate the transition of mid-career professionals to meet industry workforce requirements.**

- Identify best practices for re-training that have proven beneficial for transitioning military personnel into the workforce that accelerate transitions to electric power industry jobs
- Create a best-fit mapping of careers that are outside the industry to those that are needed in side. Where re-training is needed, and/or barriers are identified they should be noted.
- Identify lessons learned in retraining programs for military personnel and celebrate victories in public TED events.
- Identify industry leaders in recruiting veterans and students, and in retraining the long term unemployed, and celebrate successes though regional forums like TED events.
- Industry leaders will be needed to innovate and facilitate the business changes that are a result of grid modernization, new technology adaptation, and shifts in operational paradigms. Efforts are needed to define what is needed to effectively assimilate leaders from other industries and the military into the power and energy industry.

**Background #2.6: Retain experienced workers**

Over the past six years, the Center for Energy Workforce Development (CEWD) has conducted four workforce surveys for the Electric and Natural Gas Utility Industry to identify the impact of an aging workforce and the need for replacement of critical Generation, Transmission, and Distribution positions. The survey results are used to assist the industry in better targeting its efforts to recruit and train potential jobs candidates to fill positions and more accurately define the scope and timing of education offerings that will provide the supply of applicants for the future workforce demand.

The 2011 CEWD Survey findings noted that the workforce continues to mature. Over the next decade, almost 62% of the industry has the potential to retire or leave for other reasons. For those positions considered critical by the industry, skilled utility technician and engineering (excluding positions in nuclear), the analysis indicates that by 2015, 36% may need to be replaced due to potential retirement or attrition, with an additional 16% to be replaced by 2020. Furthermore, workers who could retire are continuing their employment longer in part due to the economic downturn. Based on current retirement assumptions, approximately 9%, or more than 18,000 employees, are considered "Ready Now" and could retire at any time.

In many cases, experience and specialized workers retire and quickly return to the workforce through alternative means via contracting or through service organizations. This contribution has proven extremely valuable, though it is difficult to track and is not conducive to building a sustainable, long-term supply of competent talent. The industry would be best served if these experienced employees would delay their retirements while companies are encouraged to hire incumbents, effectively transfer knowledge and mentor new employees.

**Recommendation #2.6: It is recommended that OE focus on strategies to retain the experienced and specialized workforce demographic to delay retirements, develop skills, transfer knowledge and facilitate mentoring relationships as needed to meet industry needs. In doing so, there will be a greater ability to balance the supply and demand of workers while providing necessary cross-training and knowledge transfer for incumbents.**

**Background #2.7: Increase the visibility of career opportunities to build awareness**

The suicide rate among veterans, the loan default rate among college grads, and the number of long term unemployed (99'ers) whose unemployment benefits have expired have never been greater. These three contemporary social problems have exploded in times of economic hardship. These three groups represent hard working dedicated Americans struggling to find meaningful employment. The focus of this set of recommendations is to help them find the shortest path to exploring jobs leading to a career in Energy. The regional nature of the energy industry creates a disconnect in career education for many (e.g., there are many more careers in oil in Texas and Oklahoma and jobs in solar and wind in Arizona and Nevada, etc.). A comprehensive understanding of careers in energy would communicate that ET involves several dimensions of fuels (coal, gas, oil, nuclear, bio fuels, etc.), generation (thermal, hydro, solar, geothermal, ocean, etc.), transmission, generation, construction, markets and regulation. Good jobs leading to careers exist in each of these areas.

Training and education for positions in the these sectors takes many forms, from career and technical education in secondary schools to apprenticeships, certificate programs, associate degrees and bachelor degrees in post-secondary schools and in-house training, and often take a long time. While almost every utility has a relationship with neighboring community colleges and universities, few programs have focused on optimizing career flow from graduates, veterans and long term unemployed to viable employment. Students can easily spend time and money on programs that do not incorporate the needs of industry or lead to relevant programs of study that lead directly to careers in energy. The lack of accurate information on careers in energy in the Department of Education Career Clusters makes it more difficult for students to "major in energy" or find information education and find and focus on relevant training needed. Moreover, as state departments of education and the Federal Department of Education refocus on CORE Curriculum, incorporating energy technology examples in Science, Technology, Engineering and Math (STEM) curriculum may help clarify the depth and breadth of meaningful careers in reliable power production and delivery.

As the Department of State, Department of Defense and Military Academies incorporate changes of Doctrine refocused on winning the peace in military engagements around the globe, (see http://www.fs.fed.us/fire/doctrine/genesis_and_evolution/source_materials/joint_vision_2020.pdf), opportunities for greater emphasis on power systems training should be explored and incorporated.

**Recommendation #2.7 Increase the visibility of career opportunities to build awareness**

- Identify current efforts to provide energy career navigation and advising (such as CEWD's Get Into Energy, Troops to Energy Jobs, career coaching model, and the DOE Sun Shot initiatives for Solar Energy careers).
- Document the funding and initiatives of the National Labs for career advising.
- Evaluate the role of regional centers of excellence such as the NUCP Regional Center at Indian River Community College, or the Centralia Center of Excellence.
- Identify a common repository for career information for careers in energy and develop a national energy career awareness strategy.
- Identify potential career opportunities for American veterans and industry retirees in energy programs with projects around the globe.
- Determine what career advising military members separating from service receive and if information about careers in energy could be incorporated into what they receive.
- Build a map between energy industry jobs, knowledge, skills and attributes and military occupation specialties (MOS) so that veterans can understand how they can best fit within the energy industry.

- Coordinate with DOD and VA to educate veterans on energy industry career opportunities, for example through the DOD Transition Assistance Programs (TAPS).

**Background #2.8: Develop an educational road-map that aligns with industry needs.**

There is considerable variability in the competencies that need to be developed and positions that need to be filled depending upon the existing condition and scenario that is pursued. Given that the industry is undergoing a transition, this dynamic condition is likely to continue for some time. OE has the opportunity to sponsor a study that effectively bundles the supply and demand assumptions, competency requirements, trends, risks, barriers and possible scenarios to be best prepare for the dynamic workforce needs. This can be used to define an educational road-map that develops the talent needed for critical positions that are tightly coupled with reliable system performance for the present and foreseeable future. To capture the perspectives of a broad stake-holder group, white papers can be solicited for contribution. There are many foreign nationals in school in the US that receive degrees and advanced degrees in Power Systems. These professionals later may need Visa sponsorship to remain and work in the US.

**Recommendation 2.8: Develop an educational road-map that aligns with industry needs.**

- Incorporate feedback from public and private entities, such as that obtained from a previous (2010) workforce development needs survey, to inform roadmap development.
- Explain the roles of various players in the educational process, including education institutions, utility in-house training, professional education providers, technical associations, and manufacturers and the approach for each to educate their own personnel. Include the role and time required for internships, apprenticeships, journeyman training and on-the-job successfully create “job ready” employees for critical positions.
- Examine university education and research trends (e.g., education focus, courses offered, number of students in power, faculty). Utilize analysis of IEEE PES Power and Energy Education Committee university power program surveys. Explore the implications for untenured faculty working on tenure of a future scenario of a substantial decline in government funding of research in power delivery. What is the outlook for faculty and for students? What is the linkage between research funding, engineering education and ultimately students seeking and finding jobs? What is the state of labs, test beds, equipment, etc. that can be used for education?
- Incorporate analysis of best practices for retraining the unemployed or under-employed individuals for electricity delivery jobs. Describe how it is being done, the business model(s) used and the lessons learned to successfully

creating job-ready individuals for technician and engineering jobs. See recommendation 2.3.

- Identify education and training innovations. Explore the balance is between in-residence and on-line education technologies for achieving education and training objectives. Identify game-changing innovations in education and training that should be more widely used. Consider adapting concepts used by the Department of State when they worked with Iraqi utilities to turn the industry around in a couple of years.
- Study the issue of sponsoring foreign students by energy organizations to retain well-educated foreign nationals to fit future industry needs.

**Overall Conclusions of this Paper:**

As the EAC looks across these recommendations, there are several themes that emerge. First, workforce implications should not be viewed separately from research or policy review but as a key factor in the potential success of the action. Changes in the size, scope, location and competency levels of the energy workforce can have significant impact on the ability of the current workforce to advance the industry and implement the technological advances that will make our energy future cleaner and more reliable. In addition, the timing of scalable solutions to energy needs has a critical effect on education and training needs. Solutions that will not be implemented for 10-15 years in the future must be incorporated into education at the appropriate time to balance the supply and demand of qualified workers. Educating students for jobs that do not exist or technology that is yet to be developed or implemented wastes resources that are scarce to begin with.

The second theme to highlight is the role that DOE can play as a convener of the key parties, both inside and outside of government. While many dimensions of workforce development lie outside the main missions of DOE, DOE has real and significant opportunities to serve as the catalyst that brings information to other agencies and state/community/industry partnerships. Moreover, as the economy is primed for recovery, energy technology jobs may well be a cornerstone of our economic growth across American cities. As our economy has become more global, economic recovery will have a global dimension as well, and good energy jobs hang in the balance. Depending on the program, DOE may wish to convene such entities as:

- Other Federal agencies (e.g., Labor, Commerce, Interior, Defense, EPA, FERC)
- State energy regulators
- Environmental regulators and legislators (Federal and State)
- Equipment vendors
- Financial institutions active in energy matters
- Consumer advocates
- Unions

- Energy professional societies
- Energy Trade associations
- Companies and academics on the cutting edge of technology development
- Focus groups

Of course, the purpose of such convening is not simply to talk, but rather to reach a synergistic solution that is better for the citizens of the US than otherwise would result. The "convening component" of each DOE work force program must be tailored to the program itself. In many cases, DOE is convening one or more of these groups as part of its programs; tomorrow's DOE programs with a work force component should include a systematic consideration of which groups are most likely to be affected, and how to best reach out to them at each stage of the program.

The energy sector in the US is among the most robust and reliable in the world. Indeed, while there are many urgent needs and persistent cries for improvement, the issues of aging workforce, aging equipment and new technologies plague Europe and developed countries all over the world. The salient features of US markets that balance private and public assets with robust environmental and market regulations may well be America's most valuable export. In many countries across the world, not having this balance and equilibrium of regulation, markets, and public power make private investment too risky. We should celebrate what we have while seeking to improve it.

The recommendations herein illustrate ways that the OE can establish priorities and partnerships, and take on a leadership role to ensure that adequate utility workers are recruited and trained to maintain a reliable electric system for today and for the future.

Richard Cowart
Chair, Electricity Advisory Committee

**Appendix A – Glossary of Terms**

ARRA – American Recovery and Reinvestment Act
ATE – Advanced Technology Education
CEWD – Center for Energy Workforce Development
DACUM - Developing a Curriculum
DHS – Department of Homeland Security
DOE – Department of Energy
DOL – Department of Labor
EAC – Electricity Advisory Committee
EdT – Education Technology
EERE – Energy Efficiency and Renewable Energy
EISA – Energy Independence and Security Act
EPA – Environmental Protection Agency
EPAS – Energy, Power, and Adaptive Systems
EPRI – Electric Power Research Institute
ERC – Engineering Research Center
ESIF – Energy Systems Integration Facility
ET – Energy Technology
GRFP – Graduate Research Fellowship Program
I/UCRC – Industry/University Cooperative Research Center
IAPG – Interagency Advanced Power Group
IEEE – Institute of Electrical and Electronics Engineers
IT – Information Technology
NARUC – National Association of Regulatory Utility Commissioners
NASA – National Aeronautics and Space Administration
NERC – North American Electric Reliability Corporation
NIST – National Institute of Standards and Technology
NREL – National Renewable Energy Laboratory
NRRI – Natural Regulatory Research Institute
NSF – National Science Foundation
NUCP – Nuclear Uniform Curriculum Program
OE – Office of Electricity Delivery and Energy Reliability
PR – Public Relations
PV/EV – Photovoltaics/Electric Vehicle
R&D – Research and Development
REU – Research Experiences for Undergraduates
SBIR – Small Business Innovation Research
SBTTR – Small Business Technology Transfer Resources
SOC – Standard Occupational Classifications
STEM – Science, Technology, Engineering and Math
TED – Technology, Entertainment and Design
TUES – Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics