Key Trends in the Evolution of the US Power Markets

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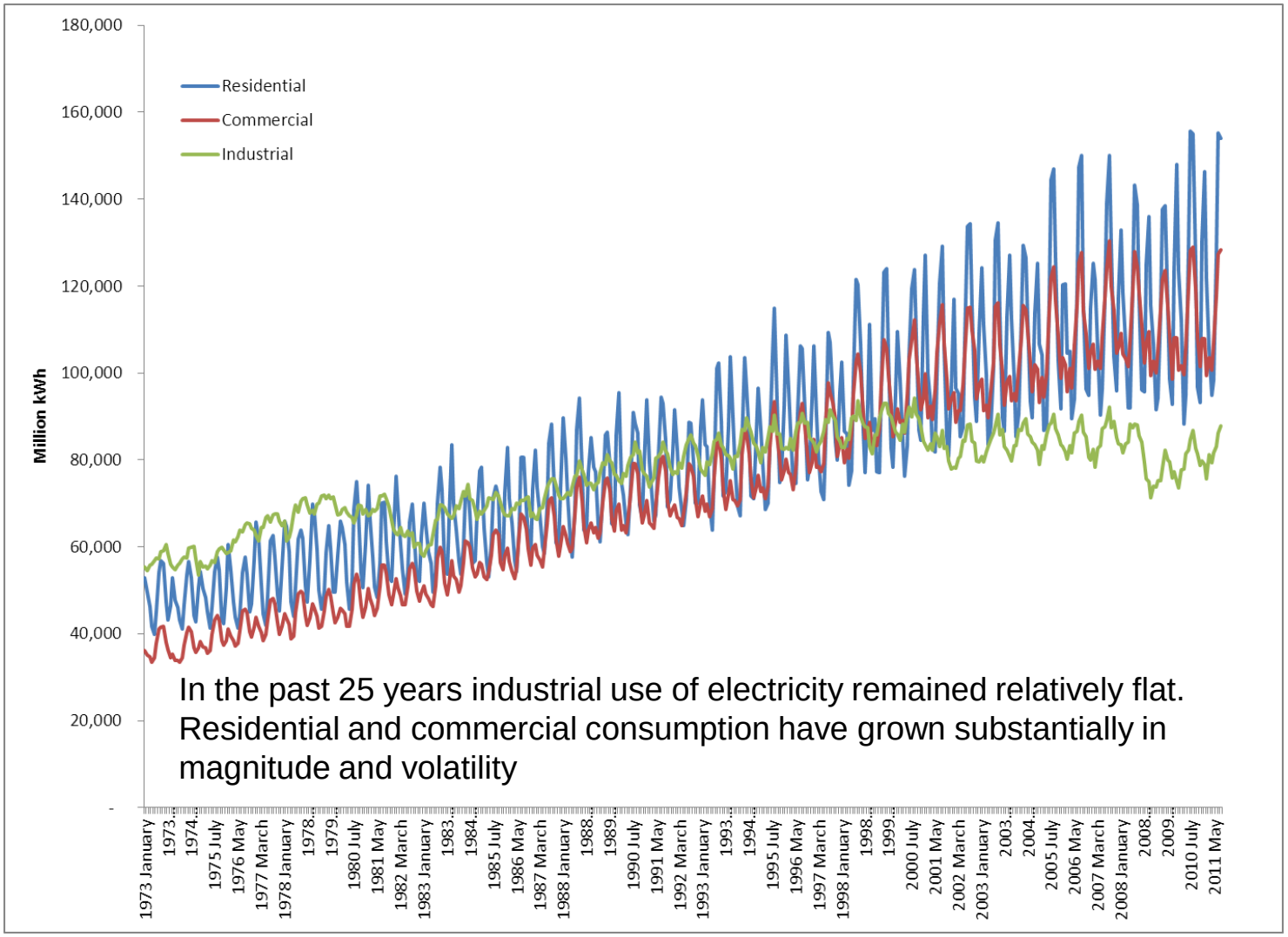
What this presentation is about…

- The evolution of market models:
  - widening the geography of competitive markets
  - new policy and economics of system planning and development,
  - expanding the spectrum of services provided by markets
- However, this should be placed in an appropriate context
  - Historical trends in the U.S. Electricity Supply and Demand
  - Emission control policies and associated with them probable levels of retirement of coal-fired generation plants
  - Shale gas and US power sector
  - Renewable resources: the wind, the sun and other options
  - Responsive demand, distributed generation, SmartGrid
- The context should go first

U.S. Monthly Electricity Consumption by End Use Sector (1973 – Aug-2011)



In the past 25 years industrial use of electricity remained relatively flat. Residential and commercial consumption have grown substantially in magnitude and volatility

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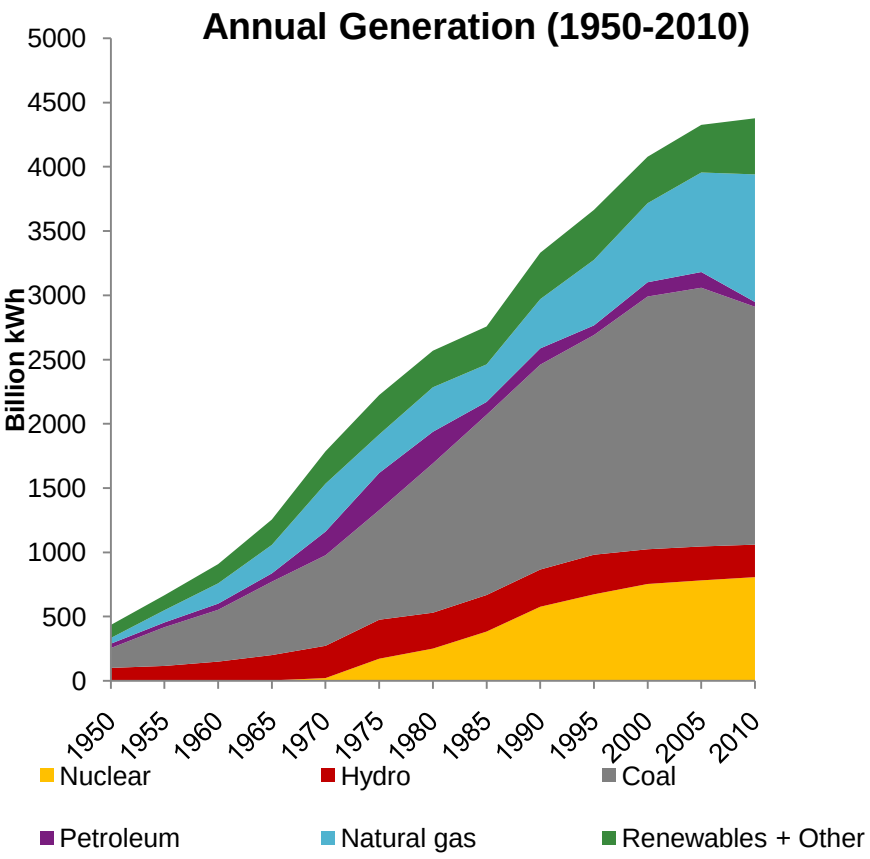
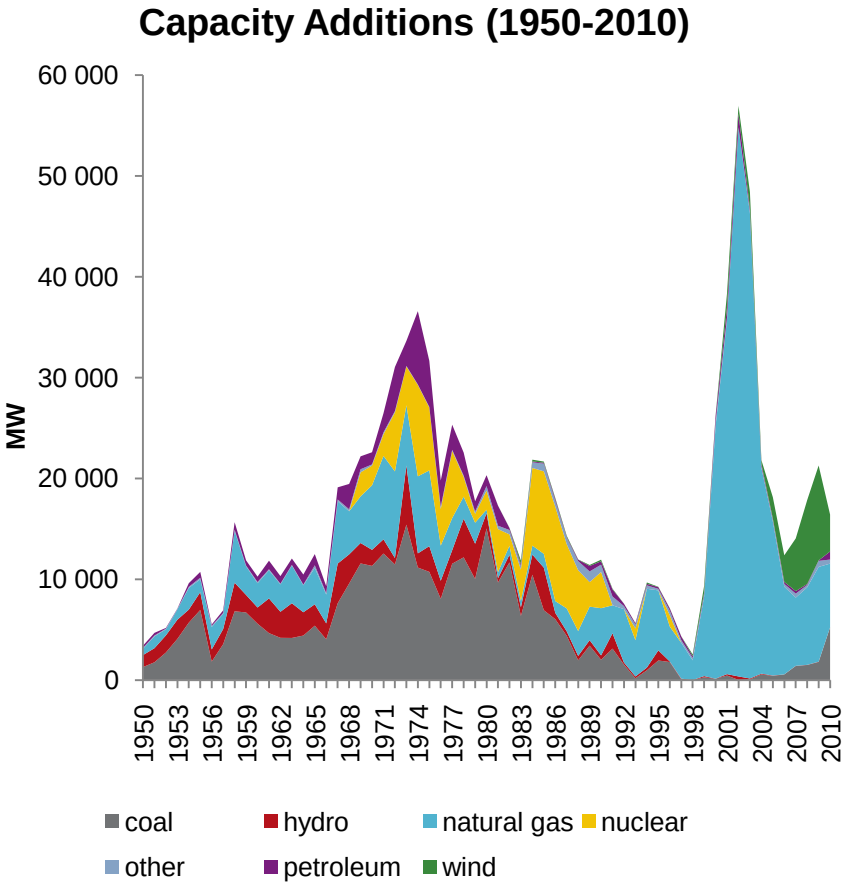
U.S. Power Production and Capacity Additions





Source: EIA

Since the beginning of the 21st Century natural gas fired generation technology was playing a dominant role. But what lays ahead in terms of technology and what market models will emerge alongside these future developments?

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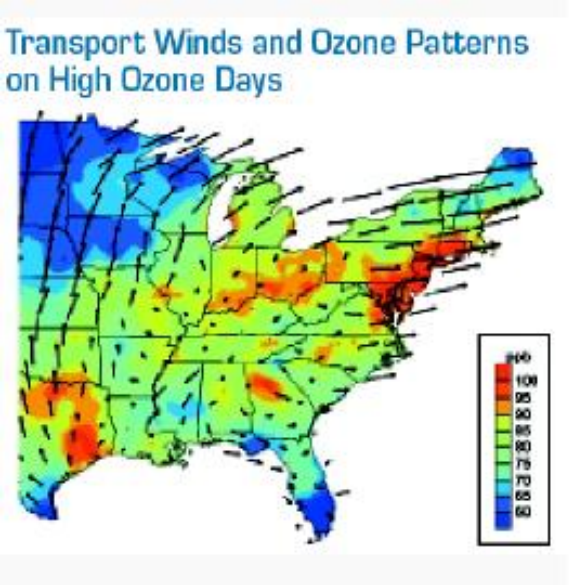
Proposed EPA Emission Control Policies and their Implications

- Cross State Air Pollution Rule (CSAPR)
  - will reduce fine particles, SOx and NOx emissions.
  - Differently affects upwind and downwind areas.
  - Establishes emission trading regimes
  - Appears so strict that will lead to retirement of a very large portion of existing coal fleet and investments in retrofitting the remaining coal plants
- Mercury & Air Toxics Rule
  - Addresses emissions of hazardous air pollutants (Hg, Pb, acid gases, arsenic, etc)
  - Affects coal and oil steam plants of over 25 MW
- Coal Combustion Residues Rule
  - Addresses storage and disposal of coal ash
- Cooling Water Intake Rule
  - Addresses protection of aquatic life



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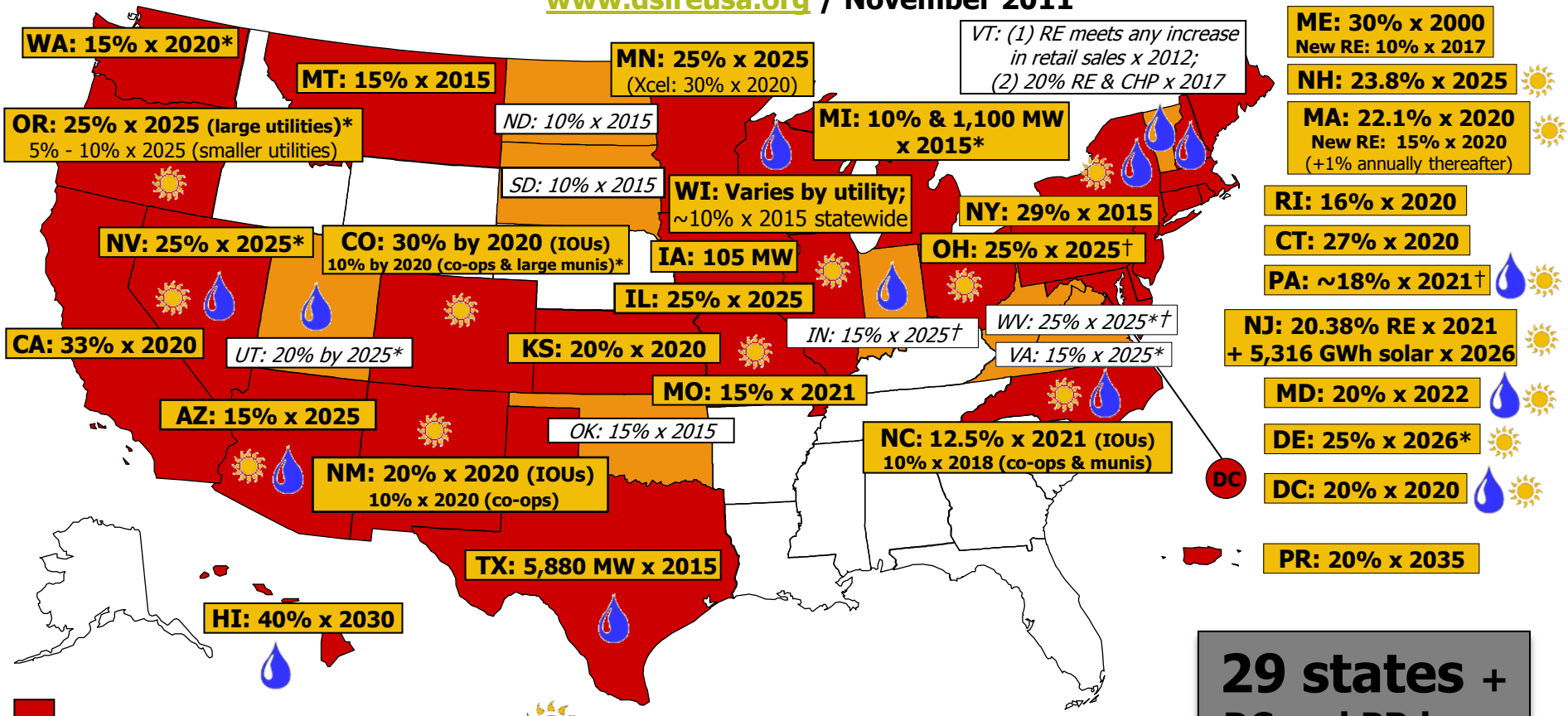
Other Important Environmental Policies in Effect or Being Considered

- Regional Greenhouse Gas Initiative (RGGI) – effective
  - The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Together these ten states have capped and will reduce power sector CO_2 emissions 10 percent by 2018
- Federal GHG policy – being considered
  - If adopted, will supersede RGGI
- State Renewable Portfolio Standards – effective
  - See next slide
- National Renewable Energy Standard – being considered
  - May supplement or replace state specific RPS policies

RPS Policies

www.dsireusa.org / November 2011



Renewable portfolio standard

Renewable portfolio goal

Solar water heating eligible

Minimum solar or customer-sited requirement

* Extra credit for solar or customer-sited renewables

† Includes non-renewable alternative resources

29 states + DC and PR have an RPS

(8 states have goals)

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Market Implications of Environmental Policies

- Potential levels of coal and oil plant retirements over a relatively short periods of time due to EPA rules may be unprecedented
- This may raise significant reliability concerns, both from the resource adequacy and security perspectives
- Which technologies are going to replace retired generation and meet future load growth? This is largely dependent on the implementation of GHG and RPS policies
- What developments of the electrical grid will be required? This is largely dependent on future generation needs
- What are the corresponding trends in the market evolution?

Other Important Market Fundamentals

- Availability and cost of natural gas, primarily shale gas developments
- The total cost of renewable technologies including the cost and operational limitations of their system integration
- The future of nuclear
- Demand growth, demand response
  - The future of the U.S. industrial sector
  - Electricity use of data centers
  - Electric vehicles
  - SmartGrid, micro-grids

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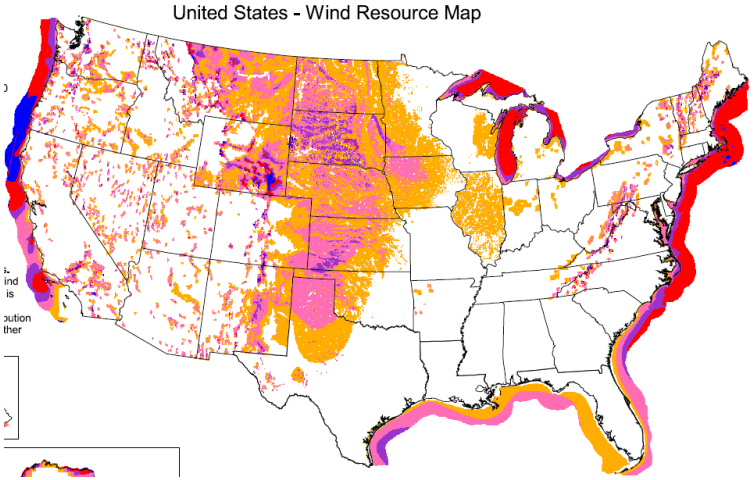
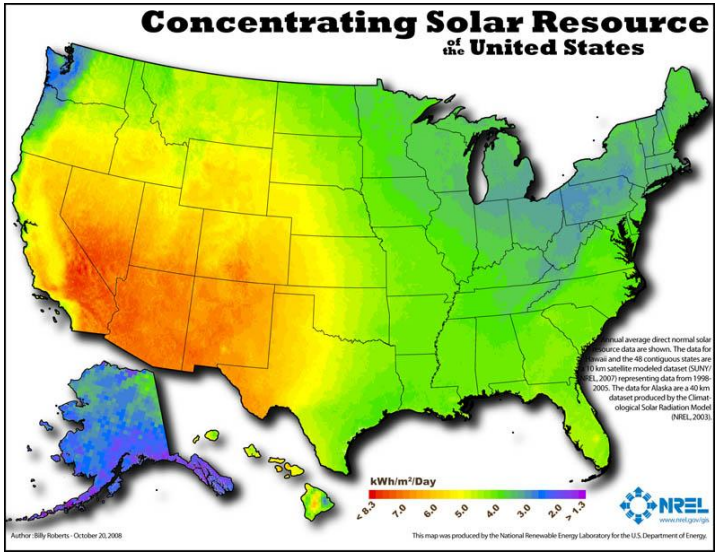
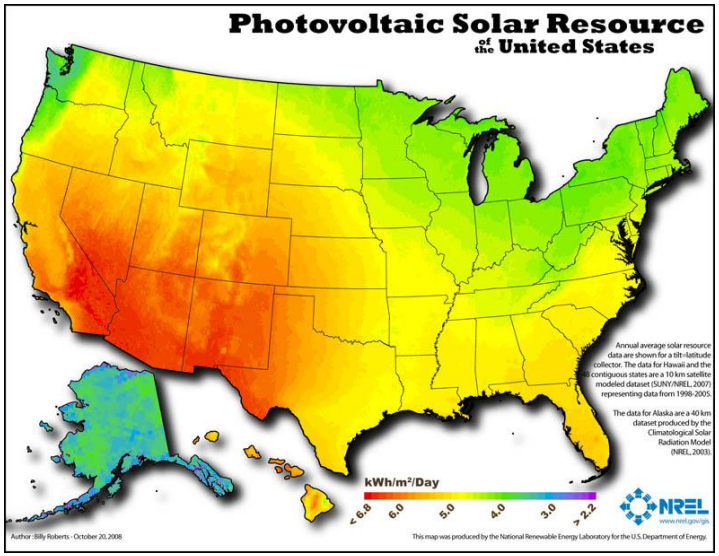
US has tremendous wind and solar resources







<u>2010 US Statistics</u>:

59 GW of installed capacity of renewable generation (5.1% of total installed capacity)

Generated 171 TWh (4.2% of all electric energy generated)

EIA 2010 Reference Case scenario projects these numbers to triple by 2035

Source: NREL, EIA

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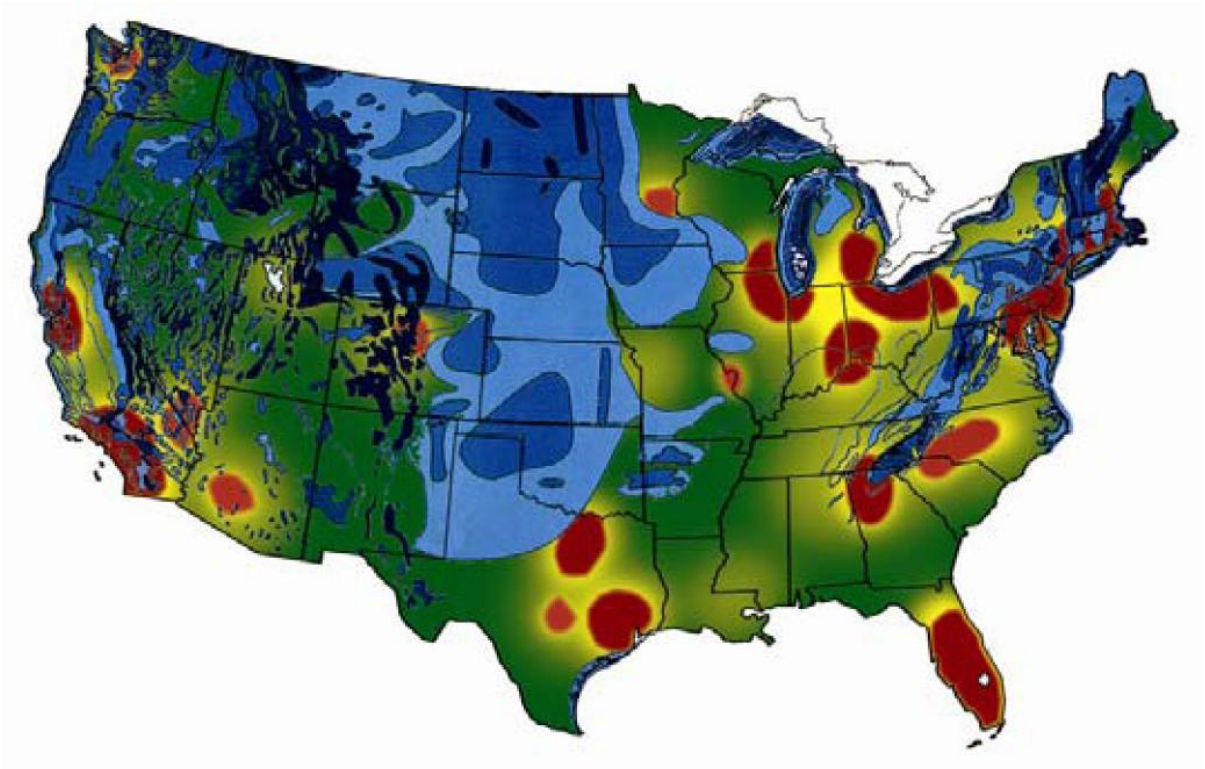
… but wind and most solar resources are typically located away from load centers. Tapping into these resources will require significant investments in transmission infrastructure



Brown spots – large load centers
Blue spots – centers of wind potentials (off-shore not shown)

Source: NERC, Accommodating High Level of Variable Generation, April, 2009

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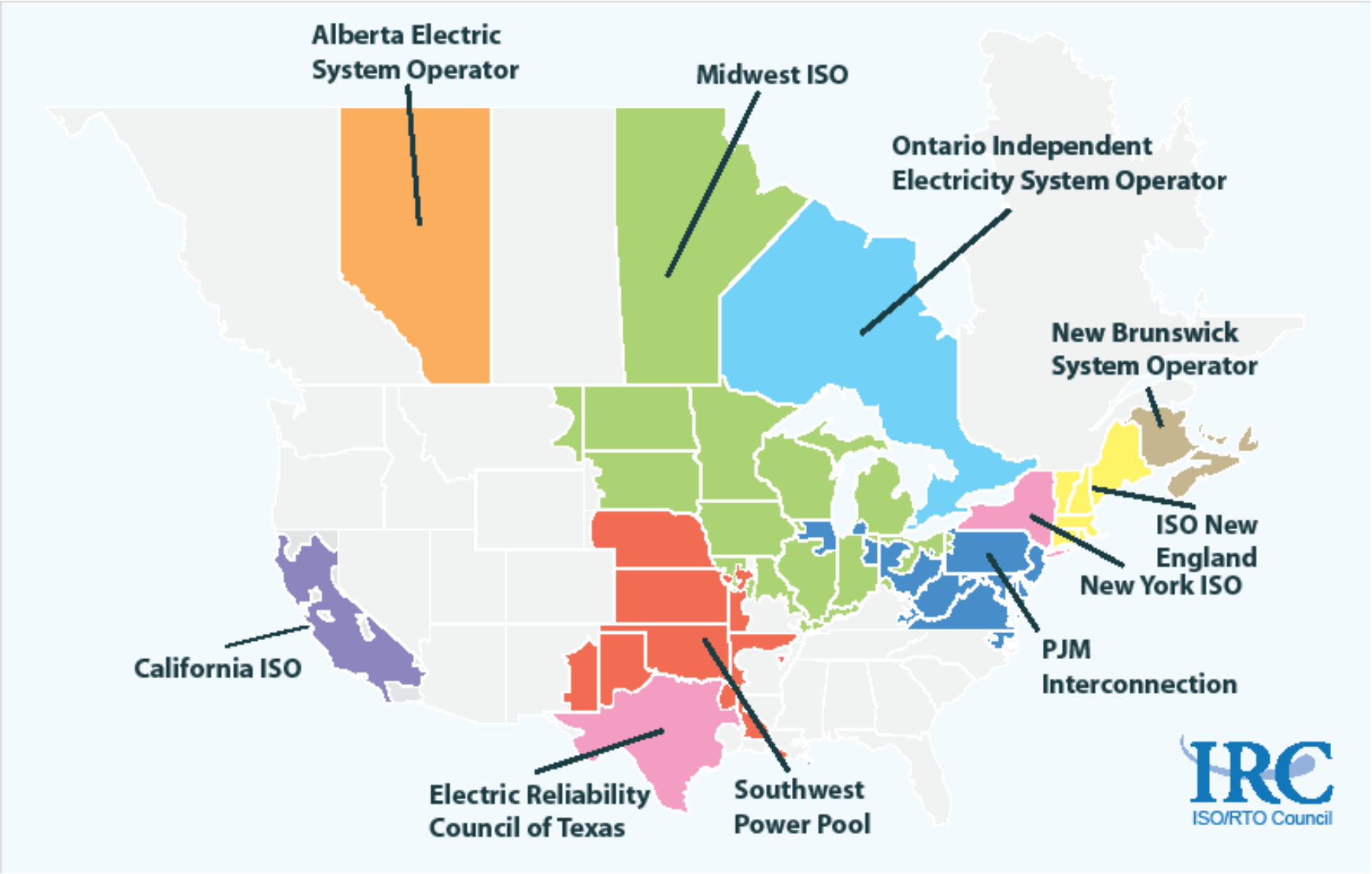
Integration of renewable generation resources on a large scale is challenging

- It changes the magnitude and the scope of required ancillary services on al time scales ranging from cycles to hours and days
- It requires significant transmission additions and reinforcements
- It calls for revisiting of resource adequacy methodology presently adopted by the industry
- It dramatically increases the role of demand-side resource in balancing the system
- It calls for the enhanced measurement and forecasting of variable generation output and of system conditions as a whole
- Greater access to large pools of available generation and demand

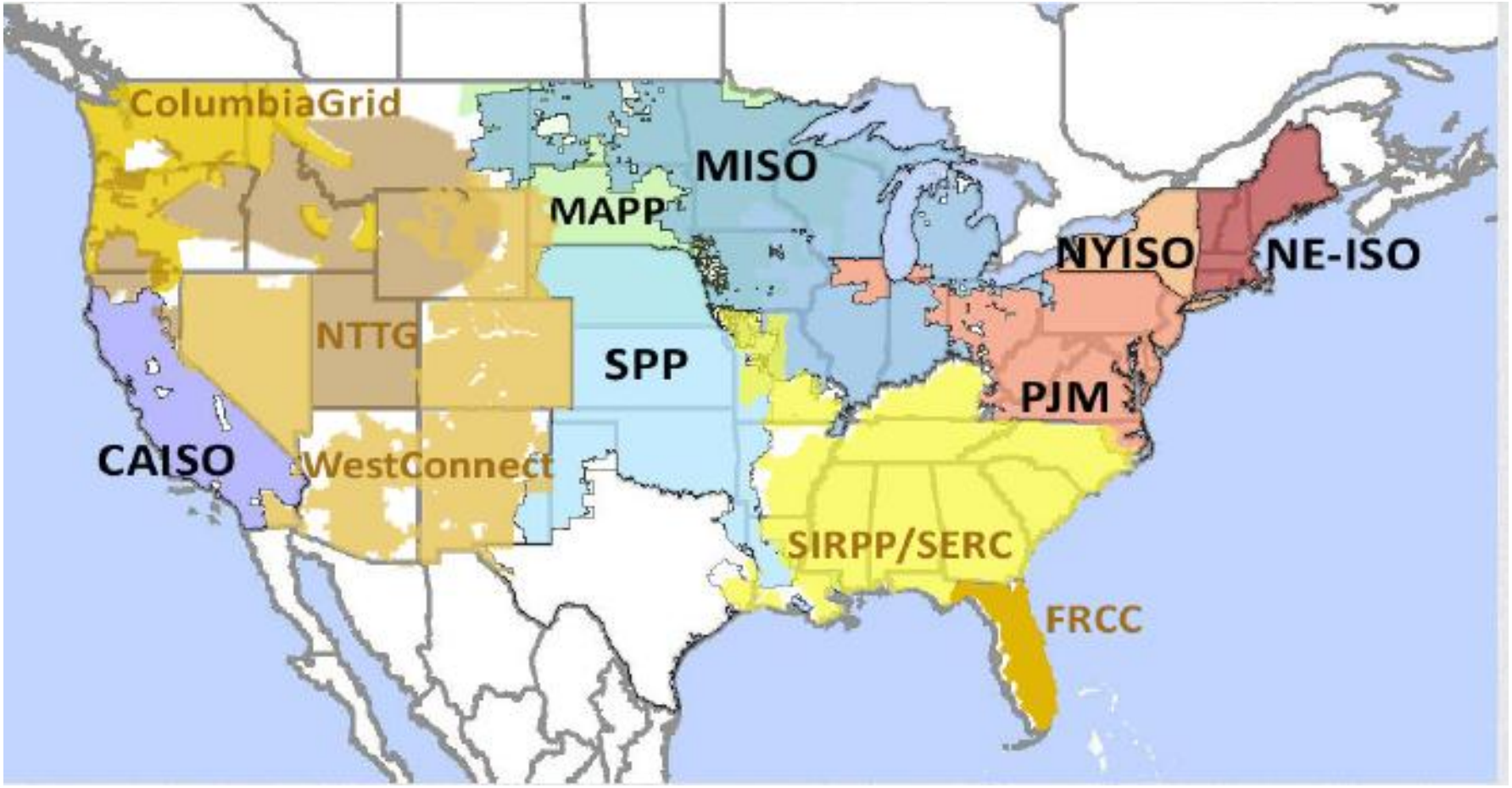
Per NERC's Report "Accommodating High Levels of Variable Generation" April 2009

Multiple centralized markets bordering vertically integrated utility systems, each is responsible for its generation expansion



Source: IRC

US Transmission planning regions generally follow market boundaries but…



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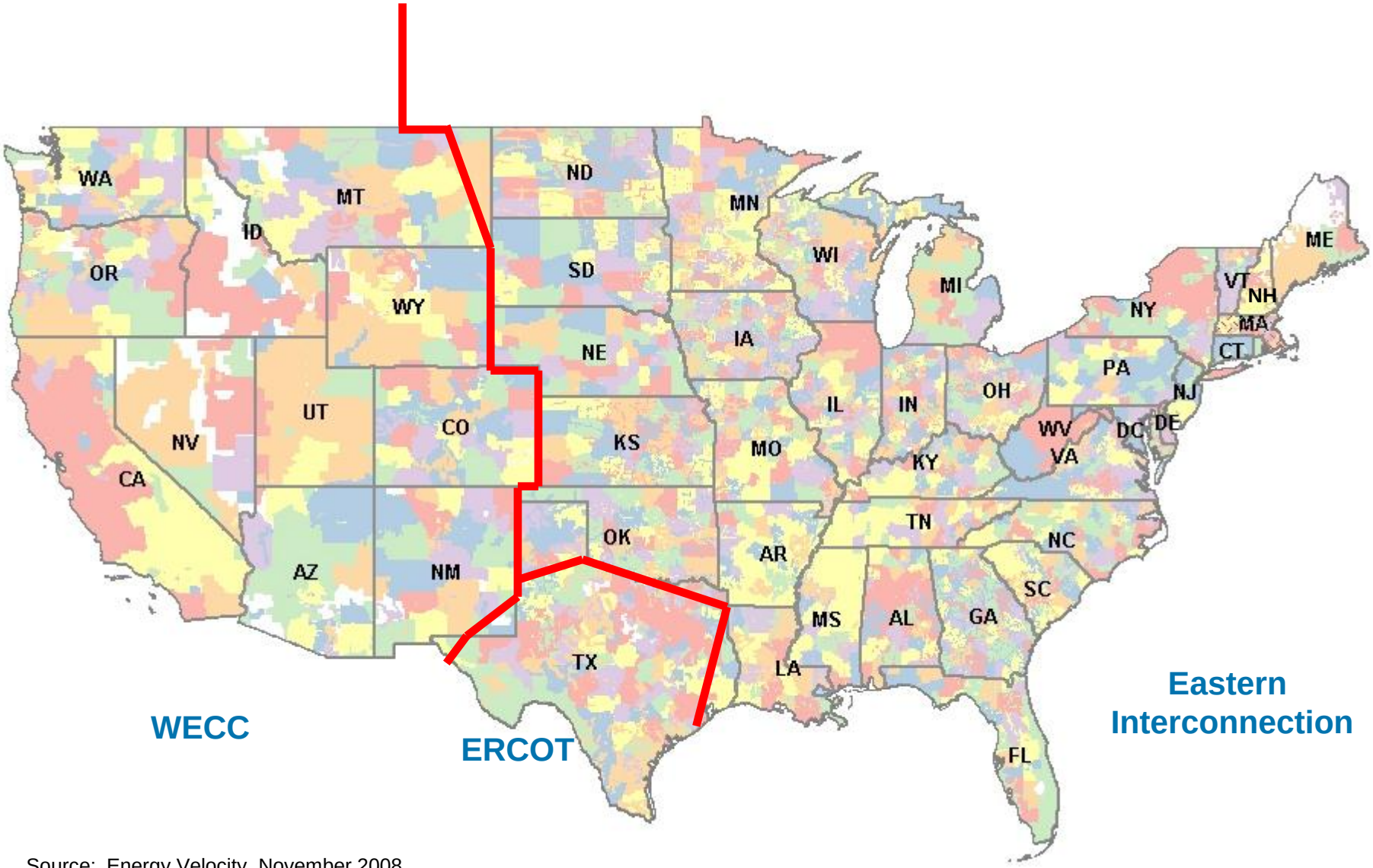
… there is a patchwork of U.S. transmission owners



Source: Energy Velocity, November 2008.

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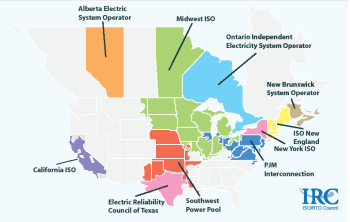
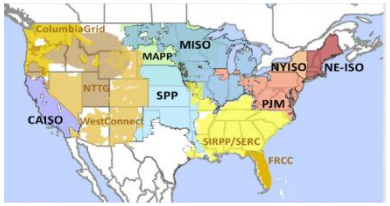
Implications for system planning

- Lack of synchronized market signals
- Generation and transmission planning processes are not sufficiently coordinated on a regional and inter-regional basis
- Lack of efficient coordination between generation and transmission expansion





- Transmission development is largely within jurisdiction of individual states. Major proposed transmission projects cut across multiple transmission companies and multiple states

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FERC Order 1000 on Transmission Planning & Cost Allocation

- Transmission Planning
  - Requires transmission planning at the regional level to consider and evaluate possible transmission alternatives and produce a regional transmission plan
- Cost Allocation
  - Requires the cost of transmission solutions chosen to meet regional transmission needs to be allocated fairly to beneficiaries

FERC Order 1000: Regional Planning

- Public utility transmission providers are required to participate in a regional transmission planning process that satisfies set principles and produces a regional transmission plan
- Local and regional transmission planning processes must consider transmission needs driven by public policy requirements established by state or federal laws or regulations
- Public utility transmission providers in each pair of neighboring transmission planning regions must coordinate to determine if more efficient or cost-effective solutions are available

Source: Shiv Mani. Presentation at the NECA Conference, November 2011

FERC Order 1000: Cost Allocation

- Regional transmission planning process must have a regional cost allocation method for a new transmission facility selected in the regional transmission plan for purposes of cost allocation
- Neighboring transmission planning regions must have a common interregional cost allocation method for a new interregional transmission facility that the regions select
- Costs allocated “roughly commensurate” with estimated benefits
- Those who do not benefit from transmission do not have to pay for it
- Benefit-to-cost thresholds must not exclude projects with significant net benefits
- No allocation of costs outside a region unless other region agrees
- Cost allocation methods and identification of beneficiaries must be transparent
- Different allocation methods could apply to different types of transmission facilities

Source: Shiv Mani Presentation at the NECA Conference, November 2011

FERC Order 1000: Cost Allocation (cont'd)

- The rule does not require a one-size fits all method for allocating costs of transmission facilities
- Each region is to develop its own proposed cost allocation method(s)
- If region can't decide on a cost allocation method, then FERC would decide based on the record
- No interconnection wide cost allocation

Source: Shiv Mani. Presentation at the NECA Conference, November 2011

Accommodation of Renewable Portfolio Standards into the Market Structure

- Presently Renewable Portfolio Standard requirements are not incorporated into the capacity market structure
- This leads to sub-optimal selection of resources
- Proposals begin to emerge (e.g., National Grid US) to incorporate RPS into the capacity market structure

Attributes of the Future Electricity Market Model for the U.S.

Market Attribute	Future Status
Multiple regional markets	Will persist
Centralized market structures	Will expand (e.g. Entergy, WECC)
Commitment and dispatch	Nodal market structure to remain, further enhanced by intra-day unit commitment processes and more granular operational structure (e.g. 10 min – 5 min – 1 min – real-time) Will co-optimizes generation dispatch with transmission controls, e.g. dynamic topology
Ancillary services	Wider spectrum of services, co-optimized with unit commitment and dispatch. But… potentially could become obsolete with advancement of stochastic optimization approaches
Capacity markets	Will further evolve, could be based on stochastic optimization embedding resource adequacy assessment, variable resources, RPS-type policies. Will attempt to properly co-optimize generation, selection of generation types capable of providing certain ancillary services and transmission expansion projects within the same market structure
Financial Transmission Rights and Virtual Bidding	Will become more sophisticated to provide better hedging opportunities
Emerging market services	Measurements and forecasting of variable generation

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