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Using Federal Credit to Mitigate Critical Financial Risks on Early Orders for New Reactors

Based on the Business Case for Nuclear Power (July 2002)
A report prepared for the US Department of Energy

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"The NEPD Group recommends that the President support the expansion of nuclear energy in the United States as a major component of our National Energy Policy."

US National Energy Policy [for the Bush Administration], page 5-17, May 2001.

"To have any new nuclear plants operating in the US by 2010, it will be necessary for generating companies to commit to new plant orders by 2005-2006, to proceed with preparation of Construction and Operation License (COL) applications. This will require very near term action by prospective owner/operators and strong support from the government."

Roadmap to Deploy New Nuclear Power Plants by 2010 (NTDG, Oct. 2001).

"The US National Energy Policy promotes nuclear energy, but no specific policies are proposed to encourage construction of new plants."

IEA Review of US Energy Policy - 2002, page 13.

"The US government should provide a modest subsidy (e.g., $200/kWe) for a small set of 'first mover' commercial nuclear power units to demonstrate cost and regulatory feasibility."

MIT Study: "The Future of Nuclear Power", 2003, John Deutch and Ernest Moniz, page 8.

ABSTRACT

A next generation of nuclear power plants in the US would be built within more of a "risk-based" marketplace than the regulated one in which the previous plants were built. During the 1990s, utilities acquired more confidence in the current LWR and PWR technology and their ability to prevent accidents and curb downtime. Operators dramatically raised capacity factors for the US fleet of 103 reactors from below 70% in the late 1980s to well over 90% in 2002. Continued

low and stable fuel prices (<US$5 per MWh), and swift relicensing since 1998, dramatically aided the competitiveness of nuclear power; such that with just 12% of US capacity, nuclear reactors provided 20% of the country’s electricity in 2001.

Based on surveys of key owners and investment firms, business risks, not operating and technical challenges, pose the biggest hurdles to future orders. Progress was made in the US on key “showstopper” issues, notably approval by the White House and Congress to proceed with licensing of the Yucca Mountain repository in July 2002, and movement on the renewal of Price-Anderson third party indemnification. However, several critical business risks remain:

- A lack of commissioning certainty without full clarity of NRC licensing procedures on the combined Construction and Operating License (COL), which remains untested in court.
- Concerns about “earnings dilution” for owner utilities due to a long construction cycle and high capital costs (>US$1600 per kWe), especially for the first orders.
- Demand side uncertainty for both pricing and dispatch outlook as a result of controversy about FERC policies and a current glut of gas-fired capacity (>200 000 MWe).
- Unprecedented equity devaluations and debt restructuring pressures in the utility and energy sector in the wake of huge energy trading losses and price manipulation scandals, which directly affect cost and availability of private finance, particularly in merchant power.

Nevertheless, the risks are definable and can be mitigated using specific federal mitigation mechanisms that allow both the public and private sectors to apportion risks for mutual benefit. Indeed, federal credit involvement in nuclear generation is justified given the evident market and regulatory failures combined with the unique public policy benefits, such as large-scale emissions savings, and conversion of warhead uranium from military purposes into reactor fuel. And the first several reactors would only be built on current sites, supported by their local communities. Growth in renewable energy, now providing less than 3% of US electricity, is forecast by EIA to merely offset a contraction in hydropower to 2020, so without nuclear power, the US cannot meet several emission reduction goals while supporting economic growth.

By stimulating the construction of new nuclear power plants, the public sector promotes progress on greenhouse gas reductions and clean air goals (including lower mercury emissions), and better insulates the economy from volatile price swings in both gas and power markets which threaten regional commercial growth and tax bases. Ratepayers, utilities and their shareholders gain from reduced risks and less volatile returns on power production assets against a market backdrop of severe equity devaluation and credit downgrades in the power sector since 2000, after the California electricity crisis and the implosion of Enron.

By virtue of the US Federal Credit Reform Act of 1990 (FCRA), federal agencies are able to execute mitigation mechanisms, principally through loans and credit enhancement tools. Moreover, government “budget scoring” impact of such mechanisms is a fraction of actual agency funds disbursed (e.g. <20%). Without federal risk mitigation mechanisms, however, it is not likely that utilities would order new nuclear reactors in the US during the next decade even with more favorable tax policies.

CONTENTS

A next generation of nuclear power plants in the US could be built within more of a "risk-based" marketplace than the regulated one in which the previous plants were built. "The Business Case for Nuclear Power", a study conducted by Scully Capital Services, Inc. (Scully Capital) for the US Department of Energy (DOE), concluded that orders for new reactors will likely require federal credit to address specific risks which industry cannot bear (See the "Business Case for Nuclear Power" by this author at www.nuclear.gov, under public information, then documents).

1. BACKGROUND

1.1 Dramatic Progress in Nuclear Operations During 1990s Improves Outlook

Nuclear power is back on the US energy landscape because several of the key factors that diminished it as a possibility, particularly in the 1980s, have remarkably turned around:

Then (1970s-80s) ➔	Now – 2010 and Beyond
New "Greenfield" sites with opposition after Three Mile Island accident (1979)	Adding reactors only on current sites in supportive communities (among 65 sites in 31 states)
High interest rates (12-15%)	Interest rates down to ~5-7%
Uncertain commissioning process with separate construction, operation licensing	Combined "Construction and Operating License" (COL) being defined by NRC
Regulated electric rates on cost-recovery basis	Evolving competition in wholesale power markets; Nuclear very competitive on marginal cost basis
Varying plant designs and no Computer-Aided Design capability	Pre-certified standard designs with CAD/CAM and 4-D modeling, and advanced alloys and materials
Uranium fuel prices at 2x-3x current price levels	Stable nuclear fuel prices at just US$5/MWh
Low capacity factors (<60%) in regulated territory	Capacity factors >90% in 2001 under competition
Regulated natural gas prices	Highly volatile gas prices >US$4-5 per Mil Btu
No resolution on spent fuel disposal	Congressional approval for Yucca Mountain, NV licensing phase (July 2002)
Management of a single reactor by public power; no option to manage fuel outages across a fleet	Better management by investor-owned utilities on combined fleet of reactors with rolling outages
Limited hours of experience, long outages	More operating experience with sharply improved safety and exposure record; high quality power

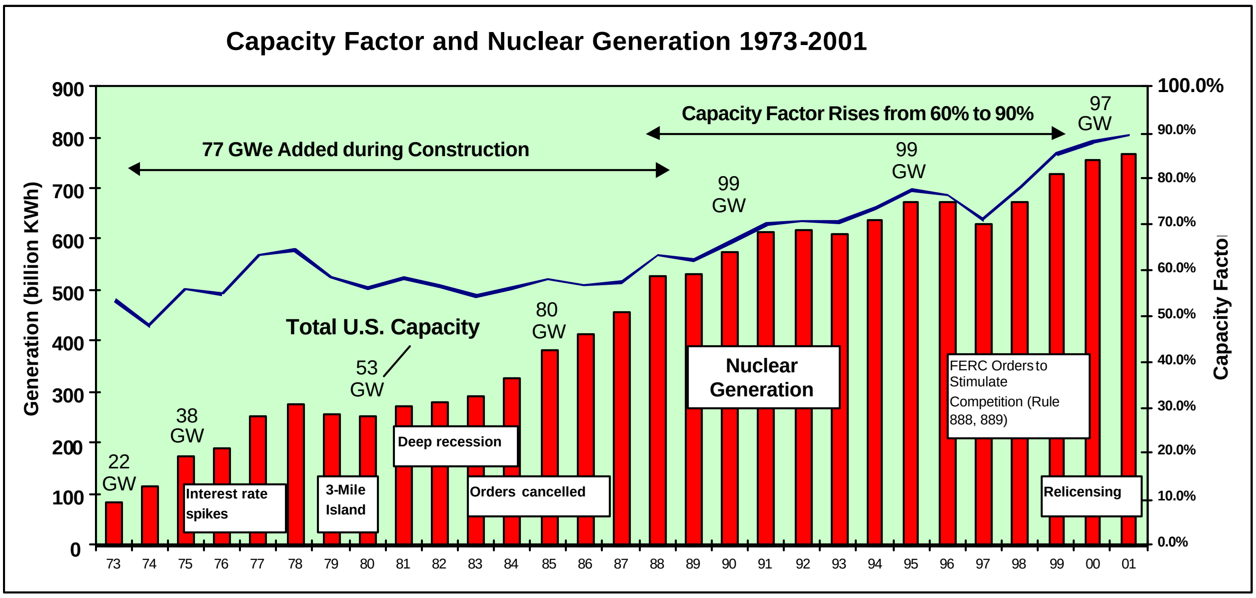
"Cold War" still underway with Soviet Union and build up of nuclear warheads	Agreement with Russia to convert warhead uranium into nuclear fuel (10 000 tonnes of U/year)
Concern about clean water, urban air pollution, and global *cooling* (!) [Time magazine, 1974]	Global concern about climate change, and puting limits on fossil-powered emissions

Source: "Business Case for Nuclear Power", Scully Capital Corp., 2002

The 780 billion KWh produced by US nuclear units in 2002 is up from less than 100 billion KWh in 1973, driven by the addition of 77 GWe of capacity between 1973 and 1987. All of the US commercial nuclear plants operate as baseload units.

Commercial orders were cancelled in the early 1980s, due to the worst possible combination of factors: the Three Mile Island (TMI) accident forcing substantial capital upgrades, record high interest rates (above 15%), and prolonged recession dampening electricity demand. Some units were completed in the mid-1980s, but no net capacity was added after 1989.

Figure 1: **Growth in US Capacity Factor and Electricity Generation from Nuclear Energy**



The fleet-wide capacity factor in the US rose from 60% in 1987 to over 90% in 2001 due to advances in management systems and practices and much shorter fuel outages; and several poorly performing units were retired. Upratings could add another 7000 MWe before 2010. However, because the US nuclear fleet is now approaching a real capacity-factor ceiling, future gains in kWh generated will be limited for nuclear power unless new reactors are built. The low marginal costs compared to volatile natural gas, and high reliability with the steady gains in capacity factor, have generated renewed interest in constructing new reactors, if only at current sites. Indeed, a dozen or more reactors (>10 000 MWe) could be added at current sites.

1.2 Regional Differences in North America Affect Market Factors

The status of electricity competition or restructuring varies widely by region and affects how utilities view off-take or dispatch risk for a new nuclear plant. Several regions are not deregulating at the retail level, particularly California, the Southeast and Plains States, and have no plans to do so. In fact, their state legislatures have openly opposed Federal Energy Regulatory Commission (FERC) efforts.

The regional grids under the North American Electric Reliability Council (NERC) include Canada (see *Appendix*), which operates 10 000 MWe of nuclear power (CANDU units) and is contemplating building more units. So, planning and assessment of market risks related to new electricity generation must be addressed regionally, including Canada. More CANDU reactors are being built overseas, potentially reducing their cost of construction in North America.

The reliance on nuclear power varies by region of the country, from 7% to 25%, and is even higher in some Eastern metropolitan areas (e.g., Chicago, Baltimore, Philadelphia, Charlotte). Regional population and urban growth trends and weather patterns also vary widely, so different demand drivers affect decisions for adding new power plant capacity in each region.

Table 1: Nuclear Generation in the US by NERC Region

(Source: NERC) **For the year 2000 NERC Region (HQ) US & Canada**	**NERC Region**	**(MWe) Nuclear Capacity**	**(MWe) Total Capacity**	**Capacity Nuclear %**	**Pop'n (Million)**	**Bil KWh Power Gene-rated**
Mid-American (IL)	MAIN	14 475	58 600	24.7%	21	259
Mid-Atlantic Area (PA)	MAAC	12 796	60 700	21.1%	23	234
Southeastern (GA)	SERC	29 103	15 9400	18.3%	45	801
New England (NY)+ E.Canada	NPCC	11 483	62 900	18.3%	51	102
Mid-Continent (MN)+ SK, MB	MAPP	4439	31 200	14.2%	12	166
Western (CO) + BC, AB	WSCC	11 749	136 500	8.6%	65	178
Florida (FL)	FRCC	3046	38 500	7.9%	15	158
East Central (OH)	ECAR	8707	112 200	7.8%	36	590
Texas (TX)	ERCOT	4800	64 800	7.4%	18	256
Southwest (AR)	SPP	2932	42 700	6.9%	18	184
US + Canada		103 530	767 500	13.5%	304	2928

(Note: totals do not include distributed or off-grid generation)

1.3 Onset of Electricity Competition Favours Low Capital Cost Generation

All nuclear plants now operating were built under a “capital cost recovery – prudent return” framework sanctioned by State utility commissioners during the 1960s–1980s. This removed many risks, including commissioning risk, market off-take and pricing risk, but saddled customers with recovery of higher capital costs.

Restructuring and deregulation have involved separating power generation from power distribution to create competition at the wholesale level. However, these processes created uncertainty in planning for new baseload power plants. After the California electricity crisis in 2000 and alarming price spikes followed by utility bankruptcies, electricity deregulation or legislation promoting competition was stalled or reversed in several States or regions, particularly in the Southeast and Plains States. Restructuring and deregulation are focused in certain States and NERC regions, particularly New England (NPCC), except in Vermont, and MAAC, plus the "Rust Belt" industrial states (IL, MI, OH, PA) in ECAR, and MAIN. Deregulation continues in Texas (ERCOT), Arizona and New Mexico. Restructuring has been limited in the Southeast (SERC, FPCC, SPP) and in the Plains States (MAPP). Restructuring has been suspended or delayed in much of the West (WSCC) and in California (see *Figure 2*).

Overbuilding of gas-powered generation after 1998 (>200 000 MWe in four years), followed by bankruptcy and massive devaluations in the merchant power sector – AES, Calpine, Dynegy, Mirant, Reliant, and Williams - has created a glut in gas-fired capacity, perhaps through the end of the decade. But a new nuclear plant could not in any case be completed before 2010 anyway.

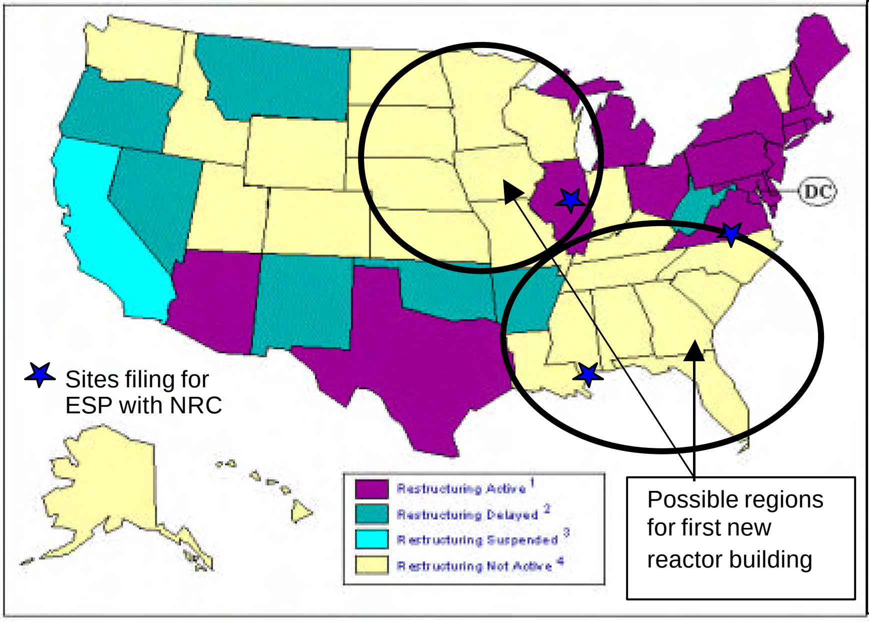
The loss of cost recovery pricing of electricity tilts the field against high capital cost electricity generation (principally coal and nuclear). However, long term contracting and the slowing of electricity restructuring in certain regions could allow consideration of nuclear units, which have now demonstrated their competitiveness on a marginal cost basis. The sharp rise in volatility of natural gas prices since the California electricity crisis, combined with a negative long-term outlook for gas supply and transmission in the US, also poses advantages for nuclear power.

In fact, since 1998, operating reactors attracted investment as utilities bought 18 units (>11 000 MWe; see table in Appendix), primarily from municipal entities in the Northeast. In other words, reactors, once commissioned, are competitive enough to garner investment backing.

1.4 Status of Restructuring and Electricity Competition in the US

The United States remains a patch quilt of regulatory regimes at the State and regional level. The Federal Energy Regulatory Commission is trying to foster the formation of five "Regional Transmission Organizations" (RTOs), to better clarify market pricing and transmission.

Figure 2: **Electricity Regulation by State**



Retail Access: Twenty-four states and the District of Columbia have either enacted enabling legislation or issued a regulatory order to implement retail access. Retail access programmes are a primary tool for creating competition in power distribution. In retail access programmes, the local distribution company continues to provide transmission and distribution (delivery of energy) services. Retail access schedules vary state by state according to the terms of legislative mandates or regulatory orders. The information in the adjacent "Status of State Electric Industry Restructuring Activity Map" was gathered from state public utility commissions, state legislatures, and utility company web pages.

Source: EIA

(Note: Current legislative proposals call for a two-year delay in SMD implementation, and regional considerations.)

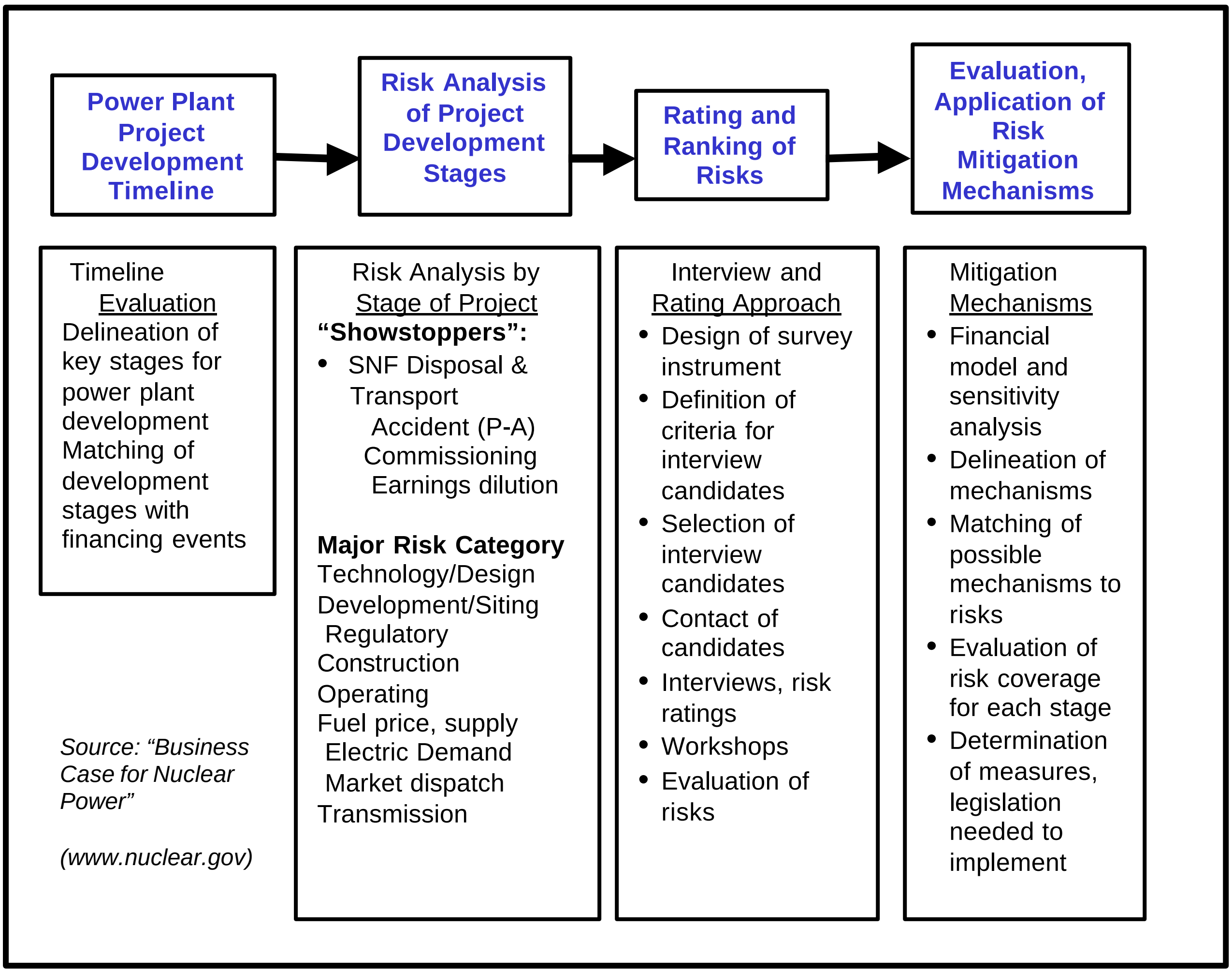
2. Approach & Methodology: Risk Framework and Survey of Industry Leaders

The authors adopted the well-developed Delphi Method, which allows experts and industry leaders to deal systematically with a complex problem or evaluation. The Delphi Method is based on a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback. Delphi represents a useful communication approach among a group of experts and thus facilitates the formation of a group judgment. This approach is particularly valuable when confronting a new and technologically-based phenomenon where prior history and data points are limited, or so out of date as to be of limited utility. Such is the case with the next wave of nuclear reactors in the US because no new units have been ordered since 1979.

A substantial financial model was also constructed to evaluate financing requirements, cash flows and return on investment from an owner/operator view based on multiple variables. This model, and an extensive sensitivity analysis on key financial assumptions, helped guide the evaluation of federal credit mechanisms based on rating of project risks.

The following risk framework guided the interview and risk evaluation process within the timeline perspective of a reactor project, and then the formulation of mitigation mechanisms, including utilizing federal credit to address the risks most affected by federal policies and actions:

Figure 3: Risk Framework used for Business Case to focus Federal Credit



2.1. "SWOT"Analysis Underlies Evaluation of Risks

A review of "Strengths, Weaknesses, Opportunities and Threats" for nuclear power helps sketch the risks associated with building new reactors. Via a roundtable of executives (conducted in May 2002) and discussions with utilities, vendors, regulators and energy sector experts, the authors compiled this SWOT summary as background for evaluating a risk framework:

Major Strengths for Nuclear Power:

- **Competitiveness:** Capacity factors, operations, and safety records have improved since 1990; many reactors are very competitive, even in deregulated power markets, especially on a marginal cost basis because nuclear fuel costs are so low (~US$5/MWh).
- **Value:** With utility divestitures and consolidation since 1999, asset transactions have quantitatively demonstrated the real financial value of current nuclear reactors. More than 10 000 MWe changed hands since 1998, and now the dozen largest commercial operators, plus TVA, own and operate over 75% of the nuclear fleet capacity (listed in Appendix).

- **Life Extension:** Since 1998, NRC has relicensed 16 reactors at 8 sites in 7 states, each for an additional 20 years. 30 more units are under review. NEI estimates that 80% of the US fleet of 103 may be relicensed through 2025.
- **Financial Performance:** Since 2000, stock prices of nearly every nuclear utility outperformed the S&P 500 and many non-nuclear utilities. In contrast, after the collapse of Enron, the merchant power sector lost over US$300 billion in equity value (see Appendix).
- **Regulatory Support:** The NRC, with US DOE 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 (1350 MWe) and the Westinghouse AP-600. The Westinghouse AP-1000 (1100 MWe) was submitted for design certification in April 2002 with approval expected in 2005. GE is in negotiations with NRC about submitting its new "Enhanced Safety" BWR (1500 MWe).
- **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 three times 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 New Mexico, which opened in May 1999. Nuclear fuel has been shipped safely to 105 reactors on 65 sites in 31 states for decades.
- **Fuel Supplies:** Affordable and stable uranium supplies continue to be available from allies Canada and Australia, plus the US nuclear warhead blend-down programme with Russia. The blend-down programme provides a very real "swords to plowshares" application, reducing the amount of nuclear material devoted to possible military or criminal threats.

Major Weaknesses for Nuclear Power:

- **Transmission Uncertainty:** Investment in transmission capacity has not kept pace with electricity demand, having fallen from US$5 billion annually in the late 1970s to an average of just US$3 billion a year in the 1990s, while total generation doubled from 1975 to 2000. Large centralised generating plants of all kinds depend 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 lagging, a problem even if new plants require smaller operation staffs.
- **Decrease in University Research Reactors:** The number of university research reactors, which are vital for training nuclear engineers, has dropped from 60 in 1982 to less than 30.
- **Drop in Undergraduate Enrollment:** Undergraduate enrollment in nuclear engineering programmes dropped from 1700 in 1982 to just 500 in

1999 in our university programmes, before rebounding to about 700 in 2001.

- **Lack of Skills Craft Training:** US 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, without new plants, nuclear power's market share, now at 20% of generation in the US, will decline to 13-14% by 2020.

Major Opportunities:

- **Low Interest Rates:** Interest rates are at lows since the 1970s energy crisis, when interest rates, and even the prime rate, rose above 15%.
- **Low, Stable Fuel Prices:** Uranium fuel prices have dropped to historic lows (~5 mils/KWh or US$10–15 per pound of uranium) and are much more stable than natural gas prices. Supply comes from stable allies Canada and Australia.
- **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 Support:** The public's view of nuclear power is more positive in recent surveys, due largely to power outages, electricity price volatility, and nuclear power's enhanced safety record since Three Mile Island (1979). Reactor incidents are down 70% since 1990 according to the ANS.
- **Disposal:** In February 2002, President Bush began the ten-year construction and licensing process for the Yucca Mountain repository for spent nuclear fuel, and Congress ratified the decision in July 2002, overturning the veto of the governor of Nevada.
- **Energy Security:** US reliance on oil imports is >55% (v. 40% in 1980), and growing. Hydrogen, where used for transportation fuel, and produced thermo-chemically from more advanced gas-cooled nuclear units, could help offset imported oil after 2020.
- **Climate Change:** Nuclear energy is a key to a climate change energy portfolio. No other non-emitting fuel source boosts US energy diversity in GWe increments. According to the MIT Study "The Future of Nuclear Power" (2003), which foresees as much as 300 000 MWe of nuclear capacity in the US by 2050, "Nuclear power should be retained precisely because it is an important carbon-free source of power that can make a significant contribution to future electricity supply."

Major Threats for Nuclear Power:

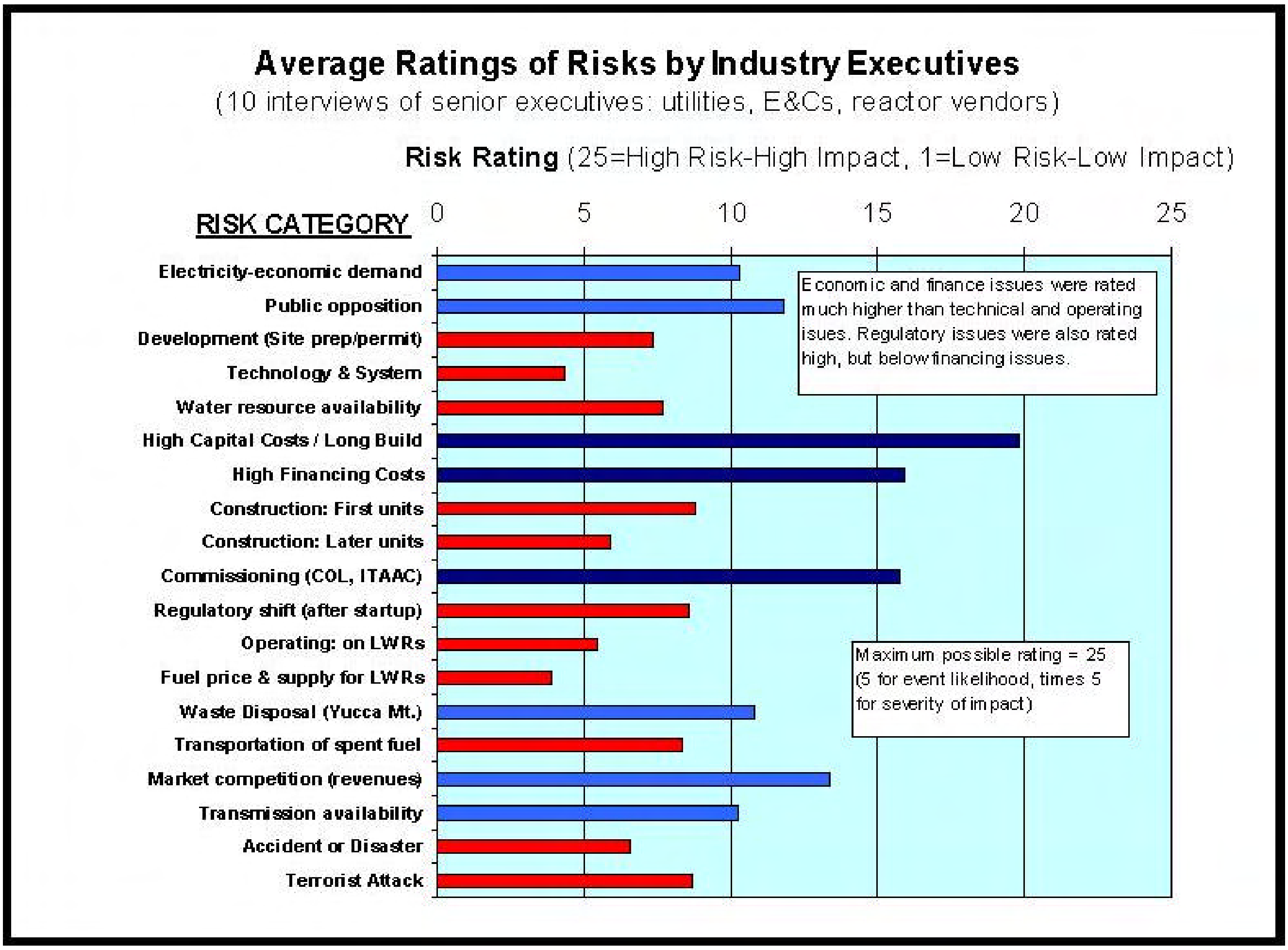
- **Commissioning Uncertainty:** Improved commissioning procedures are not yet fully clarified and court-tested. Utilities will not invest in nuclear plants if high uncertainty continues relative to turning the plant on after construction.
- **Electricity Restructuring:** Deregulation of electricity in some regions brings market pricing to more utilities, which then favour generating assets already built, or those 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 in the US were built under regulated situations.
- **US R&D Budget Flat:** While the NE R&D budget proposed for FY2003 was boosted for the Nuclear Power "2010 Initiative", US R&D budgets for nuclear power have fallen behind those of our trading partners, jeopardizing the US technology and engineering edge in nuclear power. Of US$3 billion spent each year worldwide, the US provides only US$0.2 billion, while Japan invests US$2 billion and France US$0.5 billion.
- **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. Defences are being enhanced. The Center for Strategic and International Studies (CSIS) conducted an energy terrorism exercise dubbed "Silent Vector" in October 2002. The exercise examined the vulnerability of refineries, large LNG/LPG storage facilities, pipelines, petroleum terminals, nuclear power plants, chemical plants and dams. CSIS president John Hamre noted, "Nuclear power plants have become of great concern to everybody. But they are probably our best defended targets." (Power Engineering, Jan. 2003)

2.2 Results: Risk Ratings by Industry – October 2002

An objective of this study was to obtain an update from leading industry executives on the evolution of the key risks facing new nuclear power plants, and to improve understanding of the issue of earnings dilution, an issue of concern to utility decision makers. With the SWOT analysis as a background, the specific areas of risk were identified by industry and the financial community as important to their evaluations as they make decisions related to potential new power plants:

Figure 4: **Results of Ratings of Risks (October 2002)**

Ten leading utilities and nuclear vendors were surveyed on the key risks associated with ordering, building and operating new nuclear reactors.



According to interviews, the <u>risks that utilities continue to perceive as the greatest are concentrated in the financial domain, versus operating or technical</u>. Those risks include:

- **Earnings Dilution Risk (related to high capital costs and long build cycle):** Several utilities commented that, in an environment in which massive equity devaluation has occurred in the energy sector since the collapse of Enron (October 2001), utility senior executives and boards of directors have turned risk averse toward major capital commitments, that do not offer certainty of revenues. In particular, the long-term horizon and high perceived risks associated with new nuclear capacity investments may "dilute" the long-term earnings expectations of stock and credit analysts.

- **Financing Risk (availability or equity requirements):** Utilities expressed more concern about whether financing would be available, rather than the rate of interest; hence the need for federal assistance for early nuclear power plants. This concern has been aggravated by trading losses and an increased uncertainty about electricity prices, which has led to rating agencies (e.g., Moody's, Standard & Poor's) issuing 122 credit downgrades on electric utilities (versus 35 credit upgrades) through October 2002. Although it should be noted that the stock prices of nuclear operators (e.g., Exelon, Entergy, Dominion) generally faired much better than the S&P 500 during 2002-2003, while merchant energy companies saw equity values collapse.

- **Commissioning Risk:** The risk of a plant *not* being turned on remains a "showstopper issue", as highlighted in the Business Case. NRC has not yet completed the procedures needed for obtaining a combined Construction and Operating Licence (COL), as well as the acceptance criteria process that permits commissioning to occur, and these procedures have not been tested in court for an actual reactor project. As one industry executive put it, "I was troubled to see 'programmatic ITAACs' (NRC acceptance criteria) creeping back into the regulatory process in NRC memos [April 2002]. That will keep regulatory uncertainty higher. This is disappointing, frankly."

- **Market (Off-take and Competition) Risks:** Any nuclear plant order contemplated in the 2005-2010 timeframe will not generate electricity until 2012-2015. Executives interviewed expressed concerns that high uncertainty still exists in the long term about electric rates and competitive supply; this uncertainty translates into considerable economic risk, particularly in light of high capital costs of the first few new nuclear plants.

Other risks evaluated and rated include:

- **Overall Electricity Demand:** *Risk of lower revenues because long-term regional economic growth and demand for electricity is lower than a level enabling full utilization of the plant.* Utilities stated that "forecasting is still a new, uncertain art for us."

- **Public Opposition:** *Risk that public opposition will develop leading to early shutdown of the reactor, or to pressures for additional regulations, which make the plant uneconomic.* Recent attempts by anti-nuclear groups against the Indian Point plant near New York City, based on evacuation planning, illustrate the risk. But the NRC and FEMA have both judged the evacuation and security planning to be acceptable at Indian Point.

- **Development/Plant Siting:** *Risks and costs related to getting a new reactor sited and prepared for construction, including specific site designs and preparation.* The next set of reactors, perhaps as many as a dozen, would only be added at current sites. No "greenfield" plants are currently contemplated in the US.

- **Technology/Design:** *Risk associated with failure or sub-par operating performance due to faulty design of the reactor and balance of the plant* *system.* Standardization of designs (e.g. AP-1000, ABWR or ESBWR) will help limit this risk.

- **Water Resource Availability:** *Risk of drought or change in regional policies related to water usage, which affect the availability of adequate cooling water and thermal effluent.* This risk is tied closely to local permitting, and is highly variable between regions.

- **Construction**: *Risk of cost or schedule overrun related solely to construction, labour (including strikes), and materials, not regulatory or financing activities.* Utilities and reactor vendors stated that this risk could be negotiated between them with minimal federal credit assistance.

- **Regulatory (NRC/DOE):** *Risks of additional costs, e.g., repairs and purchase of replacement electricity, arising from a shift in regulations that triggers shutdown after operations commence.* As an example, in the wake of the Three Mile Island (1979) accident, additional regulatory requirements were promulgated for all plants, not just the TMI plant. Similarly, additional inspections were ordered for reactor vessels of the same design as the Davis-Besse plant in Ohio after corrosion was discovered in 2002.

- **Operating:** *Risk of increased costs due to poor or inefficient management, operation and maintenance of the reactor (not including design or technology failings).* Since 1990, nuclear operators have developed much stronger “best practices” programmes, and dramatically improved on fuel changeout downtime.

- **Fuel Price and Supply**: *Risk of losses or higher operating costs due to fuel price spikes or supply interruptions that lead to downtime or sub-par performance.* With the warhead fuel conversion programme underway, nearly half (10 000 MT per year) of the US annual fuel usage is met without any mining. Canada and Australia provide secure supply, and prices have remained very stable since the 1980s.

- **Waste Disposal and Transport:** *Risks that costs for transporting and disposing of spent fuel and, to a lesser degree, low-level waste will be higher than anticipated (e.g., for alternatives to storage at Yucca Mountain, NV).* One nuclear operator stated: “This is a “go/no go” issue for the next set of reactors. The decision on the Yucca Mountain repository is a clear indication of political will about the future of nuclear power.”

- **Transmission Availability:** *Risk of lost revenues due to transmission constraints reducing off-take of the plant’s power production.* Transmission bottlenecks remain a long term concern for large-scale power plants, whether they are coal or nuclear.

- **Accident or Terrorist Attack:** *Risk of third party liability off-site with respect to the costs of remediation and recovery after a major accident, force majure, or terrorist incident.* Utilities have beefed up their physical defences and security teams since the 9/11 attacks, and after 40 years of operating experience, executives rate the risk of accident very low now. Not a single US reactor is designed like the Chernobyl graphite-moderated reactor. After an analysis of energy infrastructure in October 2002 by the Center for Strategic and International Studies, CSIS president John Hamre noted, "Nuclear power plants have become of great concern to everybody since 9/11. But they are probably our best defended targets." (Power Engineering, Jan. 2003)

3. Risk Mitigation Through Federal Credit

The Business Case for Nuclear Power, conducted by Scully Capital for the US Department of Energy (DOE), analysed a number of financial and risk-sharing tools that DOE might pursue as part of a programme to encourage the development of new nuclear power plants.

Government can best contribute to address risks where it controls most of the outcomes or has the unique ability to underwrite certain risks, such as commissioning and regulatory risks. Other risks must be negotiated between government and industry in several domains.

Since the publishing of the Business Case in the summer of 2002, federal credit mechanisms have emerged as a favoured option among industry and US policy makers, culminating in the introduction of the Nuclear Energy Finance Act of 2003 in the Senate Energy Bill (S.14). Under the proposed legislation, financial assistance may take the form of a loan guarantee, power purchase agreement or some combination of both. Although the legislation has yet to be passed in its current form and numerous details that could affect the impact of the proposed financing assistance have yet to be determined, the use of federal credit instruments offers an opportunity to bridge the current financing challenges faced by the industry. According to Standard & Poor's, "the versions of the Energy Bill circulating around Capitol Hill may indeed mitigate enough of the risks that would otherwise dissuade investors from financing new nuclear capacity"[1]. In addition, the Department of Energy Acquisition Regulations (DEAR), section 932.70, allows DOE to utilize loan guarantees under certain circumstances. The types of federal credit mechanisms, how they apply within the federal context, and their budgetary treatment are described briefly below.

3.1. Types of Federal Credit Mechanisms

Federal credit instruments are generally structured under one of two forms: direct loans or loan guarantees.

- **Direct Loan:** Under a direct loan, the government lends directly to the borrower, thereby eliminating the role of a private third party lender.

[1] Rigby, Peter. "Time for A New Start for US Nuclear Energy". Standard & Poor's. June 4, 2003.

Additionally, the government will receive a stream of principal and interest payments from the borrower through the life of the loan.

- **Loan Guarantee:** In the case of a loan guarantee, a private lender enters into a loan with the borrower and only draws government funds in the case of a payment default. Absent a default, no funds are drawn or received by the federal government.

Under either instrument, the government will undertake a rigorous loan underwriting process to ensure that its interests are well protected. As part of this effort, the government will look to the financial feasibility of the proposed financing and the security that underpins creditworthiness. As a general matter, direct loans and loan guarantees are introduced to address specific gaps in the financial markets, thus affecting a specific political or social outcome. Oftentimes, the credit instruments offer favourable terms in repayment characteristics, final maturity, and interest rates. As a result, the use of federal credit mechanisms is widespread, ranging from federal direct student loans to airline guaranteed loans.

3.2 Federal Credit Reform Act of 1990

Under the Federal Credit Reform Act of 1990 (FCRA), the government standardised its treatment of federal loans, requiring the long term cost of such loans to be scored on budget and in present value terms during the year that the loan commitment is made. Additionally, FCRA assigned the Office of Management and Budget (OMB) with the responsibility of reviewing legislation introduced to establish new credit programmes and to monitor performance with FCRA. OMB is assisted by the Department of Treasury (Treasury) in reviewing federal credit policies and proposals to introduce or expand credit programmes. Key OMB considerations for new programmes include the following:

- **Programme Intent:** This relates to whether the proposed federal credit programme is being developed to correct capital market imperfections (which should be defined) or to subsidise borrowers or other beneficiaries.
- **Programme Justification:** In developing a proposed federal credit programme, the justification for the programme should be articulated and include a description of existing and potential sources of credit for the proposed projects and an explanation as to why available sources of financing must be supplemented and subsidized.
- **Justification of Credit Subsidy:** To the extent the programme will provide credit at subsidised rates (i.e. below market interest rates), the programme proposal should articulate why a credit subsidy is the most efficient way of providing assistance.
- **Benefits of Programme:** A proposed programme should estimate the benefits expected from the programme, including its impact on targeted activities.
- **Effects on Private Capital Markets:** A proposed programme should estimate the extent to which the programme will substitute, directly or indirectly, private lending.

- **Subsidy Estimate:** The proposed programme should include an estimate of the budgetary impacts of the programme, including administrative costs and loan subsidy costs.
- **Resource Requirements:** The proposed programme should include an examination of the agency's current capacity to administer the proposed programme. Pursuant to OMB Circular A-129, proposed federal credit programmes need to address the items above during the legislative process and address other matters related to programme structuring during the implementation process.

3.3 Federal Credit Example: DOT's TIFIA Programme

Over the past three years, the Department of Transportation (DOT) has utilized federal credit instruments to target specific needs within the transportation sector. Under the Transportation Infrastructure Finance and Innovation Act (TIFIA), DOT has committed to US$3.6 billion in direct loans and/or loan guarantees. In developing the TIFIA programme, DOT focused on the following six key principals:

1. Target capital market gaps;
2. Assist projects of national significance;
3. Encourage the development of new revenue streams;
4. Limit federal exposure by relying on market discipline;
5. Make credit available on equitable and uniform terms; and
6. Enlist state and local participation.

Based on these principals, TIFIA offers direct, flexible payment loans from the federal government, loan guarantees by the federal government that are funded by private capital sources, and standby lines of credit that represent secondary sources of funding that may be drawn to supplement project cash flows in the early stages of the project. A significant consideration in the types of projects targeted by the TIFIA programme is the lengthy project development and construction period associated with transportation infrastructure and the high capital component associated with transportation project economics. As a result, project developers have been challenged in developing financing approaches for large transportation infrastructure projects. On the other hand, transportation projects tend to result in long-lived assets that produce cash flows well beyond the traditional terms associated with conventional financing. Therefore, these projects are well suited for federal credit instruments as the federal government represents a "patient investor". Since its implementation in 1999, the TIFIA programme has committed to 11 loans representing US$15.4 billion in project costs. As part of its participation, the government loans occupy a subordinate position in terms of project cash flows allowing the private capital markets to recruit principal and interest before the government receives payments. In spite of this subordinate position, however, the scoring impact related to these projects has been quite low. In fact, the financing commitments under TIFIA have totaled US$3.6 billion in federal credit assistance, but the overall scoring impact has been US$190 million (5.3%).

3. 4 The Suitability of Nuclear Energy to Federal Credit Instruments

The TIFIA programme offers interesting parallels to the development of nuclear power. Specifically, capital intensity, long construction cycle, involved permitting process and long-lived nature of these assets are similar to transportation infrastructure. However, unlike transportation infrastructure, nuclear energy facilities have been developed in the US principally through private financing. Given the challenges enumerated above, however, the role of the federal government in facilitating the financing and construction of new facilities is both timely and critical. Like transportation projects, nuclear facilities are long-lived assets, which can provide a stable return for a “patient investor”. Additionally, the existing challenges in the energy sector as a whole and with regard to capital intensive projects like nuclear power plants, all but preclude the development of new facilities under a purely privately financed approach. Therefore, the use of federal credit instruments to address the existing gaps in the private capital markets appears both justified and well suited to the cash flow characteristics associated with nuclear power. As a “patient investor”, the federal government can facilitate private sector investment, leveraging federal dollars and meeting stated policy objectives.

3.5 Discussion of Federal Credit Instruments

Considering the role of the federal government in facilitating the financing of new nuclear capacity, it is informative to understand the options available to agencies in facilitating the development of credit programmes. Specifically, pursuant to the Federal Credit Reform Act of 1990, federal credit programme legislation can be enacted and implemented in order to achieve specific social and economic goals. Financing mechanisms developed under this programme typically consist of direct loans, in which the government disburses funds to a borrower, or loan guarantees, in which the government guarantees a loan disbursed by a third party lender to a borrower. Under either instrument, the amounts requiring appropriation are limited to the “subsidy costs” of the instrument. That is, the estimate of the present value of cash flows from the government, less the estimate of the present value of cash flows to the government discounted to the time when the loan is disbursed. This difference in cash flows equates to what private lenders call a “credit loss estimate” and represent the amount that is scored for budgeting purposes. The implications of this treatment are that significant funds can be created to address gaps in the capital markets while at the same time minimizing the budgetary impact. This type of financing mechanism has been implemented successfully in numerous other government programmes (e.g. TIFIA). Like nuclear generating facilities, the TIFIA programme was developed to consider the long-term cash generating factors of a target transportation project (which extend well beyond the terms associated with a conventional financing) and the unique ability of the federal government to be a “patient investor” in projects that could operate up to 60 years, and transportation projects provide lasting value, enabling investors to recover a substantial portion of principal even in the event of a loan default. Accordingly, federal credit instruments provide the project with a financing source that offers long payback periods while also limiting the budgetary exposure to the expected credit loss associated with the project.

3.6 Implications of the Proposed Energy Policy Act of 2003

Under the Nuclear Energy Finance Act of 2003, the government would provide financial assistance to project developers in order to facilitate the development of a limited number of nuclear power facilities. The specific forms of financial assistance include loan guarantees for up to 50% of eligible project costs and power purchase agreements. The prospect of loan guarantees would address the current issue of the availability of financing for nuclear power projects as well as industry concerns over delays related to commissioning. Specifically, as the guarantor of the project debt, the government, in effect, would be exposed to the risks associated with a regulatory- and/or intervenor-caused delays. The use of power purchase agreements could address market risks over the debt repayment period, providing additional financial stability to the project. Under this type of assistance, funds would not be drawn upon until the facility is commissioned and thus would not be exposed to construction and commissioning risk. DOE's Power Marketing Administrations, which operate the nation's hydroelectric dams, already execute such power agreements for wind power and other sources.

The proposal for providing credit-based financial assistance to nuclear facilities offers significant potential for the US nuclear industry. By facilitating the development of the first few nuclear reactors, the critical yet uncertain risks associated with construction cost and commissioning would be addressed. A positive experience in the facility development combined with the current outstanding operational performance of these facilities would facilitate greater private sector investment infrastructure.

Budgetary Considerations

The FCRA changed "*the budgetary measurement of cost for direct loans and loan guarantees from the amount of cash flowing into or out of the Treasury to the estimated long-term cost to the Government. Only the un-reimbursed costs of making or guaranteeing new loans are included in the budget*"[2]. Accordingly, under the FCRA, the required budget authority is calculated by estimating the expected un-reimbursed cost associated with a loan or guarantee. This amount is referred to as the "subsidy" amount. Based on OMB's guidelines, agencies calculate a subsidy amount based on the present value of the cashflows from the government, less the estimated present values of the cashflows to the government.

The subsidy amount is influenced by two factors: the time value of money and the credit loss (CL) risk associated with the loan. The first factor (time value of money) is determined by calculating the difference between the interest rate charged under the loan and the interest cost to the government as measured by long-term US Treasury Bond yields. The second factor (credit loss risk) is calculated by determining the expected value of net cash receipts foregone due to loan defaults. The credit loss risk reflects two key elements:

[2] Office of Management and Budget Circular No. A-11, Section 185, page 3.

- **Probability of Default (PD):** The probability that a debt service payment will be missed, calculated on a cumulative basis over the life of the loan; and
- **Loss-Given Default Rate (LGD):** The expected loss associated with the default after accounting for the prospect of recoveries of principal through exercising lender rights over collateral and other loan security.

The credit loss risk is calculated by multiplying the probability of default by the loss-given-default-rate. By subtracting the credit loss from the required loan repayments, the expected value of loan receipts to the government can be determined. The subsidy amount reflects the credit loss risk plus any differences due to the time value of money. That is, the present value of the amounts disbursed minus the present value of the expected receipts equals the subsidy amount. This subsidy amount is then required as budget authority from Congress. Additional amounts of budget authority would be required to establish and administer the credit programmes. This cost was not examined, but is *de minimus* and could be recouped in part through fees charged to programme recipients.

Collectively, these tools would mitigate the most difficult-to-manage elements of project risk for the first few new plants and improve project internal rates of return so that they approach the acceptable range. By implementing these tools, DOE would be supporting a fuel source that is more secure, has an attractive emissions profile, and improves the fuel diversity of the US energy generation system at a time of increasing volatility, as evidenced this winter by natural gas prices jumping to a range of US$4-6 per million Btu, with spikes toward US$10.

In examining the Nuclear Energy Finance Act of 2003, the Congressional Budget Office (CBO) reviewed the implications of the Guaranteed Loan programme on the federal budget and concluded that 50% would be "on budget", therefore, requiring appropriations. This estimate was based on a probability of default of 50% and a loss-given default rate of 60%. While industry has been quick to argue that the CBO's assumption that industry would move forward with projects that exceed current estimates by over a factor of two, the estimate illustrates the potential leverage associated with government participation, even under highly conservative assumptions. Moreover, through careful project selection, prudent risk allocation, and other forms of government participation currently under consideration (e.g. power purchase agreements) the probability of default could be significantly curtailed, substantially reducing budget scoring.

4. Conclusions and Recommendations

A next generation of nuclear power plants in the US would be built within more of a "risk-based" market place than the regulated one in which the previous plants were built. During the 1990s, utilities acquired more confidence in the current LWR and PWR technology and their ability to prevent accidents and curb downtime. Operators dramatically raised capacity factors for the US fleet of 103 reactors from 60% in the late 1980s to well over 90% in 2002. Continued low and stable uranium fuel prices (<US$5 per MWh), and swift relicensing since 1998 dramatically aided the competitiveness of nuclear power; such that with just 12% of US capacity, nuclear reactors provide 20% of the country's electricity.

Based on surveys of key owners and investment firms conducted in 2002 by the authors of this Paper, business risks – such as elevated capital costs (>US$1600/kWe), licensing delays, uncertainty of market pricing and off-take of electricity, or transmission congestion – and not reactor operating and technical challenges, pose the biggest hurdles to future orders. A survey of leading nuclear utilities and vendors conducted in October 2002 noted several "showstopper" issues, which if not resolved would result in no future orders of nuclear reactors:

1. Lack of third-party liability indemnification (proposed for renewal by Congress in 2003).
2. Inadequate resolution of commissioning uncertainties by the NRC, posing another "Shoreham", NY situation (1989), where the reactor is built but not operated.
3. Failure to license and operate a repository for spent fuel (proposed for Yucca Mountain, NV).
4. "Earnings dilution" tied to high capital commitments and a 4-6 year construction cycle.

Nevertheless, the risks are definable and can be mitigated using specific federal mitigation mechanisms that allow both the public and private sectors to apportion risks for mutual benefit. Indeed, federal credit involvement in nuclear generation is justified given the prospect of market and regulatory failures combined with the public policy benefits of nuclear power, principally electricity generation without air pollution and conversion of warhead material. And, the first several reactors would only be built on current sites, supported by their local communities. Growth in renewable energy, now providing less than 3% of US electricity, is forecast by EIA to merely offset a contraction in hydropower to 2020, so without nuclear power, the US cannot meet several emission reduction goals while supporting economic growth.

By virtue of the FCRA and DOE Acquisition Regulations (DEAR 932.70), federal agencies are able to execute mitigation mechanisms, principally through loans and credit enhancement tools, even power purchase agreements structured as loans. Moreover, government "budget scoring" impact of such mechanisms is a fraction of actual agency funds disbursed. Without federal risk mitigation mechanisms, however, it is not likely that utilities would order new nuclear power plants in the US during the next decade even with more favourable tax policies. The negotiation and tailoring of federal credit to specific risks where the federal government carries a lead role (e.g. commissioning, regulatory, waste disposal and indemnification) offers a path forward to preserving nuclear power as a vital fuel source in a diversified national energy portfolio.

Appendix

NERC Regions Offer Differing Locales for Considering New Reactors

Although most consumers and voters are not aware of these facts, the United States does not have a national grid and the US grids are integrated with Canada. NERC coordinates power delivery and reliability within and between ten regional grids in North America (Alaska, Hawaii, and Mexico excluded). Three major NERC regions include Canadian provinces that also provide power to the United States. Regional grid operations also provide some insulation from a nationwide power shutdown. Hence, regional developments in Canada, beyond gas supply, have an impact in planning for US electric capacity. For example, power from nuclear units built in Canada (e.g., CANDU reactors) could be "wheeled" into the United States, as hydropower now is in the NPCC region.

Source: www.nerc.com

R:DOE-NE:Graphics:040802_NERC Regions.ppt

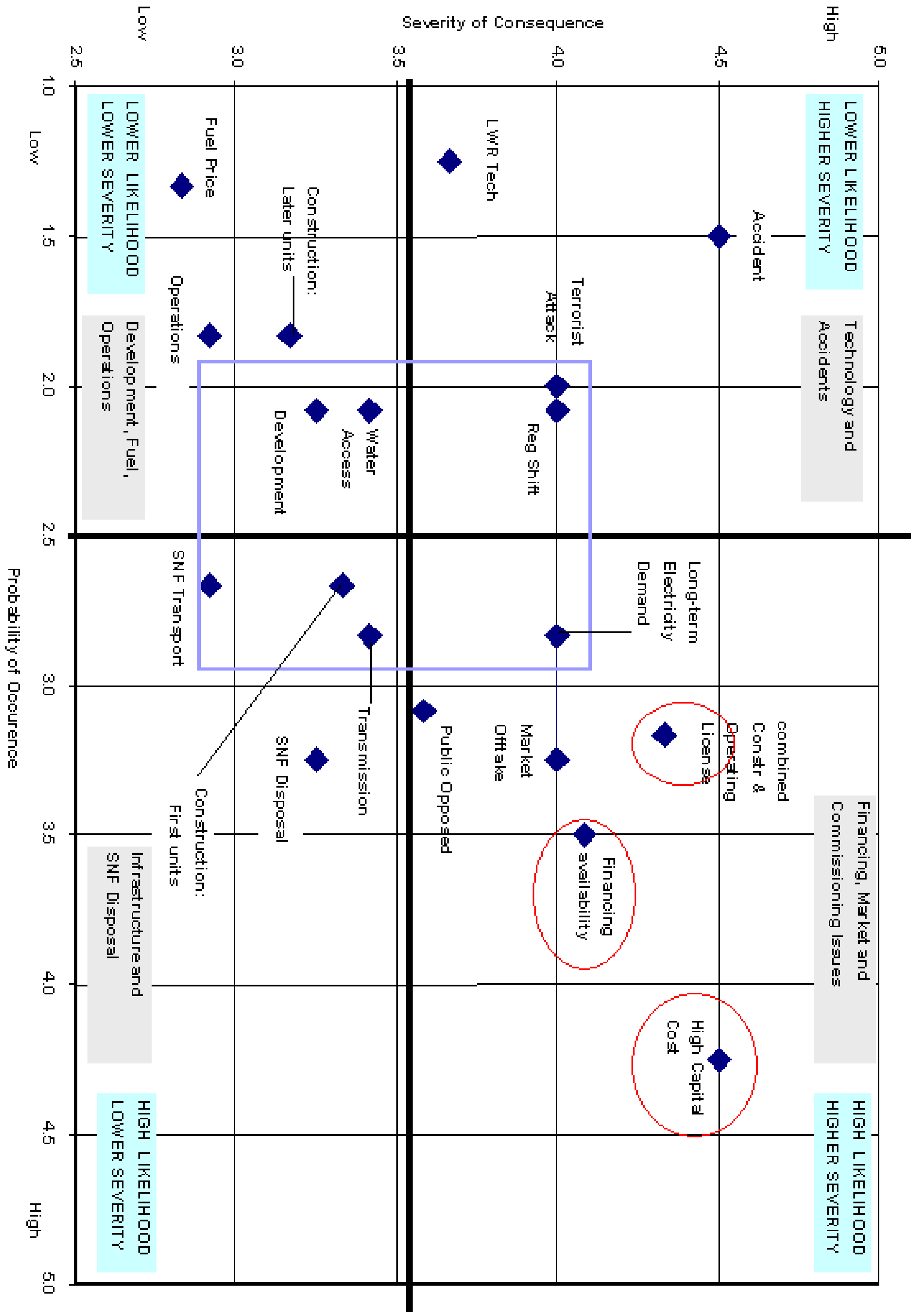
Detailed Tabulation and Analysis of Risk Ratings

Ratings by industry were made utilizing a Delphi methodology approach, and updated from those taken in May 2002 for the Business Case, among virtually the same respondents:

	12 respondents	**Oct '02**	**May '02**		**Oct '02**	**Oct '02**
	RISK CATEGORY	**Averages**	**Previous**	**Explanation of Ratings: May to Oct 2002**	**High**	**Low**
14	High Capital Costs / Long Build Cycle	**19.0**	**NR**	Highest rated risk; an emerging showstopper issue because of possible impact on utility stock price before startup (earnings dilution).	25.0	10.0
15	High Financing Costs	**14.7**	**NR**	Debt financing with attractive terms is a key concern. Utilities are worried that too much equity may be required.	25.0	6.0
5	Commissioning (COL, ITAAC)	**14.0**	**21.5**	Commissioning remains a major concern. Progress is seen because of limits on programmatic ITAAC, but not on COL yet.	25.0	8.0
12	Market competition (price levels)	13.1	10.0	More gas plants are on line, and electric prices dropped since crisis in 2000.	20.0	9.0
11	Electricity / economic demand (volume levels)	11.3	12.0	Nuclear plants run as baseload; but need an improved demand outlook.	20.0	6.0
16	Public opposition	11.3	**NR**	Public acceptance varies widely by region; First units would be built in areas where nuclear is popular (Southeast, Midwest).	25.0	6.0
9	Waste Disposal (Yucca Mt. site)	10.4	**25.0**	Congress voted in July 2002 to proceed with licensing lowered risk.	20.0	3.0
13	Transmission availability	10.2	15.0	Transmission congestion varies by region, and is important for nuclear.	25.0	2.0
4a	Construction: First units	8.9	**21.0**	Included some commissioning risk in last rating, so rating better reflects true views.	16.0	4.0
6	Regulatory shift (after startup)	8.6	**NR**	Regulatory shift was separated from commissioning; some concern exists about inadequate staffing at NRC.	15.0	2.0
18	Terrorist Attack	8.2	**NR**	Nuclear plants have elevated defenses since 9/11 to counter the risk.	15.0	3.0
10	Transportation of spent fuel to Yucca Mt.	8.1	**25.0**	Legislation for Yucca Mt. lowered risk; but still need to ship the spent fuel.	16.0	1.0
3	Water resource availability	7.7	**NR**	Not rated last time, but a key issue in some regions, not in others.	15.0	1.0
2	Development (Site prep/Local permit)	7.4	11.0	New units would be built at current sites, which are well known by utilities.	20.0	1.0
17	Accident or Disaster	6.8	10.0	Accident risk is not rated high; and it looks like Price-Anderson indemnity will pass in Congress in 2003.	10.0	3.0
4b	Construction: Later units	5.8	16.5	Once units are built, then later units are seen as less risky.	9.0	2.0
7	Operations: on LWRs	5.6	9.5	Utilities remain comfortable with operating risk after several decades.	12.0	1.0
1	Technology & System	4.4	7.5	Confidence in LWR technology continues; many have been built and now renewed.	8.0	1.0
8	Fuel price & supply for LWRs	3.8	5.5	Fuel prices are low (<$5/MWh), with a stable long-term outlook for supplies.	9.0	1.0
19	Operating: on gas reactors		19.5	Not rated in Oct.'02; not seen as a near-term option; they have not been built.		
	Overall Average	**9.4**	**14.6**		**17.4**	**3.7**

Detailed Analysis of Risk Ratings by Probability vs. Severity of Consequence – October 2002

The survey of ratings was plotted as a two-value rating of “probability of occurrence and an assessment of “severity of consequence”.



Progress on Reactor Relicensing Improves Outlook for Nuclear Power

Swift reactor relicensing since 1998 combined with competitive marginal operating costs has improved the outlook for consideration of building new reactors.

Applicant Approved	Plant Name & Units	Year Started Oper-ations	Date Appli-cation Submitted to NRC	Date NRC Issued License	Plant Size	Plant Type (PWR, BWR)	Vendor / E&C
Baltimore Gas & Electric	Calvert Cliffs, 1 & 2	1975	Apr-98	Mar-00	850 x 2	PWR	CE / Bechtel
Duke Energy	Oconee, 1, 2, & 3	1974	Jul-98	May-00	846 x 3	PWR	BW / Duke
Entergy Operations	Arkansas Nuclear, 1	1974	Feb-00	Jun-01	825	PWR	BW / Bechtel
Southern Nuclear	Edwin I. Hatch, 1 & 2	1976	Mar-00	Jan-02	924 x 2	BWR/4	GE / Bechtel
Florida Power&Light	Turkey Point, 3 & 4	1973	Sep-00	Jun-02	760 x 2	PWR	W / Bechtel
Virginia Electric & Power (Dominion)	Surry 1 & 2	1972	May-01	Pending	800 x 2	PWR	W / S&W
Virginia Electric & Power (Dominion)	North Anna 1 & 2	1979	May-01	Pending	900 x 2	PWR	W / S&W
Applicant Pending							
Duke Energy	McGuire 1 & 2	1982	Jun-01	Pending	1100 x 2	PWR	W / Duke
Duke Energy	Catawba 1 & 2	1985	Jun-01	Pending	1100 x 2	PWR	W / Duke
Exelon	Peach Bottom 2 & 3	1974	Jul-01	Pending	1160 x 2	BWR/4	GE / Bechtel
Florida Power&Light	St. Lucie 1&2	1977, 1983	Nov-01	Pending	893 x 2	PWR	CE / Bechtel
Omaha Public Power	Fort Calhoun	1974	Jan-02	Pending	475	PWR	CE / Gibbs
Carolina Pwr. & Light	Robinson 2	1971	Jun-02	Pending	683	PWR	W / Ebasco
Rochester Gas & Electric	Ginna	1970	Aug-02	Pending	490	PWR	W / Bechtel
SCE&G	Summer	1984	Aug-02	Pending	1000	PWR	W / Gilbert
TVA	Browns Ferry 1,2,3	1975	Nov-02	Pending	1065 x 3	BWR/4	GE / TVA
				Total (MW)	26,180	22P / 7B	

Source: NRC (www.nrc.gov)

Ownership of US Nuclear Plants is Consolidating in Strong Hands

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.

(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 5/30/03**	**Stock Price Change**
Exelon (PECO, Unicom)	PA, IL	$15.10	4P / 10B	14,191	$30	$52	$60	98%
Entergy Nuclear	LA, AR, MS, NY, MA	$9.60	5P / 4B	8,314	$25	$42	$51	105%
Duke	SC, NC	$59.50	7P	7,054	$25	$30	$19	-24%
Progress Energy	SC, FL	$8.40	6P / 2B	6,220	$30	$51	$48	59%
Southern Nuclear	GA, AB	$10.20	4P / 2B	5,659	$15	$27	$31	109%
TVA	TN, MS, AB	$7.00	3P / 2B	5,635	Gov't	Gov't		
Dominion Generation	VA, CN	$10.50	6P	5,405	$40	$66	$64	60%
Nuclear Mgmt Co.	WS, MN, IA	$15.00	5P / 2B	4,353	$20	$17	NMC	NMC
First Energy	PA, OH	$8.00	3P / 1B	3,726	$25	$33	$37	46%
Constellation Nuclear	MD, NY	$3.90	2P/2B	3,363	$30	$28	$34	12%
Florida Power Group	FL, NH	$8.47	4P	3,306	$42	$59	$66	56%
PSEG Nuclear	NJ	$9.80	1P / 2B	3,243	$35	$43	$43	23%
Texas Utilities	TX	$27.90	2P	2,310	$35	$51	$21	-41%
S&P 500 Index					1,470	990	945	-36%
Subtotal		**$193.37**	**40P / 25B**	**72,779**	76%			
Others		$ billions	38 units	23,481				
Nuclear Total (NEI)			103 units	96,260				

Source: Business Case for Nuclear Power

Acquisitions of US Nuclear Plants Moves Reactors from Public to Private Sector

Several acquisitions since 1998 transferred plants from municipal ownership to private hands.

Date Done	*Buyer*	*Seller / Acquired / Merged*	*Nuclear Unit*	*Type*	*Year Start*	*MW*	*Trans-action Size ($Mil)*
Jun-99	Entergy	Boston Edison	Pilgrim / MA	BWR	1972	665	$13
Jun-99	Amergen (Exelon + British Energy)	Unicom	Clinton / IL	BWR	1987	930	$23
Dec-99	Amergen (Exelon + British Energy)	GPU	Three-Mile Isle 1 / PA	PWR	1974	790	$23
Mar-00	Entergy	NYPA	Indian Point 3 / NY	PWR	1976	980	A) $967
Mar-00	Entergy	NYPA	Fitzpatrick / NY	BWR	1974	816	A) $967
Jun-00	Amergen (Exelon + British Energy)	GPU	Oyster Creek / NJ	BWR	1969	650	$10
Aug-00	Dominion	Northeast Utilities	Millstone 2 / CN	PWR	1975	858	B) $1,300
Aug-00	Dominion	Northeast Utilities	Millstone 3 / CN	PWR	1986	1150	B) $1,300
Aug-00	Entergy	Yankee Nuclear	Vermont Yankee / VT	BWR	1973	522	$180
Nov-00	Entergy	ConEd	Indian Point 1 & 2 / NY	PWR	1974	957	$602
Dec-00	Constellation	Niagra Mohawk	Nine-Mile Point 1 / NY	BWR	1969	614	C) $815
Dec-00	Constellation	Niagra Mohawk	Nine-Mile Point 2 / NY	BWR	1988	1140	C) $815
Jun-01	PECO	Delmarva	Peach Bottom 2&3/NJ	BWR	1974	330	$7
Oct-01	PSEG	Atlantic Energy	Salem 1 & 2 / NJ	PWR	1980	383	$10
Apr-02	Florida Power	NA Energy Srvc	Seabrook / NH	PWR	1990	1150	$580
	TOTAL		18 Units	9P / 9B	1977	11,935	

Source: NEI, Business Case for Nuclear Power (www.nuclear.gov)

