Restoring the Nuclear Option in the U.S.: A Real Options Approach

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Agenda

- New Cost Claims for Nuclear Power
- The Nuclear Plant Investment Opportunity
- Using Real Options to Value the Plant

Limited Presentation Time

Presentation Will Stress Real Option Concepts Over Numbers
Nuclear Power Was Priced Out of the U.S. Power Markets

As-Built Cost ($/kWe)


$0 $1,000 $2,000 $3,000 $4,000 $5,000 $6,000 $7,000

1973-74 Energy Crisis

TMI Nuclear Accident (1979)

Last Plant in Service (1996)

Last Orders (1978)
Do New Capital Cost Claims Restore Nuclear Competitiveness?
Impact of New Nuclear Supplier Claims ($/Mwhr)

- **Coal**
- **Gas**
- **Nuclear**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Coal</th>
<th>Gas</th>
<th>Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEO 2005</td>
<td>45.6</td>
<td>52.2</td>
<td>46.1</td>
</tr>
<tr>
<td>Carbon New Nuclear Claims</td>
<td>50.2</td>
<td>73.7</td>
<td>50.2</td>
</tr>
<tr>
<td>New Nuclear Claims</td>
<td>50.2</td>
<td>73.7</td>
<td>43.5</td>
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</tbody>
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A Nuclear Plant Opportunity Was Identified in Texas

- Increasing natural gas prices have Texas Gulf Coast petrochemical firms interested in nuclear plant
- TIACT/DOE commissioned nuclear plant feasibility study (under Nuclear 2010 Initiative)
- EnergyPath & Sandia National Laboratory prime contractors

Real Data Becomes Available!
Supplier Data Much Improved; But Construction Cost Still an Uncertainty

Factors:
- Supplier Capital Cost
- Interest During Construction
- Time to construction (i.e. delays)

Results
Mean: $1800/kw
95% CI: $1450-$2150/kw
Future Electric Prices Affected By Natural Gas Prices and Environmental Policy

Electric Prices are Primary Reason for Plant Present Value Uncertainty

90% Confidence Intervals

Environmental Scenario (i.e. Cap & Trade)

Optimistic Gas Scenario

Source: AEO 2005
Simulation of Plant NPV

Mean -$241M

Plant Uneconomic Using Standard NPV Rule

Net Present Value ($M)
Plant Construction Schedule
Has 3 Distinct Sequential Phases

Phase 1: Supplier Bids & Site Selection ($18M)
15 Mo

Phase 2: Acquire COL ($127M)
41 Mo

Phase 3: Construct Plant ($2950M)
41 Mo

Has 3 Distinct Sequential Phases

15 Mo

41 Mo

41 Mo

56 Months

97 Months

0% 20% 40% 60% 80% 100%
Identify Two Sequential Embedded Options in this Project Schedule

NO? Abandon Project (Lose Site & Supplier Cost)

Site & Supplier

Option 1 Exercise Licensing Option?

YES? Apply for COL

Option 2: Exercise Construction Option?

NO? Abandon Project (Lose All Costs)

COL

YES? Initiate Construction

Construction

Plant Value (V) & Investment (I) Uncertainty Decreases
The Presence of Options Renders the NPV Conclusion Wrong Because it Overlooks Opportunity Cost

Time Value-expects opportunity cost of investing immediately

Time Value Takes Into Account That The Plant & Investment Values are Changing over Time as Uncertainties are Resolved
Solution Procedure

- Binomial Real Options Model Employed

- Plant Value and Investment are Both Random Variables (complicates solution)

- Result is Obtained Using Backwards Recursion

Is Cost of 1st Option < Option Value?
## Results

<table>
<thead>
<tr>
<th>Present Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected NPV</td>
<td>($)240M</td>
</tr>
<tr>
<td>Expected Opportunity Cost</td>
<td>+$260M</td>
</tr>
<tr>
<td>Value of Option to Wait</td>
<td>+$20M</td>
</tr>
<tr>
<td>Option Cost</td>
<td>+$17M</td>
</tr>
</tbody>
</table>

Cost < Value
Buy Option (Execute 1st Phase)

Plant
Uneconomic
Conclusions

- NPV analysis understates true project value if significant uncertainty is present;

- Large energy industry capital investments almost always involve a high degree of uncertainty;

- If investment flexibility is possible (and it almost always is), then a real options approach produces a better decision;

- Nuclear plants represent one of the largest and most uncertain investments in the energy industry and have a high degree of investment flexibility; a real options analysis is essential

Lone Star Nuclear Incorporated in Texas in 2004
Thank You For Listening to Our Presentation

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TIACT Study Available On

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