Industry Perspectives on University Research

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Also, Dennis Ray, PSERC Executive Director
Who provided the Industry Survey data
Converging US Electric Industry Challenges

- Electric demand predicted to increase 40% by 2030*
  - Capacity margins eroding
  - Requires additional generation and delivery investment

- Aging infrastructure
  - More maintenance
  - Increased equipment replacement

- Aging workforce
  - Severe forecasted attrition
  - Loss of expertise across all classifications

- Changing societal needs and global concerns

- Modernization objectives
  - Smart Grid with more capacity and flexibility
  - Integration of renewables, plug-in electric hybrids (storage)

- 2009 Economic Stimulus package

$4.5 billion allocated to Office of Electricity Delivery and Energy Reliability who will target funds at:

- a nationwide plan to modernize the electric grid, enhance security of delivery and to meet growing demand.
- implementation of the Smart Grid programs authorized by the Energy Independence and Security Act of 2007.

Build a clean, efficient energy supply

- Includes: Smart Grid technology and transmission infrastructure ($4.5 billion)
Power System Grid Operations’ main challenges

- **Reliability and quality**
  - Ensure security of supply, reliability of the network and quality of the electricity delivered

- **Environmental concerns**
  - Clean energy (CO2 free) and very low environmental impact

- **Energy and economic efficiency**
  - Starting from a given quantity of energy and from existing assets, deliver the maximum of electricity to the end-user

- **Market efficiency**
  - Set up tools and processes to fully enable energy markets
  - Enable customers/end-users interactive participation
Smart Grid: T&D Components

Smart Grid

Smart Dispatch
- Generation Portfolio Management including renewable
- Full Integration of pricing and demand/supply principles to manage the grid
- Smart demand response management

Smart Transmission Grids
- On-line Asset Management
- On-Line Stability Analysis & Defense Plans
- Smart Power Electronic Controls (HVDC, FACTS, SVC…)

Smart Distribution Grids
- Automatic Meter Management System
- Integrated Distributed Management Systems
- Renewable and load management integration

Smart Substation
- Substation Protection & Control Architectures
- Self-adaptive Defense Plans
- Secondary Distribution Smart Grid Box

Visualization, Situation Awareness and Decision Support Tools

System Architecture including Common Information Model

Secure, deterministic and reliable data communication
Enablers

New technologies & push from regulators

New technologies capabilities

- Communication
  - Convergence of data, video and voice solutions
  - Potential 4th vector: Energy data
- Modeling and simulation
  - New modeling methodologies
  - Increased computing capacities
- Complex system control
  - Electronics
  - Software and HMI technologies
- Energy storage
  - H2 production
  - Fuel cells
  - Car batteries?
- Power electronics...

Governmental emerging energy policies, under the aegis of energetic and environmental efficiency:

- Energy supply
  - Quantity
  - Energy mix
- Blackout prevention
- Energy demand management
  - Including new interaction modes (consumption/production)

Creates a context favorable for evolution now
Benefits of the Smart Grid

- Reduced blackout probability
- Reduction in congestion cost
- Reduction in forced outages/interruptions
- Reduction in peak demand
- Connection of low CO2 emissions generation
- Environmental benefits gained by increased T&D asset utilization
Smarter Control Centers

- System Wide & Local Monitoring & Control
  - Complex Event Processing
    - Configurable & Rules Based
  - Wide Area Monitoring
  - Advanced Warning Systems
  - Instability Detection
  - Wide Area Protection and Control Systems WAPS, WACS, WAMPAC
  - System Integrity Protection Scheme SIPS (SPS, RAS)
  - Coordinated Restoration & Self Recovering Systems

- Multiple Analysis Modes
  - Real-Time
  - Look-Ahead Ahead
  - Post Event analysis
The Path to a Smart Grid

▶ Need for University Research

❖ Seek innovation
  ● New analysis and decision-support tools
  ● New applications
  ● New architectures and devices

❖ Alignment with smart grid challenges

❖ Target applications (short or long-term)

❖ Teach graduate students how to do meaningful research

❖ Economic stimulus initiative to create a smarter grid
  ● Renewables, efficiency, jobs

▶ Needs for a skilled workforce

❖ Need power systems, communications, IT skills (plus more)

❖ 280,000 new positions forecasted, but existing workforce must be prepared, too.

❖ Recent economic stimulus package to create even more jobs
### Workforce Survey: Summary Findings

#### Estimated Potential Replacements by 2013

<table>
<thead>
<tr>
<th>Job Category</th>
<th>Percentage of Potential Attrition &amp; Retirements</th>
<th>Estimated Number of Replacements</th>
<th>Estimated Retirement Only</th>
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</thead>
<tbody>
<tr>
<td>Technicians</td>
<td>49.0</td>
<td>27,000</td>
<td>20,500</td>
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<tr>
<td>Non-Nuclear Plant Operators</td>
<td>47.6</td>
<td>12,000</td>
<td>9,000</td>
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<td>Engineers</td>
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<td>10,000</td>
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<tr>
<td>Pipefitters / Pipelayes</td>
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<tr>
<td>Lineworkers</td>
<td>40.2</td>
<td>29,500</td>
<td>19,000</td>
</tr>
</tbody>
</table>

*Source: Center for Energy Workforce Development -- Gaps in the Energy Workforce Pipeline 2008 Survey*
Outlook Requires Healthy Student Pipeline Development

- More talent with new skills will be required
  - Build capacity and modernize aging infrastructure
  - Fill vacated positions
  - Meet national objectives

- Supply of talent is declining
  - Electrical engineering enrollment is down, professors are retiring
  - Student interest in math and science is decreasing
  - Action needed to build and sustain power engineering programs

- Need to develop student pipeline
  - Leverage emerging interest in energy, sustainability…
  - Define policies and responsibility to increase career visibility
  - Make education relevant to interest areas and challenges
University Power & Energy Programs

- Historically strong programs declined or ended

- About 170 full-time U.S. faculty with 40% eligible for retirement in 5 years. Est. 27% will do so.

- Faculty hiring on rise but is it enough to replace retiring faculty plus meet the need for more engineers?

- Increased university research funding needed for creating the future grid and for supporting faculty

  - A faculty member needs about $300K per year for a strong research program supporting graduate students

Conclusions from an NSF Workshop

- Create a single, collaborative voice on solutions to engineering workforce challenges
- Develop and communicate a positive image of engineers
- Motivate interest and prepare K-12 and university students to pursue power engineering careers
- Make the higher education experience relevant, stimulating, and effective
- Increase university research funding to find innovative solutions for pressing challenges and to enhance student education
How AREVA T&D Works with Universities

► Funding of Power Systems programs:
  ◆ PSERC (Power Systems Engineering Research Consortium)
  ◆ University of Washington Energy program (EEIC)
  ◆ Clemson University (CUEPRA)
  ◆ WSU Power professorship
  ◆ Seattle University

► Sponsorship of IEEE Grainger Student program

► Provide equipment or expertise support:
  ◆ Illinois Institute of Technology, Chicago
  ◆ University of Illinois, Urbana consortium: Cyber-security, TCIP
  ◆ Florida State University, Tallahassee
  ◆ Iowa State University, Ames
  ◆ NC State consortium: ‘Freedm’ initiative
  ◆ Gonzaga University
PSERC
Power Systems Engineering Research Center

Purpose:
Empowering minds to engineer the future electric energy system

What’s important to PSERC

- Pursuing, discovering and transferring knowledge
- Producing highly qualified and trained engineers
- Collaborating in all it does

Over 30 industry members

13 of the top 25 power universities in the US

- Research and education: complementary objectives
AREVA T&D Expectations of University Support

- Support faculty to ensure healthy power programs
- Create an environment to innovate and research new power systems frontiers
- Help faculty to teach leading-edge technologies and analytical techniques
- Support & encourage power system graduate students
- Motivate and prepare students to pursue innovation
- Faculty and students publish & share results
- Faculty accountability and feedback on use of funds
- Investment in our future
- Develop next generation of power system leaders
Thank you...