Electric Industry Perspective: Policy and Market Forces Transforming Electric Power

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NYSERDA 2011 EMEP Conference
November 15, 2011
Albany, New York
Introducing EPRI...

- Founded in 1972
- Independent, nonprofit center for public interest energy and environmental research
- **Collaborative** resource for the electricity sector
- Major offices in Palo Alto, CA; Charlotte, NC; Knoxville, TN
  - Laboratories in Knoxville, Charlotte and Lenox, MA

Chauncey Starr
EPRI Founder
Our Mission…

To conduct research on key issues facing the electricity sector…on behalf of its members, energy stakeholders, and society.
Looking Forward … Prism 2.0

Building upon previous EPRI Prism…

• US economy-wide model incorporating regional detail

• Improved treatment of renewables
  – High-resolution wind and solar resource data
  – Full treatment of integration costs of variable generation
  – Integrated biomass model with resource competition

• Full complement of environmental regulations

• Expanded demand-side detail by region
  – Energy efficiency, demand response, and distributed resources
Prism 2.0 Project Funders
Prism Model Designed to Appreciate Nuances of Carbon and Clean Energy Policy

Wind

Solar

Bioenergy

CAES Storage

New Interregional Transmission

8,760 Hourly Loads
Four Key Issues Driving Electric Power’s Future

• Climate policy

• Converging environmental initiatives

• Renewables and clean energy policy

• Natural gas prices
Climate Legislation Unlikely Soon but Potential for a National Cap-and-trade Program Remains

Net Estimates of Emissions Reductions Under Pollution Reduction Proposals in the 111th U.S. Congress, 2005-2050

June 8, 2010

- Business as usual
- 2005 levels
- 1990 levels

- CLEARA, S. 2877 (as introduced)**
  - Emission cap only
- APA, (discussion draft) (as introduced)***
  - Emission caps only
  - Caps plus all complementary requirements
  - Potential range of additional reductions
- ACESA, H.R. 2454 (as passed)***
  - Emission caps only
  - Caps plus all complementary requirements
  - Potential range of additional reductions

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Cutting National Emissions Likely to Mean Cutting CO$_2$ From Existing Coal

Electric sector’s share of national total (2006)

- 33% of total GHGs
- 39% of total CO$_2$

Shares within the electric sector CO$_2$

- 15% from natural gas  ($5/\text{MMBtu}$)
- 83% from coal  ($2/\text{MMBtu}$)

Policy cost will be driven by economics of coal substitution (renewables, nuclear, CCS, EE)
Region: Responses to CO₂ policy differ greatly by region
Regional Generation Mix: Clean Energy Standard

Responses to clean energy policy differ greatly by region
Key Question for Power Companies:
How Much to Keep Existing Coal Units Running?

Estimates of 50-100 GW of capacity “at risk”
## Pending Environmental Control Initiatives

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Perspective</th>
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<tbody>
<tr>
<td>SO$_2$; NO$_x$</td>
<td>• Cross State Air Pollution Rule in 2012&lt;br&gt;• Limited trading between states and regions</td>
</tr>
<tr>
<td>Hg; HAPs</td>
<td>• Technology-forcing regulations by 2015&lt;br&gt;• Scrubbing, SCRs&lt;br&gt;• Particulate control + ACI or Toxecon</td>
</tr>
<tr>
<td>316(b)</td>
<td>• Impingement/entrainment retrofits by 2020</td>
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<tr>
<td>Ash</td>
<td>• RCRA C or D designation by 2020</td>
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<tr>
<td>CO$_2$</td>
<td>• Cap, tax and/or performance standards</td>
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Total Cumulative Compliance Cost Potentially $300 Billion

Cumulative Retrofit Control Costs by Emission Stream ($ billions)

- Ash
- 316b
- Hg
- NOx
- SO2

Cumulative Control Costs ($ billions)

Cumulative Generation (GW)
Clean Air Act: Tremendous Progress but No Stopping Rule Implies Continued Action

U.S. SO2 Emissions Paths

- EPA history
- AEO11 Ref
- AEO11 HAPS

Year


Emissions (million tons/year)

0 2 4 6 8 10 12 14 16 18 20

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Wind: A Potentially Tremendous Resource that is Popular, Variable, and Distant

- AWS Truepower wind data
  - Provides simulated hourly output for typical turbine (80m height, 1.5 MW)
  - Derived from 1997-2010 meteorology

- Based on 5300+ identified “utility-scale” sites
  - Exclusion areas
  - 100 MW site minimum
  - Distance to grid
  - Terrain/wake effects
Location of Wind Resource by State and Capacity Factor

Potential Capacity (MW)

Capacity Factor (CF)

20%-15% 25%-20% 30%-25% 35%-30% 40%-35% 40%-50% 50%-45% >50%
EPRI Wind Resource Assessment from Truepower Shows Vast Generation Potential

2007 Combined On- and Off-shore Wind Generation Supply

Cost of Electricity ($/MWh)

Wind TWh (million MWh)

- 2007 Gen by Coal
- Total U.S. Gen in 2007
- Cost to generate a MWh from wind (no tax credits)
Anti-correlation of Wind with Load Critical to its Economics

NWC Time Series from 8/9/07 to 8/16/07 w 50 GW Added

- The morning up-ramp
- The evening down-ramp

Increased value for generation assets with faster ramping and lower minimums
National Wind Energy Potential Supply Curves* (including delivery costs)

*EPRI – AWS TruePower National Wind Energy Supply Curves
DOE Annual Energy Outlook (AEO) Natural Gas Price Forecasts Have Been Coming Down

Comparison of Natural Gas Price Series ($/MMBtu)
Markets and Forecasts Lining Up – What could possibly go wrong?

Comparison of Natural Gas and Coal Price Series ($/MMBtu)

- AEO2011 Gas
- NYMEX Gas (10/21/11) in 2009$
- AEO 2011 Coal
Some Observations on R&D Directions

• Resolving the uncertainty over climate policy

• Learning to capitalize on renewable resources, without dimming the lights or breaking the bank

• Deciding if/when enough is enough on air emission reductions

• Resolving natural gas resource development policy and environmental protection
Together…Shaping the Future of Electricity

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