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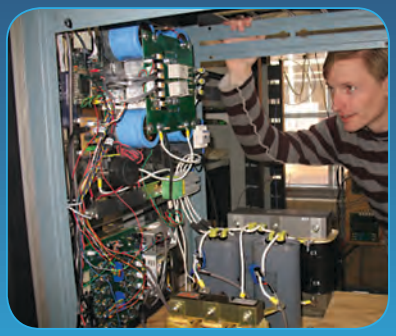
U.S. Power and Energy Engineering Workforce Collaborative

Preparing the U.S. Foundation for Future Electric Energy Systems:

A Strong Power and Energy Engineering Workforce



Prepared by the Management Steering Committee of the U.S. Power and Energy Engineering Workforce Collaborative

Endorsed by the Collaborative's Executive Council

April 2009

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The Executive Council members unanimously endorse this Action Plan as advisors to the Power and Energy Engineering Collaborative. By this endorsement, they are not necessarily committing their organizations to do any of the specific actions identified in this plan without further coordination with their organization's leadership team or other authorities. This endorsement specifically does not constitute an approval by, or reflect any position of, the Federal Energy Regulatory Commission.

Action Plan

New state and national policies are advancing actions to address environmental concerns, and increase energy independence and security. These affect economic growth and stability, and are likely to direct major technology investments to:

- Create a **Smart Grid** to make use of computer, sensor, automation, control, and communication technologies
- Achieve large-scale penetration of **Renewable and Alternative Energy** technologies
- Maintain **U.S. Electric Power Grid Reliability** when integrating sources of renewable generation with traditional generation technologies
- Improve **Energy Efficiency** in delivery and use
- Enable the public to use **Plug-in Hybrid Electric Vehicles** to reduce oil consumption, reduce carbon emissions, and store energy for support of the electric system.

The National Academy of Engineering hailed the electric power grid as the 20th century's engineering innovation most beneficial to our civilization. The 21st century electric power grid may be recognized again for efforts to connect new and old electricity generation sources to transmission, distribution, customer meters, and customer end-uses. The power grid is being transformed by innovations that draw on technology advances in different fields to meet new societal needs and public policies. Throughout this transformation, customer expectations for electric power reliability will remain high. Few people doubt that, when they flip the switch, the power will be on. Aging trends in the electrical engineering workforce and in existing infrastructure will make it difficult to meet these reliability expectations unless action is taken today. Engineering workforce shortages are already occurring. We need more electrical engineers to solve industry challenges, and to build that 21st century electric power grid. We need more electrical engineers to keep the nation's electric power reliable, secure, safe, and competitive. **Meeting these needs requires long-term investment now.**

Immediate actions must be taken to avoid letting a growing shortage of well-qualified electric power engineers slow progress in meeting critical national objectives.

Who should take these actions? The list includes:

- Industry: any business that requires electric power and energy engineering skills
- Government: state and federal electric power industry regulators, federal agencies such as the U.S. Departments of Energy and Labor, and Congress
- Education Institutions: universities, community colleges, and K-12 schools
- Research Organizations: public and private

This position paper identifies actions that should and can be taken.

Aging Workforce Trends Affecting Industry and Educators

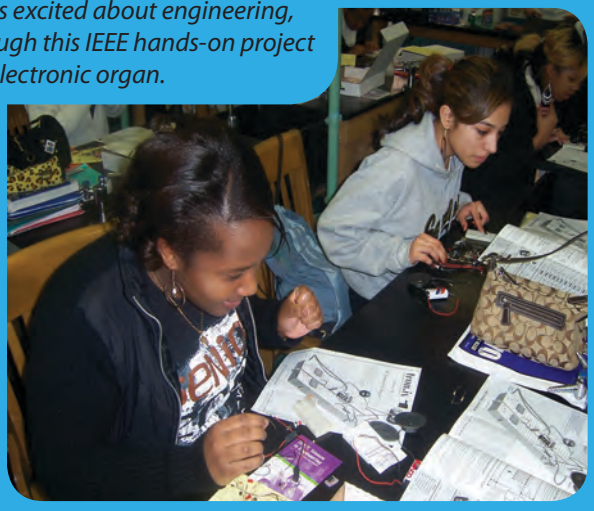
It is common knowledge that baby boomers are beginning to retire and leave the workforce. The electric power and energy industry is already beginning to experience shortages by these retirements. Over the next five years, roughly one-half of its engineers may retire or leave for other reasons. These experienced engineers provided the expertise needed to design, build, and maintain a safe and reliable electric power system. Over the years, they have planned for and expanded the system to serve a growing population, developed needed operating and maintenance practices, and brought about innovations to make improvements.

The departure of this engineering expertise is being met by hiring new engineers and by using supplementary methods, such as knowledge retention systems. The future engineering workforce will supplement traditional power system knowledge with new skills, such as in communication and information technologies. Traditional and new skills will be necessary to successfully deploy advanced technologies while maintaining the aging infrastructure.

What leads us to believe that there are workforce and education system problems?

- Over the next five years, approximately 45 percent of engineers in electric utilities will be eligible for retirement or could leave engineering for other reasons. If they are replaced, then there would be a need for over 7,000 power engineers by electric utilities alone: two or three times more power engineers may be needed to satisfy needs of the entire economy.
- About 40 percent of key power engineering faculty at U.S. universities will be eligible for retirement in five years with about 27 percent anticipated to actually retire. In other words, of the 170 engineering faculty working full-time in power engineering education and research, some 50 senior faculty members will be retiring. This does not account for senior faculty who are already working less than fulltime in the area. Finally, even more faculty will be needed to increase the number of power engineering students to meet the demand for new engineers in the workplace.

To build the student pipeline, we must get K-12 students excited about engineering, such as through this IEEE hands-on project to build an electronic organ.



- The pipeline of students entering into engineering is not strong enough to support the coming need, with surveys showing (1) that most high school students do not know much about engineering and do not feel confident enough in their math and science skills, and (2) that few parents encourage their children, particularly girls, to consider an engineering career. Furthermore, often career counselors and teachers know little about engineering as a career. Workforce diversity is also a concern. Women are only 18% of engineering enrollments and 12% of electrical engineering students. Enrollment of underrepresented student populations should be higher.
- Enrollment by university students in power and energy engineering courses is increasing (perhaps fueled by interest in renewable energy systems and green technologies); however, the overall number of students interested in electrical engineering is declining. A shrinking pool of electrical engineering students limits the future supply of new power engineers.
- The hiring rate of new power engineering faculty is beginning to grow after years of insufficient hiring to replace retiring faculty; however, as time has passed, many historically strong university power engineering programs have ended or significantly declined.

- There are less than five very strong university power engineering programs in the U.S. A very strong program has (1) four or more full-time power engineering faculty; (2) research funding per faculty member that supports a large but workable number of graduate students; (3) a broad set of undergraduate and graduate course offerings in electric power systems, power electronics, and electric machines; and (4) sizable class enrollments of undergraduates and graduate students in those courses. The general lack of research funding opportunities has made it difficult for faculty in existing programs and new emerging programs to meet university research expectations and for engineering deans to justify adding new faculty.

"As an industry we are at a critical juncture where we are working to build additional capacity, integrate renewable energy sources, address carbon and other environmental concerns, rebuild an aging infrastructure, and make the grid smarter," states Wanda Reder, President, IEEE Power & Energy Society, and chair, Executive Council, Power and Energy Engineering Collaborative. "Power engineers will make critical contributions to addressing these challenges. However, these challenges are occurring as many faculty in university power engineering programs are reaching retirement, retirement rates in industry are growing, and there is a lack of new recruits entering the industry."

Objectives for Keeping Our Power Engineering Workforce Strong

To insure that our society has the well-qualified power and energy engineers it needs, the following objectives must be sought:

1. Develop and communicate an image of a power engineer based on a realistic vision of how engineers will be solving challenges facing companies, regions, the nation, and the world, thereby improving the quality of life. Youth want to choose jobs that make a difference in the world.
2. Motivate interest in power and energy engineering careers and prepare students for a post-high school engineering education in power and energy engineering. Students should be exposed to engineering even before high school. Teachers, counselors, and parents must be the target of information as well as the students.
3. Make the higher education experience relevant, stimulating, and effective in training high quality and professional power and energy engineers. Establish and maintain a direct link between power engineering and the solution of major challenges facing the U.S. and the world.
4. Increase university research funding to find innovative solutions for pressing challenges and to enhance student education.

Students are being drawn to engineering in the hope of making a difference in the world, such as by addressing climate change concerns through the use of alternative energy systems.

The Power and Energy Engineering Workforce Collaborative used these objectives to identify goals and stakeholder actions to overcome the engineering workforce challenges. If these actions are implemented collectively, major progress will be made toward developing the talent and the education infrastructure necessary to meet national objectives. Action to meet the objectives must begin today.

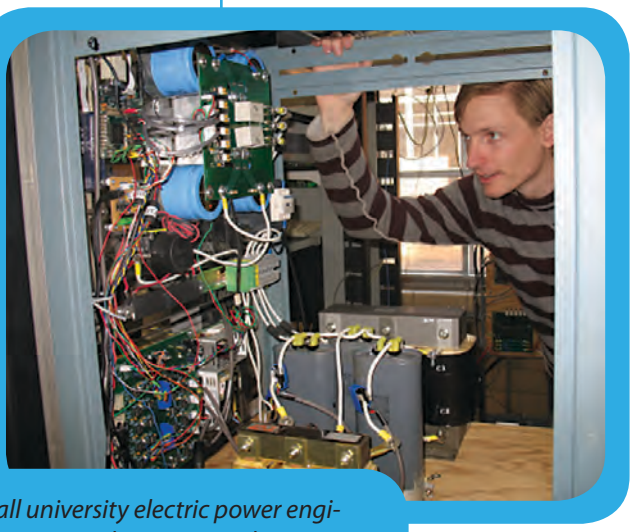
Priority Goals to Meet the Objectives

1. Double the production of undergraduate and graduate students in power engineering

The Collaborative estimates that there are about 800 to 1,000 undergraduate students graduating each year with interest in electric power engineering jobs. In addition, U.S. enrollment for masters and doctoral students in power engineering are both around 550. About sixty percent of graduate students are international. Electric utilities alone will require an estimated 7,000 new power engineering hires over the next five years. After factoring in the workforce needs of other industries, power engineering hiring could easily double to 14,000 new hires over the same time frame. While the future power engineering workforce needs are uncertain, doubling student graduations over the next five to eight years is the right direction to head.

2. Provide $4M in funding for undergraduate power engineering scholarships

To attract students into the power discipline, $4M should be provided annually to provide funding for 2,000 undergraduate scholarships to U.S. citizens. These scholarships can also be used to attract high school graduates into engineering. Graduate student support is included in the research funding goal #5.



Almost all university electric power engineering programs have power electronics courses. Here an electrical engineering masters student is using a prototype to test his design of a power electronics system for integrating energy storage devices into a microgrid. New engineering skills are needed for work on the future power grid.

3. Create 2,000 internship and cooperative opportunities for electrical engineering students

To encourage students to pursue power and energy careers and to provide them with real-life experiences, 2,000 internship and co-operative positions should be created. These industry experiences will be an integral part of an undergraduate and master student's educational experience. They will help students to understand the industry and help industry to recruit new engineers.

4. Hire 80 new faculty over the next five years to replace retiring faculty, to increase enrollments, and to broaden educational offerings.

Currently there are about 170 full-time power engineering faculty in the U.S. These faculty are teaching courses in electric power systems, electric machines, power electronics, among other subjects. If 27% retire over the next five years, almost 50 new faculty would have to be hired just to replace them. Senior faculty members are needed to mentor new faculty through their tenure process, which typically takes at least five years. With this in mind, and the need to expand the number of enrolled students, 80 new faculty should be hired over the next five years to place the power engineering education system on-track for the 21st century.

5. Raise annual non-equipment funding of university power engineering research from $50M to $100M over the next five to eight years

Power engineering research is most often reported in the following areas:

- Power electronics
- Power systems analysis, operations, dynamics, computation, economics, and transmission and distribution
- Power generation and energy development

Current funding is reported to be approximately $50M with another $10M for equipment and facilities. About 60 percent of total funding comes from government, 14 percent from domestic utilities, and 17 percent from domestic manufacturing and non-electric power industries. The remainder comes from university and foreign sources.

The allocation of these funds by research area has not been studied. A sizable portion of the research is on industrial applications that are not energy related. Certainly more funding is needed for electric power system research to support the transformation of the electric power grid. It is essential that research funding be reasonably balanced across all of the areas commensurate to achieving national objectives.

A key faculty responsibility is to obtain research funding to support graduate student salaries, benefits and tuition. A faculty member can advise more graduate students with corresponding increases in available research funding. Graduate students are critically needed for realizing new innovations in electric power and energy technologies. Furthermore, graduate students are the next generation of engineering educators and researchers. To double the number of graduate students will require more research funding.

Ultimately, the total number of engineering faculty working full-time in the electric power area may need to increase by more than 30 percent to be able to double the number of students and meet the increased need for innovations to create the future electric grid. The $100M of annual research funding includes the investment required for the University Centers of Excellence that are discussed next.

6. Revise the current education model by creating five University Centers of Excellence

Private and public universities respond to marketplace needs for engineers to design, plan, operate, and maintain power and energy systems using leading-edge technologies. They often give particular attention to employers in their state or immediate region. This aspect of the power engineering education model should continue, with an added emphasis on building relationships between industry, government, and educators.

In addition to the present university education model, five (5) University Centers of Excellence are needed. These Centers will focus on research challenges related to national objectives, and educate undergraduate and graduate students. Beyond these responsibilities, they will work to build the student pipeline, and to enhance power engineering education in the U.S. The University Centers of Excellence will:

- Conduct research and education to strengthen our nation's technical energy position and to improve its competitiveness
- Take steps to build the student pipeline nationally, by supporting collaborations such as with the Center of Energy Workforce Development
- Assist K-12 teachers in developing their energy lesson materials
- Advance power engineering education by researching education methods, by modeling modern curricula, by using best practices in teaching methods, and by communicating this information to other universities
- Administer national scholarship programs
- Hold summer certificate education programs drawing on faculty from other universities
- Identify and communicate research needs to meet national energy objectives

The University Centers of Excellence are key to achieving the Collaborative's overall objective of keeping the U.S. power engineering workforce strong. Through their efforts, relationships among industry, government, and universities will be transformed to support on-going activities that expand the pipeline of students, and that build, enhance, and sustain university power engineering programs. Geographical diversity in the Center locations will improve their effectiveness in reaching those objectives.

Funding for the University Centers of Excellence will require an estimated $5M per year per center for at least five years, perhaps renewable for a second five year period. This funding is included the funding proposed for goal #5, above.

The overall education model will include a combination of in-residence and distance education programs offered by universities, community colleges, and government and industry providers. In addition, the model will include certificate programs and professional development programs.

Universities can hire non-tenured staff, such as adjunct professors, relatively quickly to supplement the available instruction-time of university faculty. This will allow universities to expand educational opportunities to address the rising shortage of well-trained power engineers. However, actions must also be quickly taken by industry and government to build and sustain university power engineering programs through increased research support for faculty. Strong university power programs are needed to meet the needs for innovation, for future engineers, and for future educators.

Proposed Actions

All stakeholders need to assume responsibility to make this vision a reality. Each stakeholder needs to assess what can be done and initiate immediate action to achieve the stated objectives and goals. Recommendations for each stakeholder are listed below.

WHAT SHOULD UNIVERSITIES DO?

- Work toward doubling the supply of power and energy engineering students
- Continue enhancing education curricula and teaching techniques to insure an adequate supply of well qualified job candidates that can be successful in the energy jobs of the future
- Increase research in areas that can contribute to meeting national objectives
- Get involved in state and regional consortia to address workforce issues, such as those formed with the assistance of the Center for Energy Workforce Development
- Conduct seminars and encourage industry to provide information sessions to develop university student interest in power and energy engineering careers
- Build communications and collaborations with industry, particularly between industry executives, department chairs and college deans
- Communicate with industry about education needs that may require innovative approaches to education
- Insure that adequate educational opportunities exist for retraining engineers with education and experience in fields other than power engineering
- Use college or university diversity student recruiting programs to also spread the word about opportunities in power and energy engineering

Industries need to expand their cooperation with universities to help students get an exciting image of engineers and the contributions they must make in the future electric power industry.

WHAT SHOULD COMMUNITY COLLEGES DO?

- Inform students about engineering career opportunities
- Provide course opportunities that prepare students for an engineering education at a university
- Work with universities to establish credit transfer programs so students can continue education at a university after graduating from a community college

WHAT SHOULD K-12 EDUCATORS AND CAREER COUNSELORS DO?

- Identify and communicate needs and ideas on education materials, lesson plans, and computer-based learning related to energy and engineering
- Encourage students to consider engineering as a career
- Increase the number of specialized teachers in math, physics and chemistry to improve scientific education and increase professional awareness
- Work with industry to provide projects, case studies, field trips, and learning-by-doing experiences into lesson plans to increase student interest in engineering

WHAT SHOULD POWER ENGINEERING RESEARCH ORGANIZATIONS DO?

- Engage university researchers in developing research roadmaps that identify where university research can contribute in meeting power and energy engineering research needs
- Support university research, particularly in fundamental research and curriculum development
- Communicate with university researchers to develop an appreciation of university research objectives that must include education and support of graduate students over several years
- Develop requests for proposals that draw on the strengths of university researchers and contribute to their need to provide graduate student support

WHAT SHOULD IEEE POWER & ENERGY SOCIETY DO?

- Take advantage of delays in retirements due to the economic downturn to more fully develop collaborations to implement wide-scale training and marketing programs
- Keep the organization and its members knowledgeable of engineering workforce issues and mobilize the membership, where individuals, chapters or regions as a whole, to get involved in responding
- Lead the IEEE Power and Energy Engineering Workforce Collaborative until the responsibilities can be assumed by the University Centers of Excellence or another suitable institution
- Develop training plans targeted toward life-long learning. The development needs to consider the adjustment of skills arising out of technological change and new fields.
- Organize industry to provide scholarships for power engineering students, targeting U.S. citizens
- Explore ways to support retraining of engineers whose education and experience is in fields other than power and energy engineering
- Provide opportunities to bridge promising student talent and industry
- Expand participation of the career site, PES-Careers.org, through testimonials and increased promotion
- Build upon the Power and Energy Engineering Workforce Collaborative efforts

WHAT SHOULD EMPLOYERS DO?

- Maintain workforce development and hiring activities in spite of the economic downturn to avoid future power system reliability problems due to massive delayed retirements
- Communicate with university undergraduate students to offer an exciting image of an energy engineer's work that will make a difference to the company, its employees, the region and beyond. Point out the new skills that engineers will be acquiring for successful transformation of the electric power system.
- Offer development opportunities to undergraduate and graduate students; examples include mentoring, scholarships, internships, cooperatives, senior capstone projects, part-time jobs, and research support. Research support can be provided by offering data, allowing testing of innovative ideas, enabling access to company engineers for information and guidance, and providing financial sponsorship through fellowships and research project support.
- Seek beneficial opportunities through cooperation with universities. Talk with faculty about workforce needs and major business and technical challenges; listen to their education and research plans. Find ways to work together.

- Communicate with college deans and department chairs about strategic corporate and industry challenges, innovations needed by industry, importance of educating students to become power and energy engineers, and the need to hire new faculty. Brainstorm about ways to maintain a high quality and cost efficient educational system. Again, find ways to work together.
- Facilitate life-long learning through innovative programs with community colleges and universities. Reward participation in professional associations.
- Participate in collaborative efforts among industry, government, and educational institutions to address workforce issues (such as state consortia formed with the assistance of the Center for Energy Workforce Development). Take advantage of opportunities to leverage company resources to achieve common objectives such as in building the student pipeline.
- Support retraining of electrical engineers from other disciplines to the power engineering field whether in hiring new employees or in cross-training existing employees.

WHAT SHOULD INDUSTRY ASSOCIATIONS DO?

- Work with the IEEE-USA to advocate for federal programs that address the objectives and goals described in this Action Plan, particularly with respect to sustaining university power engineering programs
- Improve relationships between industry and universities to build, enhance, and sustain the power engineering programs
- Survey and report current industry practices in workforce development including activities for building the student pipeline, communications with universities and their students, recruiting practices, and university research support
- Build tools and relationships to recruit and train people leaving the military and from underrepresented populations

WHAT SHOULD STATE AND FEDERAL UTILITY REGULATORS DO?

- Stay informed on utility workforce issues and workforce development activities by regulated utilities, such as by asking utilities to provide periodic written or oral reports, communicating with state and federal agencies doing workforce development, and obtaining workforce reports and news from industry associations, Center for Energy Workforce Development, and education institutions
- Find and remove, where possible, any policy barriers or disincentives to utilities taking prudent actions to address workforce needs. Examples of barriers and disincentives include insufficient cost recovery of reasonable expenses and lack of clear regulatory expectations for and endorsement of utility goals toward workforce development, and building and sustaining the education infrastructure.
- Consider above-the-line rate treatment of prudent workforce development actions such as providing undergraduate scholarships, graduate fellowships, hiring in advance of retirement, supporting university research, building community college programs, creating workforce development and knowledge retention programs, supporting the retraining of engineers into power engineering positions, and training and engaging in hiring practices found in other industries
- Actively encourage and engage in collaborative activities to address electric power industry workforce issues such as through state consortia that now exist in over 20 states
- In approving utility plans for major initiatives and investments, ensure that there are plans for recruiting and retaining the workforce needed to select, install and maintain the leading-edge technologies. Examples of initiatives include reliability assurance, cybersecurity, transmission and distribution capability upgrades, smart grid systems, integration of distributed generation, alternative energy systems, and energy efficiency.

WHAT SHOULD THE NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS (NARUC) DO?

- Expand the report requested by the NARUC Resolution Promoting Partnerships to Train a Future Electric Industry Workforce to identify regulatory policy disincentives to utility management actions (1) to build the pipeline of students for electric industry careers, (2) to advance teaching of math and science skills in the K-12 education system, (3) to enhance and sustain university engineering programs, and (4) to engage in prudent workforce development including activities done in other industries
- Receive annual updates from the Board of NARUC's Subcommittee on Education and Research on the progress of partnerships or collaborations involving state regulatory commissions to address workforce issues
- Encourage development of state consortia such as those fostered by the Center for Energy Workforce Development
- Conduct a demographic survey of electrical engineering staff at state regulatory commissions to forecast retirement trends and hiring needs
- Seek ways to improve collaboration between industry and universities

WHAT SHOULD THE NORTH AMERICAN ELECTRIC RELIABILITY CORP. (NERC) DO?

- As part of NERC's annual Long-Term Reliability Assessment, continue to monitor and explore workforce status and identify potential industry approaches to address issues in critical reliability areas
- When appropriate, invite faculty to get involved in NERC activities to help them understand challenges in maintaining power system reliability and to help NERC benefit from their knowledge and experience
- As part of the annual Long-Term Reliability Assessment workshop on emerging issues, discuss workforce issues along with potential research and education needed to address challenges in maintaining a reliable electric power grid
- Where appropriate, invite university researchers to perform NERC studies and research projects
- When possible, visit universities and professional consortia (1) to provide lectures on timely topics, (2) discuss research and education opportunities in the power industry, (3) describe the new skills that engineers require for successful transformation of the electric power system, and (4) communicate an exciting image of an energy engineer's work with university students

WHAT SHOULD THE DEPARTMENT OF LABOR DO?

- Create a methodology to easily identify and track power and energy jobs by modifying Standard Occupation Codes
- Conduct a national study on the outlook and skill requirements for power and energy jobs in engineering and the trades to better account for future job growth, retirements, and changing skills
- Promote energy jobs as career possibilities with K-12 career counselors, parents, teachers, and students
- Improve coordination with the Department of Education such as by connecting the Department of Education's work on Career Clusters with Department of Labor's competency models
- Publicize energy-related program objectives, recipients, funding, and deliverables. Create a brochure for industry to let them know about partnership opportunities.
- Evaluate existing career outreach programs to K-12 students, parents, teachers and counselors to determine which ones are most effective in raising student interest in engineering careers and post-high school engineering education
- Provide research funding opportunities on engineering and trades education, particularly to improve effectiveness in teaching and motivating teenage and young adult students, and transitioning workers

WHAT SHOULD THE DEPARTMENT OF ENERGY DO?

- Create five (5) University Centers of Excellence in power engineering
- Maintain an appropriate balance in research funding across the power engineering areas of power electronics, power systems and delivery, and electric energy generation to insure adequate funding of critical research needs to achieve national objectives
- Support energy education initiatives for developing and distributing K-12 lesson materials
- Leverage the success of the National Science Foundation's Research Experiences for Teachers program
- Communicate information about energy engineering careers and education on the DOE website, linking to useful information sources on other sites

WHAT SHOULD THE CENTER FOR ENERGY WORKFORCE DEVELOPMENT DO?

- Partner with the Power and Energy Engineering Workforce Collaborative in areas of career awareness, workforce development and education, and workforce planning
- Expand the engineering section of the "Get Into Energy" web site to include aides in education planning and a career awareness video for engineers created in cooperation with the IEEE Power & Energy Society
- Publish promotional material and presentations that target potential power and energy engineers and transitioning military personnel; adjust messaging to appeal to under-represented groups
- Develop industry-wide and regional solutions that maximize the efficiency of electric utility workforce development activities
- Continue the annual electric utility survey to identify high priority energy industry engineering workforce needs
- Facilitate the development of regionally-based alliances of key stakeholders throughout the U.S.

Conclusion

Skilled power and energy engineers are the foundation to successful design, planning, construction, maintenance and operation of our nation's future electric energy systems. An ample supply of these engineers is critical to success in meeting national policy objectives toward energy independence and security, global competitiveness, environmental stewardship, and quality of life. To get that supply, we have to start making investments today by:

- communicating an image of an engineer as someone who solves problems that make a difference in the world
- increasing interest among our youth in math, science and engineering
- improving the quality of high school and post-high school education
- building, enhancing and sustaining university power engineering programs in part through increased research support.

In assuring future prosperity, there is work to be done by industry, government and education institutions. To build from a position of strength, action is required now. The choice is ours to make; the future is ours to lose.

Appendix

U.S. Power and Energy Engineering Workforce Collaborative

The U.S. Power and Energy Engineering Workforce Collaborative, led by the IEEE Power & Energy Society, is an initiative to address concerns about the U.S. power and energy engineering workforce. The Collaborative's main objectives are:

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

The Collaborative is working for the transformation of relationships among industry, government and universities (1) to support on-going activities that expand the pipeline of students, and (2) to build, enhance and sustain university power engineering programs.

To meet the objectives, the Collaborative has an Executive Council and Management Steering Committee that provide leadership direction and guidance to three working groups: Outreach and Image, Education, and Research. Each working group addresses specific issues related to its individual mission as well as addressing cross-functional themes between the working groups.

The Collaborative was formed to implement the recommendations from the National Science Foundation (NSF) Workshop on the Future Power Engineering Workforce held on November 29-30, 2007. The Workshop was co-sponsored by the IEEE Power & Energy Society, the North American Electric Reliability Corp., and the Power Systems Engineering Research Center. More information on the Collaborative along with the final report of the NSF Workshop, can be found at: www.ieee.org/go/pes-collaborative.

How you can get involved

1. Visit the Collaborative website: http://www.ieee.org/go/pes-collaborative.
   - For information on how your organization can become a Collaborative Partner
   - To express interest to any working group leader, or Management Steering Committee member —contact information is provided
   - Get instructions to join the Collaborative's email listserv

2. Send an email to pes-collaborative@ieee.org.

3. Contact Dennis Ray, Executive Director, Power Systems Engineering Research Center, 608-265-3808, djray@engr.wisc.edu

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*Any opinions, findings, or conclusion in this document are those of the authors and do not necessarily reflect the views of the National Science Foundation or of members of the Power Systems Engineering Research Center.

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