Synapse
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The Risks of Building New Nuclear Power Plants

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Deja Vue – All Over Again?

- Atomic Energy originally promoted as “too cheap to meter”
- But existing generation of nuclear units became so expensive:
  - Owners experienced severe financial problems
  - Many plants cancelled
  - Many cost disallowances and settlements in lieu of disallowances
  - Plants sold/divested at far below book value – ratepayers bore hundreds of millions of stranded costs

US Nuclear Industry Construction Cost Experience

- The nuclear plants operating in U.S. today were built in the 1960s-1980s.
- Data compiled by U.S. Department of Energy reveals that originally estimated cost of 75 of today's nuclear units was $45 billion in 1990 dollars.
- Actual cost of the 75 units was $145 billion, also in 1990 dollars.
- $100 billion cost overrun was more than 200 percent above the initial cost estimates.
- $100 billion overrun does not include escalation and interest.

U.S. Nuclear Industry Construction Cost Experience

Year Construction Started	Estimated Overnight Cost (1990$)	Actual Overnight Cost (1990$)	Actual vs. Estimated Cost
1966-67	$560/kW	$1,170/kW	209%
1968-69	$679/kW	$2,000/kW	294%
1970-71	$760/kW	$2,650/kW	348%
1972-73	$1,117/kW	$3,555/kW	318%
1974-75	$1,156/kW	$4,410/kW	381%
1976-77	$1,493/kW	$4,008/kW	269%

U.S. Nuclear Industry Construction Cost Experience

- DOE study understates cost overruns because (1) it does not include all of the overruns at all of the 75 units and (2) it does not include some of the most expensive plants – e.g. Comanche Peak, South Texas, Seabrook, Vogtle.
- For example, cost of the two unit Vogtle plant in Georgia increased from $660 million to $8.7 billion in nominal dollars – a 1200 percent overrun.

Many Owners Experienced Significant Financial Problems

- Public Service Company of New Hampshire went bankrupt due to financing difficulties associated with the Seabrook Nuclear Plant.
- Long Island Lighting Company nearly went bankrupt – sold $5 billion Shoreham nuclear plant to State of New York for $1. Share price dropped from high of $19.75 in 1978 to less than $7 in 1984.
- Consumers Power nearly went bankrupt – Midland nuclear plant originally estimated to open in 1975 and cost about $500 million. Ten years and $3.5 billion later, Company cancelled the unfinished plant. Shares dropped from $55 pre-Midland to $5 + Company suspended common stock dividend.

State Regulatory Commissions Disallowed Recovery of Substantial Amounts of Imprudently Incurred Costs

- From 1984 to 1993, electric utilities with nuclear construction projects wrote off in excess of $17 billion, net of tax effects, for abandoned plants and regulatory disallowances.
- In 1980s alone, state commissions disallowed from utility rate base more than $7 billion of nuclear costs due to construction imprudence.
- Another $2 billion in nuclear costs were disallowed due to imprudence of building new capacity that was physically excess when completed.

Examples of Individual Plant Disallowances

- Texas Utilities forced to write off $1.2 billion disallowance of Comanche Peak nuclear plants.
- Georgia Public Service Commission disallowed $1.1 billion due to mismanagement of construction of Vogtle nuclear units.
- Owners of the Nine Mile Point Unit 2 nuclear plant agreed to $4.45 billion cap for ratepayer recovery of costs for the unit. This meant that the owners would absorb at least $1.56 billion in project costs.
- $1.4 billion disallowance of the construction costs of Gulf States Utilities' River Bend Station.
- Many other nuclear plant owners also forced to absorb significant construction cost disallowances

Investments in New Nuclear Plants Remain Very Risky

- Industry now optimistically estimates that new generation of nuclear plants can be built at lower cost -- for $1,200 - $2,000 per KW. This means $2-$3 billion construction cost for a new nuclear plant.
- These optimistic cost estimates based on new plant designs that have not actually been built in the US and on changes in the US regulatory process.
- These estimates are from 2004 and earlier years. Do not reflect changed much more competitive environment for design, labor and commodity resources needed to build power plants.
- At same time, due to earlier overruns, the nuclear industry has a serious credibility issue concerning the reliability of nuclear construction cost estimates.

Costs of New Power Plants Have Soared in Recent Years

- It is generally accepted that power plant capital costs have increased dramatically in the past 2-3 years.
- For example, Duke Energy has said that coal plant costs have increased by approximately 90% to 100% since 2002 - costs have increased by more than 40% just since early 2006.

Factors Which Have Led to Rising Power Plant Construction Costs

- Cost increases are due, in large part, to significant increase in worldwide demand for power plants. Demand for plants is straining the supply.
- Demand from China and India.
- Strong U.S. demand for new power plants and pollution control projects for older plants.
- Limited capacity of EPC (Engineering, Procurement and Construction) firms and manufacturers.
- Fewer bidders for work, higher prices, earlier payment schedules and longer delivery times.

Rising Power Plant Cost Escalation

- Significant cost increases for critical power plant commodities, e.g., steel, copper, cement, fabricated alloy piping.

Table 1

Commodity/ Construction Material	Avg. Annual Escalation from ~1986 – 2003 (Recent Historic Average)	Avg. Annual Escalation Since Dec. 2003 – April 2007 (Last 40 Months)	Last 40 Mo. Of Escalation As Ratio of Recent Historic Avg.
Nickel	3.80%	60.30%	15.9X
Copper	3.30%	69.20%	21X
Cement	2.70%	11.60%	4.3X
Iron & Steel	1.20%	19.60%	16.3X
Heavy Construction	2.20%	10.50%	4.8X

Sources: Nickel, Copper: London Metal Exchange
Cement, Iron, Steel & Heavy Construction: U.S. Bureau of Labor Statistics

- Source American Electric Power

Rising Power Plant Cost Escalation

- Demand and cost have escalated significantly for both on-site construction labor and skilled manufacturing labor
- There are some regional labor shortages.
- Reasonable to expect that these changed market conditions also will increase capital costs of new nuclear power plant.

What U.S. has done to encourage investment in new nuclear units

- Streamlining licensing process
  - Early Site Permitting
  - Combined construction and operating licenses
  - Significantly limited role for public in hearing process
  - NRC pre-approval of standardized plant designs
  - Allow utilities to use more commercial grade components and equipment

What U.S. is doing to encourage investment in new nuclear units

- Financial incentives in EPACT 2005
  - Extension of Price-Anderson Act to 2025
  - 1.8 cents per kWh production tax credit for first 6,000 MW of new nuclear generation for first 8 years of operation. Limited to a total of $125 million per 1,000 MW of new generation
  - Insures utilities for construction delays due to hearings or litigation.
  - Federal guarantees for up to 80 percent of estimated project costs for innovative technologies – including new advanced nuclear reactor designs – that will diversify and increase energy supply while protecting the environment.
- Moral Support from federal government

New Power Plant Designs Under Consideration in the US

- 4 main designs are under consideration for the new nuclear plants in the U.S.

  Advanced Boiling Water Reactor (ABWR)
  Westinghouse AP1000
  GE Extra Simplified BWR (ESBWR)
  European Pressurized Water Reactor (EPR)

The ABWR and AP1000 designs already have been pre-approved by NRC.

New Power Plant Designs Under Consideration in the US

- Although it contains many design changes, the ABWR basically is an updated version of the BWRs that were built in the US in the 1960s-1990s.
- Four ABWRs have been built in Japan. Two more are under-construction in Taiwan.
- The AP1000, ESBWR and EPR represent very different designs with new passive design features.
- Will use natural circulation, larger design margins and fewer plant systems.

Actual Construction or Operating Experience with New Plant Designs

- No operating experience with any plant with AP1000, ESBWR or EPR design.
- Only one plant with an EPR design – Olkiluoto-3 – is even under construction.
- Project has experienced significant problems, delays and cost increases.
- Turnkey project -- builder, the French company Areva, took a $922 million write off in 2006 due to cost increases at Olkiluoto-3.
- Project now 18 months to 2 years behind schedule, with currently projected completion in 2009 and 2010.

Japan and Taiwan ABWR Cost Experience

- First 2 ABWRs completed in Japan in 1995 and 1996 cost about $2000/kW
- 3rd ABWR, Shira 2, has been described as "expensive" compared to these first two units, costing between $2375-$2590/kW.
- 4th ABWR in Japan cost about $2220-2224/kW.
- Two 1350 MW ABWRs under construction in Taiwan were originally projected to cost about $3.7 billion and to be completed in 2003 and 2004.
- Latest estimates - commercial operations will not start until 2009 and 2010 and project may cost between $7.4 and $9.1 billion.

US Nuclear Industry Plans

- The NRC has said that it has received letters of intent for 19 construction-operating license applications (COL) including 27 reactors.
- These include:
  - Constellation Power – 2 EPR plants at Calvert Cliffs and Nine Mile Point (NY)
  - Dominion – 2 ESBWR at North Anna (VA)
  - Duke – 2 AP1000 at Cherokee in South Carolina
  - Exelon – 1 plant at the Clinton site (IL)
  - NRG – 2 ABWRs at South Texas
  - NuStart Consortium/Entergy – 1 ESBWR in Mississippi
  - NuStart/TVA = 1 AP1000 at the Bellefonte site (AL)
  - Progress -2 AP1000, 1 in FL, 1 in NC
  - SCANA – 2 AP1000 in SC
  - Southern Company – 2 AP1000 in GA
  - TXU – 6 new units with undetermined design

Mega-Project Construction Cost Experience

- New billion dollar mega-projects traditionally cost much more than original estimates.
- Especially true for first-of-a-kind projects
- 1988 RAND Corporation studied the performance of 52 mega-projects.
- Study concluded that: "the data on cost growth, schedule slippage and performance shortfalls of megaprojects are certainly sobering, but the most chilling statistic is that only about one in three of these projects is meeting its profit goals… Megaprojects take so long to develop from concept to reality that the need or opportunity for profits that originally spawned them may have passed by the time they are ready to begin producing"

Nuclear Power and Climate Change

- MIT and Princeton studies suggest that in order to make a significant contribution to reducing world CO_2 emissions, 1,000 new reactors will have to be built by 2050 – that's 2 new reactors coming on line each month.
- A study by the Institute for Energy and Environmental Research suggests that between 1,900 and 3,000 reactors would be needed to maintain global CO_2 emissions at year 2000 levels. That would be one new reactor almost every week.

Consequences of Expansion of Nuclear Power

- A recent assessment for the Council of Foreign Relations has concluded that:

  As a practical matter, building reactors at this rapid pace would initially tend to drive up unit costs and, thus, scare off investors. For example, there are currently only a few companies in the world that can make reactor-quality steel, concrete, and other vital parts. Moreover, a rush to build would aggravate existing shortages of skilled workers to construct the reactors, qualified engineers to run the power plants, and inspectors to ensure safe operations.

  AND

  In the foreseeable future, nuclear energy is not a major part of the solution to further countering global warming or energy insecurity. Expanding nuclear energy use to make a relatively modest contribution to combating climate change would require constructing nuclear plants at a rate so rapid as to create shortages in building materials, trained personnel, and safety controls.

Consequences of Expansion of Nuclear Power

- Expansion of nuclear power would exacerbate waste and nuclear proliferation concerns.
- New nuclear power plants would increase the need for new permanent fuel repositories unless reprocessing of spent reactor fuel is attempted. There are currently no permanent waste repositories anywhere in the world.
- But reprocessing is more expensive and could not handle all existing spent fuel wastes and new wastes that would be created by the new plants unless there were a significant number of reprocessing plants around the country and new reprocessing technologies are developed.
- However, the new reprocessing technologies now being developed have not been proven beyond laboratory bench tests at about 1/1,000,000 scale.

Consequences of Expansion of Nuclear Power

- Use of reprocessing to facilitate expansion of nuclear industry also would create more pure plutonium or other weapons grade materials that could be used by terrorists.

Economics of New Nuclear Power Plants

- New nuclear power plants are being promoted as a green option for reducing emissions of greenhouse gases.
- However, analyses show that there are renewable and energy efficiency that are more economic and carry fewer risks than new nuclear units.
- For example, in 2005 Synapse compared the cost of a new nuclear unit with an alternative portfolio of wind, energy efficiency and natural gas-fired generation.

2005 Synapse Study

Type of Capacity	Installed Capacity Rating	Capacity Factor	Generation (GWh)	Cents/kWh Cost (2003)	Total Cost of GWh Generated (2003$)
Nuclear	2,180 MW	90%	17,187	6.8	$1,169 million
Portfolio:					
Wind	1,500 MW	35%	4,599	4.5-6.0	$207-$276 million
Gas	1,220 MW	85%	9,084	4.7	$427 million
Efficiency	NA	NA	3,504	4.4	$154 million
Combination	NA	NA	17,187	4.7	$788-$806 million

Economics of New Nuclear Power Plants

- This comparison does not reflect higher plant capital costs and more recent natural gas prices.
- For example, Entergy recently has estimated the cost of a new nuclear power plant as $4,000/Kw. This means a total cost of $90/MWh or 9 cents/KWh to produce power at a new nuclear plant.

Remaining Nuclear Risks for Plant Owners and Investors

- **Risk of higher construction costs**
  - Higher costs due to changed market conditions and increased worldwide demand for new power plants.
  - Availability of skilled craftsmen
  - Some significant increases in construction costs should be expected even if actions by federal government and nuclear industry mean no repeat of the 200 percent or higher overruns experienced by the existing generation of plants.
- **Risk of regulatory delays due to first-of-a-kind designs, inadequate documentation, or insufficient NRC staff (i.e., too many applications, too few staff to review).**
- **Risk that future state commissions in regulated states will not pass imprudently incurred construction or operation costs through to ratepayers.**

Remaining Nuclear Risks for Plant Owners and Investors (con't)

- **Risks resulting from deregulation of electric industry in areas of the U.S.**
  - **No captive customers**
  - **Plant owners must fund entire decommissioning liability.**
- **Risk of loss of substantial plant investment as a result of a significant accident or incident – TMI-2 went from a billion dollar asset to a liability in less than an hour.**
- **Risk that federal subsidies and guarantees will not be sufficient to induce investors**

Remaining Nuclear Risks for Plant Owners and Investors (con't)

- **Risk that not enough new nuclear power plants of any one design will be built and, therefore, that critical economies of scale and learning curve will not be achieved – as result, nuclear units will not become cost competitive without substantial continuing governmental incentives and guarantees.**
- **Risk that Congress will revise, limit or eliminate nuclear incentives and guarantees in EPACT2005.**
- **Public Acceptance of new nuclear units could be lost if a significant accident/event occurs at any nuclear plant**
- **Risks associated with temporary storage and the permanent disposal of high level nuclear wastes.**
- **Risk of nuclear terrorism.**

