ETCC Super Session on Emerging Technologies in Support of Smart Grids

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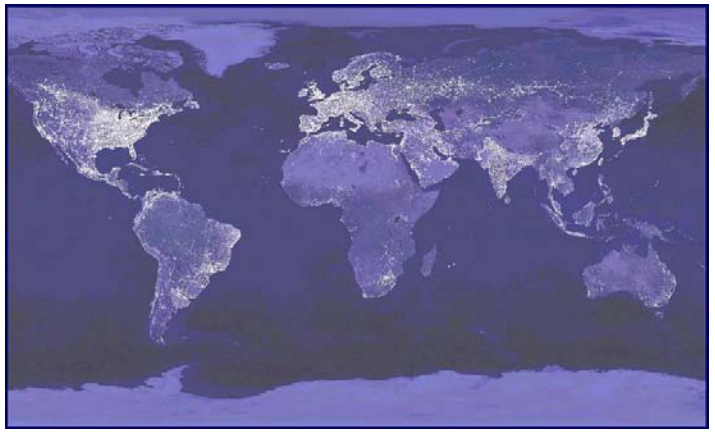
July, 2008



You can see prosperity… it's where the lights are on

Trends and Industry Challenges

Energy demand growth

- By 2025, US will need approx. 428 GW of new capacity
- International growth (China, Brazil, South Africa, …)

Society mindset changing and new sense of urgency

- Increasing prices for oil & natural gas bring sense of urgency to all energy issues, including the grid
- Environmental concerns over power plant pollutions, its impact on climate
- Increasing customer expectation for uninterruptible power

Trends and Industry Challenges

- Public pressure and concerns have led regulators to sponsor new programs in
  - Energy efficiency
  - Renewable energy capacity generation
- Industry is responding to regulatory and public pressure

- Energy generation assets (e.g. wind, solar, storage, bio-mass) have become more attractive for big buy-out groups and investors
- Government and private investors provide financial support to support technologies, such as “Smart Grid”

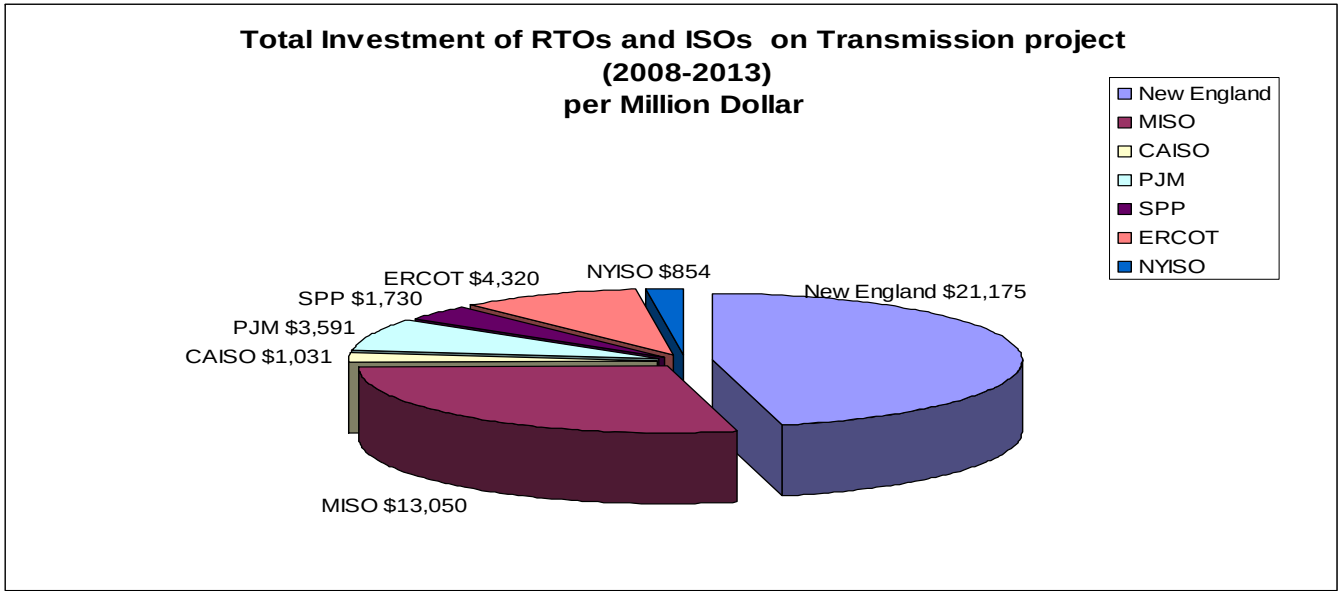
Trends and Industry Challenges

Regulatory incentives and oversight

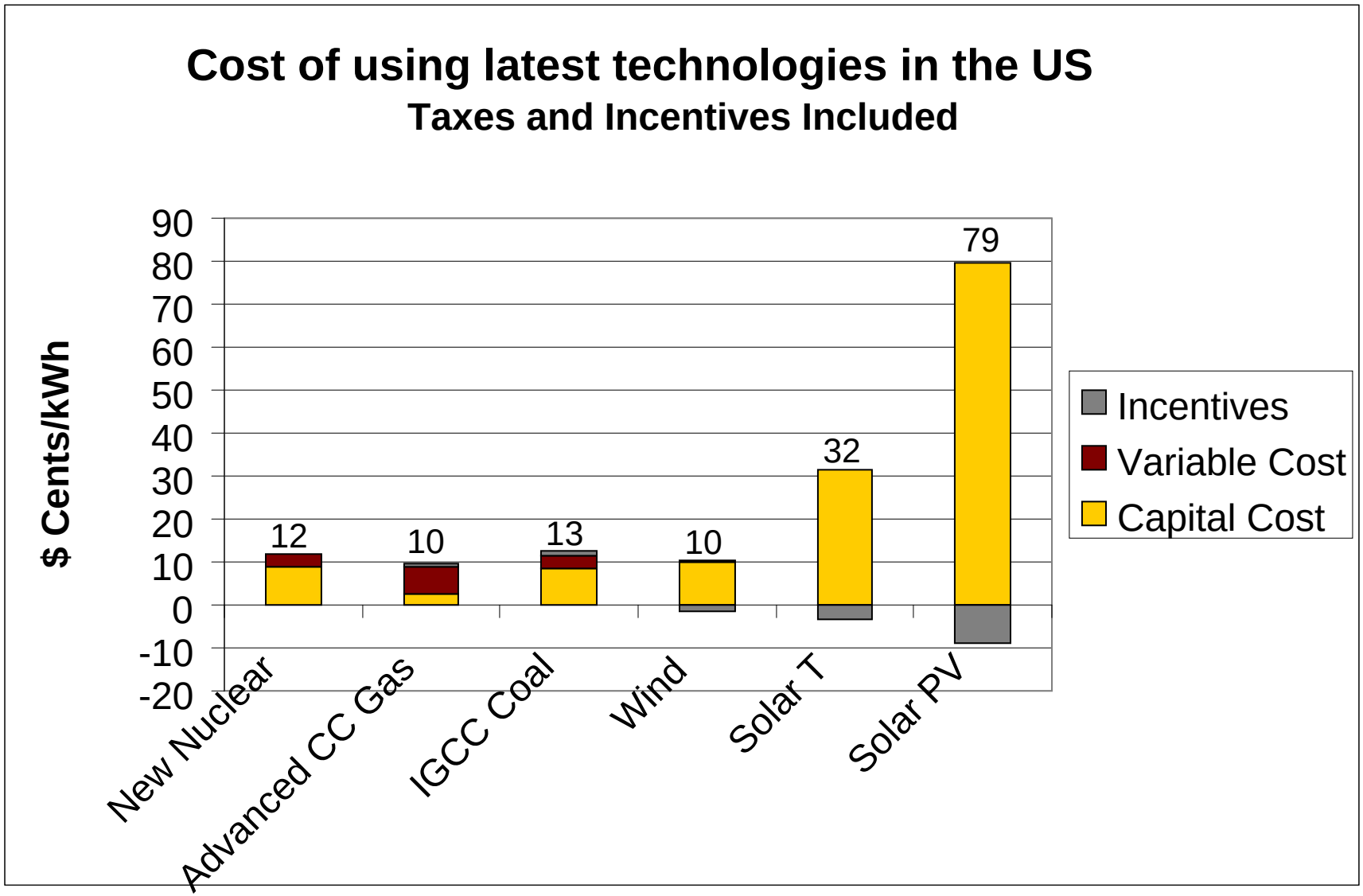
- EPAct 2005 and EIS Act of Dec'07 (Title XIII on "Smart Grid")
- NERC compliance requirements with substantial penalties
- State regulators driving utilities to improve performance

Capital spending & planning viewed as needed

- Aging infrastructures/workforce having business impacts
- Lucrative transmission investment pushed by FERC & state regulators



Levelized Costs of Generation w/ Latest Technology

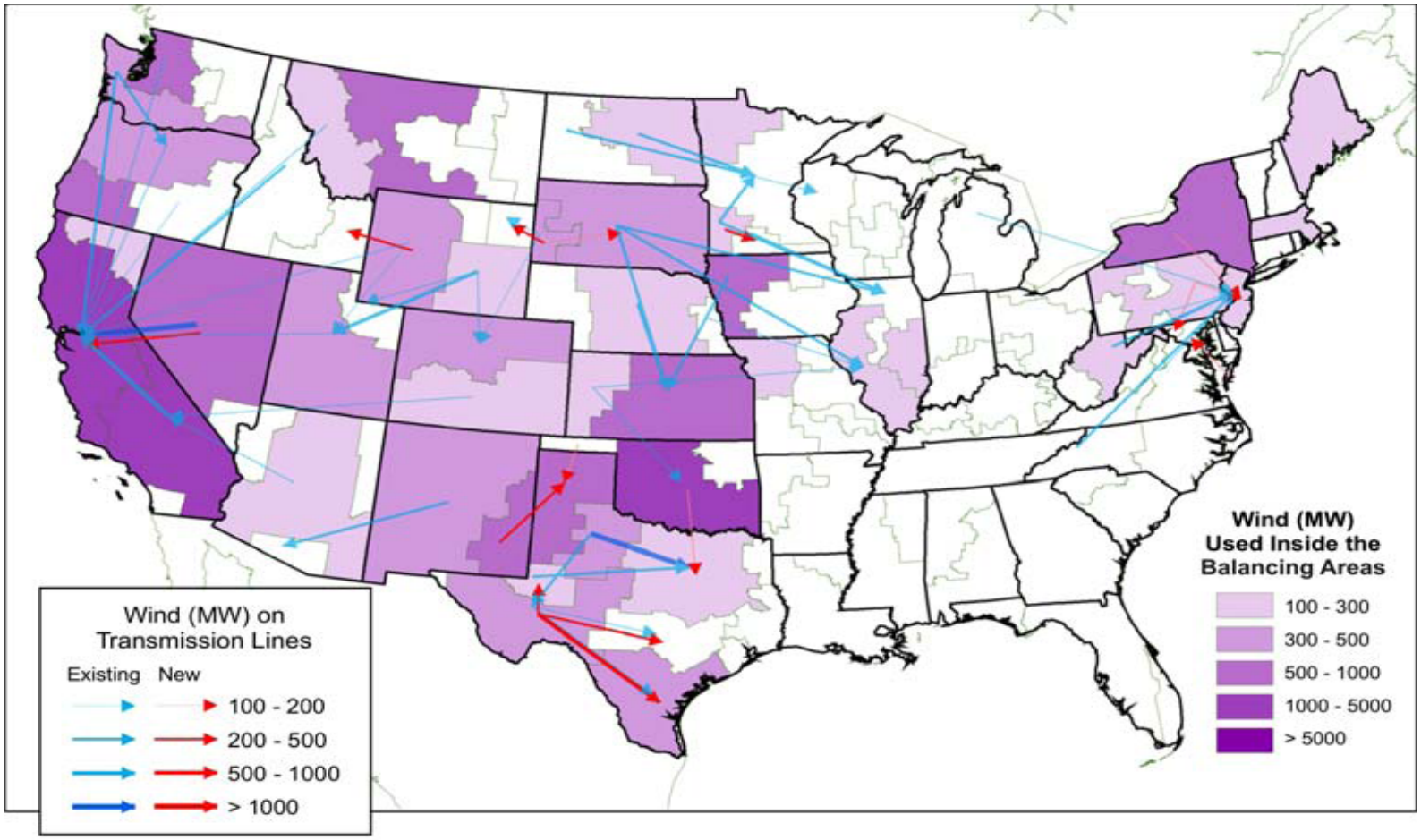


New Grid Planning and Control

- Capacity management with reserve power for large penetration
  - Large base-load units
  - Conventional spinning reserve insufficient for large power swings
- Balanced portfolio of generation sources
  - Renewables (wind, solar, geothermal, bio-mass, etc.)
  - Energy Storage
  - Energy efficiency and DSM (w/ peak load shaving)
  - Nuclear power

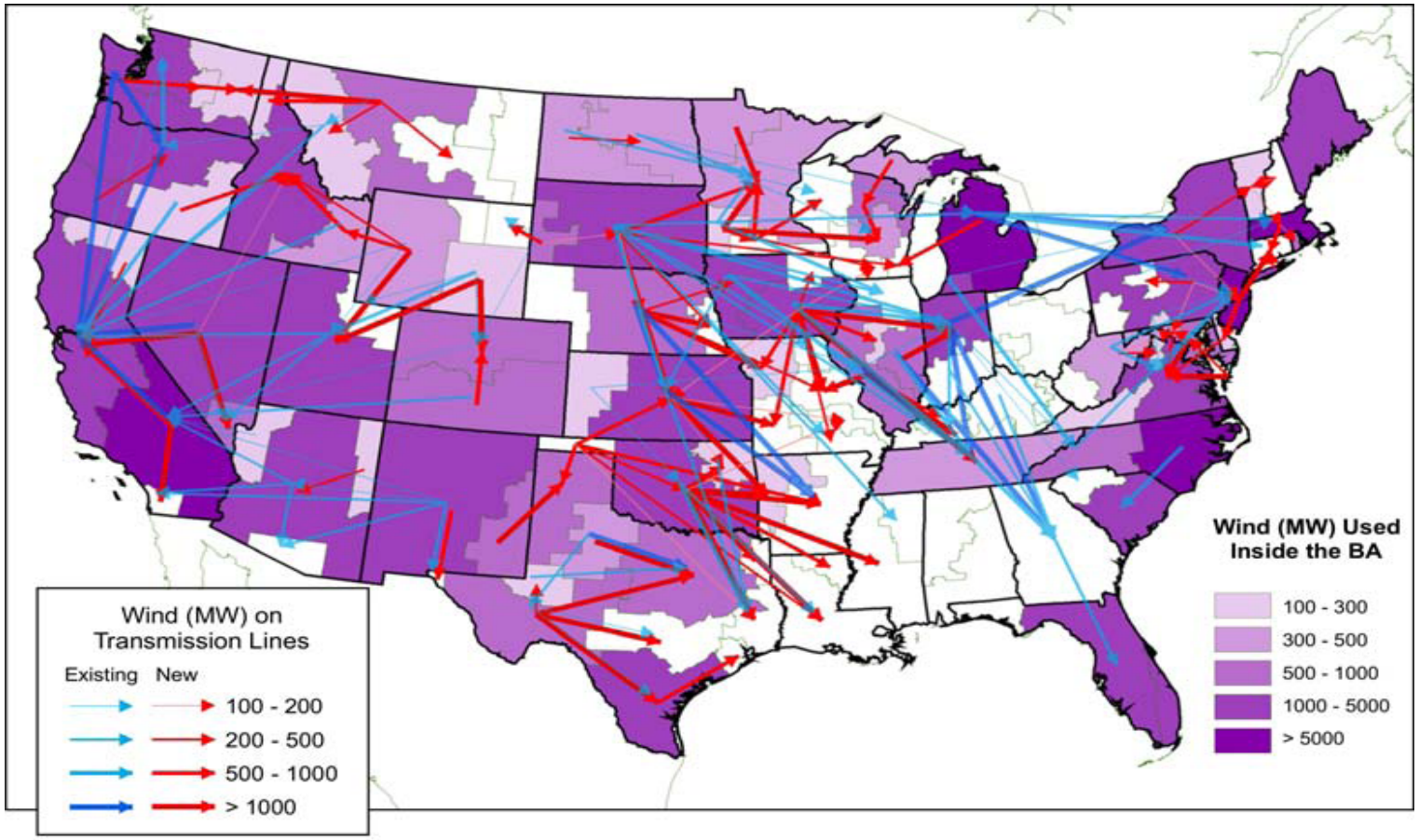
- Increased effort in *system planning and control* due to intermittent nature: Grid control with suddenly lost renewable power
- Adequate transmission infrastructure and *technology*

Projected Transmission Need 2012



Total Between Balancing Areas Transfer >= 100 MW (all power classes, land-based and offshore) in 2012.
Wind power can be used locally within a Balancing Area (BA), represented by purple shading, or transferred out of the area on new or existing transmission lines, represented by red or blue arrows. Arrows originate and terminate at the centroid of the BA for visualization purposes; they do not represent physical locations of transmission lines.

Projected Transmission Need 2030



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Summary

- Incentives for renewable energy, the fastest growing generating sources, and energy efficiency
- System infrastructure reinforcement required
- Solutions to increased penetration levels of renewables
  - Balanced generation portfolio
  - Energy storage
  - Distributed control
  - Implementing dynamic VAr devices (FACTS)
  - HVDC regional interties and remote ties

- Changes in operations and regulatory policies

Smart Grid Vision

"Use of advanced technologies to improve the *performance* of electric utility systems to address the needs of society."

- Efficiency and Utilization
- Renewable Energy
- Demand Response
- Power Quality and Reliability
- Utility Bottom Line, …

Other Names
Grid Of the Future
Utility of the Future
Digital Electric Grid

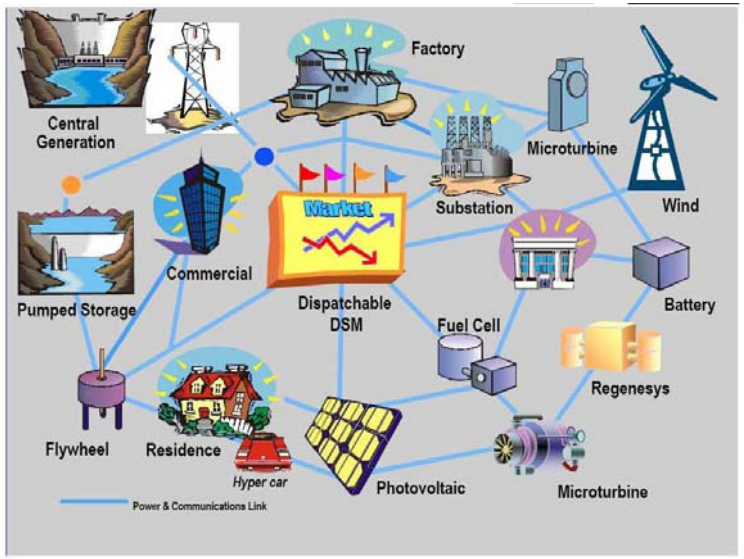
Enterprise Solution: "Align and integrate planning, engineering, automation, customer solution, energy and information technologies with business strategy & processes."

"Its foundation is new *distributed data communication, computing, and control technologies* – efficient transfer of data and control from/to/among many field units and use of those data."

“Smart Grid”

Fueled by the Energy Independence and Security Act of Dec’07 that provides guidelines to FERC and state Public Utility Commissions

- Requiring utilities to consider Smart Grid
- Inclusion of ratepayer and societal benefits in business cases
- Allowing continued rate recovery of assets replaced by Smart Grid
- Allowing accelerated depreciation



Enterprise Systems

- Smart Metering or AMI
- Demand Response
- Renewable Energy/Distributed Resources
- Home Area Network & Electric Vehicles
- Wide Area Monitoring Protection & Control

Expectations

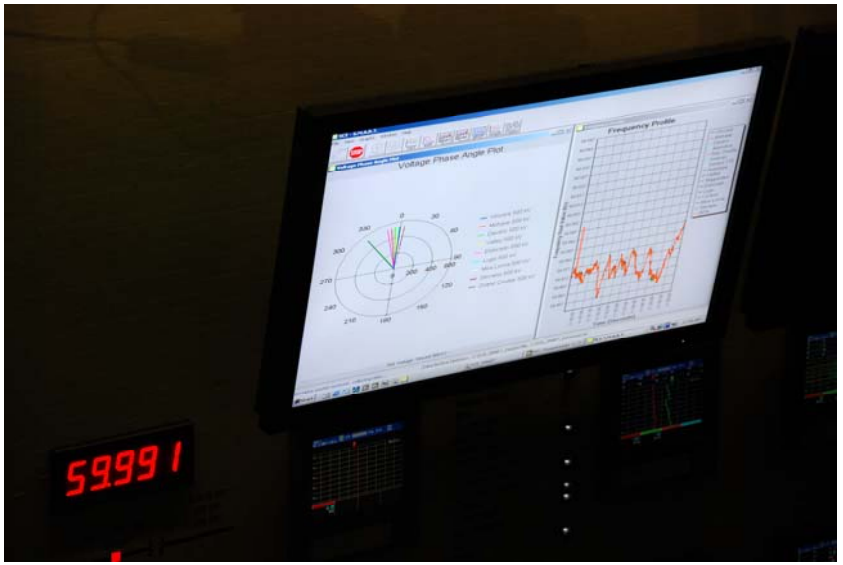
- **Not a revolution**
  There *is* merit in this important concept, and it *will* lead to evolutionary changes in the industry
- **Smart Grid is currently "the next new thing."**
  Some technologies moving from cutting edge to production fast
- **Sometimes surrounded by smoke**
  A lot of hype and speculation
- **All these are transformational technologies**

  Many and big changes throughout the utility enterprise with new utility paradigms
  - Sharing pricing risks with customers
  - Proactive communications – external and internal
  - Fostering energy efficiencies

Should be defined by what it can do with enabling technologies creating an overall roadmap.

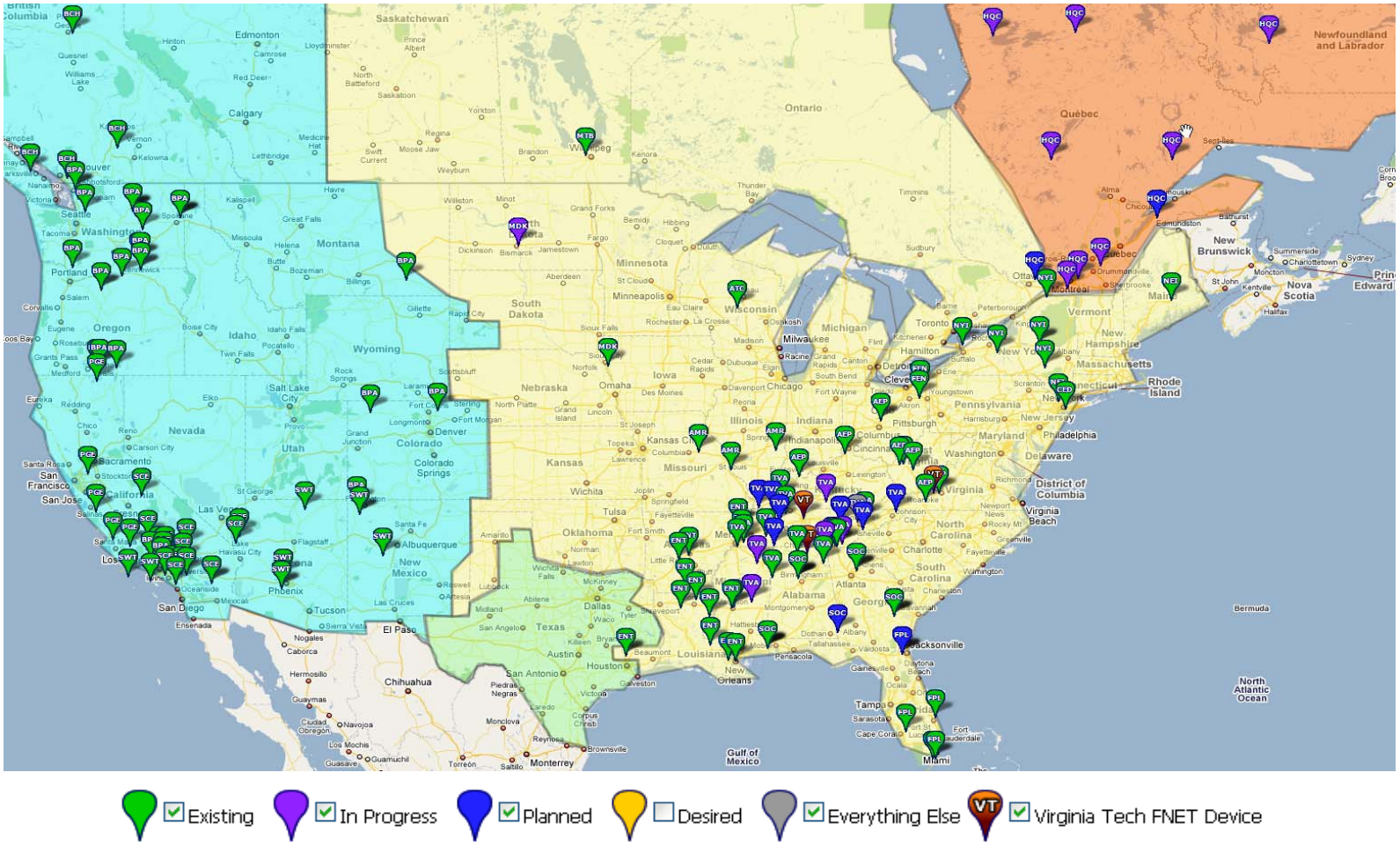
Transmission: Wide Area Monitoring Protection & Control

- Integrated system-wide communication infrastructure, with distributed data management, allowing flexible and secure data collection
- Advanced sensors: PMUs; line thermal monitors; equipment condition assessment; etc.
- Advanced visualization tools and algorithms
- Standard technology (e.g.IEC61850) for easier integration, configuration, engineering, and maintenance
  - Station bus and Process bus



Transmission: Wide Area Monitoring Protection & Control

- Synchronized Measurement as WAMPAC enabler



Emerging Technologies in Support of Smart Grids

- **2:00 – 2:15** **Introduction:** ***Damir Novosel (Quanta)***

Session 1: Power Delivery Aspects and Supporting Services

- **2:15 – 2:35** **Using AMI Applications to Realize the Smart Grid**
  David Hart (Elster)
- **2:35 – 2:55** **Future Power Delivery Systems**
  Alex Huang/Mesut Baran (NC State)
- **2:55 – 3:15** **Smart Distributed Control of Power Systems**
  Ron Harley/*Deepak Divan (Georgia Tech)*
- **3:15 – 3:35** **Utility Experience with Developing a Smart Grid Roadmap**
  M. McGranaghan/D. Dollen/P. Myrda(EPRI), E. Gunther (Enernex)
- **3:35 – 3:55** **Information Services for Smart Grid**
  Roger King (Mississippi State University)
- **3:55 – 4:10** **Questions and discussions**

Emerging Technologies in Support of Smart Grids

Session 2: Transmission and Sustainable Energy Aspects

- **4:10 – 4:25** **Introduction:** ***Miroslav Begovic (Georgia Tech)***
- **4:25 – 4:45** **Power Electronics and Storage to Increase Penetration Levels of Renewable Power and Renewable Portfolio Management**
  Johan Enslin/Bartosz Wojszczyk/Farid Katerai (Quanta)
- **4:45 – 5:05** **Use of Synchronized Measurement System for Monitoring Power System Stability and System Dynamics in Real Time**
  Armando Salazar/Bharat Bhargava(SCE)
- **5:05 – 5:25** **SynchroPhasor Measurements: System Architecture and Performance Evaluation in Supporting Wide Area Applications**
  Henry Huang/Jeff Dagle (PNNL)
- **5:25 – 5:45** **Technological Advancements in Grid Revitalization: Present and Future**
  Larry Sollecito (GE) and Vahid Madani (PG&E)
- **5:45 – 6:00** **Questions and discussions**