To: U.S. Department of Energy  
Date: 3 Sept. 2010  
Subject: Response to DOE Request for Information (DE-FOA-0000402)

The IEEE Power & Energy Society (IEEE PES) and IEEE-USA are pleased to provide input in response to the Department of Energy’s request for information on energy education and workforce development (DE-FOA-0000402).

A National Science Foundation Workshop on the Future Power Engineering Workforce co-sponsored by IEEE PES, the North American Electric Reliability Corporation and the Power Systems Engineering Research Center on November 29-30, 2007, attended by some 75 people from industry, government and universities, spawned the formation of a “Power and Energy Engineering Workforce Collaborative.” The Workforce Collaborative seeks to strengthen the U.S. power and energy workforce needed for the smart grid of the future and related technologies by transforming relationships among industry, government and universities to support on-going activities that expand the pipeline of students, and that build, enhance and sustain university power engineering programs.

The Nature of the Problem

Recent workshops and surveys indicate a serious need is emerging for more power and energy engineers to:

- replace retiring engineers so that critical expertise is maintained
- meet rising infrastructure construction needs
- modernize the grid as communications, computing and new technologies converge
- help stem the tide of electric equipment manufacturing moving off-shore, and
- solve new engineering challenges to integrate advances in power electronics, energy conversion systems, new generation and storage technologies, into the grid.

Analyses of the workshop results and surveys suggest that there are not enough students in the pipeline excited about and prepared for a post-high school education in power engineering. Innovative university research is critically needed to address new engineering challenges while creating the faculty of the future. The university research support for doing so is increasingly difficult to find.
Responses to Questions

a) What are the biggest gaps in energy efficiency and renewable energy education and training and workforce demands?

Energy efficiency is one of the most difficult topics to properly discuss and explain. There is a need for global consensus on the theoretical and mathematical approach to properly describe and quantify energy efficiency in terms of specific energy conversion cycles from one fuel source and its origins through converters to consumer consumption. Load forecasting is a critical component to understand the overall peak reduction observed or projected through efficiency improvements. Tracking and validating energy efficiency programs is vital to increase the accuracy of forecasts. Education on the ways to project and include energy efficiency programs into the planning, design and operations of the power systems is a vital link to obtain the benefits from these technologies. Course development is needed to reflect technology advances. This includes a need for multi-disciplinary classes in business, engineering and sociology so that the interactions of technology and behavior can be better understood, and the lessons applied to solving energy and environmental challenges.

b) What can the U.S. Department of Energy do to address these gaps?

The DOE could begin by sponsoring an effort aimed to create tutorial or education modules that provide the fundamental basics behind efficiency of energy conversion processes that would be accepted by all stakeholders – with a strong reliance on engineering principles and fundamental laws. Such a tutorial or text would be rich in examples and demonstrations of renewable technologies. DOE could support pilot courses on customer behavior and energy technology for energy certificate or degree programs. Labs could be added for education and research. DOE could sponsor curriculum reform to stimulate innovation in education for the smart grid.

c) What is the status of education and technical training programs at the K-12, community college, undergraduate, graduate, and doctorate level?

Formal education from K-12 through the doctorate level is designed to be an effective sequence of building platforms for higher and higher understanding of nature, humans, and their creations. As technology and social innovation have advanced in so many areas, the subject matter that must be introduced into those platforms has increased almost beyond comprehension. New student interest has been motivated by renewable technologies and hybrid vehicles. However, there is still a need to assure a fundamental understanding of power systems is learned. New curricula that incorporate energy efficiency into forecasting and power system analysis would increase the understanding of the deployment of this valuable resource and improve design options.
d) What would be the proper balance of funding between K-12, community college, undergraduate, graduate, doctoral, and post-doctoral programs?

Certainly it can be argued that education is important at all stages of the progression from elementary material through advanced graduate material. Funding at each stage is critical and should be provided as needed by the relative educational systems. Since the pipeline for technicians and engineering comes from the science and mathematical focus that begins in K-12, sufficient funding should be directed towards stimulating K-12 interest, and showing pathways forward. The college experience is crucial for technicians and beginning engineers and also needs to be supported. At the final stage of Ph.D. work, funding to universities for graduate student research is the final key to maintaining a productive line of new young faculty.

e) What educational and training approaches have shown success in attracting and retaining students and a workforce in clean energy fields?

Institutions that have hired significant numbers of faculty have been successful in attracting and retaining students in electric power and energy curricula. With the strength of the faculty at these institutions, the curricula can offer courses and research opportunities in electric power systems, power electronics, and electric machinery and drives. In addition, the offering of scholarships and internships has proven effective to attract student to a particular area of study and to gain hands-on experience while they are studying. The more ‘real-life’ experience that can be added to the educational process, the better. Supporting students to attend IEEE conferences and expositions to see equipment and to hear about innovation brings classroom material alive. Video clips and actual data from installations may be useful to integrate into study work.

f) What methods should be used to attract and connect underserved communities and populations to education and workforce development opportunities?

Scholarship and internship opportunities at universities in close proximity to major population centers will be effective in attracting and retaining workforces that can serve communities in energy fields. Industrial support of these institutions through adjunct faculty and support of research will provide the evidence needed to engage university administrators. The NSF Broadening Participation in Computing (BPC) has lessons that could be learned in energy: reforming statewide systems, focusing on undergraduate experiences, connecting unlike institutions, and creating national networks.

g) In order to accelerate the adoption, deployment and improvement of clean energy technologies, what other approaches should be considered?

A balanced approach involving universities, industry and government has been shown to be very effective in growing strong electric power and energy programs. Collaborative organizations like the Power Systems Engineering Research Center (PSERC) that continues to leverage small amounts of National Science Foundation funding to
stimulate and grow active programs at universities throughout the U.S. can be useful to facilitate this exchange. Encouraging such collaborations between industry and universities can lead to innovative research and education advances. Another approach is the use of prizes, awards and contests (e.g. L-Prize, X-Prize, DARPA Challenge, etc.) to incentivize technology innovation.

h) How should DOE funding be structured for education in energy technology areas where career paths and career ladders are not well established?

DOE should advocate education for energy technology to incubate necessary educational efforts to support the national agenda. In parallel, DOE needs to work with the Department of Labor to establish visible energy career paths and ladders. Energy career choices need to be apparent for K-12. Furthermore, recognition of excellence in the arena needs to be developed. For example, these DOE offices could institute the DOE Electric Power and Energy Young Investigator Award – as currently exists in the DOE Office of Science, Office of Nuclear Physics, and other federal agencies.

i) How can the challenges of developing new curricula and integrating it into State and local educational systems be best addressed?

Curricula changes are normally made on a departmental basis where electric power and energy options must literally compete with other options for “preferred status”. Modules can be developed that can be incorporated into existing courses. These modules can reference power system and renewable applications. This approach is a way to easily update course material while leaving the basic curricula unchanged. They can also help new programs begin at education institutions. Development and adaptation of new curricula will require hiring of new faculty in the power and energy systems area. Research support to universities will enable this movement to stimulate graduate student studies. To increase local support, a regional focus involving advisory groups of industry and academia to identify needs and best investment opportunities would provide a mechanism to enhance ownership and commitment.

j) What methods have been used or can be recommended to help encourage collaboration in creating and sharing courses and effect instructional methods? Can Information Technology play a role?

Yes, courses and educational methods can and should be shared. Often the number of instructors in one university available to teach related content is limited; providing a method to easily share content would be useful. Course development and the educational methods will likely evolve as technologies are developed and installed. Establishing a process and encouraging the exchange would be useful.

k) In what ways could public and private partnerships help address education and workforce development challenges?

There is value in cultivating financial support for students and faculty. In many cases,
corporate support has been leveraged with federal support for student competitions and laboratory developments. The IEEE/PES Workforce Collaborative is developing a scholarship – internship program funded by industry donations to attract and retain undergraduate engineering students toward power and energy engineering. Leveraging industry support with DOE assistance, along with support for research would help assure progress in building the power engineering student pipeline and educational infrastructure. Power engineers are critical to successful integration of renewable energy resources and smart grid technologies.

I) What evaluation and assessment methods should be used to demonstrate the program’s success?

The proof of success in these efforts largely lies in the number of faculty and students engaged in both the education and research of electric power and energy systems. In addition, the true measure is for employees to have the talent available for hire to design, plan, install, operate, and maintain the technologies needed to enable more efficient energy supply, delivery, and use while reducing environmental impacts.

Importance of Standards Education

The Department of Energy (DOE) recognizes through its Technical Standards Program (TSP) the enormous value of technical standards in determining uniform engineering, interoperability, and effective processes and practices. A new effort to include education about technical standards would give students information concerning the best available design tools and industry practices and would better prepare them to deal with real-world applications. Technical standards education can be accomplished by making reference to standards in materials and instruction, by the use of specific standards in classroom instruction and homework, and by encouraging the inclusion of standards in large-scale academic projects. The IEEE’s Standards Association is taking the lead in promoting standards-oriented education. The important role of technical standards in the curriculum of academic engineering, technology and computing programs is outlined in more detail in a 2009 IEEE Position Statement available on-line at: http://www.ieee.org/documents/standardspositionpaper ApprovedJune09.doc

Closing Notes

IEEE PES and its Workforce Collaborative along with IEEE USA stand ready to assist and advise DOE on the development of energy workforce-related programs. For additional information or assistance, please contact Wanda Reder as noted below.

Wanda Reder
2008-2009 President, IEEE PES
Phone: 773-338-1000 x2318
w.reder@ieee.org

Gordon Day
2009 President, IEEE-USA