***Disclaimer*: This draft report was prepared to help the Department of Energy determine the barriers related to the deployment of new nuclear power plants but does not necessarily represent the views or policy of the Department.**

Business Case for New Nuclear Power Plants

Bringing Public and Private Resources Together for Nuclear Energy

Mitigating Critical Risks on Early Orders for New Reactors

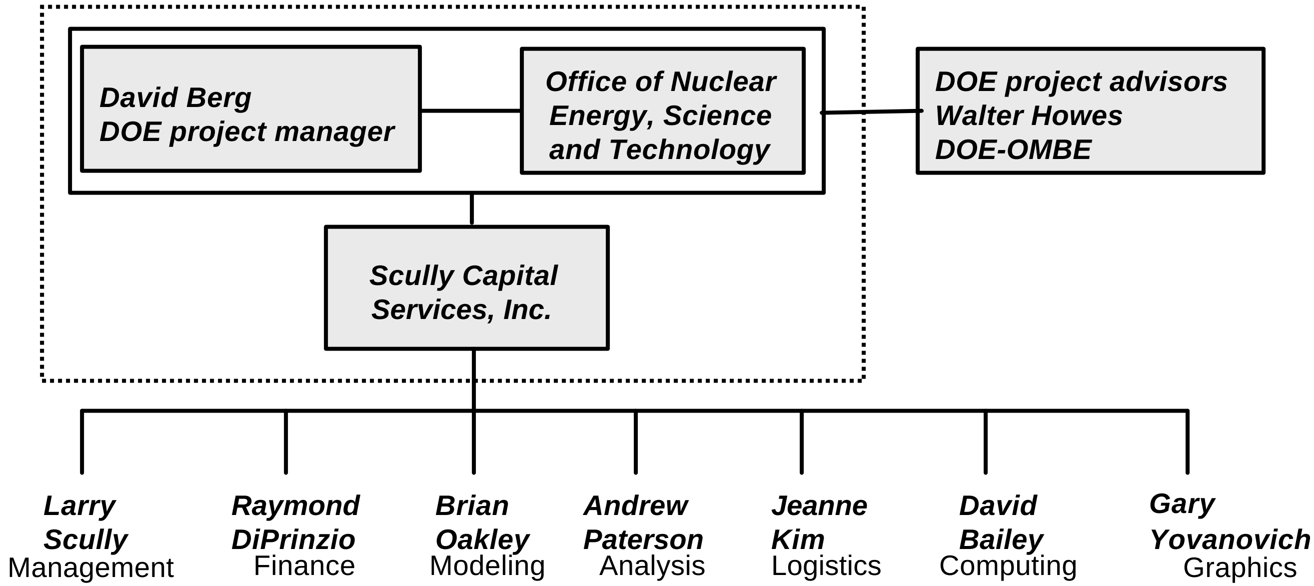
Briefing for NERAC
October 1, 2002

SCULLY CAPITAL
WASHINGTON NEW YORK

Nuclear Energy

Integrated Project Team Process

- Integrated project team (IPT) approach facilitated consideration of complex issues involved in the project and to ensure contractor access to important data from NE.
- IPT members: Scully Capital, DOE project manager, key NE staff, and advisors.
- Consultations with NE senior management.
- IPT met weekly, plus consulted, as needed; vetted assumptions; brought combined expertise of team members to bear rapidly and fully.



Introduction and Policy Background

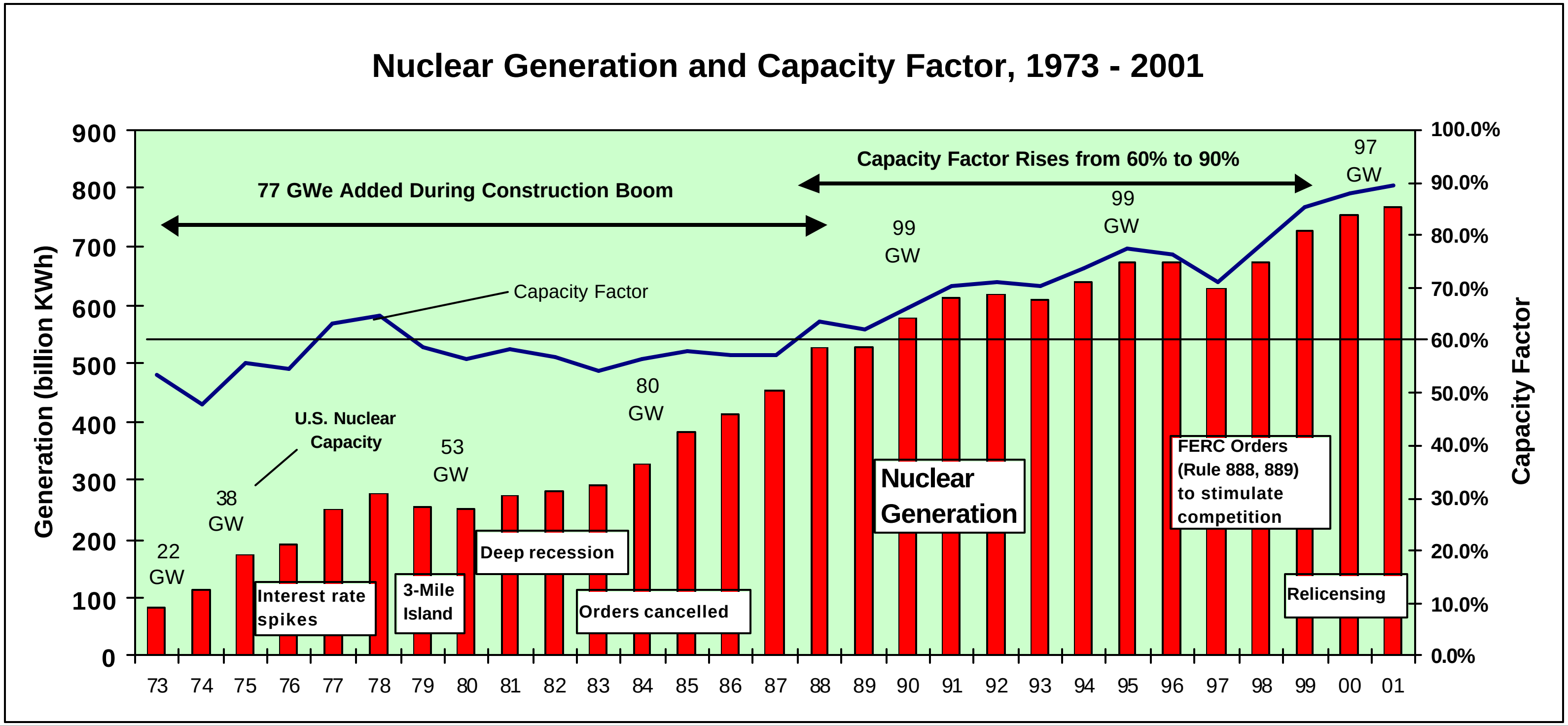
- U.S. **National Energy Policy recommended** (NEP, May 2001): **The President should support expansion of nuclear energy** as "a major component of national energy policy", noting that nuclear power offers a low-cost, safe, and environmentally clean source of energy (usually in the form of electricity).
- Energy **Secretary Abraham recommended** (February 2002): **Yucca Mountain should be formally considered for disposal** of nuclear spent fuel.
- **President Bush called** (May 2002): For development of a U.S. strategy to **reduce carbon intensity** in the American economy.
- The current study improved DOE's understanding of the business risks and risk management strategies associated with new nuclear power plants.

Market Context for Nuclear Power

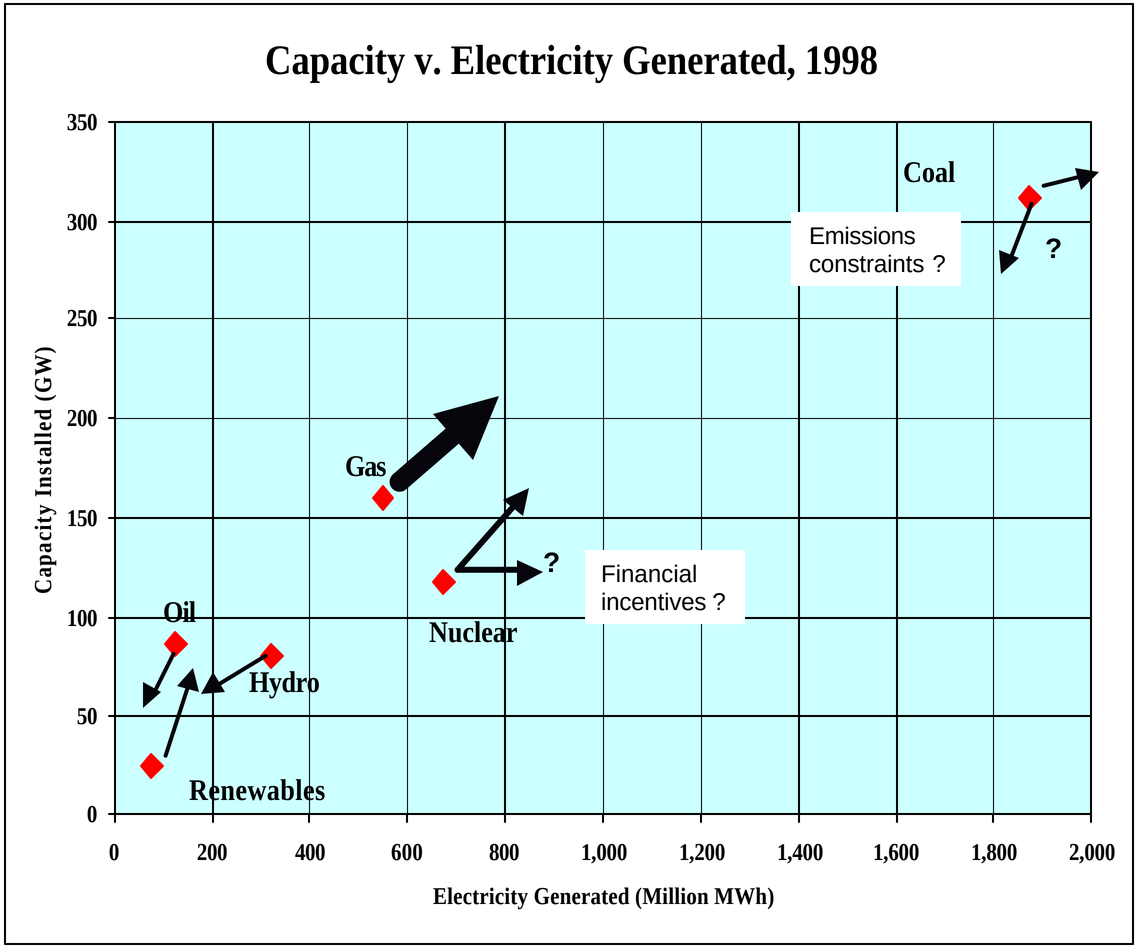
- Nuclear power provides about 20% of the nation's electricity and adds diversity to the mix of fuels used to generate electricity. Stable allies provide most U.S. supplies of uranium fuel; supplies and prices are steady.
- Nuclear power has reached >90% capacity factor, demonstrating high reliability. Only with new plants can nuclear power maintain a 20% market share.
- Coal provides >50% of U.S. electricity supply, but environmental constraints and cost issues jeopardize construction of new coal plants.
- Market share for gas is rising rapidly, but many new gas plants provide intermediate, rather than baseload, electricity supplies.
- Renewable-based electricity: Additions in renewables and biomass will barely offset the decline in hydropower projected by EIA through 2020.
- Nuclear power, which emits neither carbon nor other important regulated environmental pollutants (e.g., SOx, NOx, mercury), can play a critical role in meeting carbon-reduction goals, if unique regulatory processes that affect new plant decisions can be surmounted.
- Why worry? NERC projects that electricity supply margins may disappear in about five years (~2006).

U.S. Nuclear Power Generated, Capacity Factor Improved, 1973 – 2001

- Nuclear power produced in 2001: 768 billion KWh (up from less than 100 billion KWh in 1973, driven by the addition of 77 GWe of capacity between 1973 and 1987). U.S. nuclear plants operate as baseload units.
- Commercial orders were cancelled in the early 1980s, in part due to high interest rates, the TMI accident, and recession. Some units were finished in the mid-1980s, but no net capacity was added after 1989.
- U.S. fleet-wide capacity factor: Rose from 60% in 1987 to over 90% in 2001due to advances in management systems and practices and much shorter fuel outages. Upratings could add another 7 GWe before 2010.
- Because the U.S. nuclear fleet is now approaching a real capacity-factor ceiling, future increases in KWh generated will be limited unless new reactors are built.



U.S. Electricity Capacity v. Generation: Gas Share Surges

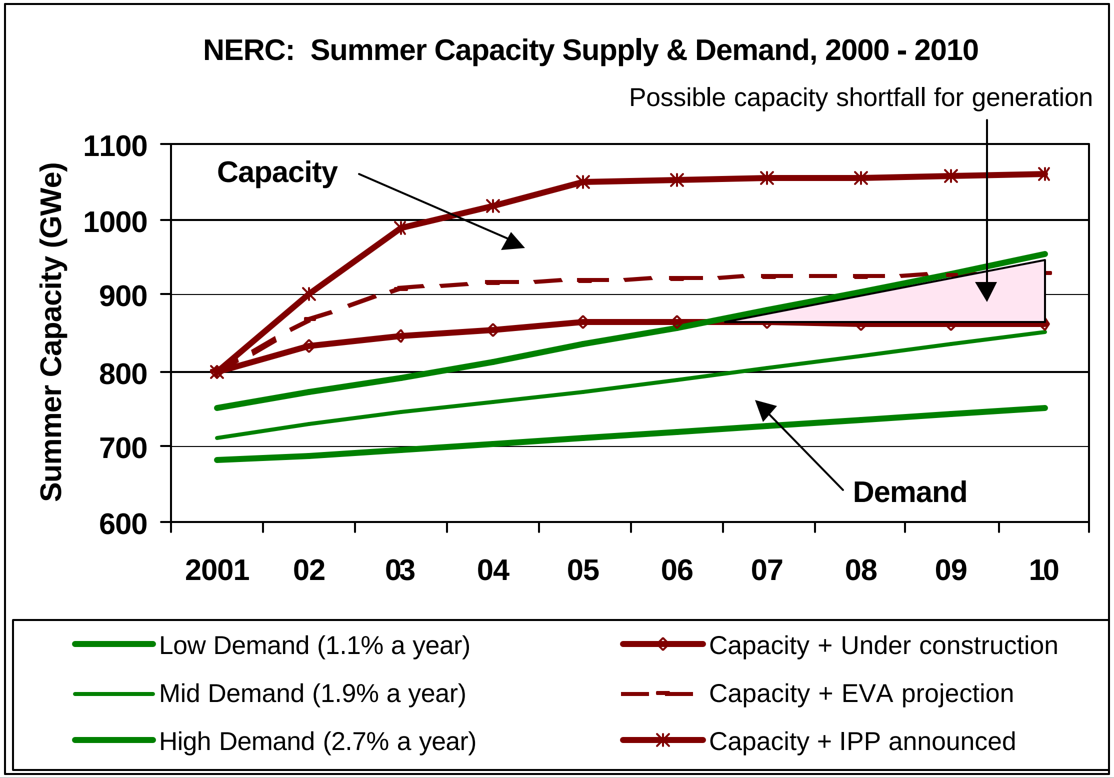


- Coal (capacity = >300 GWe), delivers >50% of U.S. electricity. Older coal plants (age = >30 years) could face increasing emissions constraints (on SOx, NOx, mercury) in coming years.
- Most planned new U.S. electricity capacity will be gas-fired, but these plants will be used for intermediate demand rather than baseload. New nuclear plants would be baseload.
- Additions in renewables and biomass will barely offset the decline in hydropower projected by EIA through 2020. But hydropower has been used as baseload, and renewables (which are vulnerable to weather disruptions) are not well-suited to baseload.

Source: EIA

NERC Outlook for Electricity Peak Supply, Transmission, 2000 – 2010

- The North American Electric Reliability Council's (NERC) annual reliability assessment review for both electricity capacity and transmission capacity over the next decade is based on input from the regional grids.
- NERC projects that, including gas plants now planned or under construction, electricity capacity may be adequate through 2005; reserve margins may narrow as 2010 nears.
- NERC notes that "transmission congestion" is likely to continue. Only 7,300 miles of transmission capacity expansion is currently proposed (as of October 2001) for a U.S. system comprised of nearly 157,000 miles, plus 45,000 in Canada. Transmission status varies by region, but load relief requests were up sharply (3x – 5x) in 2000 and 2001 versus levels in 1996 – 1997.



Source: NERC Reliability Assessment report, October 2001

www.nerc.com

Ownership of U.S. Nuclear Plants Is Consolidating in Strong Hands

- Nuclear plant ownership is increasingly concentrated. Twelve utilities, plus TVA, now own and operate more than 75% of total nuclear capacity and about 2 / 3 of plants.
- Consolidation of the current nuclear fleet under the management of fewer utilities has improved overall technical and financial performance. The larger owners, now with 75% of U.S. capacity, are able to manage a portfolio of units. They can consider financing new units based on a larger balance sheet of total asset value.
- Stock prices of nuclear utilities outperformed non-nuclear utilities from January 2000 – June 2002, and their credit ratings have remained sound.

Symbol	*(Source: NEI)* Nuclear Utility	Region, States	2001 Revenues (billions)	Units PWR / BWR	MWs Nuclear Capacity	Stock Price 1/1/00	Stock Price 7/1/02	Stock Price Change
EXC	Exelon (PECO, Unicom)	PA, IL	$15.10	4P / 10B	14,191	$30	$52	73%
ETR	Entergy Nuclear	LA, AR, MS, NY, MA	$9.60	5P / 4B	8,314	$25	$42	68%
DUK	Duke	SC, NC	$59.50	7P	7,054	$25	$30	20%
PGN	Progress Energy	SC, FL	$8.40	6P / 2B	6,220	$30	$51	70%
SO	Southern Nuclear	GA, AB	$10.20	4P / 2B	5,659	$15	$27	80%
	TVA	TN, MS, AB	$7.00	3P / 2B	5,635	Gov't	Gov't	
D	Dominion Generation	VA, CN	$10.50	6P	5,405	$40	$66	65%
XEL	Nuclear Mgmt Co.	WS, MN, MI, IA	$15.00	5P / 2B	4,353	$21	$17	-19%
FE	First Energy	PA, OH	$8.00	3P / 1B	3,726	$25	$33	32%
CEG	Constellation Nuclear	MD, NY	$3.90	2P/2B	3,363	$30	$28	-7%
FPL	Florida Power Group	FL, NH	$8.47	4P	3,306	$42	$59	40%
PEG	PSEG Nuclear	NJ	$9.80	1P / 2B	3,243	$35	$43	23%
TXU	Texas Utilities	TX	$27.90	2P	2,310	$35	$51	46%
	S&P 500 Index					1,470	990	-33%
	Subtotal		**$193.37**	**40P / 25B**	**72,779**			
	Others		$ billions	38 units	23,481			
	Nuclear Total (NEI)			103 units	96,260			

Overview and Approach to the Risk Framework

This diagram depicts the study's logic flow and approach to the analysis.

Power Plant Project Development Timeline → **Risk Analysis of Project Development Stages** → **Rating and Ranking of Risks** → **Evaluation, Application of Risk Mitigation Mechanisms**

Timeline Evaluation

- Delineation of key development stages for power plant
- Matching of development stages with financing events

Risk Analysis by Stage of Project Development

"Showstoppers":
- Disposal
- Accident
- Commissioning

Major Risk Categories
- Technology / Design
- Development / Siting
- Regulatory
- Construction
- Operating
- Fuel price, supply
- Demand
- Dispatch
- Transmission

Interview and Rating Approach

- Design of survey instrument
- Definition of criteria for interview candidates
- Selection of interview candidates
- Contact of candidates
- Interviews, risk ratings
- Evaluation of risks
- Two workshops

Evaluation of Mitigation Mechanisms

- Financial model and sensitivity analysis
- Delineation of mechanisms
- Matching of possible mechanisms to risks
- Evaluation of risk coverage for each stage
- Determination of measures, legislation needed to implement

The risk framework approach builds on the key barriers identified in DOE's Near Term Deployment Roadmap, October 2001.

Findings, Conclusions, and Recommendations

Primary Findings and Conclusions

- **Outlook for nuclear power has improved since 1990** due to several market and industry developments, particularly:
  - A sharp rise in fleet capacity factor (65% in 1990; nearly 90% in 2000), plus
  - Lower marginal cost of power produced relative to competing sources.
  - Lower interest rates.
  - Good safety record and improved public sentiment in several regions.
- **New nuclear plants can be competitive** (@ "Nth" plant costs = ~$1100 / KWe).
- **Three unresolved key barriers could prevent new U.S. orders:**
  - Spent fuel disposal, including transportation.
  - Reauthorization of accident indemnification.
  - Clear, finite NRC licensing processes, particularly for commissioning.
- **Early-plant capital costs appear to be too high**, especially with gas <$3:
  - Capital costs (financing included) could be >$1600 / KWe for first plants, declining to ~$1200 / KWe for 4^{th}/5^{th} plants.
  - Therefore, orders of first plants could require government assistance.
  - Such assistance should more precisely address risks than cost-shared grants or contracts and should reduce potential costs to government.

Primary Findings and Conclusions *(continued)*

- **New nuclear power plants by 2010?:** Plants financed solely by the private sector face serious obstacles, including foremost:
  - Three key barriers, termed by some industry executives "show-stopper" risks; these risks may limit a go-forward investment decision, and
  - Current electricity market conditions and industry forecasts—particularly adequate supply and moderate prices, and the difficulty of projecting demand and price to 2010.
  - Long lead time, high capital costs of nuclear plants cause earnings dilution.
- **Plus, high capital costs** jeopardize market competitiveness of electricity generated in the first new plants:
  - The first several new nuclear plants may deliver economic returns that are below generating companies' cost of capital (10% – 12%, after-tax).
- **Conclusion of the analysis: Once the first several plants have been built and operated, nuclear power *can be competitive* in electricity marketplace.**
- Concentrate effort on first units in regions most supportive of nuclear power.

Primary Findings and Conclusions *(continued)*

- **Government is making progress on the three key barriers:**
  - Waste disposal: Congress voted to proceed toward opening Yucca Mountain.
  - Accident indemnification: The Administration is working with Congress on re-authorization of the Price-Anderson Act to cover new plants.
  - Commissioning: NRC has not yet completed defining approval processes for new plants (e.g., ITAAC). The processes are not yet certain and finite.
- **Industry and the financial community are capable of addressing—to varying degrees—most new plant development business risks.**
- **Without government participation, some risks and costs of new nuclear plants may remain at unmanageable levels, particularly:**
  - Regulatory risk not due to contractor fault that leads to delays during plant construction and commissioning.
  - First-of-a-kind engineering (FOAKE) costs for first new plants.
  - High capital costs for the first few nuclear plants, plus potential construction cost overruns for early plants using new designs.
  - Forecasting electricity demand and price levels for 2010 and beyond.
  - Transmission availability and congestion, which vary widely by region.

Summary of Recommendations to DOE

- **Address the three key barriers:**
  - Building on DOE project results, complete the licensing and construction phase for Yucca Mountain.
  - Complete work with the Congress to re-authorize Price-Anderson Act.
  - Complete development of certain, finite commissioning process for new plants. (Assist first plants during completion, testing of COL, ITAAC procedures).
- **Evaluate authority, financing mechanisms, and funding sources for a federal energy credit program** that uses a financial risk-based approach.
  - Sharply focus risk-based framework to better target assistance, mechanisms.
  - Use business case financial model to optimize structure of DOE acquisition strategy. *Negotiate* assistance on first plants with industry, investors.
  - **Consider energy credit program that is applicable across all energy sectors and types of energy projects**, has broad flexibility (a variety of innovative finance techniques), and leverages federal funds with private dollars.
- Take advantage of currently healthy financial condition of nuclear utilities to devise best levels, means of assistance. Financings may be "on balance sheet".
- **Pursue other important mechanisms to create level playing field for nuclear energy** (e.g., include clean nuclear power in future U.S. emissions programs).

Industry and Financial Participants

Utilities
- Constellation Energy
- Dominion Resources
- Entergy Nuclear
- Exelon
- Southern Nuclear
- Tokyo Electric Power

Engineering & Construction
- Bechtel Nuclear
- Sargent & Lundy

Electricity Grid
- PJM Interconnect

Reactor Systems & Services
- Framatome ANP
- GE Nuclear
- BNFL Westinghouse Nuclear
- General Atomics

Financial Community
- ANZ Investment Bank
- Citibank
- Credit Suisse First Boston
- Credit Lyonnais
- Deutsche Bank Securities
- Goldman, Sachs & Co.
- Lehman Brothers
- Merrill Lynch
- Morgan Stanley & Co.
- Zurich, U.S.

Non-Governmental Organizations
- National Defense University
- Natural Resources Defense Council
- Nuclear Control Institute
- Union of Concerned Scientists

Government
- Nuclear Regulatory Commission

Recommended Risk Mitigation Techniques

- **Effective use of several mitigation techniques could enable DOE to help industry manage critical "risk gaps" for the first several plants.**
- **Illustrative early plant risk-mitigation strategy:** Evaluate the following tools (including a possible innovative financing via a new federal energy credit program authority similar to existing authorities and mechanisms of other federal agencies):
  - **To help address unique regulatory risks:** Standby facility (comprised of interest maintenance, debt principal buy-down, and equity options available to support the financing in the event of delays or judicial intervention).
  - **To help address construction risk:** Standby construction cost overrun facility.
  - **To help address FOAKE risk:** Government preferred equity facility.
  - **To help reduce high capital costs:** Direct loan facility, investment tax credits.
  - **To help reduce high capital costs by augmenting revenues:** (1) Power purchase agreements, (2) carbon emissions credit program that includes nuclear energy, and (3) production tax credits.
  - **Additional insurance capacity** with broader coverage.
  - **To help address earnings dilution:** Investment tax credits.

Sensitivity Analysis: EPC Cost v. Electricity Rate

- **The sensitivity analysis shows that IRR improves as capital costs are reduced.** Over the range evaluated and with wholesale electricity rates held constant at $35 / MWh, IRR increased from 7.3% to 9.3% for early plants, reaching 10.7% for a plant with EPC costs of $1.0 billion.
- IRR rose rapidly when EPC costs were held constant and electricity rates were increased. **Among the major variables, electricity rate is one of the factors IRR is most sensitive to.**
- For example, for a $1.2 billion EPC cost plant, a $2 / MWh change in electricity rate (a 6% change) causes a 1% change in after-tax IRR.

- **If wholesale electricity rates are projected at less than $35 / MWh, then early orders of nuclear plants would not likely be attractive investments.** On the other hand, at the highest electricity rates examined, even the most expensive nuclear plant can meet IRR targets.
- Even the highest-cost plant tested, costing more than $1,700 / KWe, can achieve an adequate IRR if electricity rates rise sufficiently (i.e, to a point significantly higher than today's market rates, which range widely but are most frequently in the $20 – $40 / MWe range).
- **The table below shows that rising electricity rates or rate augmentation can create a relatively large zone of investment feasibility.**

$ / KWe (1100 MWe)	EPC + (A) + Financing	**EPC Cost**	**Electricity Rate ($ / MWh)** $25	$30	$35	$40	$45
			IRR →				
$1,943	$2.14B	**$1.6B**	2.5%	5.1%	7.3%	9.4%	**11.4%**
$1,708	$1.88B	**$1.4B**	2.8%	5.8%	8.2%	**10.5%**	**12.7%**
$1,475	$1.62B	**$1.2B**	3.4%	6.6%	9.3%	**11.9%**	**14.4%**
$1,247	$1.37B	**$1.0B**	4.2%	7.6%	**10.7%**	**13.7%**	**16.6%**

(A) Development, Startup, Buyer's Contingency

Impact of Potential Mitigants (from Sensitivity Analysis)

- Some mitigants work better than others to improve IRR and competitiveness in the base case. Multiple issues require multiple solutions.
- Risk mitigation assistance brings power price competitiveness to early units.
- *Unaided*, a $1.0 billion EPC-cost plant could achieve IRR goals.

IRR Threshold	10%	A	B	C	D	E	F	G	H	I
	$1.2 B EPC Base Case	Lower EPC Cost ($1.0B)	Higher EPC Cost ($1.6 B)	Increase Electric Rate to Get 10% IRR	Effect of Interest Rate Buydown to 6%	Effect of Gov't. Preferred Equity	Effect of Gov't. PPA at $50	Effect of Emission Credits	$1.6 B EPC with Gov't. Equity	$1.6 B EPC with Combo of Factors
EPC Cost ($ billions)	$1.20	**$1.00**	**$1.60**	$1.20	$1.20	$1.20	$1.20	$1.20	**$1.60**	**$1.60**
Fuel Cost (mils / KWh)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Electricity Rate ($ / MWh)	$35	$35	$35	**$36.40**	$35	$35	$35	$35	$35	$35
Average Capacity Factor	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**
Debt : Equity Ratio	50/50	50/50	50/50	50/50	50/50	50/50	50/50	50/50	50/50	50/50
Interest Rate (20-year loan)	8%	8%	8%	8%	**6%**	8%	8%	8%	8%	8%
Gov't. Preferred Equity ($ millions)	--	--	--	--	--	**$107**	--	--	**$480**	**$200**
Power Purchase Agreement at $50 / MWh for 50% of production (of 8.67 mm MWh / year, at a 90% capacity factor).	--	--	--	--	--	–	**3 years**	--	--	**10 years**
Emission Credit (% boost of revenue)	--	--	--	--	--	–	--	**4.0%**	--	
After-tax IRR (with tax loss benefit)	9.3%	10.7%	7.3%	10.0%	9.9%	10.0%	10.0%	10.0%	10.0%	10.0%

Illustrative Example: Capital Costs for AP1000s

Illustrative Example: Capital Costs for AP1000s

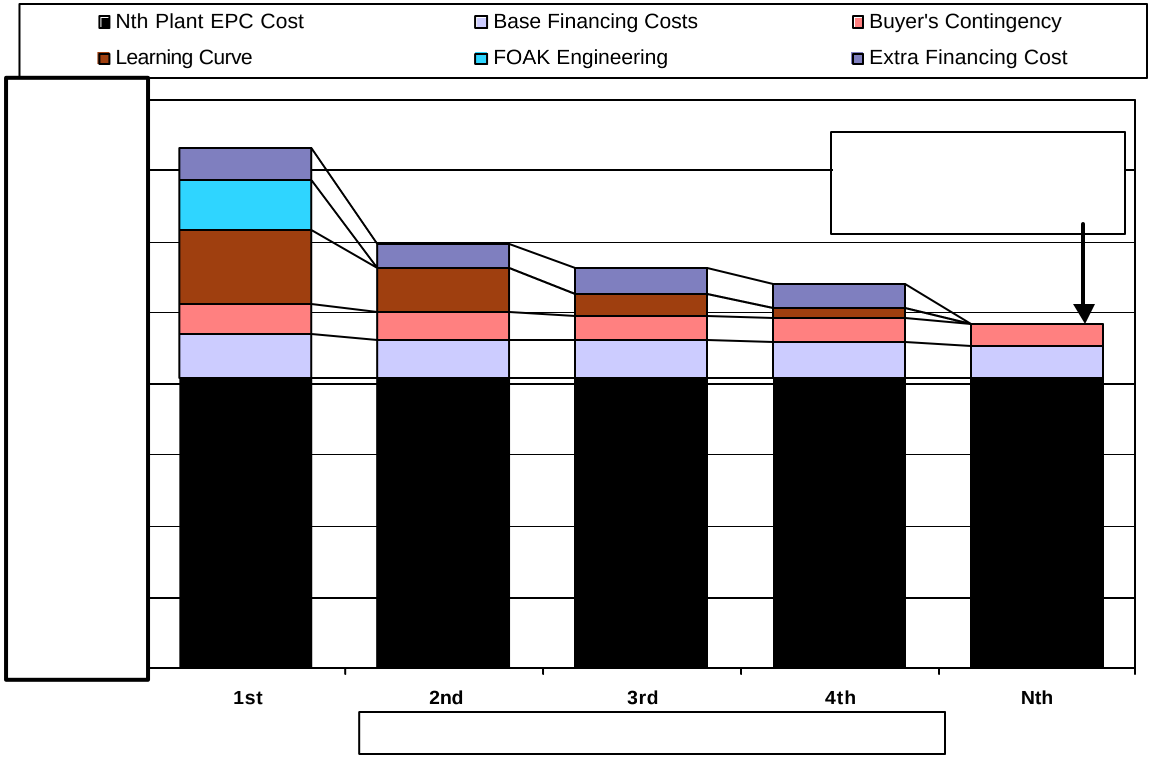
- Costs provided by Westinghouse for a series of AP1000s (twin-reactor plants at 2200 MWe each) have been reviewed by a panel of seven nuclear utilities and two E&C firms to validate cost estimates.
- In this analysis, we developed a financial model and ran it using EPC costs for plants 1 through 4 in the series. The "Nth" plant is estimated at the target cost of $1100 / KWe for a 2200 MWe plant.

Twin-reactor plants (MWe)
Cost Elements: AP1000
FOAK Engineering
Learning Curve
Extra Finance
Subtotal: Additional Costs
Buyer's Contingency (7.5% on EPC)
Base Financing Costs
"Nth" Plant EPC Cost
Total Cost Financed
Financed Cost per KWe

Note: GE is finalizing its cost estimates for single-reactor (1500 MWe) and twin-reactor plants to be built in the United States.

Illustrative Example: Capital Costs for AP1000s

- Capital cost premium may total $1.5 – $2.75 billion over 4 – 5 plants, ~13% of $14.56 billion total cost for five plants (total MWe = 11,000; cost = $1,324 / KWe).
- Cost of assistance would vary based on mechanisms used, levels negotiated.
- FOAKE costs assigned to first plant. Learning curve effects improve quickly.

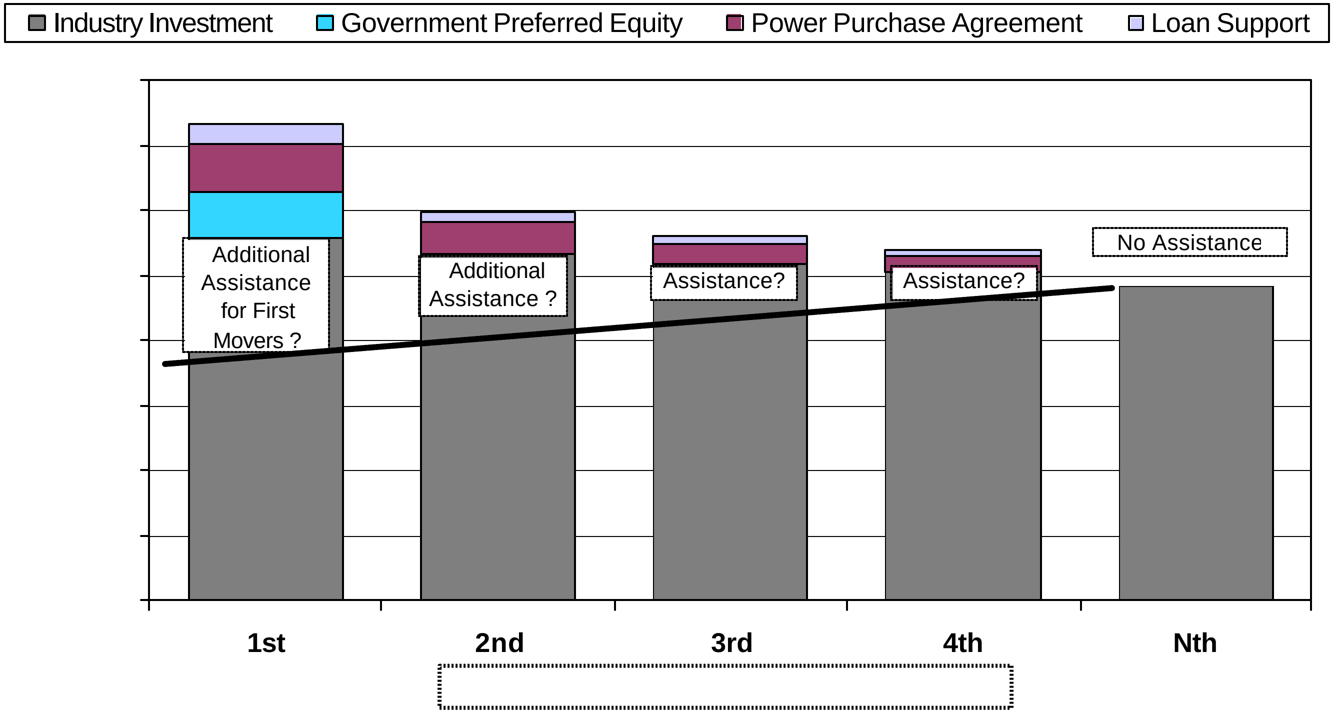


Estimates of Capital Cost Premium: AP1000s

- Total risk-related cost premium for early nuclear power plants using Generation III light water reactor (LWR) technology is substantial. For AP1000 reactors, the first four or five two-reactor plants are likely to contribute varying amounts to this premium, which is comprised of three large elements:
  - First-of-a-kind engineering (FOAKE) costs: ~$200 – ~$350 million, based on the type of reactor and plant.
  - Learning-curve inefficiencies on construction costs: At least $1 – $2 billion in total for the first four plants, on a base cost of $14 – $15 billion for five plants (11,000 MWe) in the case of AP1000s.
  - Extra interest costs associated with the other elements: ~$300 – 400 million.
- **Any government assistance would be negotiated, ideally with the government shaping the assistance to stimulate private investment and reward "first movers".**
- These amounts do not include the cost of government efforts to address the three key barriers.

Challenge: Cost Disadvantage on Early Orders

- “Catch-22” challenge: Only government can address barriers + “first movers” will pay a capital cost premium on the first units ordered, *so*...
- Without government assistance, utilities may wait to order later units after FOAKE and other 1st-time costs are absorbed, *so* "first units" would not likely be ordered.
- DOE could weight assistance to reward first orders.



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Reference Slides

SWOT Analysis Summary: Nuclear Industry Strengths and Weaknesses

Major Strengths

- **Competitiveness:** Capacity factors, operations, and safety records have improved since 1990; many reactors are very competitive, even in deregulated power markets.
- **Value:** With utility divestitures and consolidation since 1999, asset transactions have quantitatively demonstrated the real financial value of current nuclear reactors.
- **Life extension:** Since 1998, NRC has relicensed six reactors, each for an additional 20 years. Fourteen more are under review, and another 24 are in the pipeline.
- **Financial performance**: Since 2000, stock prices of nearly every nuclear utility outperformed the S&P 500 and many non-nuclear utilities.
- **Regulatory support:** The NRC, with NE support, has embarked on a “certified design” approach to reduce licensing uncertainties for new reactors. NRC has certified three reactor designs, including the GE ABWR and the Westinghouse AP-600.
- **Waste reduction**: Utilities have reduced low-level waste volumes from 3 million cubic feet in 1982 to <300,000 cubic feet a year, while generating twice as much electricity.
- **Safe waste transportation:** Hundreds of shipments of DOE radioactive waste (transuranic waste from DOE facilities) have been made safely to the Waste Isolation Pilot Plant (WIPP) depository for radioactive waste in NM.
- **Fuel Supplies:** Affordable and stable uranium supplies continue to be available from allies Canada and Australia, plus the U.S. nuclear warhead blend-down program.

Major Weaknesses

- **Transmission uncertainty:** Investment in transmission capacity has not kept pace with electricity demand. Large centralized generating plants of all kinds are highly dependent on efficient and sufficient transmission.
- **Aging workforce:** New nuclear plants have not been built in the United States for a generation. Nuclear talent is aging, and prospects for new workers are not good, a problem even if new plants require smaller operation staffs:
  - The number of university research reactors, which are vital for training nuclear engineers, has dropped from 60 in 1982 to less than 30.
  - Undergraduate enrollment in nuclear engineering programs dropped from 1700 in 1982 to just 500 in 1999 in our university programs, before rebounding to about 700.
  - U.S. engineering firms comment that skilled crafts training needs to be rejuvenated to support nuclear plant construction.
- **Energy security challenges:** Nuclear power could provide an important aspect of energy supply diversification, reinforcing a major strategic theme in the National Energy Policy. However, no new plants are being built here. New plants are needed just to sustain current market share (20% of generation) for nuclear power.

SWOT Analysis Summary: Nuclear Industry Opportunities and Threats

Major Opportunities

- **Low interest rates:** Interest rates are at lows since the 1970s energy crisis, when interest rates rose above 15%.
- **Low, stable fuel prices:** Uranium fuel prices have dropped to historic lows (~5 mils / KWh; $10-$15 per pound U) and are more stable than natural gas prices.
- **Improved safety, efficiency:** New reactor designs, benefiting from prior experience, have new passive safety features, plus efficiency gains from advances in design and materials, CAD design, and modular construction.
- **Public views:** The public's view of nuclear power is more positive in recent surveys, due largely to power outages, electricity price volatility, and nuclear's enhanced safety record since Three-Mile Island (1979).
- **Disposal**: In February 2002, President Bush began the ten-year construction and licensing process for the Yucca Mountain depository for spent nuclear fuel.
- **Energy security:** Reliance on oil imports is >55% (v. 40% in 1980), and growing. Electric vehicles could offset foreign crude, as could hydrogen from nuclear power.
- **Hydrogen production:** Thermo-chemical (v. electrolytic) production of hydrogen at nuclear plants could reduce refinery emissions, boost energy values in gasoline, and provide a non-carbon fuel source.
- **Climate change:** Nuclear energy is a key to a climate-change energy portfolio. No other non-emitting fuel source boosts U.S. energy diversity in GWe increments.

Major Threats

- **Terrorist attack:** Terrorists have threatened to attack nuclear power plants (Washington Times, May 4, 2002). Attack simulation exercises on nuclear plants during the last several years—much of it before the attack of September 11—have shown mixed results in success by nuclear operators.
- **Commissioning uncertainty:** Improved commissioning procedures are not yet fully clarified and court-tested. Utilities will not invest in nuclear plants if high uncertainty continues relative to turning the plant on after construction.
- **Electricity restructuring**: Deregulation of electricity in some regions brings market pricing to more utilities, which then favor generating assets with low capital costs and short construction periods. In contrast, regulated generating assets are allowed capital cost recovery, plus a reasonable rate of return as negotiated with a public utility commission. All prior nuclear units were built under regulated situations.
- **U.S. R&D budget flat:** While the NE R&D budget proposed for FY2003 was boosted for the Nuclear Power "2010 Initiative", U.S. R&D budgets for nuclear power have fallen behind our those of our trading partners, jeopardizing the U.S. technology and engineering edge in nuclear power.

Summary: Nuclear Plants Being Built Worldwide, But Not in United States

- This table below summarizes recent changes in the position of nuclear power. Although some issues have turned positive for nuclear power, a number of important issues need to be resolved.
- Unless these key issues are resolved *(highlighted in red italics)*, the future of nuclear power faces clear doubts from a financial standpoint, despite its strong advantages.

Historic Issue to be Addressed	Status in 2002
Technology: Are nuclear reactor systems (Generation III) ready for commercial scale deployment?	Three system designs were certified by NRC in the 1990s; two types were built in Asia (GE ABWRs).
Capital costs: Are nuclear power plant construction costs still too high (>$1200 / KWe) for first units, posing high risks for capital recovery in deregulating regions? How much impact results from lower interest rates?	Projected costs on early units remain >$1200 / KWe, but some units are being built in Asia. *Modular construction advances bring costs down, but require multiple orders*. Interest rates are 50% lower than rates in the early 1980s.
Construction: Can U.S. engineering fims retain the talent and experience needed to reliably build units?	U.S. firms are actively building units overseas, learning from foreign partners. Supply is global. *Recruitment of skilled labor remains an issue.*
Regulatory: How can certainty and finite timing be built into NRC approval processes?	NRC is defining better approval approaches, *but has not completed procedures (COL, ITAAC).*
Fuel supply: What are the trends in uranium fuel prices, sources, and reserves?	Uranium prices are much more stable than gas, and inventories and supply are from stable allies (e.g., Canada, Australia).
Transmission: How are regional grids dealing with capacity constraints, and a lack of investment during the last twenty years?	FERC is working to encourage voluntary formation of four RTOs. *Grid control remains an area of uncertainty, since large nuclear units require significant transmission capacity.*
Market status: How do regional variations in electricity deregulation create uncertainty about rates and revenues, affecting willingness to invest in new plants?	*Deregulation remains incomplete.* Momentum reversed in several states after bankruptcies in California. The southeast is not moving on deregulation at all now.
Competition: What competition will nuclear plants face from new gas plants and new baseload coal plants?	Highly volatile gas prices in 2000 – 2001 caused some utilities to consider other fuels, such as nuclear.
Siting & Public support: What impact will anti-nuclear groups have nationally and in regions where support for nuclear power is stronger?	In April 2002, three utilities announced they would file for Early Site Permits. Public opinion polls are more positive toward nuclear (>65%) since the California electricity crisis, and due to better operating records for nuclear since 1990.
Energy Policy: What is the current nature of the U.S. political consensus regarding nuclear power, as compared to France, Japan, Korea, and others?	Several regions of the country have no problem supporting nuclear power. Six reactors were relicensed since 1999 without much opposition.
Finance: How financially strong are utilities after the collapse of Enron and defaults by PG&E in California.	Energy trading markets survived the collapse of Enron, and nuclear utility stocks are outperforming other utilities.

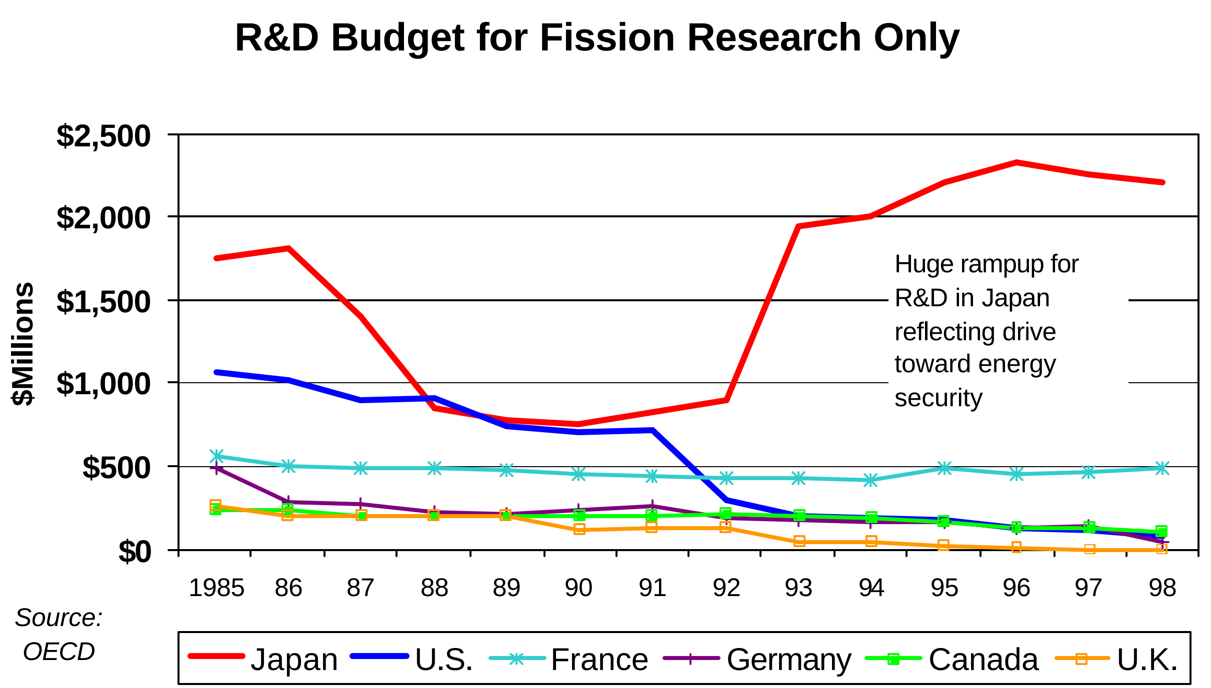
NE Budget 2001 – 2003: Shift Toward Deployment

NE's proposed technology budget includes significant additional funding for the "2010 Deployment Initiative" (source: NE). The additional funds for this initiative will be focused on reducing some of the most important areas of risk to prospective new nuclear power plant projects (e.g., expedited site permitting, waste disposal). With this initiative, DOE will address areas of "show-stopper" risk that otherwise are likely to limit the prospect that any new plants will be built by 2010.

		Actual	Proposed	% Total	2001 - '03
Funding Category	**FY2001**	**FY2002**	**FY2003**	**FY2003**	**Change**
University Reactor Fuel Assistance	$12.0	$17.5	$17.5	7.0%	$5.5
R&D					
Nuclear Energy Plant Optimization	$4.8	$6.5	$0.0	0.0%	-$4.8
Nuclear Energy Research Initiative	$33.9	$32.0	$25.0	10.0%	-$8.9
NE Technology (2010 Initiative)	$7.5	$12.0	$46.5	18.6%	$39.0
Advanced Nuclear Medicine	$2.5	$2.5	$0.0	0.0%	-$2.5
Total R&D	**$48.7**	**$53.0**	**$71.5**	**28.5%**	**$22.8**
Infrastructure					
Fast Flux Test Facility	$38.4	$36.4	$36.1	14.4%	-$2.3
Radiological Facility Management	$88.3	$86.7	$83.0	33.1%	-$5.3
Total Infrastructure	**$126.7**	**$123.1**	**$119.1**	**47.5%**	**-$7.6**
Spent Fuel Pyro & Transmutation	$68.7	$76.4	$18.2	7.3%	-$50.5
Program Direction	$23.8	$23.8	$24.3	9.7%	$0.5
Total NE Funding ($ millions)	**$279.9**	**$293.8**	**$250.6**	**100.0%**	**-$29.3**
Total Without Transmutation	$211.2	$217.4	$232.4		$21.2

Japan, France Lead Global R&D Expenditures for Nuclear Fission

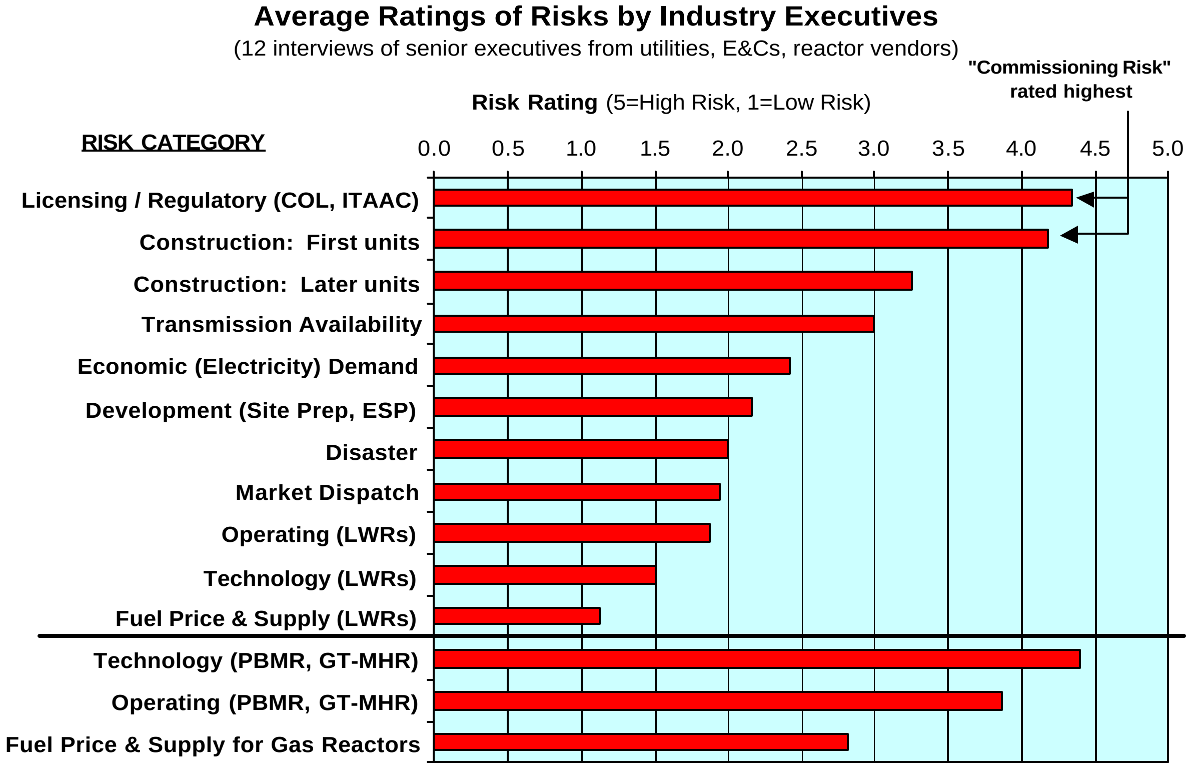
- Worldwide, nuclear fission R&D has declined since the early 1980s from its $5 billion-per-year peak to about $3 billion a year, almost all of it in OECD countries.
- Japan has taken over the lead in funding for nuclear power-related research with large recent increases; French R&D support has been stable at $500 million per year since 1985.
- Since 1985, Japan has funded and managed 60% of global R&D on the next generation of nuclear reactors. Japanese companies recently built two GE ABWR reactors and have executed orders for 10 new reactors by 2010. These companies are pioneering modular construction techniques, an important step in accelerating new plant construction and reducing cost.
- NE indicates that the United States still leads in some key areas of R&D, but the discrepancy in funding levels jeopardizes this lead, despite potentially positive impacts from the 2010 initiative.



Source: OECD

Industry Executives' Ratings of Risk Categories

- Ratings by industry executives of critical risks: "1" = low risk; "5" = high risk.
- "Construction" risk (first units) includes "commissioning" risk (delayed production or never produces).
- Gas-cooled reactors (at bottom) are farther from commercial use.



Base Case Sources and Uses of Funds

- The schedule of sources and uses of funds (for the base case plant with a $1.21 billion EPC cost) illustrates the capital structure and use of funds.
- The $1.21 billion (with inflation added) equates to a $1.44 billion facility cost, including:
  - Development costs: $60.4 million
  - Startup costs: $21.6 million
  - Buyer's contingency: $94.6 million (7.5%)
- **For the $1.2 billion EPC plant, the gross funding requirements are $1.62 billion**, including financing costs of nearly $190 million.
- The $1.44 billion installed facility cost for this 1100 MWe reactor equates to $1,307 / KWe.
- If the EPC cost is reduced to $1.0 billion, the facility cost is $1.21 billion and the gross funding requirement rises to about $1.35 billion.

SCULLY CAPITAL
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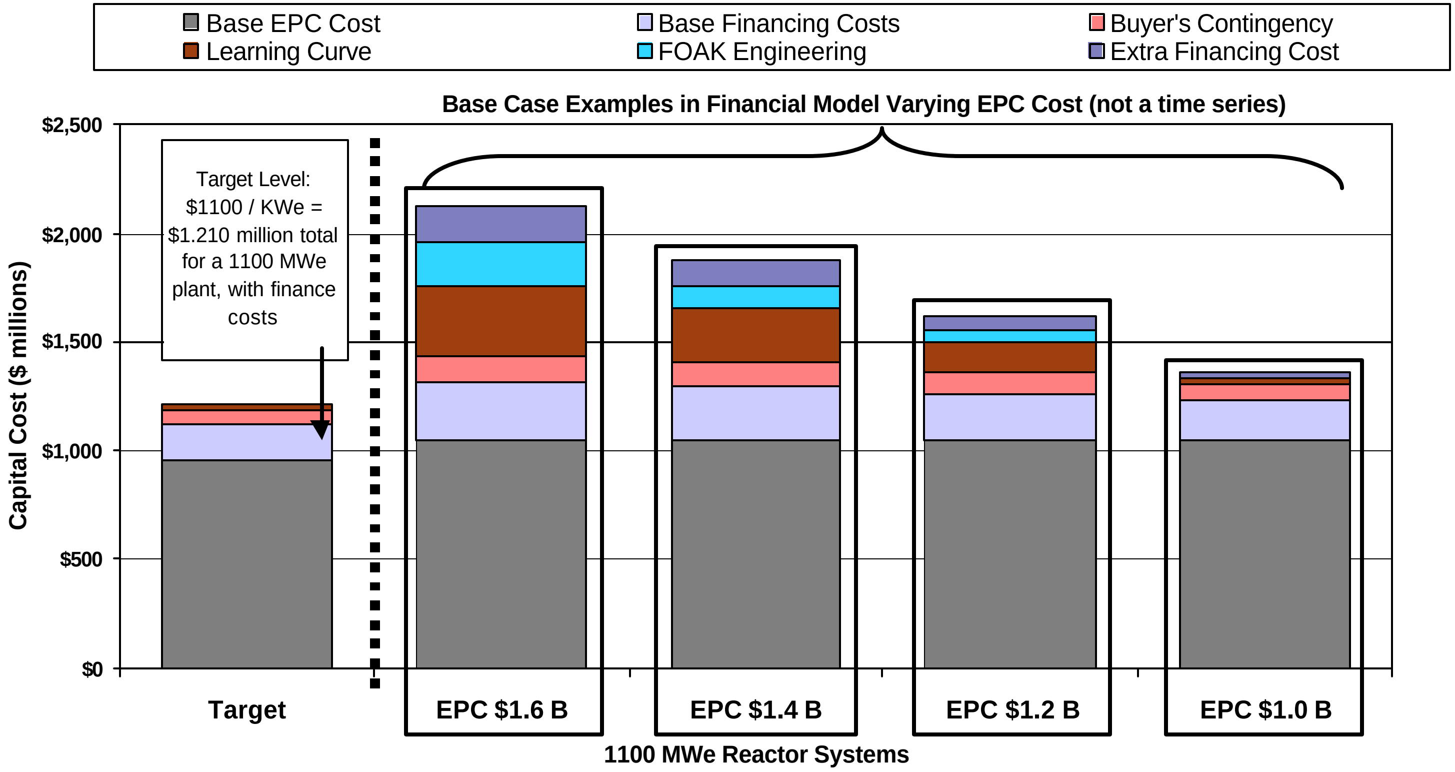
EXHIBIT 1: SOURCE AND USES OF FUNDS ($000)
PROJECT: DOE - NE
Project Number: 2 - $1.2B EPC Naked Base Case

USES		SOURCES	
Facility Costs		**Gross Funding Requirements**	$ 1,623,809
Development Costs	60,400		
EPC	1,261,130		
Start-Up & Commissioning	21,649		
Contingency	94,585		
Capital Additions	-		
Subtotal	$ 1,437,763	Senior Debt	$ 812,973
		Senior Debt %	50%
Financing Costs		Equity	$ 810,836
Reimbursement of Development Costs	$ -	Equity %	50%
Interest Capitalized	121,300		
Commitment Fees	7,661		
Closing Cost	16,259		
Capitalized Reserves		Grant Funding	$ -
DSR	40,826	Grant Funding %	0%
O&M/R&R Reserve	-		
Working Capital	-		
Subtotal	$ 186,046		
Gross Funding Requirements	**$ 1,623,809**	**Total Funds Drawn**	**$ 1,623,809**

Capital Costs of Early Orders: EPC Cost Varies

- Chart shows a range of assumptions for independent base cases with varying EPC costs—$1.6 to $1.0 billion—for early orders of new nuclear reactors.
- Special early-plant costs vary (i.e., FOAKE, additional construction costs from learning curve inefficiencies, extra financing costs). Operating variables constant.



Basis for Estimating Potential Cost of Mitigants

- **Estimates of cost require further study before this strategy is applied to negotiations for early reactors.** A subsidy rate could be applied as follows:
  - For standby facilities established for exposure to unique regulatory risks: The maximum additional interest on the total amount of debt principal, the debt principal amount, and the equity capital.
  - For construction cost overruns (negotiable): An amount based on the worst case cost overrun (beyond guaranteed price).
  - For first-of-a-kind engineering costs (FOAKE): An amount based on the allocation of FOAKE among early plants.
  - For direct loans to reduce high capital costs: The principal amount.

  Note: Only some mechanisms would be used on any one project.
- Actual cost estimates would require further analysis of credit risk, default history, and recovery rates to calculate the subsidy rate and costs.
- **Structure of comprehensive energy credit program should incorporate a variety of credit facilities** to address regulatory risks, higher initial construction and operating costs associated with new designs and technologies, etc.