ICREDITS: DEVELOPING AN EPICENTER OF TRAINING AND RESEARCH IN SMARTGRIDS TECHNOLOGIES

Enrico Pontelli

Interim Assoc. Dean

College of Arts & Sciences

Satish Ranade

Department Head

Electrical and Computer Engineering

Team:

- Susan Brown (STEM Outreach)
- Sukumar Brahma (ECE)
- Huiping Cao (CS)
- Louiza Fouli (Math)
- Hong Huang (ECE)
- Wenxin Liu (ECE)
- Jay Misra (CS)
- Son Tran (CS)
- Jeffrey Teich (Management)
- William Yeoh (CS)

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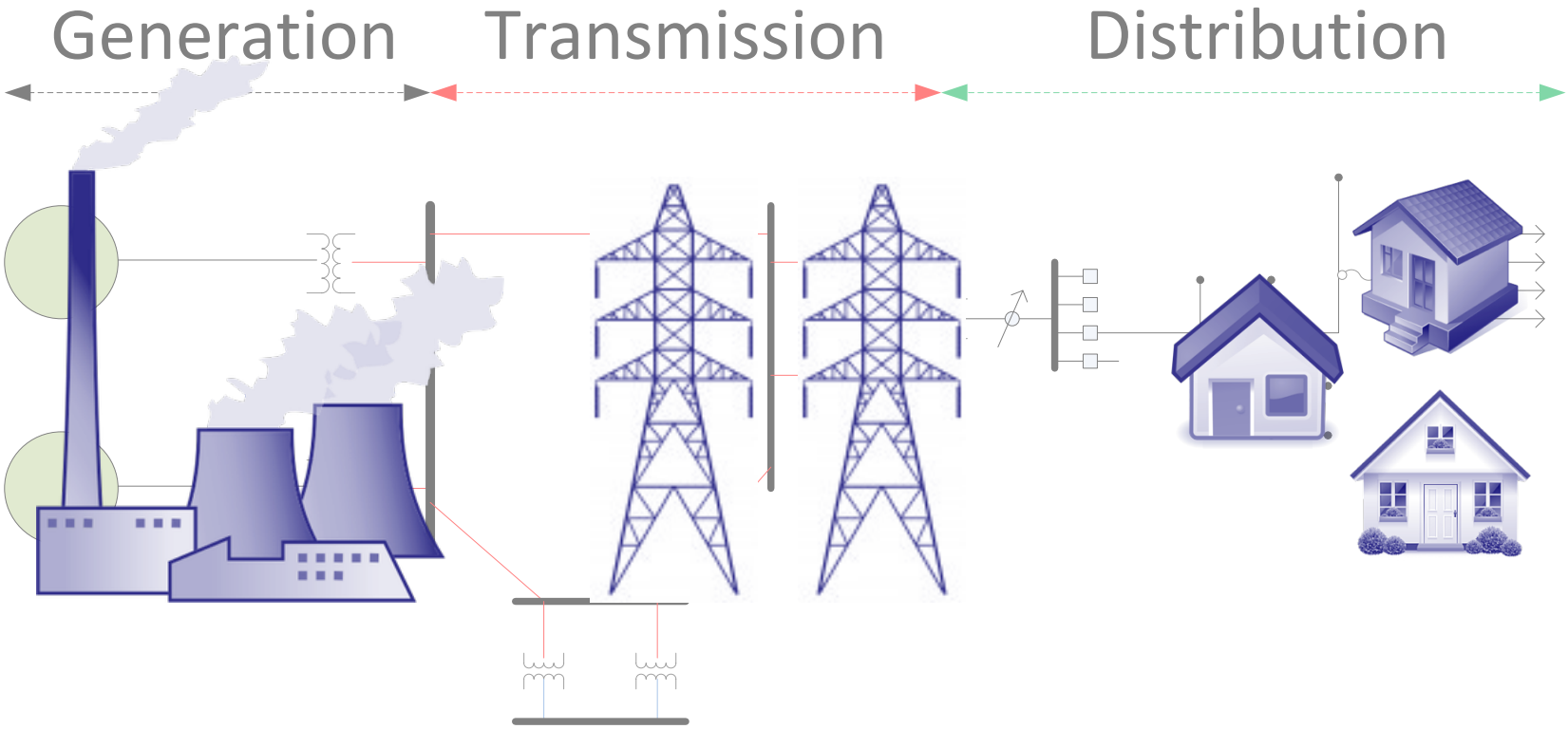
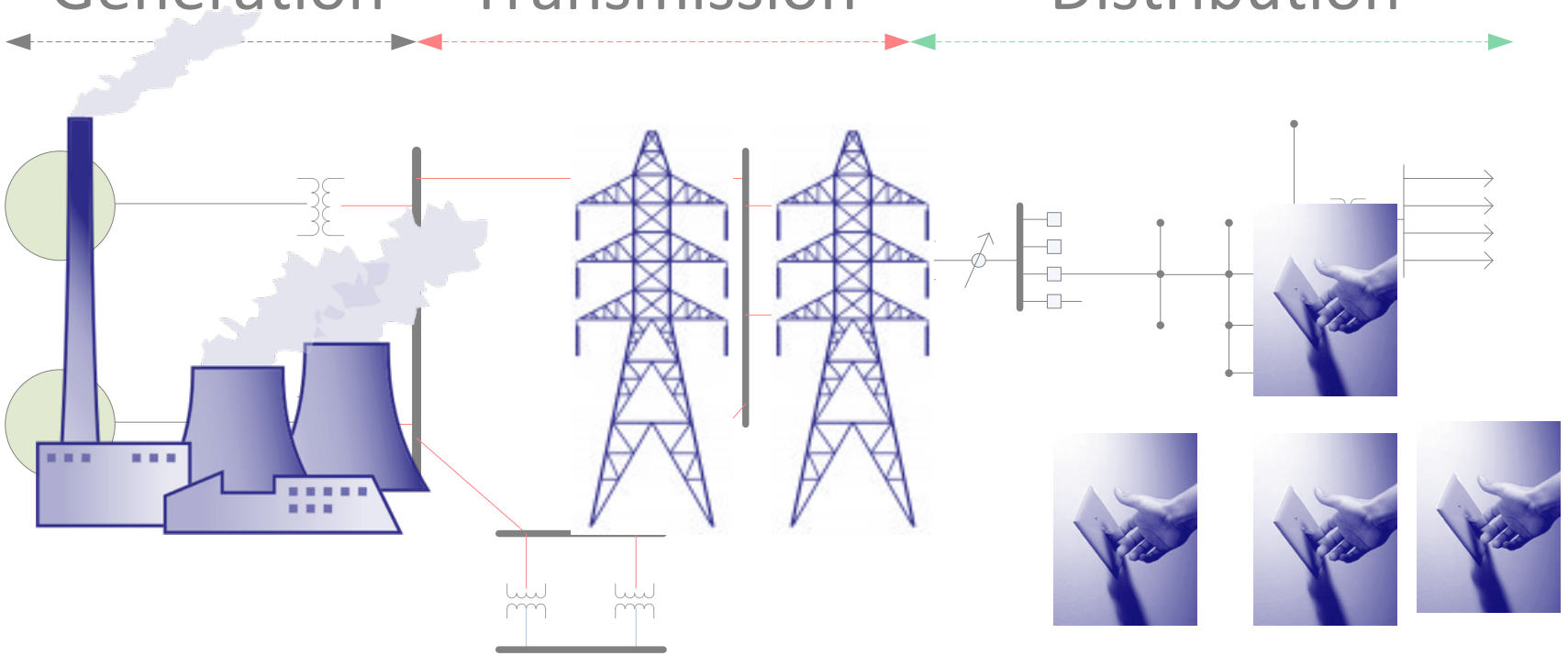
MOTIVATION & VISION



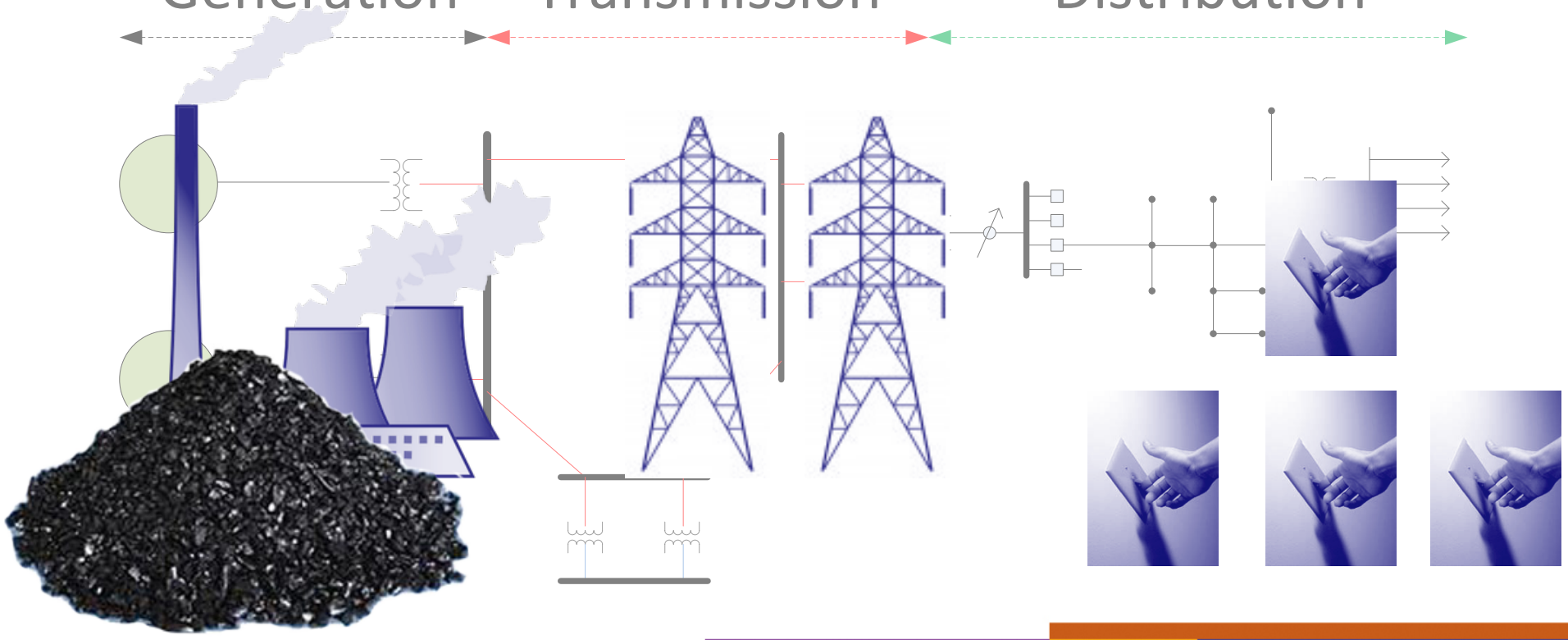
MOTIVATION & VISION

Generation Transmission Distribution



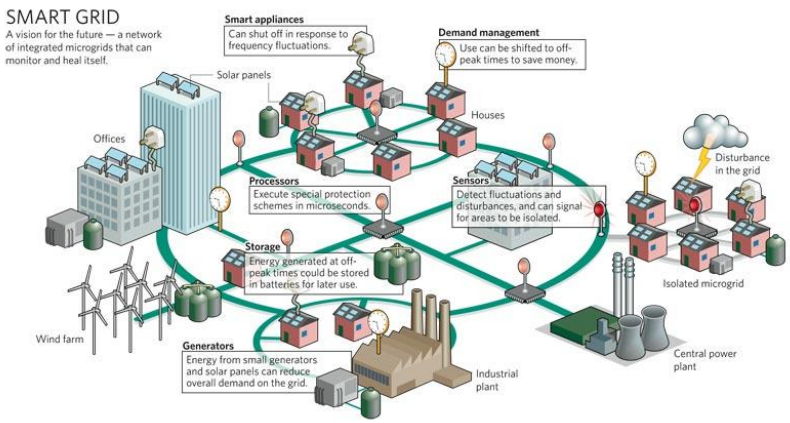
MOTIVATION & VISION

Generation Transmission Distribution



MOTIVATIONS & VISION

- Existing systems/Grids:
  - Few generations facilities (authority); Many customers
  - Building electric generation for peak demand is unsustainable
  - Environmentally unfriendly
  - Inefficient and unsustainable
  - Rigid, reactive



- Solution: The Smartgrids *"Vision"*

Motivations

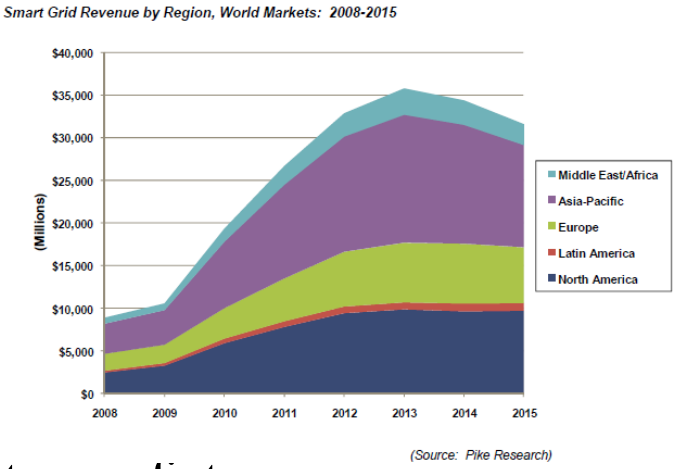
Relevance for New Mexico

- Renewables and storage need to properly integrated
- Smartgrid and Microgrid concepts pave the way
- Extensive initiatives in New Mexico, e.g.,
  - Kit Carson Electric Cooperative
    - Intelligent Meters, Broadband communication
    - Automatic switch between sources to balance supply & demand
  - Advanced Building-Scale Smart Grid Demonstration, Aperture Center at Mesa del Sol
  - In 2011 alone, 20-30 MWs of micro-grid projects in New Mexico
- Need advanced work force training to complement state investments

New Mexico can be *the* Leader

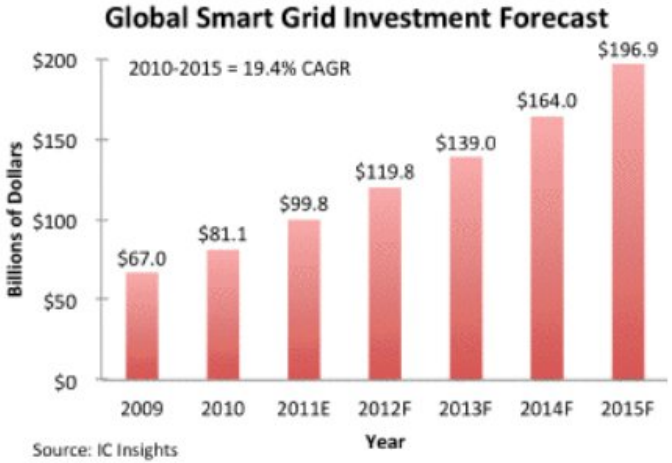
Motivation

- Explosive growth of Importance in Smartgrids Technologies
  - "Urgent National Priority" (Obama Administration)
  - Enabled by new technologies
  - Required by needs (demand, security, safety, sustainability,…)
  - ~$16B/yr Federal Investments in Smartgrids technologies for upcoming 4 years (GridWise Alliance, IBM)



Motivation

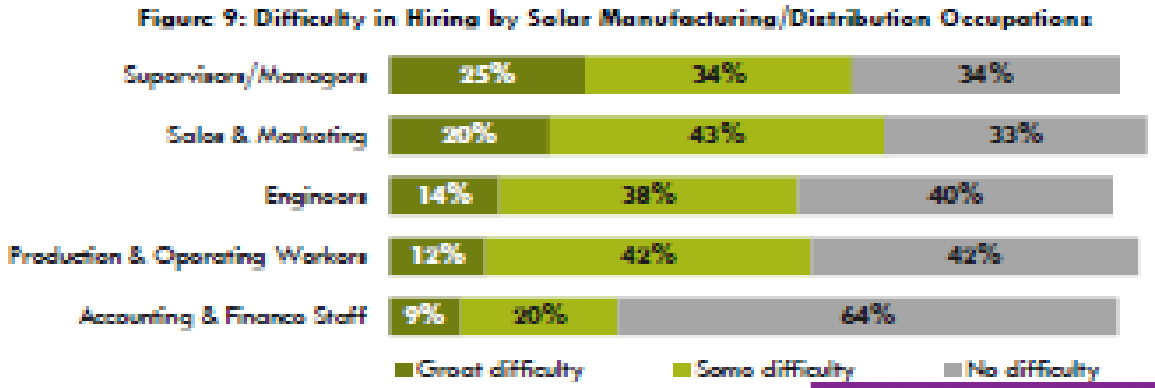
- Need for new theoretical and analytical techniques, algorithms, and tools
  - Integration of many scientific and engineering disciplines (STEM!)
- Need for specialized expertise
  - Unmet workforce demand
    - ~280,000 new jobs
    - DoE SmartGrid Workforce Training Programs
      - ~$3M to WSU, Syracuse, NCState, … to create SmartgridsTechnologies courses
  - Underrepresentation



Energy Technology	Source of Estimate	Average Employment Over Life of Facility (jobs/MWa)		
		Construction, Manufacturing, Installation	O&M and fuel processing	Total Employment
PV 1	REPP, 2001	6.21	1.20	7.41
PV 2	Greenpeace, 2001	5.76	4.80	10.56
Wind 1	REPP, 2001	0.43	0.27	0.71
Wind 2	EWEA/Greenpeace, 2003	2.51	0.27	2.79
Biomass – high estimate	REPP, 2001	0.40	2.44	2.84
Biomass – low estimate	REPP, 2001	0.40	0.38	0.78
Coal	REPP, 2001	0.27	0.74	1.01
Gas	Kammen, from REPP, 2001; CALPIRG, 2003; BLS, 2004	0.25	0.70	0.95

Table ES–1: Average employment for different energy technologies. "MWa" refers to average installed megawatts de-rated by the capacity factor of the technology; for a 1 MW solar facility operating on average 21% of the time, the power output would be 0.21 MWa. References in parentheses and sources refer to the studies reviewed in the text

http://socrates.berkeley.edu/~rael/papers.html



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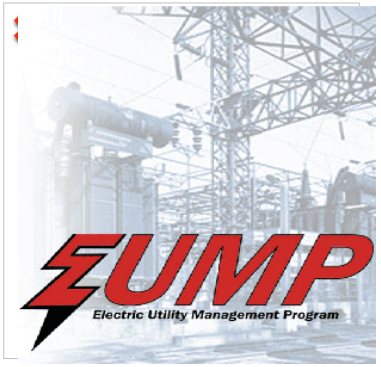
Smartgrids at NMSU: Foundations

- Foundational Research
  - *Electrical and Computer Engineering*
    - Renewables Integration and Microgrids
    - Customer Driven Microgrid
    - Energy Delivery
  - *Computer Science*
    - Intelligent Agents and Multi-agent systems
    - Constraint Optimization Methods
    - Distributed systems
    - Hybrid and heterogeneous communication networks
  - *Economics*
    - Leaders in regulatory issues
    - Negotiation and Auction paradigms

Foundations



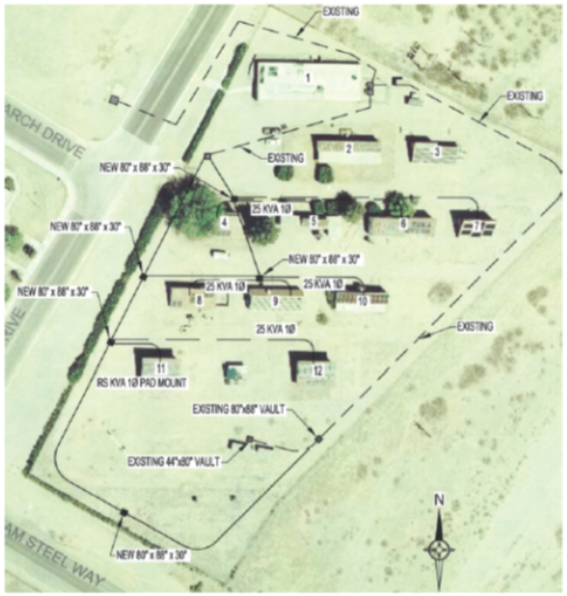
- Electric Utility Management Program
  - Industry funded program provides MSEE Fellowships for 5-8 students per year
  - Program combines engineering, management and regulatory economics
  - Significant recent research in microgids and renewables
  - Graduates have gone on to lead major utilities in NM and the southwest, and start businesses in NM

Foundations

- Southwest Technology Development Institute (SWTDI)
  - Internationally known for independent test and evaluation photovoltaic components and system , design, and safety through codes and standards

System and Component Testing
Data Acquisition and Analysis
System Verification
Codes, Standards and Safety
Performance Monitoring

On the job training of Students
NEC and Code related Training
Instructional Videos
Touch Screen Kiosks
Third party system verification



2.5 acre test facility with grid-tied solar, forming a microgrid

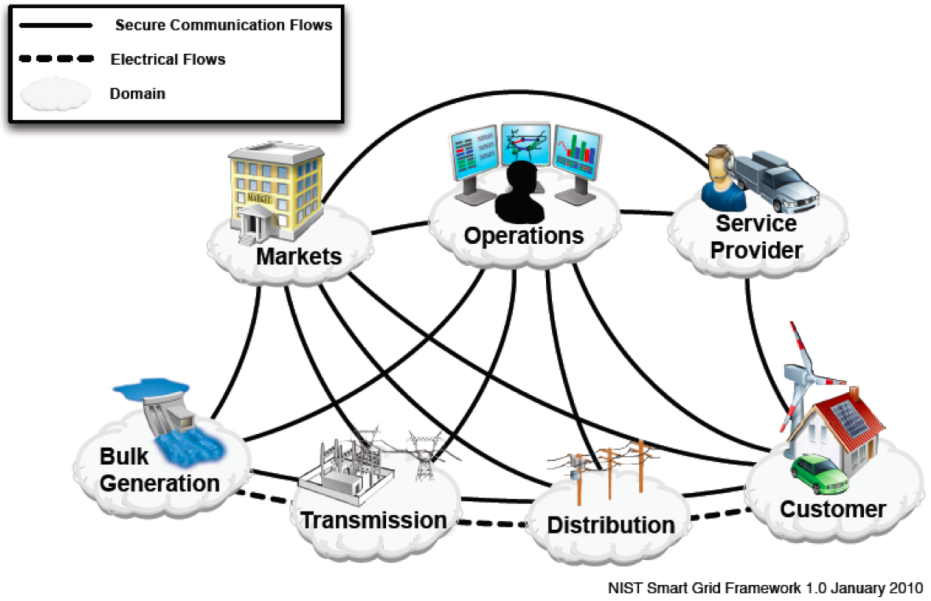
Interdisciplinary Center of Research Excellence in Design of Intelligent Technologies for Smartgrids (iCREDITS)

- Idea:
  - Create an Epicenter of Research and Training in smartgrids
  - Coordinate, connect, and nurture research and education in areas relevant to Smartgrids technologies [Realize the *Vision*]
- Mission: **C R E D S**
  - **C**enter infrastructure to enable interdisciplinary research and training
  - **R**esearch contributions to advance state-of-the-art in smartgrids
  - **E**ducate the future generations of researchers and practitioners in smartgrids
  - **D**iversify the future generations of researchers and practitioners in smartgrids
  - **S**ustain a leadership role in smartgrids research and training: NMSU as an international hub of knowledge

Research Directions

Create the Science and Technology for the design and development of general smartgrid frameworks that are intelligent, efficient, robust, self-sustaining and resilient against failures

- *"An electric system that uses information, two-way, cyber-secure communication technologies, and computational intelligence in an integrated fashion across electricity generation, transmission, substations, distribution and consumption to achieve a system that is clean, safe, secure, reliable, resilient, efficient, and sustainable."* [Fang, Misra, Xue, Yang 2011]

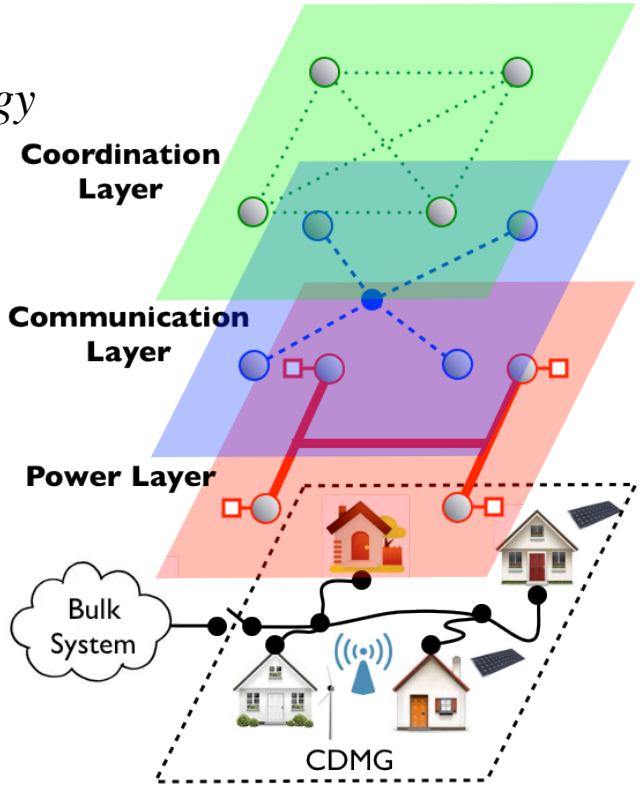


NIST Smart Grid Framework 1.0 January 2010

Research Directions

Four intertwined research strands

- **ENERGY**: *Design and develop models for power and energy delivery, control, and protection in smartgrid*
  [**Ranade**, Liu, Pontelli, Misra, Yeoh]
- **COMMUNICATION**: *Design and develop information-centric communication networks and tailor them to smartgrids*
  [**Misra**, Huang, Ranade, Cao, Fouli]
- **COORDINATION**: *Design and develop agent-based coordination mechanisms to optimize power demand and supply*
  [**Yeoh**, Pontelli, Tran, Ranade, Liu, Teich]
- **MONITORING**: *Design and develop real-time data analysis algorithms to monitor the health of smartgrids in order to protect them from failure*
  [**Brahma**, Cao, Misra]



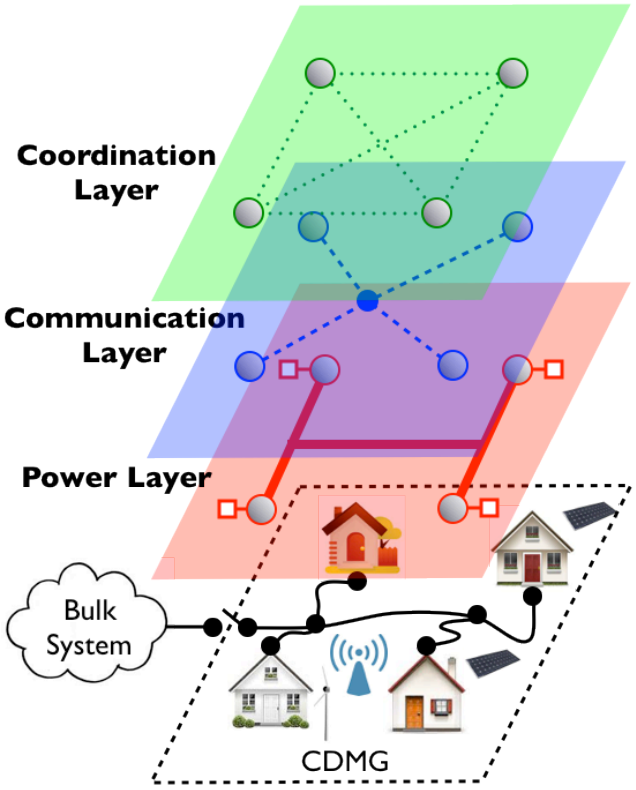
Research Directions

The Energy Delivery Paradigm

- Customers invest in local generation,
- Demand management and storage

Utilities complement and enable feeder evolution into customer driven microgrids

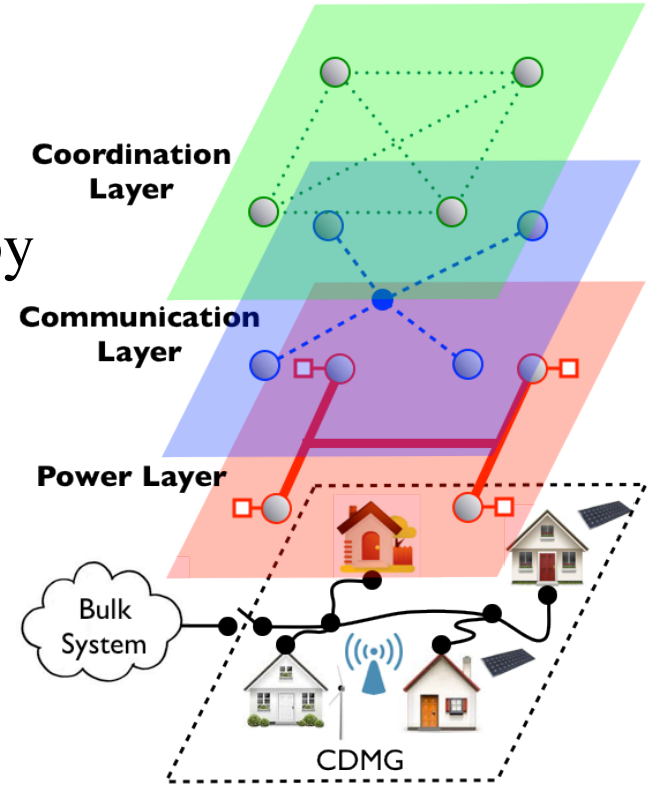
The grid delivers packets of energy to customers who manage demand locally



Research Directions

The Energy Delivery Paradigm Promises

- Efficient integration of renewables
- Scheduling energy improves economics by reducing need for peaking and firming resources
- Reduces stress on the grid – reliability
- Creates resiliency

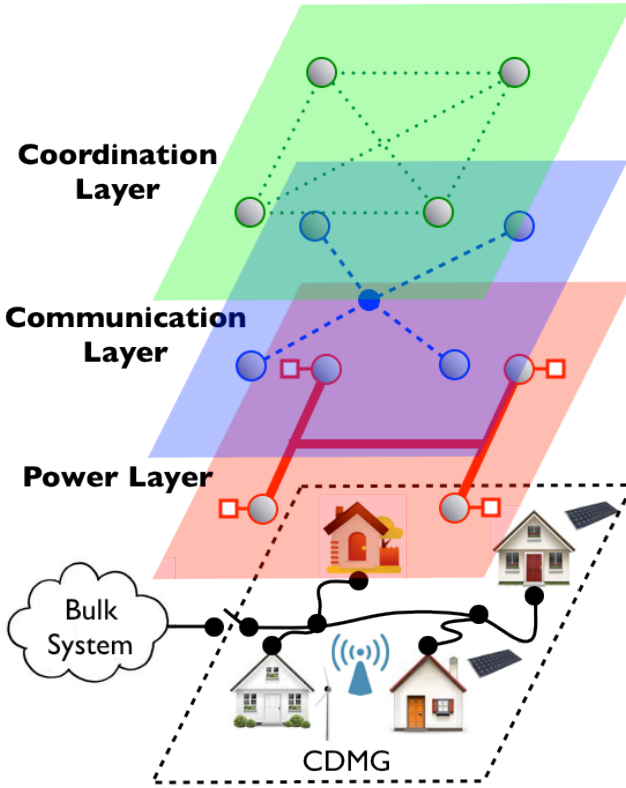


Research Directions

From Reliability To Resiliency

- Resiliency is a new concern
- Codependent utility services, e.g., electric-gas
- Rare Events; 2012 freeze, Hurricane Sandy
- How to anticipate and measure risk
- Co-design of infrastructures
- Emergency planning and management

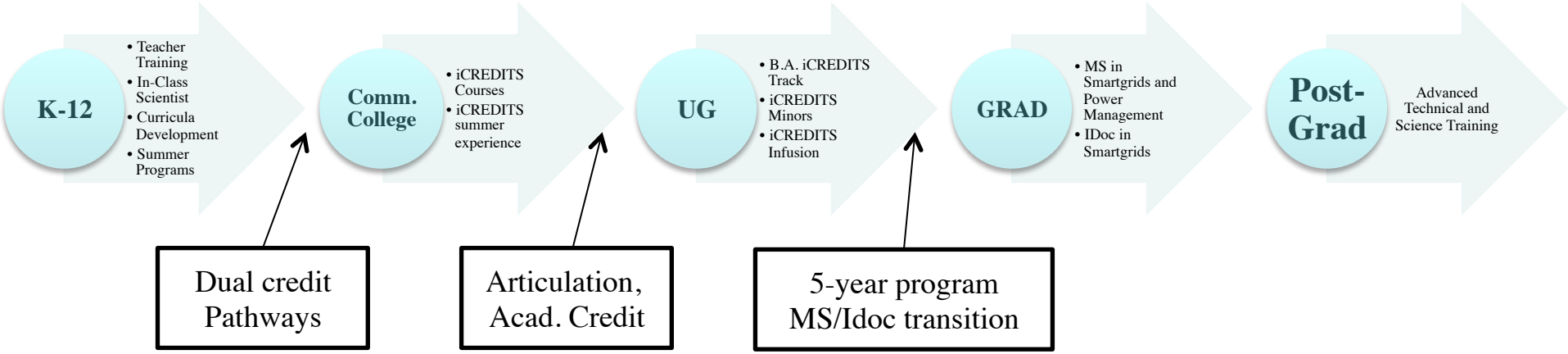
Will distributed generation, etc., help?



Educational Programs

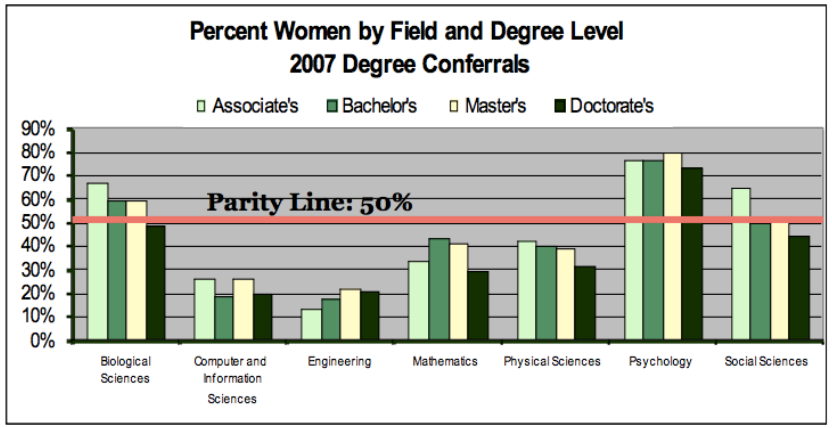
Motivating Factors

- Complete and flexible pipeline – broad infusion as well as specialized degree programs
- Multiple Entry and Exit Points
- Facilitate retention, reduce attrition – meet needs of students from underrepresented backgrounds
- Integration among stages



Underrepresentation

- Promote recruitment, training, and retention of Women and Hispanic students
  - K-12 Activities
  - Retention and Graduation
  - Path to the professoriate and the profession
- Why? Nationally:
  - UG: ~12% Women; 6% Hispanic
  - Doctorate: ~16% Women; 1.5% Hispanic



Partnerships

- Partnership Plan
  - **Local**
    - SEMAA
    - SC^2
    - School districts (Las Cruces, Gadsden)
    - NM Supercomputing Challenge
    - YWiC, GUTS
  - **National**
    - CAHSI
    - UTEP CyberShare
  - **International**
    - IMDEA-Software (Spain)
    - Univ. Udine (Italy)




Thank You