Overview

• Industry Workforce Challenge and Supply
• IEEE PES Initiatives
• Power Engineering Education Trends and Concerns
• NSF Workforce Workshop and Recommendations
• Shifting the Education Paradigm
• Power and Energy Engineering Collaborative
The US Electric Industry Challenge

- US electric demand predicted to increase 40% by 2030*
  - Capacity margins eroding
  - Requires additional generation and delivery investments

- Aging infrastructure:
  - More maintenance
  - Increased equipment replacement

- Complex systems:
  - More reliant on technology
  - Convergence of communications, computing and energy systems

- Changing societal needs and global concerns

Engineering Workforce Employees Exiting

46% of electric utility engineering jobs could be vacated by 2012 *

*Source: Gaps in the Energy Workforce Pipeline: A 2007 Workforce Survey Report From the Center for Energy Workforce Development Center
Recognition of the Workforce Challenge


“Today, the power engineering education system in the United States is at a critical decision point. Without strong support for strategic research in power systems engineering and without qualified replacements for retiring faculty, the strength of our Nation’s university-based power engineering programs will wane, and along with them, the foundation for innovation in the power sector to meet our energy challenges in the 21st century.”

Long-Term Reliability Assessment: NERC, 2007

“The loss of industry workers and their years of accumulated expertise due to retirements is a serious threat to the bulk power system reliability, exacerbated by the lack of new recruits entering the field.”
PES is Strong, Though It Needs Members!

PES and its membership
- 22,000 members
- 125 years of rich tradition

Demographically challenged
- Members > age 50 are increasing
- Members < 50 are decreasing

IEEE PES addressing this:
- Initiatives underway
- More to do
2007 Student Survey Identifies Opportunity

Top three career path influencers:
1. Interesting career
2. Opportunity to solve significant societal challenges
3. Make the world a better place to live

Energy and Power Engineering is...
- Exciting
- Critical to society-at-large
- Relevant opportunities

48% were “more” or “significantly more” interested in PES with the name change

Student Feedback Focus Groups
- Image is ‘old-fashioned’
- Offerings are for academics: not relevant for practitioners
- Be more ‘open’ and ‘inviting’
IEEE PES Workforce and Image Initiatives

- Tools for K-12 outreach
- Engineering student career fairs
- Tutorials, training, workshops
- Membership brochures
- Web site improvements
- Society Name Change
- Vice President positions added:
  - Membership Image
  - New Initiatives / Outreach
- Enhancing GOLD representation
- Launched student on-line career service
- Implemented the NSF workforce workshop

Professor Schultz, Mississippi State University brings students to T&D Conf & Expo in Dallas in 2006
PES-Careers: Connecting Students with Employers

- IEEE PES on-line career service began Sep. 2007
  - To help address emerging engineering workforce challenges
  - As a service to students and their future employers
  - To facilitate collaboration to provide a quality education for the next generation of power engineers

- [http://www.PES-Careers.org](http://www.PES-Careers.org)
  - Developed in cooperation PSERC
  - Full-time, part-time and internship positions
  - Applies in U.S. and Canada: expansion will be evaluated
  - Registrations: 325 students from about 80 institutions, 100 employers (engineering services, manufacturing, utilities, RTO/ISO’s, etc.) and over 175 job/internship postings
Power Engineering Academic Status

**Inside USA**

- Retirements outpacing new professor hires
  - Average age increasing
  - Power program faculties have ~3 professors
- Viable programs are down
- Students:
  - Attracted to other areas
  - Many are non-US

**Outside USA**

- New professor hires outpace retirements
  - Average age decreasing
  - Power faculties have ~10 professors
- Growing enrollment
- Students:
  - Positive image
  - Potential provider for U.S. needs

*Source: IEEE Power Engineering Education Committee Survey Results*
Power Engineering Student and Faculty Trends

- **U.S. university engineering students enrollments** (needs to be growing in anticipation of increased demand)
  - Electrical engineering enrollments: declining
  - Undergraduate students interested in power: stable to rising
  - Graduate students in power: stable
  - Increasing international graduate students: 59% of total *

- **Untenured faculty declining**: 20% of total faculty in early 90s to 12% now (thus, need for new faculty)*

- **Poor research funding outlook**: down 17% in 2005/6 compared to 2001-02 (needs to be rising to support hiring of new faculty)*

University Power Systems Engineering Programs

• Weakening programs: Of 48 university programs surveyed in 1987/8 and 2005/6, 50% declined and 15% grew in number of major faculty members.

• Former strong programs declining or ending

Source: IEEE Power Engineering Education Committee Survey Results for Various Academic Years.

Power Engineering Faculty
Carnegie Mellon University:
1975: 8 faculty; 2007: 1
Cornell University:
1975: 7 faculty; 2007: 1
University of Michigan*:
1971: 5 faculty; 2007: 0
UC Berkeley:
1971: 4 faculty; 2007: 1
Univ. of Missouri-Columbia:
1975: 8 faculty; 2007: 0

* Recent decision to rebuild program

Source: IEEE Power Engineering Education Committee Survey Results for Various Academic Years.
The Education Dilemma

• Undergraduate specialization is becoming less prevalent
  – Power electives often not offered due to a lack of qualified faculty
  – The average age of faculty is increasing
  – Funds are limited for recruiting new faculty
  – The reduction in elective credit hours further challenges ability to graduate with a power emphasis

• Declining research funding … causing:
  – A lack of “Power” faculty for teaching and research
  – Difficulties for new faculty to establish themselves
Power Engineering Concerns

Need more young engineers:
- Increasing demand for technical talent and experience
- Rapid forecasted attrition

Supply is questionable (although there are some positive signs):
- Students in the pipeline are declining
- All retiring faculty are not being replaced

Education infrastructure needed
- to capture emerging student interest in energy, sustainability, and saving the earth
Breakthroughs Require Diverse Skills

- Asset management
- Power electronics
- Advanced protection equipment
- Sophisticated computations
- New monitoring systems
- Powerful communications
- Risk assessment and management
- Circuit of the Future (distribution)
- Utility of the Future (smart grid)
- Integration of wind, dispersed generation and storage
Shifting the Education Paradigm

• Provide specialty programs by integrating power system functions and technological breakthroughs
  – Information Technology, Telecommunication, Cyber Security
  – Advanced use of signal processing and process controls

• Address undergraduate education needs with distance learning
  – Adjust requirements: residency, video classes, virtual professors
  – Achieve synergy and cost savings
    • A specialist teaches students from multiple institutions
    • Create agreements for tuition and faculty loading

The Graduate Case and a Solution

*University/Industry Joint Initiative*

- Advanced degree challenges:
  - Lack of adequate infrastructure for graduate degrees
  - Lack of research funding for potential graduate students
  - Residency requirement an impediment for doctoral programs

- A Solution -- an off-campus Ph. D. program:
  - Collaboration of Mississippi State University, San Jose State University, and Pacific Gas & Electric
  - Creating an advanced Ph. D. degree
  - For part-time industry students via distance learning
    - Does not require relocation
    - Can continue full-time employment
The Graduate Case and a Solution

University/Industry Joint Initiative

• Agreement signed where fulltime employees in California can pursue a Ph.D. while maintaining their present employment
  – Meet the residency requirements
  – Focuses on students field of expertise
  – Fosters steady stream of industry knowledge into academics

• Public announcement
  – State acceptance of “other” accredited universities for advance degrees vs. PhDs limited to University of California Systems

• Brings industry experts into academic environment differently than partnering between University and Industry
  – Promotes a means for future academics
  – Provides a strong stream of financial industry support
National Grid’s Response

*University/Industry Joint Initiative*

- Began increasing hiring 10 years ago
  - National Grid engineering average age is 40 vs. overall average age at National Grid of 46
- Created masters via Worcester Polytechnic Institute (WPI)
  - 1 year program
  - 6 courses (graduate level)
    - 3 Power Engineering
    - 1 Engineering Economics
    - 1 Change Management
    - 1 Organizational Behavior
  - Graduated 80 Engineers from the program in over 5 years

Source: Chris Root, National Grid
Presented at EEI T, D & M Conference 10-8-07
Future Power Engineering Workforce Workshop and Executive Summit

• Workshop held in November 29-30, 2007 in Alexandria, VA
  – 75 attendees from industry, government and universities
  – Included an Executive Summit comprised of key leaders
• Purpose: Explore ways to build the university infrastructure to meet the upcoming power engineering demand
• Sponsor: National Science Foundation
• Co-Sponsors: NERC, IEEE PES, PSERC
Workshop Themes

- Making the case for efforts to build the infrastructure
- Accepting ownership of the problems
- Communicating an exciting image of an engineer
- Teaching to motivate students
- Supporting research for innovation and faculty hiring
- Committing to work for solutions
Key Recommendations

• Create a single, collaborative voice on solutions
• Paint future challenges to enhance the image and increase interest in related careers
• Stimulate interest and prepare students for a post-high school engineering education
• Make the higher education experience relevant, stimulating and effective
• Strengthen the case to build, enhance and sustain university programs
• Increase university research funding by government and industry to find innovative solutions and to enhance student education
IEEE PES Engineering Workforce Initiative through Collaboration

University Power and Energy Engineering Education

Power and Energy Industries

K-12 pipeline

Government
Power and Energy Engineering Collaborative

Executive Task Force
A single, collaborative voice

Outreach & Image
- Predict the future to envision challenges and what education is needed
- Create an appealing image of power engineers
- Market the image
- Help prepare K-12 students

Education
- Build the case to build, enhance and sustain university power programs
- Take the case to universities, industry and government
- Stimulate power career interests in college students
- Make power and energy education relevant, stimulating and effective

Research Support
- Identify research needs and ways to overcome barriers to increased research support
- Make the case for increased university research support for innovation and for the education infrastructure
- Communicate with industry, government and universities
Organized for Action

• Initiative of the IEEE Power and Energy Society

• Organized to implement recommendations
  – Build collaboration for outreach, education and research
  – Complement existing efforts of others to the extent possible
  – Get all stakeholders to realize their roles in the solutions

• Proposed transitional structure
  – Executive Council
  – Working groups
  – Management Steering Committee

• Operating within the PES structure
What are the problems?

• Aging US infrastructure (including people)
• Growing demand for clean electric energy
• Manufacturing trend to move off-shore
• A need for the next technology leaders
• Student pipeline not adequate to meet future demand
• U.S. universities not filling key faculty vacancies
• A need for a unified voice and coordinated effort
Who can solve them?

- Universities, industry and government working together

- **Key decision-makers**
  - University administrators: decide whether new faculty should be hired
  - Executives: decide the priority of issues and resource use
  - Government leaders: set policies and allocate resources
Key Objectives

- Expand the pipeline of students seeking careers and power and energy engineering
- Build, enhance and sustain university power engineering programs
- Work for the transformation of relationships among industry, government and university power engineering programs
Executive Council

- Membership: About 15 leaders from industry, government and universities working on behalf of students, employers, and educators
- Advocate for the Collaborative and exercise leadership in its implementation activities
- Support and advise the working groups
- Plan on-going strategic activities to sustain the Initiative
- Work to create federal and state policies that facilitate the Initiative
Working Groups

• Three Working Groups
  – Outreach and Image
  – Education
  – Research Support

• Work interactively with the Executive Council in planning and implementation activities
• Act to meet the Collaborative’s objectives
Outreach and Image Working Group: Objectives

• Transform the old rusty, dusty image of a power engineer into something green, hi-tech and smart
  – Do K-12 students know what we do?
• Create a single, collaborative voice on outreach and image solutions
  – Who are we?
• Increase K-12 student interest in power and energy engineering careers
  – What future can we create?
Outreach and Image Working Group: Tasks

- Predict the future (what we will need)
  - Envision future challenges in the electric energy industry

- Create the image (what they will want)
  - Appeal to K-12 students, their parents and others that can reach students
  - Provide compelling data and personal profiles

- Market the opportunity (spread the word)
  - Coordinate with Science, Technology, Engineering, and Mathematics (STEM) advocacy programs
  - Coordinate with Center for Energy Workforce Devp.
Education Working Group: Objectives

• Strengthen the case for extraordinary efforts to build, enhance and sustain university power engineering programs
• Prepare K-12 students for a post-high school engineering education
• Stimulate interest in power engineering careers: Focus on college students
• Make the higher education experience relevant, stimulating and effective
Education Working Group: Actions

- Provide data ammunition to the Executive Council on the status of power engineering programs in the U.S. (faculty and enrollment facts and trends)
- Coordinate with Center for Energy Workforce Development and other organizations to obtain data on workforce needs
- Take the case to academic administrators
- Promote information exchange among universities
- Stimulate the creation of K-12 instructional tools on power engineering
Education Working Group: Actions

• Work with others to share best practices and to stimulate programs that support students through internships, co-ops, and scholarships.

• Work with the IEEE PES Power Engineering and Education Committee to advertise power engineering programs.

• Stimulate collaboration between universities on power engineering program issues and opportunities.

• Engage industry, government and universities in conversations about desired education and skills of future power engineers.
Research Support Working Group

- Develop the case for university research supported by government and industry
  - Identify innovation needs by synthesizing existing research road maps
  - Describe the link between education and research
  - Establish that a positive outlook for research funding is key to adding new faculty.
- Identify the barriers to and incentives for increased support by:
  - Government agencies
  - Industry
Research Support Working Group

• Develop strategies to convince key decision-makers to support university infrastructure for power and energy engineering research
• Assess collaboration options to achieve innovative solutions to challenges and to increase support of university research
• Work with the Executive Council to approach government and industry on research support needed to build, enhance and sustain university research programs while addressing critical challenges
Management Steering Committee

• Manage overall planning and implementation activities
• Facilitate coordination and communications within the Collaborative
• Membership:
  – Executive Council leadership
  – Working group leaders
  – Ad hoc advisors when needed
How to Keep Informed and Get Involved

- Visit the new website that is just getting started: www.pes-collaborative.org.
- Go to the website and join one of the working group listserv’s: education-wgroup@ieee.org; outreach-wgroup@ieee.org; research-wgroup@ieee.org
- Get your organization to become a Collaborative Partner
- Contact working group leaders
- Send an email to pes-collaborative@ieee.org
How to Get Involved as a Partner

• Collaborative Partners are organizations that affirm and endorse the objectives of the Collaborative, and will work with the Collaborative to reach those objectives.

• Eligibility: Any organization in or serving industry (including but not limited to electric power), in government, or in education

• Industry, non-profit organizations, government agencies and universities can be Partners

• Some initial Partners are:
  CEWD    Illinois Inst. of Tech.    NERC    PSERC    S&C Electric
  Univ. of Ill. at Urbana/Champaign    Washington State Univ.
Expectations of Partners

• Affirm and endorse the Collaborative and its objectives
• Participate in and support Collaborative activities in ways that are most appropriate for the organization, such as in helping organize regional meetings, or in funding or working on Collaborative projects
• Name an official liaison to the Collaborative
• How to become a partner:
  – Send an email to pes-collaborative@ieee.org.
Conclusions

- The emerging technical talent is our future
  - Demand is increasing
  - Supply is decreasing
- Collaboration and organization is key for success
- By working together, we will be ready!
Collaborative’s Leadership

Wanda Reder
Chair, Executive Council
IEEE Power & Energy President
VP, S&C Electric Company
773-338-1000 x2318
w.reder@ieee.org

Anjan Bose
Chair, Research Support Working Group
Prof., Washington State Univ.
PSERC Site Director
509-335-1147; bose@wsu.edu

Alex Flueck
Chair, Outreach and Image Working Group
Assoc. Prof., Illinois Institute of Technology
312-567-3625; flueck@iit.edu

Gregory Reed
Co-Chair, Education Working Group
Senior Vice President, KEMA
Adjunct Professor, Univ. of Pittsburgh
724-244-0620
gregory.reed@kema.com

Peter Sauer
Co-Chair, Education Working Group
Prof., Univ. of Illinois at Urbana/Champaign
PSERC Site Director
217-333-0394; sauer@ece.uiuc.edu