

Industry Perspectives on University Research

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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



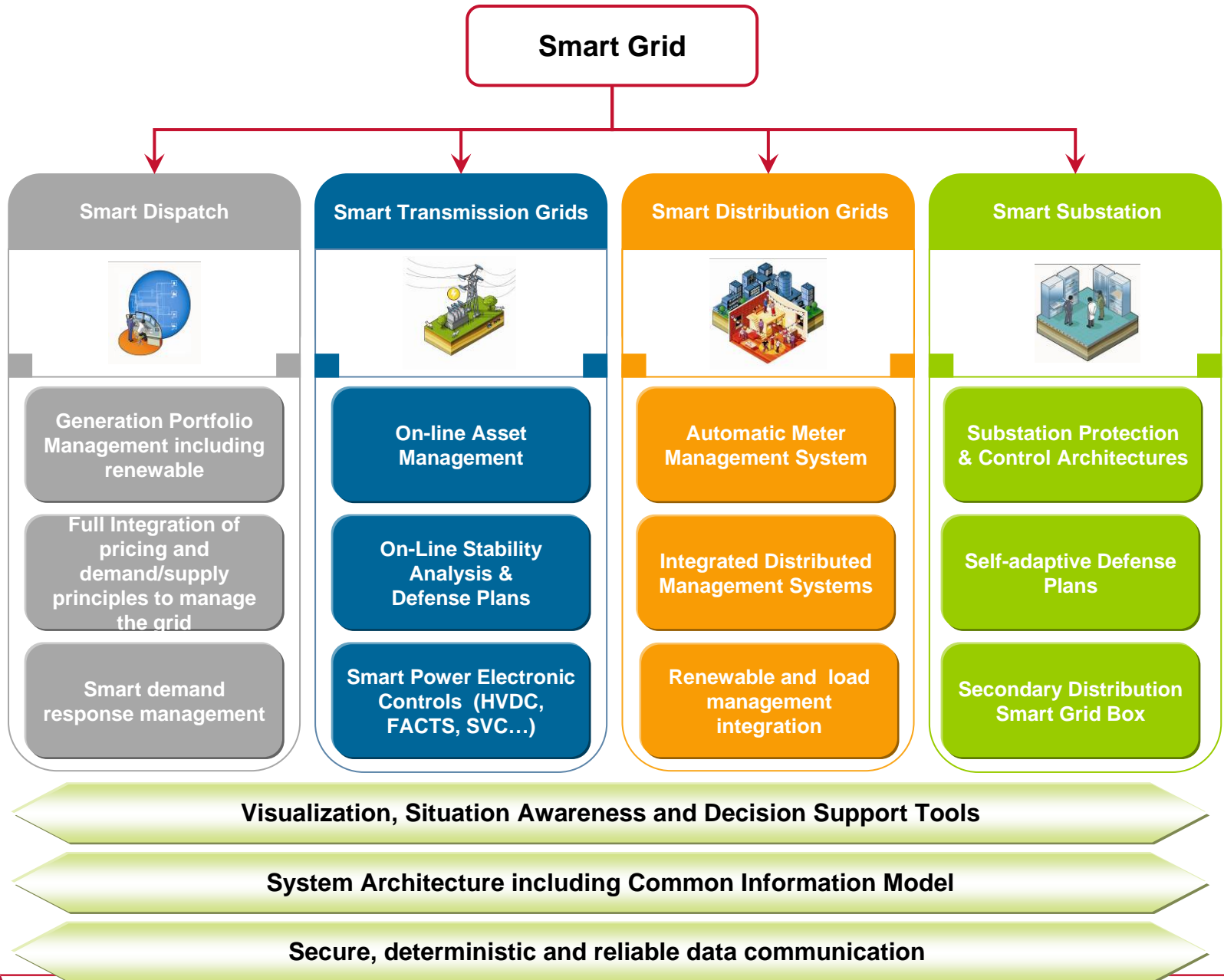
▶ Energy and economic efficiency

- ◆ 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



New technologies & push from regulators

New technologies capabilities



▶ 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...**

Energy policies / Regulatory push



▶ 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

- ▶ **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**



▶ 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

► 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

Job Category	Percentage of Potential Attrition & Retirements	Estimated Number of Replacements	Estimated Retirement Only
Technicians	49.0	27,000	20,500
Non-Nuclear Plant Operators	47.6	12,000	9,000
Engineers	44.7	14,500	10,000
Pipefitters / Pipelayers	45.0	8,500	6,500
Lineworkers	40.2	29,500	19,000

Source: Center for Energy Workforce Development -- Gaps in the Energy Workforce Pipeline 2008 Survey

Outlook Requires Healthy Student Pipeline Development

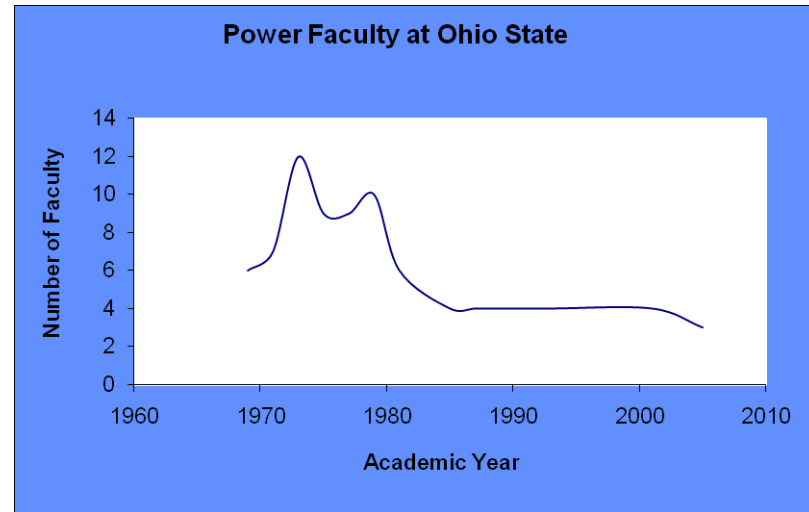
- ▶ **More talent with new skills will be required**
 - ◆ **Build capacity and modernize aging infrastructure**
 - ◆ **Fill vacated positions**
 - ◆ **Meet national objectives**

- ▶ **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**



Source: Power & Energy Eng. Workforce Collaborative:
<http://www.ieee.org/go/pes-collaborative>

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: 'Freedom' 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...