Resource Planning Under Technology, Market, and Regulatory Uncertainty: Practical Approaches to Valuing Flexibility

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Agenda

- Major Risks Facing Electric Service Providers
  - Technology
  - Markets
  - Regulatory
- Application of Standard Decision Techniques
  - Deterministic forecasting
  - Stochastic Forecasting
  - Scenario Analysis
  - Real Option Approach
- Practical Application of Multiple Methods
Technology Risks

- Nuclear Development

- Integrated Gasification Combined Cycle with Carbon Capture and Sequestration (CCS)
  - Retrofit CCS
  - Renewable Technologies

Cost and Performance Trends
Market Risks

- Natural Gas Prices
- Capital Escalation for Conventional Generation
- Price Elasticity of Electric Demand
Estimates of available gas vary widely

- Estimates reflect evolving knowledge of geology & production issues
  - Resource = Amount of gas in place (GIP) by geotechnical estimation
  - Reserve = GIP x (Fractional Technical Producibility) x (Fractional Economic Producibility)

[Graph showing estimated gas-in-place and technically recoverable gas over time]

How much shale gas is available to North America?

Marcellus Shale Gas

Graphic source: Black & Veatch compilation from various public & private reports.
Finding and development costs are very uncertain

- Real gas production has been limited
- Indications are for higher-than-average F&D for Marcellus
  - $4-$5 / Mcf (?) vs. $1-$3 / Mcf for other plays

Cost of marginal North American supplies?
U.S. generating plant capital costs rose sharply from 2003 to 2008

In January 2007, 20-50% cost increase over previous 18-36 months

>50% increase; no declines noted yet
Key commodity prices have dropped ~50% since September 2008

\[\text{Carbon Steel}\]
\[\text{Copper Ores}\]
\[\text{Iron & Steel}\]
\[\text{Nickel}\]

* Source: Bureau of Labor Statistics

**Longer term trends and effects on capital goods prices?**
Load growth in past 15 years was accompanied by declining real electric prices. E.g., U.S. Southeast

**SERC Supply & Demand Analysis - VACAR**

Notes: (1) Cooling Degree Days are summations of positive differences between the mean daily temperature and the 65°F base and then population weighted to reflect temperature-related energy consumption
(2) Net Internal Demand is peak summer demand remaining after deduction of potential demand side management (DSM) and interruptible loads
(3) Gross Summer Demand is prior to DSM or interruptible load reductions
(4) Reserve margins based on Gross Summer Demand

**Effects of large real price increases?**
Volatile price signals to customers in gas-dominated electricity markets. E.g., ERCOT

**ERCOT Supply & Demand Analysis**

**Notes:**
1. Cooling Degree Days are summations of positive differences between the mean daily temperature and the 65°F base and then population weighted for effect on temperature-related energy consumption.
2. Net Internal Demand is peak summer demand remaining after deduction of potential demand side management (DSM) and interruptible loads.
3. Gross Summer Demand is prior to DSM or interruptible load reductions.
4. Reserve Margins based on Gross Summer Demand.
5. DSM averages 1.64% of Gross Summer Demand.

**Short-term vs. long-term demand elasticity?**
Regulatory Risks

- Potential GHG legislation
- Renewable Portfolio Standards
- End user efficiency requirements
- NOx, SOx and Mercury
GHG caps will drive marginal abatement costs

- Cap trajectories vary widely
- B-L-W calls for a ~30% total reduction from 2006 levels by 2030
- Rapid near-term GHG reduction could balloon carbon price
- Recession could defer effects of legislation
Estimated CO₂ avoidance / abatement costs vary from small or negative costs to over $110/ton.

Substitution of gas for coal not economic at >$12-14/mmbtu.
Need for CCS to meet caps is uncertain

- Combination of nuclear boom, CCCT build-out and dispatch priority, 10x increase in firmed wind, and expanded DSM likely not to meet 40% reduction target for power industry
- Off-system offsets could close part of gap
- PC retrofit or new IGCCs represent probable marginal on-system source of abatements, at cost (>70/ton) 60% greater than next less expensive block
- Faster growth of other options could erode coal plant economics

Market-clearing carbon price?
How is a Generating Company to make an investment decision in the face of such uncertainty?

Traditional methods still apply. The key is in their application and organization of the issues.

“Do nothing” is most often not an option.
Key Questions for Regulated and Public Utilities

- Do I need to add generating capacity?
- If so what type?
- What are my options? Nuclear participation?
- Will I soon need to meet an RPS target or pay for CO2 emissions? If so how much?
- Is it better to invest to keep existing older generators operating or to replace them?
- Can my customers support the costs or will I remain competitive?
Deterministic comparisons of revenue requirements or investment returns establish the best decision, but do not consider risk.
Sensitivity and scenario analyses can identify a low-cost plan/investment in spite of uncertainties in future conditions. Scenario analyses can combine correlated risks.

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135 of a 235 MW PC with capacity return in 2020 is least cost in all cases.
Graphic comparisons can clearly illustrate the risks of each plan.
Probabilistic risk assessments may add value beyond scenario analyses.

Best used if:

- input probability distributions can be empirically derived
- decisions are modeled dynamically

Often miss-applied
How do generating companies account for risk?

- Consider a variety of outcomes
  - In mixed scenarios and/or stochastically
  - Even if legislation is passed, it may be rescinded if costs are too high
- Understand own costs relative to other regional participants
- Understand the full dynamic interactions between drivers
  - Gas price impacts and GHG abatement costs
  - Replacement capacity capital costs
- Keep options open – have contingency plans
- Consider a real option approach to buying time

*Use comprehensive analyses focused to identify and simplify the key tradeoff decisions.*