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Readiness of US Power Engineers for Large-Scale Renewable Development

Wanda Reder

Wanda.reder@sandc.com

Vice President – S&C Electric Company

DOE Electricity Advisory Committee

IEEE Power & Energy Society - President 2008-09

IEEE Division VII Director – 2014-15

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Overview

- Business is changing
- Significant workforce attrition
- Workforce drivers and trends
- Attracting the best and brightest
- Building multi-disciplinary competencies
- Managing the workforce transition

Electricity Demand is Increasing

Changing Power & Energy World

Growing Population, More Electronics

Rising Cost of Energy

Increasing Environmental Requirements

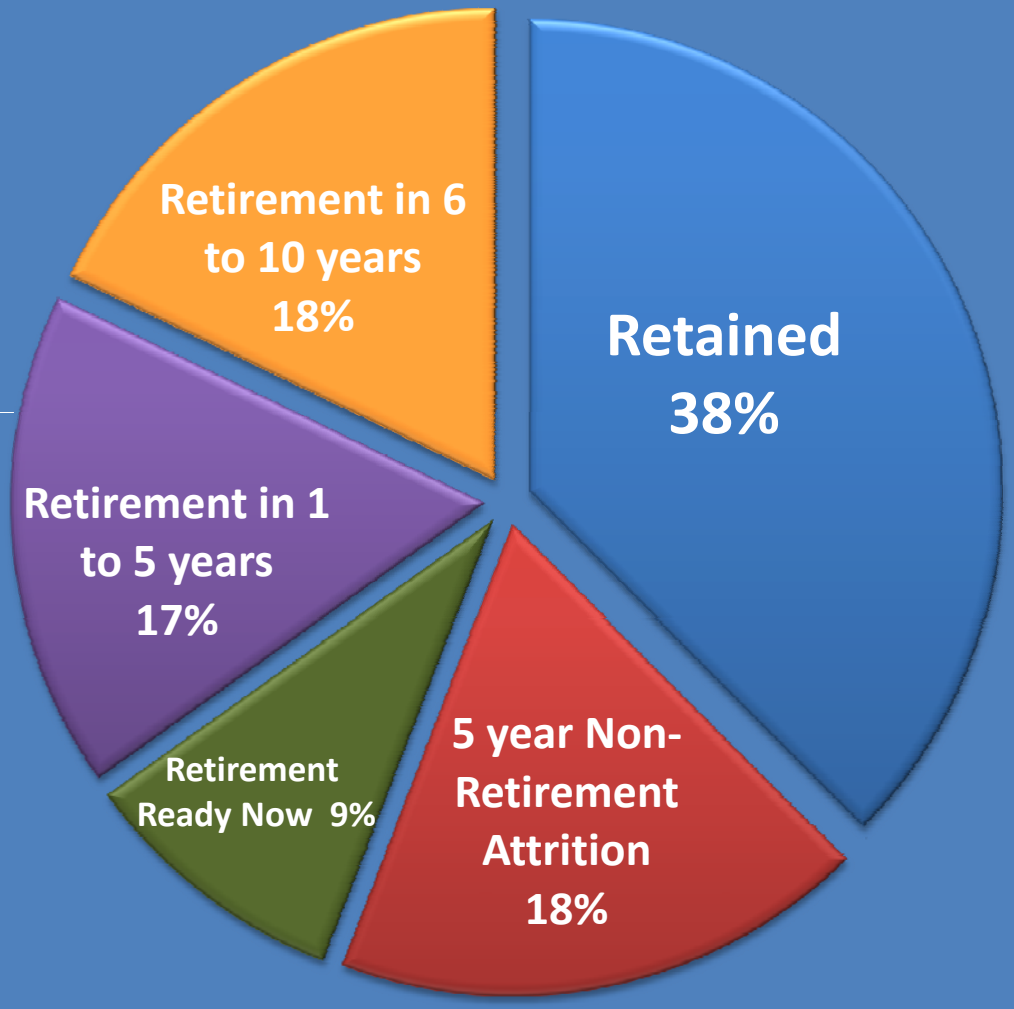
Escalating Security Concerns

Heightened Investor Demands

Driving Technology:

- Carbon Management
- Electric Transportation
- Sustainability
- Distributed Sources
- Efficiency
- Modernization
- Reliability

Total Industry Potential Replacement Impact on Retirement and Non-Retirement Attrition



62% may need replaced by 2020

Source: Gaps in the Energy Workforce Pipeline: 2011 CEWD Survey Results

Landscape is Changing

- Industry workforce has decreased by 11,000+ jobs since 2009
- The average age of the workforce has increased to 46.1
- Employees age 53 and above has increased by 5% since 2006
- Employees 30+ years of service has increased by 5.2% since 2006

Potential Replacements for Key Jobs

	Potential Replacements 2010 - 2015		Potential Replacements 2015 - 2020	
Job Category	**Potential Attrition & Retirement**	**Estimated Number of Replacements**	**Potential Retirement**	**Estimated Number of Replacements**
Lineworkers	32%	22,100	15%	10,300
Technicians	39%	28,500	19%	13,500
Plant Operators	37%	12,400	17%	5,800
Engineers	38%	10,600	15%	4,100
Total	**36%**	**73,600**	**16%**	**33,700**
Totals exclude Nuclear				

Drivers of Workforce Requirements

- Electric demand growing
- Infrastructure is aging
- Retirements are increasing while younger, less experienced, culturally different workers, are entering the workforce.
  - *Average age of utility employee continues to increase*
- Grid modernization and clean generation is a priority
- Societal needs are changing

Workforce Needs Over Time

- Renewable build-rate has varied annually and technology is evolving
- Many core competencies are consistent with related jobs

What's Changed

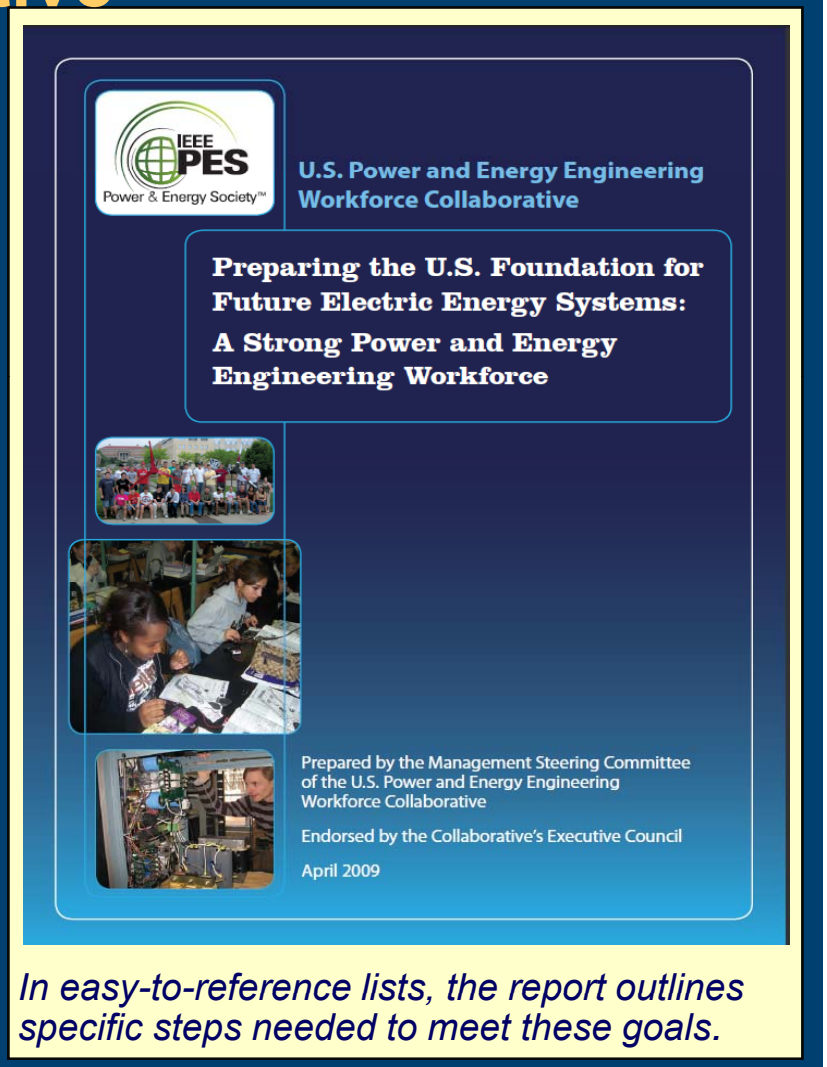
- The economy, un-employment, government incentives
- Workforce shift: renewable increasing, utility shrinking*
- Emerging skills, need for multi-disciplinary contributions
- Increased research, primarily driven by US Stimulus
- More programs, education offerings, career awareness
- Increased student interest: undergraduates up ~33%**
- Aging power professors demographic
- Increased industry / academic collaboration

* *Gaps in the Energy Workforce Pipeline: 2011 CEWD Survey Results*

** *IEEE PES Power Engineering Education Committee Survey – 2006 versus 2013 data*

IEEE Power and Energy Engineering Workforce Collaborative

1. Double the number of power graduates
2. Provide $4 million undergraduate power engineering scholarships
3. Create 2,000 internship opportunities
4. Hire 80 new power faculty members in the US over the next five years
5. Raise annual university research funding to $50 million per year
6. Create five University Centers of Excellence to conduct power research and education



In easy-to-reference lists, the report outlines specific steps needed to meet these goals.

www.ieee-pes.org/workforce/workforce-collaborative

Published April, 2009

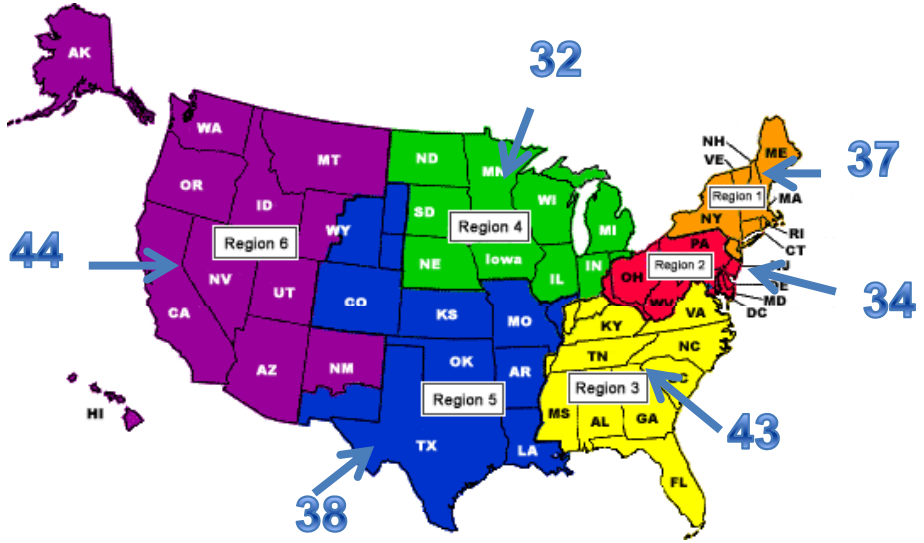
IEEE PES Scholarship Plus Initiative ™

- Created to address the coming workforce shortage in the Power & Energy industry
- Offers a Scholarship & Career experience to attract top performing EE students into power and energy careers
- Undergraduate students can receive up to $7,000 in financial support & assistance in obtaining a career experience prior to graduation
- For US citizen or permanent residents with one year of completed undergraduate study

2012 - 2013 IEEE PES Scholars

- 2012 – 2013 PES Scholars:
  - 228 PES Scholars selected
  - From 100 U.S. Universities
- Fundraising
  - Over $4.95M raised
  - Target: $10M in donations
  - Supplements university funding
- Career Experiences
  - Mentor and Post career opportunities on PES Career website & Scholarship Plus webpage – http://www.pes-careers.org

IEEE PES Scholars in 2012 - 2013 by IEEE Region



http://www.ee-scholarship.org

Applications from March to June 30th

Career-Choice Decision Factors

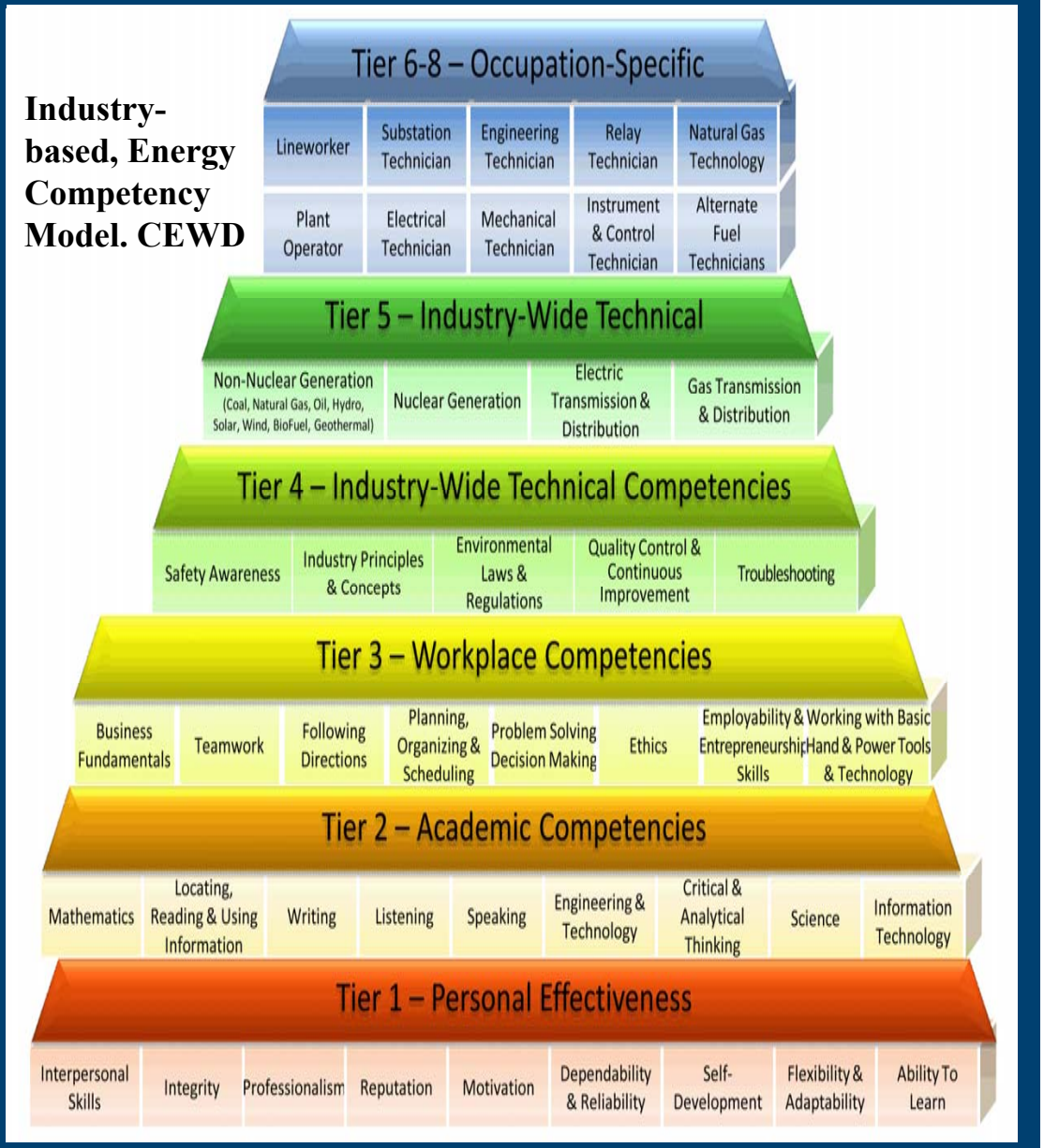
- What made you decide on your career path?
  - Interesting career (67%)
  - Opportunity to help solve significant societal challenges (38%)
  - Make the world a better place to live (33%)
  - Good pay opportunities (30%)
  - High likelihood of getting a job (20%)

Appeal to these motivators to attract the best and brightest!

IEEE PES International Survey of Power Engineering Students June 2007

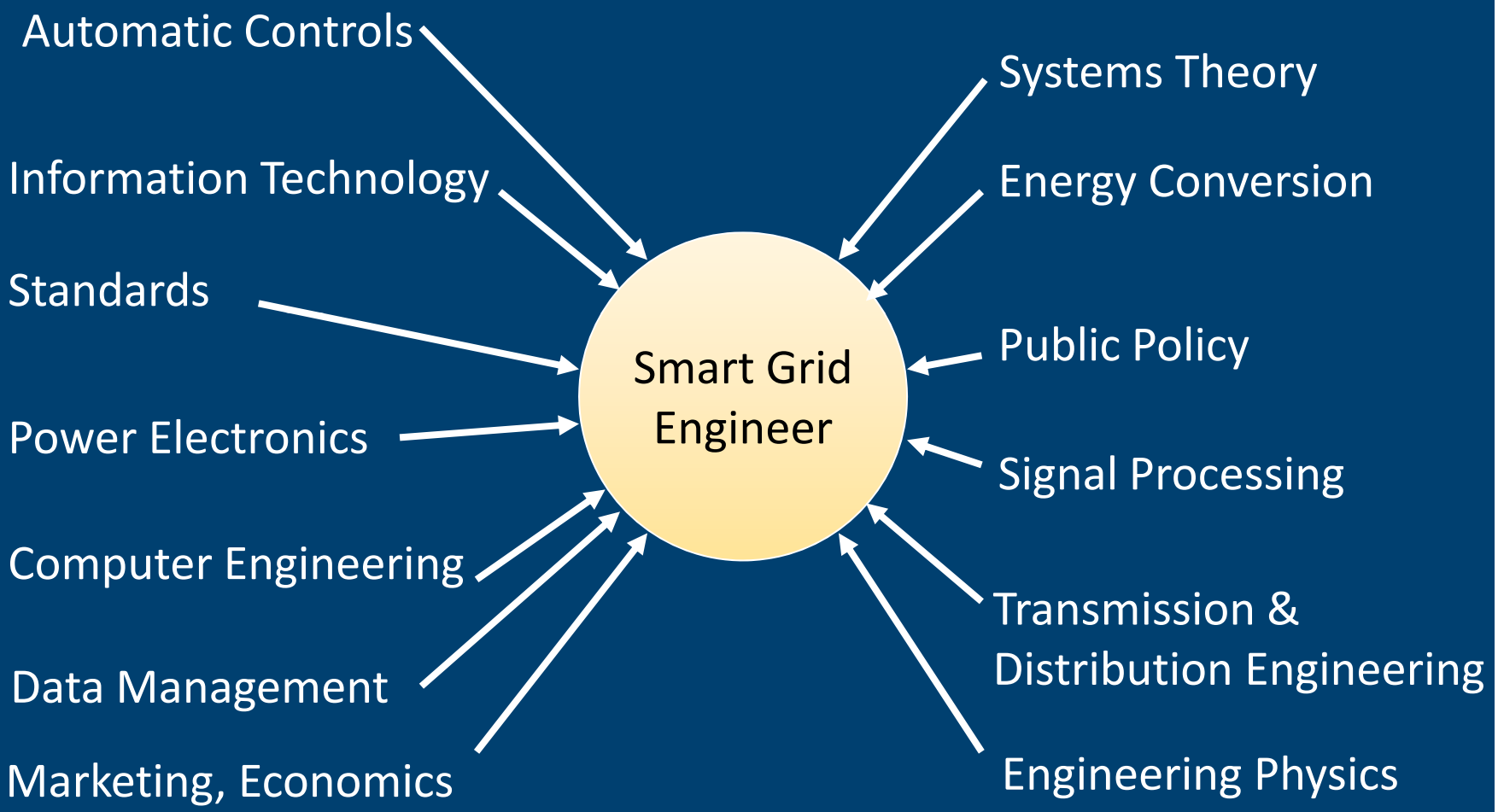
Educating within a Framework

The competencies required by lineworkers, power plant operators, relay and substation technicians, and other skilled craft positions in the electric energy industry will not change. New training will be required to understand the new technology and new procedures or protocols.



Source: The Smart Grid Evolution: Impact on Skilled Utility Technician Positions. Center for Energy Workforce Development.

Multi-Disciplinary Education



Source: Professional Resources to Implement the "Smart Grid"
Gerald T. Heydt and others
2009 IEEE Power & Energy Society General Meeting

Curriculum Enhancements

- Direct digital control
- Power system dynamics and stability
- Power quality and signal analysis
- “Middleware” migration
- Environmental and policy aspects
- Reliability and risk assessment
- Economic analysis, energy markets
- New concepts for power system monitoring, protection and control
- Communications, IT

“Professional Resources to Implement the ‘Smart Grid’ ”, Gerald T. Heydt and others, North American Power Symposium, 2009.

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Engineering Research Centers (ERCs)

National Science Foundation created ERCs to:

- Create / sustain an integrated, interdisciplinary research environment to advance fundamental engineering knowledge and engineered systems
- Educate a globally competitive, diverse engineering workforce from K-12 on
- Join academe and industry in partnership to achieve goals

Source: Barbara Kenny – NSF, Presentation at IEEE PES Innovative Smart Grid Technology Conference, February, 2013

The Department of Energy Investing in America's Workforce

- ~$100 million of American Recovery and Reinvestment Act (ARRA) funds to 54 workforce training projects.
- To develop well-trained, highly skilled, electric power sector workforce
- Focus areas:
  - Smart Grid Workforce Training
  - Curriculum Development
- Trained ~30,000 over 3 years
- Many success stories

Source: Gil Bindewald– US DOE, Presentation at IEEE PES Innovative Smart Grid Technology Conference, February, 2013

2012 DOE Workforce Ad-Hoc

Created a DOE Electric Advisory Committee Workforce Ad-Hoc Group in 2012

A Few Recommendations:

- Disseminate lessons and scalable solutions from ARRA grants
- Incorporate workforce in future technology development
- Recognize the best worker training and education programs
- Develop benchmarking / metrics on workforce needs

Power Engineering Education Trends

- Getting the data has been a challenge
- On-line IEEE PES Power & Energy Education Committee Survey of Higher Education has been developed
- Trends to Mid-2000's:
  - Declining student enrollments except at the doctoral level
  - Untenured faculty declined from 20% in early 90s to 12%
  - ~3 faculty members hired for every 4 that left
  - Research funding per institution declined
- Recent Trends:
  - Course enrollments rising ~ 33% since 2006
  - New or rejuvenated programs are emerging with energy engineering focus and a variety in delivery methods
  - Faculty hiring: temporarily jumped following ARRA funding

Workforce Diversity and Culture

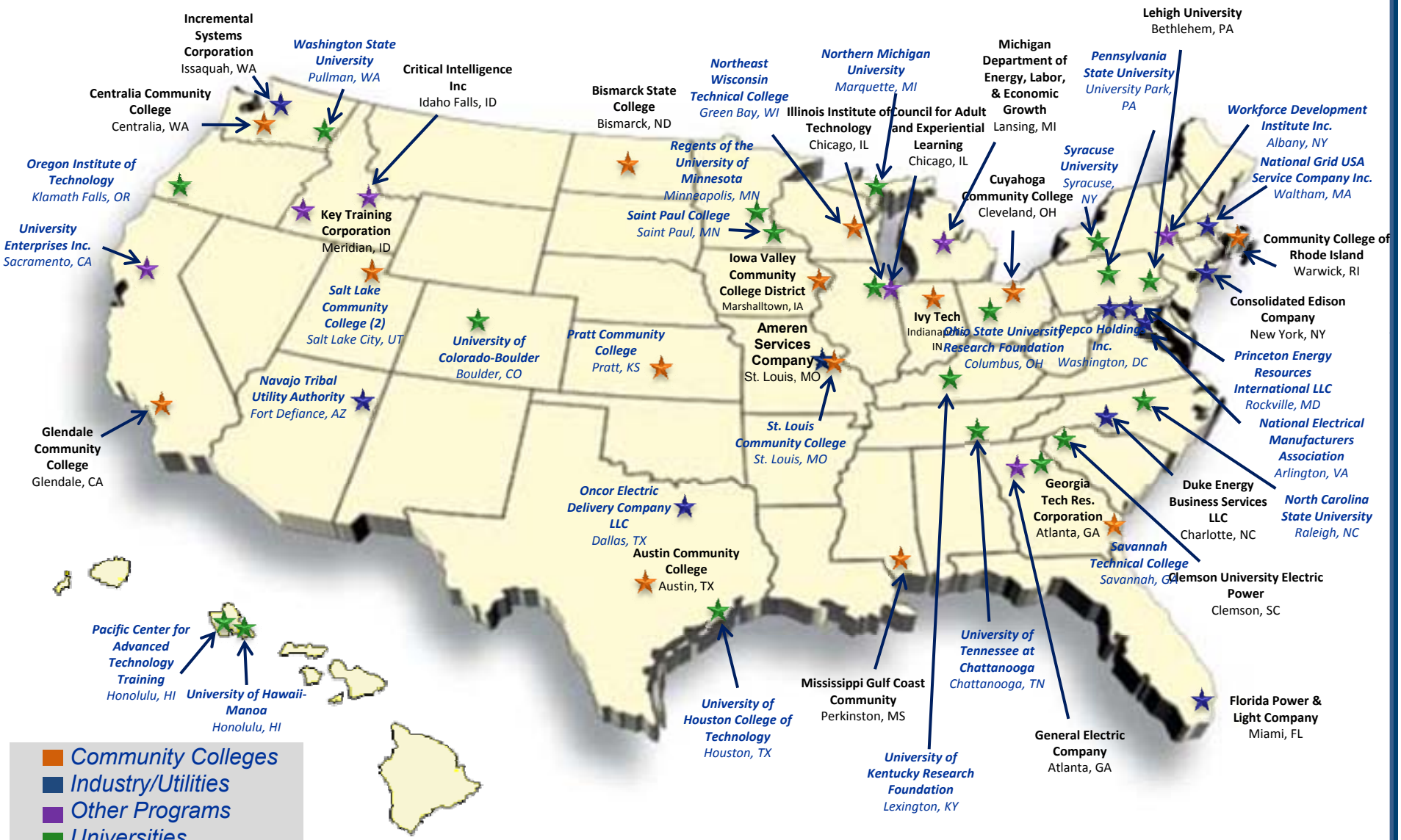
- More workforce diversity is inevitable
  - Embrace it! Promotes creativity
  - Provides a distinct advantage when flexibility is needed
  - Utilize “quick-hit” teams to engage hi-potential candidates and realize business benefit
- Recognize that the culture for the traditional workforce is conservative and process driven unlike that in renewables which is fast-paced, entrepreneur-oriented
- Train and re-train existing employees. Methodically manage knowledge transfer and succession planning. Recognize implications from technology and process changes.

Conclusion

- Business is transforming
- Significant demand for talent due to pending attrition and ‘green’ build
- Educational foundation is strengthening
- A new day, a new workforce: manage the transition
  - Create a nimble workforce using competency framework
  - Support programs to attract and develop the talent needed
  - Appealing to ‘green’ student interests
  - Recognize unique cultural requirements

Wanda Reder
VP – Power Systems Services
S&C Electric Company
Wanda.reder@sandc.com
773-338-1000 x2318

Workforce Training Projects



http://www.smartgrid.gov/recovery_act/overview/workforce_training

Source: Gil Bindewald– US DOE, Presentation at IEEE PES Innovative Smart Grid Technology Conference, February, 2013