IEEE Power & Energy Society Organizes Initiative to Solve Challenges in Meeting Power and Energy Engineering Education and Workforce Needs

By
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Concerns about the Future Power and Energy Engineering Workforce

Are there the makings of a 'perfect storm' scenario for meeting future workforce needs in the electric power and energy industries? Many people, both casual observers and passionate participants alike, have strongly answered 'yes' to this question. Why?

First, the need for new infrastructure investments in electricity generation, delivery, and use technologies will be growing in the years and decades to come. The U.S. Department of Energy's Energy Information Administration [1] projects that electricity consumption in the U.S. will continue to grow through 2030 [2]. Growth internationally is expected to be even higher than in the U.S. Not only will there be a need for investments to support the growth, but there will also be a need for new investments to replace and modernize aging assets.

Second, the need for technology innovation is rising, driven by a world beset by new challenges. In the coming decades, the power and energy industries will have to make substantial efforts to support economic progress particularly in developing nations while stabilizing carbon dioxide emissions and switching from high cost energy resources that continue to deplete to more sustainable energy supply systems. A myriad of technology developments and applications will need to be greatly accelerated, such as renewable and distributed energy resources, clean coal and carbon capture technologies, nuclear energy, advanced energy storage, conversion systems relying on power electronics, "smart" energy delivery and use systems, and energy efficiency to name a few.

Finally, the need for new infrastructure and technology innovations means a steady, if not rising, need for well-trained engineers. This next generation of innovators and technology leaders will be expected to make critical contributions to solving the challenges that we and future generations face. While these unprecedented industry challenges begin to be addressed, a wave of retirements of experienced power and energy engineers is imminent. In fact, based on a survey of U.S. electric utilities, the Center for Energy Workforce Development [3] estimated that approximately 46% of all engineering jobs in the electric and gas utility industries could become vacant by 2012 due to retirement and other forms of attrition [4]. Recent executive surveys show that workforce issues are among top concerns in energy businesses. A collection of selected documents about power and energy engineering workforce issues is available [5].

Critical needs have been developing over the past decade or more and continue to advance exponentially in terms of severity due to the aging workforce. To address these concerns, the power and energy engineering industry needs to:

- Replace retiring engineers so that critical expertise and knowledge transfer is maintained;
- Meet rising infrastructure construction and technology integration needs;

- Modernize the grid as communications, computing and electric energy technologies converge;
- Help stem the tide of electric equipment manufacturing moving overseas; and
- Solve arising engineering challenges, such as in the development of advanced power electronics and energy conversion systems, new generation and storage technologies, and the integration of those technologies into the grid.

Last September, the IEEE Power & Energy Society (PES) [6] initiated a free, online service called PES Careers [7] to help address emerging engineering workforce challenges for power engineering students and their future employers. The site is being used by a range of businesses – from very small engineering service businesses to electric utilities and large manufacturers. Employers using the site were asked about the future of the industry and almost half of those that responded said they expected a growing demand for new power engineers over the next 10 years while almost none expected a declining demand in their future business growth.

As all of the key constituents better understand the issues of the aging and experience the impact it is already beginning to have industry-wide, they must become more attentive to solutions and initiatives aimed at addressing this critical situation. Much of what needs to be done will be achieved with strong collaboration among industry, government, and academia, especially in preparing the next generation of power and energy engineering professionals. While in many ways industry faces a crisis situation in workforce issues today, they must set their sights now on preparing for the future. Academia obviously plays a pivotal role in preparing future engineers and in discovering new solutions, so it is obvious that more attention needs to be given to strengthening university power and energy education and research programs.

Concerns about the Student Pipeline and the University Education System

Many of the key constituents involved are concerned that there will not be enough students in the pipeline who are excited about and prepared for a post-high school education in power engineering. IEEE PES Power Engineering Education Committee surveys of university power engineering programs show that university education and research infrastructures are being weakened by university decisions to not replace retiring power engineering faculty. Universities have been putting greater emphasis on hiring faculty in new research areas such as biomedical engineering and nanotechnology, where research funding is strong, so there has been a decline in university power engineering programs.

Innovative approaches to educating the next generation of engineers are being tried. Through partnerships among industry, government, and universities, new undergraduate and graduate power engineering education programs are being developed and older programs are being renewed and modernized. At some schools, students and faculty alike are being strongly attracted to the power and energy area, creating a new era for the rebirth of modernized education programs and research tracks in power and energy. The job market for new engineers is extremely healthy and is projected to only improve for new graduates over the next several decades as the aging workforce impacts begin to take hold. Conversations with power engineering faculty around the U.S. suggest that there is a strong demand for students graduating with undergraduate or graduate degrees in power and energy, with many students have multiple

good offers from which to select. However, more work is needed to boost the number of students entering the power and energy engineering fields, and to sustain power engineering programs across the country for the long-term.

The Role of University Research Programs and Industry Collaboration

Developing modernized education programs and attracting more students to enter the power and energy field is certainly a daunting task. A challenge that needs particular attention is the funding of engineering research programs in the power and energy area. Innovative university research is needed to address new engineering challenges, while educating students at the same time. Indeed, at research universities, research is central to the education process. Thus, education and research are inseparably linked as synergistic university activities. The continuing challenge is that university research support for cultivating such activities is increasingly difficult to find. Nonetheless, the role of university research is viewed as highly critical toward moving the industry and academia forward in the power and energy areas.

The need for greatly increased university research is not only important for new and innovative technology advancements, but also for the growth and enhancement of electric power university programs in general. In order to ensure success with renewed initiatives, vibrant power engineering programs with growing student interest must be established via sustained research support. The obvious need to ensure vibrant electric power programs and to continue to attract students is necessary for the continued viability of electric power programs in the U.S. overall. The keys to building, enhancing and sustaining university power engineering programs are (1) establishing avenues and funding for sustained research support and (2) providing a growing stream of students and faculty needed to meet future workforce needs. Support and funding will be needed from both government and industry sources.

Enhancing the interaction among universities, industry, and government is a very important aspect of obtaining the needed growth of university research. Greater collaboration can result in stimulating ideas for innovative research for faculty and graduate students, as well as for funding and supporting such research. Industry participation can provide new and sustainable avenues for research funding, but also for innovative education programs that appeal to a new generation of potential students. In cases where collaboration has been successful, the interaction of all levels of industry organization participants, from executives to engineers, has been a key component of obtaining commitment and sustained support. One main area that needs considerable improvement from all parties involved is the issue of intellectual property, which needs to be addressed in a collaborative manner. Higher levels of successful collaboration can be achieved by carefully selecting research projects that minimize intellectual property issues given the needs of faculty and graduate students to publish research results,. The key aspect of enhancing interactions is to first create the opportunity for university power engineering faculty to engage proactively with regional industry partners to develop relationships and understanding. We need to do this across the country.

Workshop on the Future Power Engineering Workforce

Many of the ideas expressed above resulted from discussions at the National Science Foundation's (NSF) *Workshop on the Future Power Engineering Workforce* last November [8]. Approximately 75 industry, government, and university representatives came together to discuss how to prepare universities for the coming large increase in demand for new power and energy engineers. An executive summit comprised of key leaders in industry, government, and academia was also part of the workshop. In the discussions, workshop, and summit, participants identified key issues and actions regarding how to meet the coming increased demand for new power and energy engineers along with possible actions to address those questions.

Attendees at the workshop and executive summit concluded that a coordinated effort by industry, government, and universities is needed now to prepare for this exodus. Without this effort, there will be a lag in replacing the lost expertise needed to maintain economic, reliable, and environmentally acceptable electric service, while innovatively solving the significant technical challenges facing all industries. The workshop recommendations included to:

1. Create a single, collaborative voice on solutions to engineering workforce challenges;
2. Strengthen the case for extraordinary efforts to build, enhance, and sustain university power engineering programs;
3. Envision the future challenges in electric energy supply and demand and develop an image that will increase interest in power and energy engineering careers;
4. Stimulate interest in power and energy engineering careers and prepare students for a post-high school engineering education in power and energy engineering;
5. Make the higher education experience relevant, stimulating, and effective in creating high quality and professional power and energy engineers; and
6. Encourage and support increased university research to find innovative solutions and enhance student education.

The workshop and executive summit demonstrated that there are collective concerns across industry, government, and universities about power engineering workforce issues. The time the attendees spent together was sufficient to generate wide-ranging ideas about how to address the issues, but not long enough to reach a consensus on what comprehensive approach should be pursued. Details about the workshop including the presentations and final report are available [8].

IEEE PES Power & Energy Engineering Workforce Collaboration Initiative

To make progress toward finding and implementing solutions to those concerns, the IEEE PES under the leadership of President Wanda Reder, has initiated the *Power and Energy Engineering Workforce Collaborative.* PES will seek partners from industry, government, and universities to work on this initiative. Existing efforts and organizations will be used to the maximum extent possible; however, it's possible that new institutions or organizations will be needed to sustain the Initiative. Industries in addition to electric power will also be involved.

One of the first steps will be to form a collaborative executive council of key decision-makers from industry, government, and universities to plan a comprehensive approach that will be widely supported and initiate actions that are necessary, timely, and supportable with available

resources. The executive council will provide a single, collaborative voice on solutions to the power and energy engineering workforce challenges.

Working groups in outreach and image, education, and research will be created to support the decision-making of the executive council. Working groups will scope tasks, identify where further action is needed, do what they can themselves, plan needed changes, and negotiate with others to implement actions.

Organizational partners will be sought to help make this Initiative successful in the long-term. This is not just a short-term effort; there are long-term needs for educating well-trained, high quality engineers, and for conducting research for the innovations that solve regional and global challenges. The effort is seeking transformation in the relationships among industry, government and universities to achieve a sustainable education and research system in power and energy engineering.

Although this Initiative has just begun, Reder is optimistic that the actions proposed by the Initiative will address workforce and education challenges in the power and energy engineering industry. “By working together,” she said, “we can be more effective than working separately.”

If you are interested in receiving updates on this initiative, send an email to PES-Careers@ieee.org with your name, organization and e-mail address.

References:

[1] U.S. Department of Energy’s Energy Information Administration: http://www.eia.doe.gov/

[2] Energy Information Agency *Annual Energy Outlook 2008*: http://www.eia.doe.gov/oiaf/aeo/

[3] Center for Energy Workforce Development: http://www.cewd.org

[4] Mary Miller. *Power Engineers and the Electric Utility Industry.* Presentation at the National Science Foundation *Workshop on the Future Power Engineering Workforce*. Nov. 29, 2007: http://ecpe.ece.iastate.edu/nsfws/.

[5] Selected bibliography of power and energy engineering workforce publications: http://www.pserc.org/ecow/get/publicatio/specialepr/workforcec/

[6] IEEE Power & Energy Society: http://www.ieee.org/portal/site/pes

[7] PES Careers: http://www.PES-Careers.org

[8] National Science Foundation *Workshop on the Future Power Engineering Workforce:* http://ecpe.ece.iastate.edu/nsfws/

Bios:

Dennis Ray, Ph.D., has been the Executive Director of the Power Systems Engineering Research Center (http://www.PSERC.org) for the last eight years. PSERC is a multi-university research center working with industry to meet its education and research mission of *Empowering Minds to Engineer the Future Electric Energy System*. As a member of the steering committee, he helped organize a recent National Science Foundation workshop on the future power engineering workforce. He played a principal role in designing and maintaining PES Careers, an on-line career service (http://www.PES-Careers.org) of the IEEE Power and Energy Society for power engineering students and their potential employers. Currently he serves on the steering committee of the IEEE PES Power and Energy Engineering Workforce Collaborative. He is an IEEE PES member with a B.S. in electrical engineering from the University of New Mexico and a Ph.D. in business (public utility economics and policy major) from the University of Wisconsin-Madison.

Gregory Reed, Ph.D., is Senior Vice President of the Power & Energy Systems Technical Services Group at KEMA, Inc. (www.kema.com) – an international company providing power & energy consulting, technology implementation, and market knowledge expertise. He is also an Adjunct Professor in the Electrical & Computer Engineering Department at the University of Pittsburgh, Swanson School of Engineering (www.engr.pitt.edu), where he teaches courses in electric power engineering, serves on the ECE Department's Industrial Board of Visitors, and has provided major contributions to the development of a renewed Power & Energy Initiative at Pitt. He has over 23 years of international industry and academic experience in the power & energy arena, supporting and developing advanced system technologies and services; including expertise in the design and applications of power generation, transmission & distribution equipment and power electronics & control technologies (FACTS, HVDC, and Power Quality systems), as well as a wide range of power system engineering consulting services. He has been a member of the American Society for Engineering Education since 1996 and IEEE PES since 1985, where he serves on various committees and working groups. He is currently a member of the steering committee and co-chair of the Education Working Group of the IEEE PES Power & Energy Engineering Workforce Collaborative.