

**NECA 2009 Convention & Trade Show**  
**Seattle, Washington**  
**September 14, 2009**

## **Energy Roadmap Guiding Electrical Contractors To Energy Independence Opportunities**



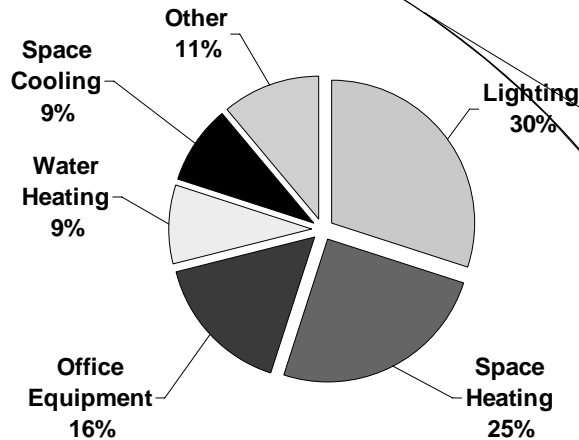
Thomas E. Glavinich, D.E., P.E. - KU  
Oswald Chong, Ph.D., LEED-AP - KU  
Heather Eilers, P.E., LEED-AP - KU  
David R. Riley, Ph.D., P.E. - PSU

## **U.S. Building Statistics**

- Buildings number about:
  - 76 million residential
  - 5 million commercial
- Buildings consume about:
  - One third to one half of energy
  - Two thirds of electricity
- Buildings account for about:
  - 35% carbon dioxide emissions
  - 49% sulfur dioxide emissions
  - 25% nitrous oxide emissions
  - 10% particulate emissions

Data Source: U.S. Department of Energy

## Commercial Buildings Consume About 17% Of Total U.S. Energy But 6% Of Building Stock



Data Source: U.S. Department of Energy, Energy Efficiency & Renewable Energy (EERE) Building Technologies Program

## Hi-P Building Defined

*A high performance building is a building that utilizes a whole building approach to integrate and optimize all major high performance building attributes over the building lifecycle, including energy efficiency, durability, life-cycle performance, and occupant productivity and the other values.*

***High-Performance = Green?***

*Definition by National Institute of Building Sciences (NIBS)*

## **Green Building Defined**

*A building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life.*

ASTM International, *Standard Terminology for Sustainability Relative to the Performance of Buildings*, ASTM Standard E 2114 – 06a, 2006.

## **Carbon-Neutral Buildings & Zero Energy Buildings (ZEBs)**

- AIA “2030 Challenge” sets the goal for carbon-neutral buildings by 2020.
- ASHRAE plans to create a “Net Zero” guide for building design and construction by 2020.
- U.S. Department of Energy’s (DOE) Building Technologies Program has set a goal of “zero-energy buildings” by 2025.

## Hi-P Building Market Drivers

- Concern About Environment
- Concern About Natural Resources
- Concern About National Security
- Rising Cost Of Energy
- Awareness Of Building Life-Cycle Costs
- Government Regulations & Incentives
- Commercially Available Technology
- Others

## “Original” New Deal



- Construction & Utility Legislation
- Tennessee Valley Authority (TVA) [May 18, 1933]
- Rural Electrification Administration (REA) [May 11, 1935]
- Bonneville Power Administration (BPA) [August 20, 1937]

REA Photograph: “Stringing Rural TVA Transmission Line”

## **“Green” New Deal**

- *Emergency Stabilization Act of 2008* [P.L. 110-343] (03OCT08)
- *American Recovery and Reinvestment Act of 2009* [P.L. 111-5] (17FEB09)
- Pending Energy & Environment Legislation:
  - *American Clean Energy and Security Act of 2009* (a.k.a. Waxman-Markey Bill) [H.R. 2454] (HR Passed 26JUN09)
  - *American Clean Energy Leadership Act of 2009* [S. ---] (Passed Energy & Natural Resources Committee 17JUN09. Currently in Senate.)
- Other Federal, State, & Local Legislation

**EC Future = Energy Efficiency**

## **Emergency Economic Stabilization Act of 2008**

- Extends expired and expiring tax incentives for renewable energy, energy-efficient building upgrades, and appliance and equipment purchases.
- These incentives are essential to achieving U.S. energy-efficiency and environmental goals.

## **Emergency Economic Stabilization Act of 2008**

- Extends Commercial Building Tax Deduction (CBTD) through 2013.
- CBTD allows owners to claim a deduction of up to \$1.80 per square foot for upgrades resulting in 50 percent savings over ANSI/ASHRAE/IESNA Standard 90.1-2001 for upgrades in:
  - HVAC
  - Lighting
  - Building Envelope
- Five-year extension allows owners time to plan and execute upgrades.

## **Emergency Economic Stabilization Act of 2008**

- Creates new credits through 2016 for:
  - Combined Heat & Power (CHP)
  - Small Wind Energy
  - Geothermal Heat Pumps
- Establishes provisions for Energy Conservation Bonds issued by states and local governments to conduct energy conservation projects.
- Establishes residential tax credits for:
  - Energy Saving Appliances
  - Energy Efficient Homes
  - On-Site Renewables

## **Emergency Economic Stabilization Act of 2008**

- Solar Investment Tax Credit
  - Extend 8 years until 2016
  - 30% Investment Tax Credit
  - No Cap On Residential
  - ITC In Addition To Other Incentives & Depreciation
- Also includes fuel cells and microturbines.

## **Emergency Economic Stabilization Act of 2008**

- Alternate Energy Production Tax Credit
  - \$0.02/kWh
  - Extended Depending On Technology
- Applies to:
  - Wind (2010)
  - Geothermal (2011)
  - Closed Loop Biomass (2011)
  - Solar (2011)
  - Hydropower (2011)
  - Landfill Gas (2011)
  - Trash Combustion (2011)
  - Marine (Waves, Tides, & Currents) (2012)

## **Emergency Economic Stabilization Act of 2008**

- Adds accelerated depreciation period for:
  - Smart Meters
  - Smart Grid Systems
- Extends program providing tax-exempt bond designation to designated green building and sustainable design projects on brownfields.
- Extends expired business research credit through 2009.

## **ARRA 2009 Status**

- Less than 10% of the ARRA 2009 \$787 billion of stimulus money has been spent to date.
- Most of stimulus money will be released in FY 2010 starting in October 1.
- Purpose of ARRA 2009 was to stimulate job growth.
- National unemployment rate hit 9.5% last month and double-digit unemployment expected.
- Consideration will be given to a “Round 2” stimulus package this fall.



## **Pending Energy & Environmental Legislation**

- Increased Building Efficiency Requirements
- Utility Renewable Energy Standards (RES)
- Carbon Cap & Trade
- Smart Grid
- Other Provisions

## **Future Building Design**

*Buildings account for forty-eight percent of U.S. energy consumption and generate far more greenhouse gas emissions than any other sector. As architects, we must accept responsibility for our role in creating the built environment. We feel that it is incumbent upon the architecture profession to alter our actions and encourage both our clients and the entire design and construction industry to join us in plotting a course of measurable changes that will improve the quality of life for everyone.*

R. K. Stewart, FAIA  
Facilitator  
AIA Sustainability Summit Task Force

## **AIA High Performance Building Position Statements**

- *Promote sustainable design including resource conservation to achieve a minimum 50 percent reduction from the current level of consumption of fossil fuels used to construct and operate new buildings by the year 2010, and promote further reductions of remaining fossil fuel consumption by 10 percent or more in each of the following five years.*
- *The AIA supports the development and use of rating systems and standards that promote the design and construction of communities and buildings that contribute to a sustainable future.*

***AIA-USGBC Strategic Alliance  
Announced 28MAY08***

***Third-party certification is a growing trend in construction. Fourteen percent of cities with 50,000 or more residents have green building programs. These programs require that buildings meet certain environmental standards.***

**Benjamin D. Heath, Howrey LLP**

**“FTC Updating Green Guides Which Govern Environmental Building Claims,” *Construction Weblinks*, February 23, 2009.**

**([www.constructionweblinks.com](http://www.constructionweblinks.com))**

# USGBC LEED™ 2009 Rating Systems

| LEED Designator | Rating System Purpose                         | Approved  |
|-----------------|---|-----------|
| NC              | New Construction & Major Renovations          | Nov 2008  |
| CS              | Core & Shell Development                      | Nov 2008  |
| CI              | Commercial Interiors                          | Nov 2008  |
| EB              | Existing Buildings: Operations, & Maintenance | Nov 2008  |
|                 | Schools: New Construction & Major Renovations | Nov 2008  |
|                 | Homes   | Jan 2009  |
|                 | Retail: New Construction                      | Under Dev |
|                 | Retail: Commercial Interiors                  | Under Dev |
|                 | Health Care                                   | Under Dev |
|                 | Neighborhood Development                      | Under Dev |

**U.S. Green Building Council**  
**Leadership In Energy & Environmental Design (LEED™)**  
**LEED 2009 for New Construction & Major Renovations**



LEED 2009 for New Construction and Major Renovations

For Public Use and Display  
 USGBC Member Approved November 2008

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality
- Innovation In Design
- Regional Priority

**ASHRAE/USGBC/IESNA Standard 189  
Standard for the Design of High-  
Performance Green Buildings Except  
Low-Rise Residential Buildings**

- Addresses the same five major categories as the LEED rating systems.
- Intended to apply to same categories of buildings covered by *International Energy Conservation Code (IECC)* and ASHRAE/IESNA 90.1.
- Additional requirements beyond LEED-NC requirements.
- Use as a basis for infrastructure development.

**Electrical Contractor**

**=**

**Energy Solutions  
Provider**

***Electricity = Energy***

## Three-Pronged Approach To Addressing Customer Energy Needs

- Conservation (e.g. Controls)
- Efficiency (e.g. Light Source)
- Generation (e.g. PV)

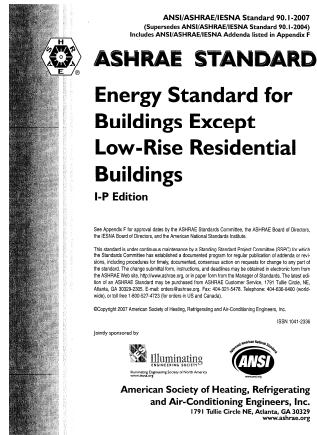
## Re-Light Inefficient Buildings



*According to the U.S. Department of Energy (DOE) there are over five million non-residential buildings in the country and more than 75 percent of them were built before the energy-efficient lighting technologies we have today were available. By utilizing new lamp/ballast efficiencies, we could eliminate a large portion of \$50 billion wasted each year on outmoded lighting systems.*

Willard L. Warren, "Energy Advisor," *Lighting Design + Application (LD+A)*, Illuminating Engineering Society of North America, April 2009, pp. 18-22.

# ASHRAE/IESNA Standard 90.1-2007 Energy Standard For Buildings Except Low-Rise Residential Buildings



- 1 Purpose
- 2 Scope
- 3 Definitions, Abbreviations, & Acronyms
- 4 Administration & Enforcement
- 5 Building Envelope
- 6 Heating, Ventilating, & Air Conditioning
- 7 Service Water Heating
- 8 Power
- 9 Lighting
- 10 Other Equipment
- 11 Energy Cost Budget Method
- 12 Normative references

## ASHRAE/IESNA Standard 90.1-2007 Section 10/Other Equipment 10.4.1 Electric Motors

*Electric motors shall comply with the requirements of the Energy Policy Act of 1992 where applicable as shown in Table 10.8. Motors that are not part of the Energy Policy Act of 1992 have no performance requirements in this section.*

TABLE 10.8 Minimum Nominal Efficiency for General Purpose Design A and Design B Motors<sup>a</sup>

| Number of Poles →         | Minimum Nominal Full-Load Efficiency (%) |      |      |                 |      |      |
|---------------------------|--|------|------|-----------------|------|------|
|                           | Open Motors                              |      |      | Enclosed Motors |      |      |
|                           | 2  | 4    | 6    | 2               | 4    | 6    |
| Synchronous Speed (RPM) → | 3600                                     | 1800 | 1200 | 3600            | 1800 | 1200 |
| Motor Horsepower          |  |      |      |                 |      |      |
| 1                         | —  | 82.5 | 80.0 | 75.5            | 82.5 | 80.0 |
| 1.5                       | 82.5                                     | 84.0 | 84.0 | 82.5            | 84.0 | 85.5 |
| 2                         | 84.0                                     | 84.0 | 85.5 | 84.0            | 84.0 | 86.5 |
| 3                         | 84.0                                     | 86.5 | 86.5 | 85.5            | 87.5 | 87.5 |
| 5                         | 85.5                                     | 87.5 | 87.5 | 87.5            | 87.5 | 87.5 |
| 7.5                       | 87.5                                     | 88.5 | 88.5 | 88.5            | 89.5 | 89.5 |
| 10                        | 88.5                                     | 89.5 | 90.2 | 89.5            | 89.5 | 89.5 |
| 15                        | 89.5                                     | 91.0 | 90.2 | 90.2            | 91.0 | 90.2 |
| 20                        | 90.2                                     | 91.0 | 91.0 | 90.2            | 91.0 | 90.2 |
| 25                        | 91.0                                     | 91.7 | 91.7 | 91.0            | 92.4 | 91.7 |
| 30                        | 91.0                                     | 92.4 | 92.4 | 91.0            | 92.4 | 91.7 |
| 40                        | 91.7                                     | 93.0 | 93.0 | 91.7            | 93.0 | 93.0 |
| 50                        | 92.4                                     | 93.0 | 93.0 | 92.4            | 93.0 | 93.0 |
| 60                        | 93.0                                     | 93.6 | 93.6 | 93.0            | 93.6 | 93.6 |
| 75                        | 93.0                                     | 94.1 | 93.6 | 93.0            | 94.1 | 93.6 |
| 100                       | 93.0                                     | 94.1 | 94.1 | 93.6            | 94.5 | 94.1 |
| 125                       | 93.6                                     | 94.5 | 94.1 | 94.5            | 94.5 | 94.1 |
| 150                       | 93.6                                     | 95.0 | 94.5 | 94.5            | 95.0 | 93.0 |
| 200                       | 94.5                                     | 95.0 | 94.5 | 95.0            | 95.0 | 93.0 |

<sup>a</sup>Nominal efficiency shall be established in accordance with NEMA Standard MG1. Design A and Design B are National Electrical Manufacturers Association (NEMA) design class designations for three frequency rated and medium AC technology induction motors.

***NEMA Energy-Efficient Design A & B Motors***

## Motor Retrofit: NEMA Premium Motor Rebate (aka “Crush-For-Credit” Program)

- Part of both the pending HR and S energy and environment legislation.
- \$25/hp rebate for new NEMA Premium motor replacement.
- \$5/hp rebate for disposal of old motor.
- DOE annual savings calculation:

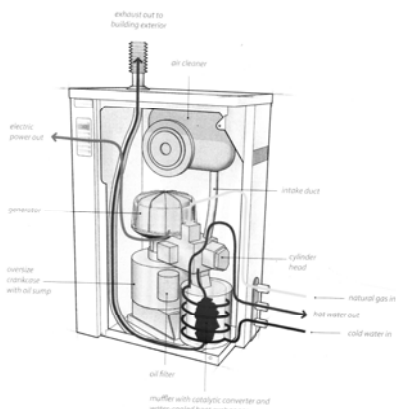
**Table 1. Annual Savings from Specifying NEMA Premium Motors**

| Horsepower | Full-load Motor Efficiency (%) |                               | Annual Savings from Use of a NEMA Premium Motor |                        |
|------------|--------------------------------|-------------------------------|---|------------------------|
|            | Energy Efficient Motor         | NEMA Premium Efficiency Motor | Annual Energy Savings, kWh                      | Dollar Savings \$/year |
| 10         | 89.5                           | 91.7                          | 1,200   | \$60                   |
| 25         | 92.4                           | 93.6                          | 1,553   | 78                     |
| 50         | 93.0                           | 94.5                          | 3,820   | 191                    |
| 100        | 94.5                           | 95.4                          | 4,470   | 223                    |
| 200        | 95.0                           | 96.2                          | 11,755  | 588                    |

Note: Based on purchase of a 1,800 rpm totally enclosed fan-cooled motor with 8,000 hours per year of operation, 75% load, and an electrical rate of \$0.05/kWh.

**23% Of Electric Energy In U.S. Is Consumed By Motors (DOE)**

## New Bldg DG Technologies Micro Combined Heat -Power Unit



- Honda introduced MCHP unit in U.S. last November.
- Other manufactures of MCHP units:
  - WhisperGen - New Zealand
  - SenerTec Dachs CHP - Germany
- Fueled by NG:
  - 20% Electric Energy
  - 80% Hot Water

## **DG Economic Incentives**

- Net Metering
- Time Of Day (TOD) Differential
- Feed-In Tariffs
- Utility & State Rebate Programs
- Federal & State:
  - Tax Credits
  - Grants
- Accelerated Depreciation For Businesses
- “Built-In” Financing:
  - Utility Bill Financing
  - Property Tax Financing

*See Database of State Incentives for Renewables & Efficiency (DSIRE) maintained by the Solar Center at North Carolina State University at [www.dsireusa.org](http://www.dsireusa.org).*

## **Net Metering & TOD Tariffs**



*Los Angeles Electrical JATC*



## **RE Feed-In Tariffs**

- Feed-in tariffs encourage individuals and businesses to install grid-connected RE generation.
- Long-term contracts guarantee revenue stream for RE investment and provide “collateral” for loans and investment.
- Feed-in tariffs used successfully in Europe.
- Feed-in tariffs differ from net metering in that feed-in tariffs allow investors to profit from RE and not just zero out facility energy charge.
- *Vermont Energy Act of 2009* establishes standard rates for buy-back of RE production by utilities for 15- to 20- year contracts.

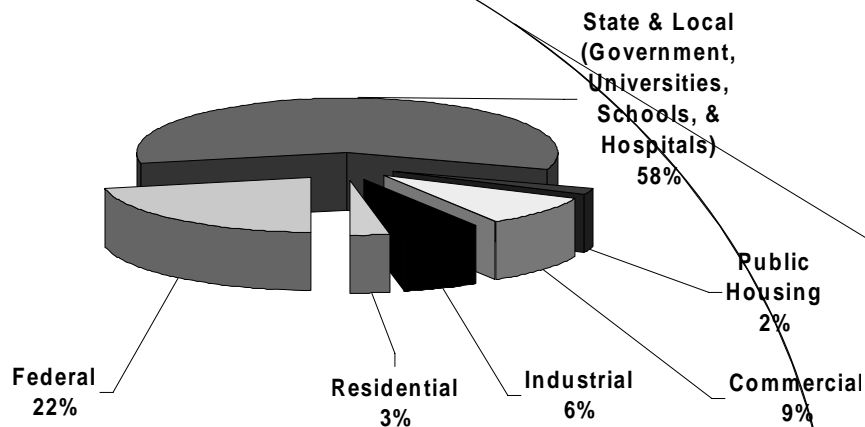
## **Energy Efficiency Market: EC Competitors & Allies**

- Utilities
- Energy Service Companies (ESCO)
- Energy Efficient Product Manufacturers

## ESCO Business Model

- An ESCO is a business that develops, installs, and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a 7 to 20 year time period.
- ESCOs typically offer the following services:
  - Develop, design, and arrange financing for energy efficiency projects.
  - Install and maintain the energy efficient equipment installed.
  - Measure, monitor, and verify the project's energy savings.
  - Assume the technical and performance risk that the project will save the amount of energy guaranteed.
- ESCO services are bundled into the project's cost and repaid through the amount of energy guaranteed.

## ESCO Business Is Primarily Large Institutional Facilities



***Publicly Owned Facilities = 82% Of ESCO Business***

Data Source: California Green Solutions - 2006 Data

## **Private Sector Customer Energy Efficiency Project Payment & Financing Options**

- **Purchase:**
  - Cash
  - Commercial Loan
- **Lease:**
  - Capital Lease
  - Operating Lease
  - Tax-Exempt Lease
- **Utility Finance**
  - Utility Bill
  - Other
- **Public Financing Of Private Projects Through Tax Bill**
- **Performance Contract:**
  - Shared Savings
  - Paid From Savings

## **Private Sector Payment & Financing Options Evaluation Criteria**

- Availability Of Payment/Financing Option
- Initial Payment
- Ongoing Payments
- Ownership
- Tax Incentives & Depreciation
- Rebates & Other Incentives
- Performance Risk
- Impact On Financial Statements
- Other Factors

## **EC Energy Efficiency Business: Preliminary Business Model**

- Focus on private sector commercial, multifamily residential, and industrial customers.
- Align interests and partner with:
  - Utilities
  - Energy Efficient Product Manufacturers
- Help customers reduce operating costs by increasing facility energy efficiency through investments in efficiency, conservation, and distributed generation.

## **Business Model Hypothesis**

*It is more economical for private sector commercial and industrial customers to pay for or finance their energy efficiency projects directly and take advantage of available incentives, rebates, and energy savings directly than to enter into a performance contract.*

## **EC Energy Efficiency Services**

- Perform customer facility energy audit.
- Analyze customer facility performance to identify possible operational savings.
- Develop energy efficiency program along with projected cost and energy savings for any energy efficiency projects.
- Perform economic analysis of energy efficiency project.
- Assist customer in obtaining energy efficiency project financing.
- Perform detailed design needed for energy efficiency project.
- Procure materials and equipment for energy efficiency project.
- Install energy efficiency project systems and equipment.
- Commission energy efficiency project systems and equipment.
- Measure and verify energy efficiency project savings.
- Assist customer in maintaining systems and equipment.
- Monitor customer facility for additional energy efficiency opportunities.

***Energy Efficiency Services  
Should Be An Outgrowth  
Of EC's Existing Service And  
Design Build Capabilities***

***EC Needs Energy Audit, Financial  
Analysis, And Measurement &  
Verification (M&V) Capabilities***

# ***Develop Energy Audit Capability***

*Energy Audit Capability Is Entrée  
Into Energy Service Market - Both  
Service & Design Build*

## **“Green New Deal” Initiatives Will Impact Utility EC Future**

- Transmission & Distribution System Upgrade & Expansion
- Utility Renewable Energy Standards (RES)
- Carbon Cap & Trade
- Smart Grid
- Other Drivers

# U.S. Electric Grid

- DOE refers to the U.S. electric grid as the “largest machine on Earth.”
- U.S. electric grid consists of:
  - 9,200 generating units capable of producing 1 million megawatts (MW) of power.
  - Network of more than 300,000 miles of transmission lines.
- National Academy of Engineering identified electrification of U.S. made possible by the U.S. electric grid “the most significant engineering achievement of the 20th Century.”

# U.S. Regional Electric Grids

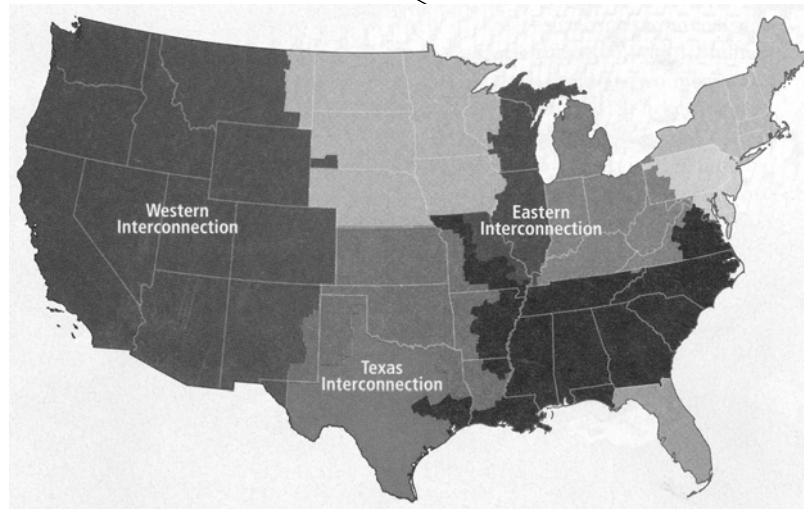


Diagram from *Scientific American Earth* 3.0. Vol 19, No. 1, 2009, p. 55.

## **Transmission Infrastructure Upgrade & Expansion Objectives**

- Support RE Development
- Increased Grid Reliability & Security
- Cost Savings From:
  - Reduced Congestion
  - Enhanced Energy Trading Opportunities
  - Reduced Line Losses
  - Increased Generation Trading
- Reduce Emissions
- Assistance With:
  - Demand Response
  - Energy Efficiency
  - Distributed Generation
- Other Objectives

## **Transmission Planning**

- Requires FERC to develop a national transmission plan.
- Gives FERC jurisdiction over high priority national transmission facility siting when:
  - States have been unable to site needed transmission facilities.
  - State has denied an application for needed transmission facilities.
- Provides intrastate siting of transmission facilities by Department of Interior similar to natural gas pipelines.

***High-Priority National Transmission Projects***



## Proposed National 765kV Backbone Coordinates With U.S. Wind Resources

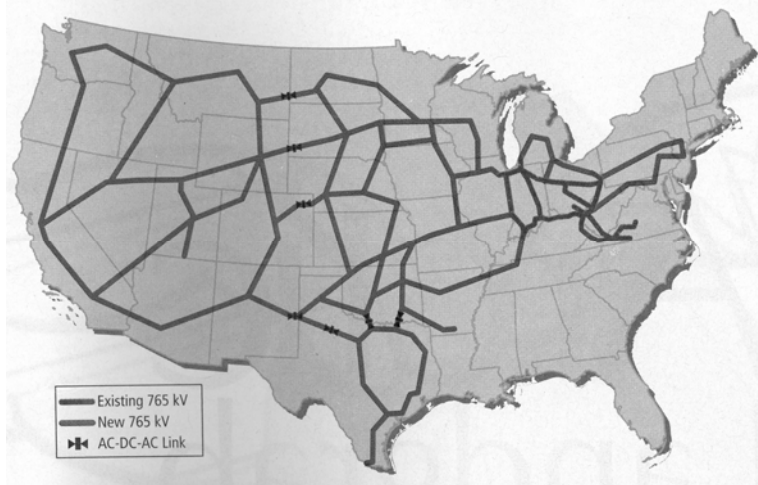


Diagram from *Scientific American Earth 3.0*. Vol 19, No. 1, 2009, p. 57.

## 765 kV Line Advantages

- Reduced ROW requirements based on SIL:
  - 765-kV 1- Single Ckt - 200 ft.
  - 345-kV 6 - Single Ckt - 900 ft.
  - 345-kV 3 - Dbl Ckt - 450 ft.
- Six-conductor bundles provide:
  - Higher line capacity.
  - Lower line losses.
  - Reduced noise & EMI.
- Independent-phase operation for improved line performance.
- FO shield wires for improved protection and control.

Source: American Electric Power

## Utility RES Summary

- Utility RES Objectives:
  - Reduce GHG Emissions
  - Improve Grid Reliability
  - Increase Energy Security
- Qualifying Renewables:
  - Wind
  - Solar
  - Ocean
  - Geothermal
  - Biomass
  - Landfill Gas
  - Hydropower
  - Others
- RES Timetable:

|             |     |
|-------------|-----|
| – 2011-2013 | 3%  |
| – 2014-2016 | 6%  |
| – 2017-2018 | 9%  |
| – 2019-2020 | 12% |
| – 2021-2039 | 15% |
- Utilities selling less than 4 MM mwh/yr are exempt.

## Meeting Utility RES

- Self RE generation or demonstrated energy efficiency savings offset.
- Purchase RE or energy efficiency savings offset.
- Purchase RE credits of energy efficiency credits.
- Make payments to DOE at 2.1 cents/kWh.

## RE On Public Lands

- Appropriate siting of RE sources on public lands.
- Bureau of Land Management (BLM) manages:
  - 20 MM acres with wind potential.
  - 30 MM acres with solar potential.
- Geothermal potential assessment.
- Develop expedited permitting process.
- Requires pilot projects.

## RE Feed-In Tariffs

- Feed-in tariffs encourage individuals and businesses to install grid-connected RE generation.
- Long-term contracts guarantee revenue stream for RE investment and provide “collateral” for loans and investment.
- Feed-in tariffs used successfully in Europe.
- Feed-in tariffs differ from net metering in that feed-in tariffs all investors to profit from RE and not just zero out facility energy charge.
- *Vermont Energy Act of 2009* establishes standard rates for buy-back of RE production by utilities for 15- to 20- year contracts.

## **RE & Distribution Networks**

- Electric grid is mainly radial except in many metropolitan areas.
- Distribution networks (aka area or grid networks) have been used in high-density load areas since the 1930's.
- Distribution networks are similar to spot networks for individual buildings.
- Areas are served by multiple substations with redundant distribution equipment that form an interconnected distribution system using network protectors.
- Connecting RE resources to distribution networks can cause safety, reliability, and operational issues.
- Distribution networks need upgrading due to age and the need to handle RE.

## **Carbon Cap & Trade Possible Impacts On Utility EC Business**

- Increase in generating unit pollution control retrofits with existing and new technologies.
- Replacement of older less efficient and dirtier generating units.
- Carbon capture and storage demonstration projects.
- New utility-scale RE projects including nuclear.
- New and upgraded transmission and distribution facilities to accommodate more robust energy trading and distributed generation.
- Other possible impacts.

# Impact Of All-In Energy Prices On Future Generation Decisions

*Future U.S. Natural Gas Prices May Lead To Continued GT & CC Plant Construction*

## Alternate Generation Fuels & Technologies

- Alternate fuels and technologies for power production:
  - Becoming economical due to rising all-in energy prices.
  - Environmentally friendly and carbon neutral.
  - Government subsidies may result in grid parity.
- Government sponsoring pilot projects.
- Example: Geothermal
- Example: U.S. is exporter of wood pellets as power plant feedstock. Wood is considered carbon neutral.

## Smart Grid Defined

- Smart Grid = Digitization Of Electric Power
- Smart Grid is mainly about communication and control to improve the operating efficiency and reliability of the U.S. electric infrastructure.
- Integration of entire electrical supply chain.
- Essentially no storage of electricity. Must balance supply and demand.
- DOE's five Smart Grid elements:
  - Integrated communications for real-time control.
  - Monitoring to provide real-time system conditions.
  - Control and monitoring capability to permit timely reaction to system changes and problems.
  - Improved interfaces throughout the system and decision-support tools.
  - Development and deployment of advanced transmission and distribution equipment and materials.

## Smart Grid Interoperability Standards Framework Release 1.0

| STANDARD                                  | APPLICATION  |
|---|--|
| AMI-SEC System Security Requirements      | Advanced metering infrastructure (AMI) and Smart Grid end-to-end security.   |
| ANSI C12.19/MC1219                        | Revenue metering information model.  |
| BACnet ANSI ASHRAE 135-2008/ISO 16484-5   | Building automation.   |
| DNP3                                      | Substation and feeder device automation.   |
| IEC 60870-6/TASE.2                        | Inter-control center communications.   |
| IEC 61850                                 | Substation automation and protection.  |
| IEC 61968/61970                           | Application level energy management system interfaces.   |
| IEC 62351 Parts 1-8                       | Information security for power system control operations.  |
| IEEE 37.118                               | Phasor measurement unit (PMU) communications.  |
| IEEE 1547                                 | Physical and electrical interconnections between utility and distributed DG.                                       |
| IEEE 1686-2007                            | Security for intelligent electronic devices (IEDs).  |
| NERC CIP 002-009                          | Cyber security standards for the bulk power system.  |
| NIST SP 900-53 and NIST SP 800-82         | Cyber security standards and guidelines for federal information systems including those for the bulk power system. |
| Open Automated Demand Response (Open ADR) | Price responsive and direct load control.  |
| OpenHAN                                   | Home Area Network device communication, measurement, and control.  |
| ZigBee/HomePlug Smart Energy Profile      | Home Area Network (HAN) Device Communications and Information Model  |

**Source: Department of Energy & Department of Commerce**

## **Smart Grid Work For Utility EC**

- EPRI estimates cost of building Smart Grid to be \$165 MM or about \$8 MM/year for 2 decades.
- Retrofit utility generation, transmission, and distribution facilities with Smart Grid technologies.
- Utility EC will be working with “technology” companies supplying Smart Grid technologies.
- Utility EC may need “high-tech” linemen.

# **Questions?**