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Natural Gas Utilities Options Analysis for the Hydrogen Economy

> **Hydrogen Pipeline R&D Project Review Meeting**
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Mark E. Richards
Manager, Advanced Energy Systems

Team and Collaborators

> Team
  – Gas Technology Institute
  – RAND Corporation
  – Ares Corporation

> Collaborators
  – Keyspan
  – NiSource
  – Southern California Gas

Funding and Duration

> Funding: $300,000
  – Carve-out of NiSource earmark
> Duration
  – Original plan was nine months
  – Current expectation is approximately 12-14 months, completion in fourth quarter 2005

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Objectives

> Identify business opportunities and valuation of strategic options for the natural gas industry as hydrogen energy systems evolve

  – Vehicle to encourage a strategic perspective regarding hydrogen and to encourage their engagement in policy development

Approach

> Define/refine markets for analysis
  – Power generation, generation/transport of hydrogen, vehicle fueling
> Model development
  – Structures for selected markets
  – Real options decision structures
    > Overlay of exploratory modeling (scenarios and economics) on real options lattice
> Model execution and analysis
  – Exploratory simulation and data mining

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Results and Accomplishments

> Initial utility interviews and follow-ups
> Policy considerations
> Model development
> Model execution
> Interim results

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Collaborators' Views

> Each organization has different sets of assets and risks, but many common themes emerged

- 3-5 year investment window
- Investments in new technologies must reflect a core business need:
  - > Reduce risks (e.g. LNG investments), or
  - > Mobilize underutilized assets, or
  - > Serve as "platform" for other technologies
- Little in-house R&D, but some equity investments
- Unregulated energy service subsidiary may be most practical vehicle for introduction of hydrogen
- Skeptical of hydrogen, but are very interested in finding out whether it can be part of core business, and generally interested in new methodologies that give richer sense of risks and uncertainties

Policy Considerations

> Renewable Portfolio Standard (RPS) initiatives may appreciably detract from gas load growth for electric generation over the next 20 years
> The gas industry may recoup some of this lost gas growth through involvement in RPS
  – Selling gas to fuel cell owners/operators
  – Selling electricity generated by fuel cells or service contract
  – Selling other types of energy services that qualify (e.g. hydrogen/renewables synergies, carbon sequestration)
> However, it depends greatly on whether fuel cells qualify within renewable legislation
  – Legislation is still young, but both policymakers and industry could benefit from analysis of tradeoffs
  – NY state qualifies natural gas-run fuel cells, CA only renewable hydrogen (potential for partial credits?)

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Model Development: Markets and Policy

> Market model aspects
  – Forecast the size of the renewables market
  – Estimate potential loss of natural gas load from 2005-2020
  – Use reduced-form model for simplicity, interpretability and compatibility with other models
> Government policies regarding renewables and fuel cells
  – RPS adoption rates: standard, accelerated, decline
  – Fuel cells may play a role within the RPS market if they qualify for partial or total renewable energy credit
> Market and technology assumptions
  – Electricity and gas growth rates
  – Gas displacement and heat rates
> Geographic specificity
  – California used as template, but structure can transfer well to other regions

Model Development: Real Options

> Core decision analysis model is based on real options valuation
  – Solves for optimal investment pathways, given set of strategies, uncertainties, and payoffs
  – Discrete time, 15-year period (2006-2020)
> Strategies (core branch)
  – Early investment
  – Defer until market or policy signal
  – Business-as-usual
> Investments and options
  – Investments include learning investments (e.g. market study), R&D, and expanding unregulated energy services subsidiary
  – Investments serve as options on future investments (sequential options) in market
  – Options to defer, expand, abandon investment at various points

Model Execution: Exploratory Simulation

> Many of the relationships within the model are described parametrically
  - Real Options and Market Models contain more than 20 adjustable parameters that describe probabilities, states, payoffs and relationships
  - These relationships are either (1) difficult or cumbersome to describe, (2) unknown, or possibly (3) unknowable

> We are interested where solution set has breaking points
  - Goal is to search for regions of the solution space where behavior is "interesting" and thus where further study is needed
  - A strategy that performs poorly relative to best strategy for a particular scenario has a high "regret"

> Implemented software developed by RAND to visualize and analyze solution space of complex models
  - Parametric exploration over solution space of Real Options Model

Model Execution: Data Mining

> Once a database is constructed with the full solution space, goal is to identify regions where any particular strategies dominates

> Search for clusters or "hybercubes"

– Low-dimensional regions where there is a high probability of one type of outcome (e.g. high regret or ROI)

> Scenario development

– Lower dimensionality aids in developing narrative scenarios that make intuitive sense and quantitative underpinning

Modeling Approach Assumptions

> Government action is uncertain
  – Government action is increasingly uncertain the deeper industry looks into future
  – Represented by perfect certainty until 2010, and probability of collapsed or accelerated RPS from 2010-2020
> Investment resolves some technical and market uncertainties
  – Pilot study/market study gives imperfect insights, at low cost
  – Investments in R&D and Energy Services Subsidiary resolves market uncertainty (e.g. how big is the fuel cell market?), but at higher cost
> Industry may be able to shape market…or not
  – Early investment may have some impact on the natural gas industry's market position in the fuel cell market
  – Early investment may also have an impact on the viability of the fuel cell market as a whole (e.g. successful R&D)

Some Interim Results

> Early Action is the most robust strategy within the following clusters or scenarios

> Scenario 1: Profitable Early Market
  – If an early fuel cell market emerges that is competitive with renewables and the utility has a good ability to gauge this market, regardless of long-term outcome of market
  – "Competitive" here means either on an straight economic basis or because it is included within RPS

> Scenario 2: Market Shaping
  – If early investments can increase the likelihood of the fuel cell market emerging and also increasing the industry's share of this market, regardless of viability of early market

Future Plans

> Meeting(s) with collaborators to review initial results and incorporate feedback
> Revise and integrate overall scenarios
> Perform exploratory analyses
> Issue draft report

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