Responding to Changing Workforce Needs and Challenges

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PSERC Overview

- Also Federally-Supported Research
  - Consortium for Electric Reliability Technology Solutions
  - Future Grid for Enabling Sustainable Energy Systems
- Almost industry members, 13 universities, 50+ faculty (many more “in the wings”), 60+ grad students
- Website: http://www.pserc.org
Collaborating Universities and Site Directors

- Arizona State University - Gerald Heydt
- University of California at Berkeley - Shmuel Oren
- Carnegie Mellon University - Marija Ilic
- Colorado School of Mines - P.K. Sen
- Cornell University - Lang Tong
- Georgia Institute of Technology - Sakis Meliopoulos
- Howard University - James Momoh
- University of Illinois at Urbana - Peter Sauer
- Iowa State University - Venkataramana Ajjarapu
- Texas A&M University - Mladen Kezunovic
- Washington State University - Anjan Bose
- University of Wisconsin-Madison - Chris DeMarco
- Wichita State University - Ward Jewell
Students Connecting with Industry at PSERC Meetings
Objectives

• Review age distribution and employment trends
• Identify some workforce challenges and recommendations that have been made to address them
• Provide examples of responses
• Take a closer look at the role of education
CEWD Surveys: Age Distribution Electric Utilities Total Company


Source: Gaps in the Energy Workforce Pipeline, Center for Energy Workforce Development Survey Results
Proportion of Employees vs. Years of Service


Source: Gaps in the Energy Workforce Pipeline: CEWD Survey Results (multiple years)
Estimate: 62% of the industry has the potential to retire or leave for other reasons through 2020.

Source: Gaps in the Energy Workforce Pipeline: 2011 CEWD Survey Results
## Potential Replacements: 2010-2020

<table>
<thead>
<tr>
<th>Job Category</th>
<th>Potential Attrition and Retirements 2010-2015</th>
<th>Potential Retirements 2016-2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lineworkers</td>
<td>32%</td>
<td>15%</td>
</tr>
<tr>
<td>Technicians</td>
<td>39%</td>
<td>19%</td>
</tr>
<tr>
<td>Non-Nuclear Plant Operators</td>
<td>37%</td>
<td>17%</td>
</tr>
<tr>
<td>Engineers</td>
<td>38%</td>
<td>15%</td>
</tr>
<tr>
<td>Total</td>
<td>36%</td>
<td>16%</td>
</tr>
</tbody>
</table>

CEWD Recommendations (2011)

- Support flexible programs that balance supply with demand
- Build partnerships with education, labor and government sectors to develop secondary and post-secondary programs
- Use the CEWD competency model to create programs that reduce skill gaps
- Create industry-recognized credentials
- Develop workforce planning strategies
Historical Employment in Utilities

Employment for utilities sector including electric power, natural gas, steam supply, water supply, and sewage removal

BLS Employment Outlook 2010 to 2020 Estimates

• Power plant operators, distributors and dispatchers: -2% (little or no change)
• Line installers and repairers: +13% (about as fast average)
• Electrical and electronic engineering technicians: +2% (little or no change)
• Electrical and electronics engineers: +6% (slower than average)

Note: BLS not helping us attract people to the utility industry. Not correctly accounting for replacements!
Nuclear Energy Industry

• Trends
  • 120,000 employees, 38% eligible to retire within the next few years (but workers have been deferring retirement)
  • Retirement-related attrition starting to rise

• Actions taken over the last 7-10 years
  • expanded community college and university enrollments
  • developed uniform nuclear curriculum at 2-year institutions (technicians)
  • companies added staffing margin to prepare for turnover (although this has likely ended – now replace employees on a case by case basis)

Source: Nuclear Energy Institute 2013 Pipeline Survey
Nuclear Industry Employment Distribution by Age

Source: 2013 Nuclear Energy Institute Pipeline Survey Results found at http://www.nei.org (contractors and vendors not included)
Nuclear Energy Industry

• Data suggest “that the industry now has sufficient engineers and operators to continue operating as the aging workforce retires.”

• Challenges
  • Hiring rates have not kept up with graduation rates in certain disciplines.
  • Industry support for nuclear education declining
Another Field: Electronics Engineers*

- Age distribution of survey respondents
  - 40-44: 7%
  - 45-49: 11%
  - 50-54: 20%
  - 55-59: 17%
  - 60+: 33%

- Electronics engineering salaries down slightly over last year ($105,028)

- Unemployment rate: 4.5% in second quarter of 2013 (6.5% in first quarter)

Source: Electronic Design 2013 Engineering Salary Survey
Employability Challenges in all Businesses

- % of U.S. employers having difficulty filling jobs: 49% in 2012, down from 52% in 2011
- 3 hardest jobs to fill: skilled trades, engineers, IT staff
- Why?
  - Lack of experience (44%)
  - Looking for more pay than offered (54%)
  - Lack of available talent/no applicants (55%)

Source: Manpower Group 2012 Annual Talent Shortage Survey
Reported Strategies to Overcome the Workforce Shortages (all businesses)

- Focusing more on staff retention in jobs where recruitment is difficult (37%)
- Selecting people who don’t have the job skills, but have potential to learn and grow (36%)
- Providing additional training and development to existing staff to fill vacancies (28%)

Source: Manpower Group 2012 Annual Talent Shortage Survey
Historical Notes:
2006 DOE Workforce Trends Report

• Analysis of lineworkers and T&D engineers supply and demand (BLS, DOL)
  • Shortage of lineworkers – most acute in 2010
  • No forecasted shortage in power engineers

• Recommendations to Congress
  • Foster math and science education
  • Build interest in energy-related careers
The reliability of the North American electric utility grid is dependent on the accumulated experience and technical expertise of those who design and operate the system. As the rapidly aging workforce leaves the industry over the next five to ten years, the challenge to the electric utility industry will be to fill this void…
Hiring Observations

• Hiring seems sluggish in general.
• Hiring experienced engineers appears to be a critical need, but demand seems to exceed supply.
• Utilities more likely to hire BS grads than MS/PhD grads.
• Hiring of intern/co-op students is a best practice!
• Engineering students getting hired (multiple offers), but they have to look outside of the utility sector, too.
• Hiring of international students not done or limited in many companies.
  • More likely to be done in manufacturing, engineering services, consultants, research organizations.
• Median salaries for power engineers lowest among major EE fields
Strategic Planning to Include Transitioning the Workforce

Workforce requirements
- Situation analysis
- Key competencies

Succession planning
Knowledge capture
Training and development
Recruitment and retention
- Student support
- Image and awareness
- Diversity

Contract labor
Outsourcing
Better use of people/assets
Automation
Role of Non-US citizens

**Workforce Strategy Matrix**

- **New Employees**
  - Mentorship
  - Curriculum Development
- **Existing Employees**
  - Knowledge Transfer
  - Employee Development
- **Legacy Assets**
- **New Assets**
Keys to Workforce Strategies

• Understanding the business of the future, including the drivers of change in the business
• Understanding workforce competencies needed
• Understanding the workforce (internal and external)
• Addressing the workforce gaps
Drivers of Workforce Requirements in the Electric Energy Sector

- Electric demand growing via electrification
- Fuel mix and generation technologies are changing.
- Infrastructure is aging (already old).
- Younger, less experienced, culturally different workers are entering the workforce.
- Grid modernization has become a priority.
- Societal needs are changing (e.g., goals for high penetration of renewable generation, more customer engagement)
Electrification Trend

- ~1% annual growth to 2035 (EIA 2011 Annual Energy Outlook)
- Broadening portfolio of ways to meet energy needs

Major Investments Needed

• $1.5 to $2.0 Trillion by 2030 with $880 B for transmission and distribution (Brattle Group 2008)

• $338 to $476 Billion for Smart Grid investments until 2020 (EPRI 2011)

• Examples
  • Transportation electrification
  • Transmission integrating renewable generation
  • Replacing aging infrastructure
  • Climate change: adaptation and mitigation
New Technologies: Storage, Sensors, Self-Healing… in the Grid

Communication Media: BPL, Wi-Max, Satellite, Fiber, DSL, Wi-Fi, RF Mesh, etc.

Smart Grid Infrastructure: Software/database, network communication and monitoring, and control architecture

Renewables Integration

Substation/Feeder Integration

Self Healing

Residential Customer Demand Response Integration

Smart Grid: System Functions vs. Customer Functions
Smart Grid Brings New Challenges

- Interoperability
- Cybersecurity
- Grid reliability
- System monitoring, control and protection
- Communications
- Decentralized vs. centralized control
- Customer engagement
- Capital investment (utility, users)
- Access to information vs. privacy
Smart Grid Requires Multi-Disciplinary Engineering Support

- Automatic Controls
- Systems Theory
- Energy Conversion
- Public Policy
- Signal Processing
- Transmission & Distribution Engineering
- Engineering Physics
- Marketing, Economics
- Engineering Physics
- Data Management
- Computer Engineering
- Power Electronics
- Standards
- Information Technology

Examples of Possible Future Workforce Needs: A Projection for a Smart Grid

• Short-term: 280,000 new positions from smart grid projects
• Long-term: 140,000 “high value” jobs
• Also loss of jobs due to new technology
• Big boost for equipment suppliers, suppliers of enabled services of distribution smart grid services

Examples of Possible Future Workforce Needs

- 2022: 150,000 professional and skilled craft for construction
- By 2030: 60,000 to operate and maintain electric generation systems
- 10,000-15,000 to construct transmission facilities
- 90,000 for smart grid (while 25,000 will be redeployed)
- 11,000 for energy efficiency

Educating the Next Generation: Conventional Education Pathways

High School

Engineering Technology Schools

Universities (undergrad and grad)

Community Colleges

Apprenticeship programs

Jobs
Educating within a Framework

Industry-based, Energy Competency Model. CEWD
Creating Systematic Career Pathways Programs

CEWD Get Intro Energy Career Pathway Model

• Provide outreach and support to students and potential applicants (e.g., career awareness, mentoring)

• Provide an education framework for career preparation (e.g., stackable credentials, uniform curriculum, education network)

• Encourage partnerships, building on the Energy Workforce Consortia model (28 state consortia in operation)
Smart Grid Education Challenges

• Education and training needs evolving
  • Body of knowledge still growing
  • Applications using the data are still being developed.
  • Programs, practices and standards still in-progress.
• Number of employees actually needing the information growing as deployment continues – but not every engineer and technician today
• Technical knowledge needs often are company-specific.
• Need for sound smart grid curricula and materials
• People still need the basic competencies.
Advances in Education and Training Growing

• ARRA Funding: $100 million for 54 smart grid workforce training programs (universities, community colleges, utilities, vendors, etc.)

• Grid Engineering for Accelerated Renewable Energy Deployment (GEARED). DOE Sunshot Initiative supporting five awardees to grow expertise in electric utility professionals for high penetrations of solar and other distributed tech.

• Professional development: universities, EPRI, vendors, consultants, professional societies, associations, national labs, unions, etc.

• PSERC Future Grid Initiative – creating courses, materials and reference videos
### Additional Training Challenges and Opportunities

- Utilities are finding that fewer new applicants can pass the background checks, drug screening and pre-employment tests.
- Pass rates on pre-employment tests: $<50\%$
- Company-sponsored training
- Courses before pre-employment testing
- Boot camps (e.g., low-income initiative targeting 16-26 year olds by Center for Energy Workforce Development)
  - Industry fundamentals
  - Lineworker, line construction
- Professional development
- Retraining engineers for an energy career
Balancing Supply and Demand for Technicians and Engineers

**Demand**
- Ready Now
- Ready in 1-2 Years
- Ready in 3-5 Years
- Ready in 6-10 Years

**Supply**
- Military Transitioning Adults
- CC/Univ. Graduates
- Recent Energy Career Academy Grads
- Union Apprenticeships
- Currently enrolled in CC/Univ.
- HS Seniors
- HS Juniors in Energy Career Academy
- Currently in Grades 9-12 or beginning engineering studies at university
- Currently in Grades 4-8
Challenges

• Getting students interested and prepared for energy jobs or post-high school education
• Improving diversity in the workforce and reaching targeted segments
• Providing support for students to get them interested in and keeping them committed to energy careers
• Advancing education value, quality and cost efficiency
Making Face to Face Contacts

FPL is committed to education

Whether it's energy conservation discussions in grade school classrooms or nuclear science training at universities, FPL is passionately committed to education. Through FPL's continued support, employees and their communities are able to engage in numerous educational opportunities.

Professor Whys
This interactive show teaches kids in public schools the science behind electricity
Learn More

Captain Conservation
FPL's energy conservation superhero offers an educational program for public schools
Learn More

Solar Stations
This program promotes solar education in schools and offer grants that teach about energy
Learn More

Workplace Partnerships
FPL has created job-training programs with local communities and state colleges
Learn More

Energy Encounter
Visit over 30 interactive displays on energy, electricity, nuclear power and the environment
Learn More

FPL for Kids
Educational games, experiments and information for kids, parents and teachers
Learn More
Developing Effective Websites

There are many reasons to consider a career in the energy industry. With the right education and training, you can begin a rewarding, well-paying career that benefits millions of people every day.

Youth

Find out how you can make a difference with a rewarding, well-paying and exciting career in the energy industry.

> EXPLORE CAREERS FOR YOUTH
Stimulating Competitions

IEEE PES Smart Grid Competition, DOE’s National Science Bowl, FIRST Family of Programs, ...
IEEE Power & Energy Society, 2010
Reaching Out to Targeted Sectors

Helmets to Hardhats is the fastest way for Military, Reservists, & Guardsmen to transition from active duty to a career in the construction industry.

1. We’ll help you build your profile
2. Guide you through searching, & applying for careers
3. Connect you with other Veterans
4. Provide you with advice from our staff of construction industry and military professionals

GET STARTED >>

>> Intl. Brotherhood of Boilermakers & Iron Ship...
Boilermakers and boilermaker mechanics make, install, and repair boilers, closed vats...

>> Want to be a Boilermaker?
It’s more than just the construction and repair of boilers.
Supporting Teachers

Lesson plans, materials, applets, guest speakers, targeted learning programs, academies, field trips, NSF research experiences, etc.

TCIPG Education

Description

The power grid is the system of producers and consumers of electricity. It includes power generators, the users of electricity, switches that control the electricity, and the system of substations, power lines, and transformers that deliver the electricity. A community might have a generator to provide its power. The generator may be able to vary its production as the usage of the customers changes, but there may be times when the demand for energy is too great for the generator. Then the community buys electricity from another source. At other times, the generator may be making more electricity than the community is using, so it wants to sell it.

Challenges

Resources for Students and Teachers

Contact Us
Attracting Engineering Student: IEEE PES Scholarship Plus Initiative™

Offers a scholarship and career experience to attract top EE undergraduate students

Undergraduate students can receive up to $7,000 in financial support over three years, and assistance in obtaining career experiences before graduation

Over 500 scholarships provided since 2011 (228 recipients in 2013)

Internships required after first year

http://www.ee-scholarship.org
Supporters – Oct 2013
Engineering Education Trends

• More multi-disciplinary engineering curriculum
• More use of learning by doing
• Expanding options for online/distance education
• Balancing depth versus breadth
• Students practicing good business skills: team work, communication, etc.
• Developing new education approaches and materials

Following examples from the PSERC Future Grid Initiative (http://www.pserc.wisc.edu/research/FutureGrid.aspx)
New Smart Grid Course at Wash. State Univ.: Learning Objectives

At the end of this course, student will:

1) Understand the basic principles of smart grid components and operation

2) Understand the principles of communication networks, data management, distributed computing and cyber security

3) Be able to critically analyze the interdependencies of related infrastructure in the smart grid needed to sense, communicate, compute and control in secure way

4) Be able to apply the interdisciplinary principles that you have learned in building secure smart grid infrastructure
New Education Resource from Arizona State Univ.: PSERC Academy

- Creating an online library of short (10-15 minute) videos on various topics in sustainable energy systems, smart grid and power engineering. At PsercAcademy.asu.edu.

- Goal: develop hundreds or even thousands of such videos that serve as an online source for instructors, students and practicing engineers.
Observations

• Greater recognition of the workforce challenges
• Risk of declining support of university research
• More university programs, education offerings, career awareness
• Increased student interest: undergraduates up at many universities
• Aging power engineering professors. Young faculty hired (enough?).
• Increased industry / academic collaboration
Ideas for Working with Universities to Address Engineering Workforce Needs

• Meeting education needs of your existing electrical engineers
  • Professional development opportunities (short courses at universities, online courses, onsite courses)
  • Partner with local universities for employee education
  • Online certificate and degree opportunities
  • Support/encourage IEEE PES membership

• Retraining engineers for power engineering responsibilities
  • Partner with local universities
  • Options for short certificate and degree programs
  • Online certificate and degree opportunities
Ideas for Working with Universities to Address Engineering Workforce Needs

• Helping educate engineering students
  • Senior capstone projects
  • Guest speakers / adjunct instructors
  • Field trips
  • Support student research projects

• Building awareness of power engineering careers and your company
  • Internships and cooperatives
  • Career fairs
  • Information sessions about your company
  • Information webinars
  • Diversity outreach
Ideas for Working with Universities to Address Engineering Workforce Needs

• Providing financial assistance
  • Undergraduate scholarships (e.g., IEEE PES Scholarship Plus Initiative)
  • Graduate student fellowships
  • Research support (much of which goes to graduate students)

• Supporting university power programs
  • Conversations with faculty to explore partnerships
  • Speak with deans and department chairs about the value of the programs
  • Endow chairs

• Partnering in STEM education and outreach
Enhancing Recruiting:
PES Careers to Find Engineering Students Interested in Power (www.pes-careers.org)
Meeting Professional Development Needs: IEEE Power & Energy Society

- The PES Plain Talk Courses For Non-Engineering Power Professionals
  - Power System Basics: Electric Utility Operation Inside and Out
  - Distribution System: Delivering Power to the Customer
  - Transmission System: The Interconnected Bulk Electric System

- IEEE eLearning Smart Grid 101 Series
- Distribution Automation – an Enabling Technology for Smart Grid
- Cyber Security for the Smart Grid
- NIST Smart Grid Conceptual Model
- Smart Devices for the Smart Grid
- Smart Grid Integration
- Standards for the Smart Grid
- The “Smarter” Grid – What is it?
- Smart Grid: From Concept to Reality
Future Grid Education Challenges

• Understanding and quantifying uncertainty
• Decision-making under risk
• New analytical tools for operations and planning (still a work in progress)
• Multi-disciplinary balance (engineering, business, economics, public policy, etc.)
• Engineering curricula balance: power system fundamentals vs. energy systems, power electronics, communications, IT, etc.
Workplace Challenges

- Understanding and responding to the differences between younger and older generations
- Getting flexibility for succession planning when employment levels are tightly scrutinized
- Maintaining morale and career excitement while providing quality training when the pressure is for rapid organizational change (e.g., wind energy integration)
- Doing what seems to be needed for retention when cost control is a priority.
Who’s Responsible for Solutions

- Universities
- Community Colleges
- K-12 teachers, counselors, admin.
- Parents
- K-12 service organizations
- Research organizations
- Professional societies
- Industry associations
- Employers
- North American Electric Reliability Corp.
- CEWD
- State regulators
- Federal regulators
- National regulatory associations
- Congress
- State legislatures
- State workforce agencies
- Department of Labor
- Department of Energy
- National Science Foundation
- State and national consortia
- National Academies
- And many more