Business Risks and Costs of New Nuclear Power

Craig A. Severance

Several U.S. utilities are now advancing proposals for a new generation of nuclear power plants. Though massive cost overruns and construction delays in the 1970's and 1980's caused U.S. utilities to cancel over 130 nuclear plant orders [1], the nuclear industry is now hoping to ride a wave of concern over global warming. Can new nuclear power help the U.S. electric power industry cut greenhouse gas emissions, at a reasonable cost?

EXECUTIVE SUMMARY

It has been an entire generation since nuclear power was seriously considered as an energy option in the U.S. It seems to have been forgotten that the reason U.S. utilities stopped ordering nuclear power plants was their conclusion that nuclear power's business risks and costs proved excessive.

With global warming concerns now taking traditional coal plants off the table, U.S. utilities are risk averse to rely solely on natural gas for new generation. Many U.S. utilities are diversifying through a combination of aggressive load reduction incentives to customers, better grid management, and a mixture of renewable energy sources supplying zero-fuel-cost kWh's, backed by the KW capacity of natural gas turbines where needed. Some U.S. utilities, primarily in the South, often have less aggressive load reduction programs, and view their region as deficient in renewable energy resources. These utilities are now exploring new nuclear power.

Estimates for new nuclear power place these facilities among the costliest private projects ever undertaken. Utilities promoting new nuclear power assert it is their least costly option. However, independent studies have concluded new nuclear power is not economically competitive.

Given this discrepancy, nuclear's history of cost overruns, and the fact new generation designs have never been constructed any where, there is a major business risk nuclear power will be more costly than projected. Recent construction cost estimates imply capital costs/kWh (not counting operation or fuel costs) from 17-22 cents/kWh when the nuclear facilities come on-line. Another major business risk is nuclear's history of construction delays. Delays would run costs higher, risking funding shortfalls. The strain on cash flow is expected to degrade credit ratings.

Generation costs/kWh for new nuclear (including fuel & O&M but not distribution to customers) are likely to be from 25 - 30 cents/kWh. This high cost may destroy the very demand the plant was built to serve. High electric rates may seriously impact utility customers and make nuclear utilities' service areas noncompetitive with other regions of the U.S. which are developing lower-cost electricity.

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[1] World Nuclear Industry Status Report 2007, p. 19

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Craig A. Severance - January 2, 2009

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Who Stopped U.S. Nuclear Power?

An entire generation has passed since nuclear power has been seriously considered in America. New faces are now on utility boards, and new reporters are covering the energy beat. After so much time, a particular amnesia about the record of the nuclear industry is evident in discussions.

Contrary to historical revisionism now promoted by some, it was not the environmentalists who stopped the growth of U.S. nuclear power. Environmentalists were uniformly ineffectual, as government policies at both the Federal and state levels continued to favor nuclear power.

It was also not the Three Mile Island accident that caused the nuclear industry's collapse. By the time Three Mile Island happened in 1979, a wave of cancellations of new nuclear plant orders was already underway. If anything, the accident simply capped off a trend which was already occurring.

Utility executives and Wall Street financiers were the ones who stopped nuclear power's expansion in the 1970's. As more evidence of the business risks and the costs associated with nuclear power became clear through utilities' own experiences, utility boards across the country, and the financial houses who fund them, stopped considering nuclear power a serious future option. Orders for new plants that had already been advanced, were quietly withdrawn.

The nuclear industry simply failed to compete against other available options, whose risks and costs were significantly lower.

Has this situation now changed? What is different in today's world? Can a new nuclear plant pass evaluation as a business proposal?

What is Driving the Push for New Nuclear Power?

The major competitors to nuclear power as a potential source of electricity have traditionally been coal and natural gas. Both of these fossil fuels have served U.S. utilities well, as economical and reliable fuels. They both also have the advantage of being obtained primarily from domestic sources, thus contributing to U.S. energy self-sufficiency.[2]

As global warming concerns have risen to the fore, however, fossil fuels in general and coal in particular have come to be seen as major contributors to greenhouse gas emissions. In the recent election, both Presidential candidates announced support for reductions in CO^2 emissions. Although Federal regulations are yet to be adopted, there is growing consensus they are likely.

As a result of this expectation, it is an "inconvenient truth" that it has become more difficult for a utility to build a new coal-fired power plant. Some states have already enacted regulations restricting carbon dioxide emissions of new power plants to effectively preclude the building of new coal plants unless they employ carbon sequestration. Environmental groups are also now routinely questioning new coal-fired plants, citing global warming concerns. If coal is "taken off the table" until such time as carbon sequestration technologies are available [3], the choices for electric utilities become difficult.

Natural gas is still a viable option, generally not opposed by environmentalists or expected government regulations, because of the excellent efficiency of natural gas combined cycle gas turbines (CCGT's). Roughly only half the carbon dioxide is emitted per kWh, compared to the carbon dioxide emissions from a coal plant.[4] New gas discoveries have also expanded supply.

Nevertheless, the removal of coal as a new generation option has been a major shock to utility planning, when one considers that roughly 50% of all U.S. electricity is now obtained from coal.

As utility managers are generally risk adverse, they see a reduction from two available main fuel sources for new construction (coal or natural gas) down to only one (natural gas) as unacceptable. Until mid-2008, when new natural gas resources from domestic shale gas began to alleviate concerns, natural gas was seen as having significant price and supply issues. A desire for more options, therefore, is opening a door for alternatives, including nuclear power.

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[2]While coal and natural gas are primarily domestic fuels, the opposite has proven true for uranium. For example, per the Energy Information Administration Annual Energy Review 2007, "Table 9.3, Uranium Overview, Selected Years 1949-2007", in 2007 the U.S. purchased imports of 54.1 million lbs uranium oxide vs. only 4.53 million lbs of domestic concentrate production.

[3] For a full discussion see "The Future of Coal", MIT Interdisciplinary Study, 2007

[4]Because of combined cycle efficiency, some utilities are including combined cycle gas turbines as part of strategies to lower greenhouse gases , e.g. by replacing older coal-fired plants with natural gas CCGT's, to achieve approx.. a 50% reduction in CO^2 per kWh for those kWh.

Diversification Plans of U.S. Utilities

Adopting a "Least Cost" approach, many U.S. utilities now are taking cost-effective measures to *avoid* the need for new power plants. Going beyond mere information booklets, these utilities are now paying customers to be more energy efficient. Significant utility rebates include payments for more efficient air conditioners, insulation, Energy Star appliances, etc. These measures are known to reduce demand for power, and the "negawatts"[5] gained eliminate or defer the need for new generating stations, at a cost per kilowatt an order of magnitude lower.

Energy storage and load management offer additional solutions to reduce, shift and better manage loads. Pumped-water and compressed-air energy storage as well as utility-scale batteries are now being implemented. A system approach utilizing both hardware and software, called "The Smart Grid", employs utility-scale energy storage, smart meters which can modulate consumer load centers, plus consumer interfaces in the home or business that display instantaneously how a customer's behavior is affecting their energy bill and their demands on the grid.[6]

To promote a more diverse (and thus more stable) energy mix for new generation, most U.S. utilities are also adopting renewable energy. Wind, solar, biomass/trash, and geothermal electricity generation are now being adopted at scale, as part of a total solution that may also include new gas turbines. If demand reduction has been implemented and new KW capacity is still needed, the low-cost KW capacity of the gas turbines assures grid reliability, while renewable-source kWh's cut natural gas use[7], and help mitigate concerns about natural gas price and supply.[8] One of the advantages of this approach also is that these new generation units come in small MW capacity increments, allowing a utility to closely match its building program with its need curve.

The majority of U.S. utilities are effectively managing future growth needs through a combination of these technologies. They have gone well beyond replacing the loss of coal as an option, by expanding available options to include a wide range of cost effective technologies.

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[5]"Negawatts" is a term promoted by Amory Lovins of the Rocky Mountain Institute for kilowatts of generating capacity need *eliminated* by efficiency measures.

[6]See, for instance, this in-depth recent article on Smart Grid technologies: http://ecoworld.com/features/2008/10/07/smart-grid-enablers-gridpoint

[7]The Pickens Plan, promoted by oilman billionaire T. Boone Pickens, envisions freeing up most of the natural gas resources now used by U.S. utilities to generate over 20% of U.S. electricity, by replacing these kWh with wind and solar electricity, see www.PickensPlan.com

As 30% of U.S. natural gas resources are now used to generate electricity www.NaturalGas.org/ replacing most of the kWh's now generated by natural gas with renewable kWh's helps avoid natural gas supply shortages, and reduces pressure on natural gas prices.

[8]Recent experience with worldwide oil prices being radically impacted by reductions in consumer demand (i.e.. dropping from a high of over $147/barrel to less than $60/barrel) shows the efficacy of managing price and supply concerns by reducing use of the fuel.

U.S. Utilities Seeking to Build New Nuclear Power Plants

Several U.S. utilities, located primarily in the Southern U.S., are now seeking to build new nuclear power plants. A total of over two dozen reactors are in some stage of exploration.

This is a region where, in general, the "Least Cost" approach, which includes efficiency rebates, load management technologies, and Smart Grid implementation, has yet to be aggressively pursued. While all of these utilities have information programs on energy efficiency, many have yet to implement significant rebates and other demand side management (DSM) programs that require greater investments, and more direct partnering with customers.[9]

Many of these utilities also see their own region's renewable energy resources as far less abundant. They compare themselves to the windy Midwest or the sunny deserts of Nevada and California, and see their own region's resources as far less abundant.[10] As there is currently no efficient national grid, they do not yet see an option to purchase significant power from other regions.[11]

The "closer" is when the utility also is in a high-growth area with rapidly expanding population, creating a projected surge in new demand for electricity in its service area. Where predictions of rising electricity demand have met with a perception there are few if any options available to curb or to fulfill demand, these utilities have chosen to build new central generation power plants. For most, their first choice would have been coal – but that option is now seen as thwarted..[12]

Predicting a significant potential increase in demand for electricity a decade from now[13], these utilities are now exploring new nuclear power.

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[9]Investing "serious money" in Demand Side Management requires state regulatory support to allow utilities to include these investments in the rate base, or its shareholders will be investing funds without the ability to earn a return. Many states have adopted such rate policies.

[10]For instance, in its recent application to the South Carolina Public Service Commission for a determination on two proposed nuclear power plants, South Carolina Electric & Gas noted it is "purchasing power from three customers on the system who have installed solar panels." (Testimony of Joseph Lynch, SC E&G, Docket 2008-196-E). This is in sharp contrast to utilities in California or Colorado which already have experience with thousands of distributed solar applications.

[11]The deficiencies in the nation's electric transmission grid have been widely noted by the FERC, Congressional committees, the Pickens Plan, and renewable energy industries. The 2008 energy act (contained in the financial rescue legislation) included incentives to help jump start investments in new long-distance transmission lines.

[12]Florida P&L, for instance, cites denial of its Glades Power Park coal project as a reason for new nuclear. (FL PSC Docket 07-0650-EI, Armondo J. Olivera, October 16, 2007, Page 13).

[13] The long lead time for nuclear forces major decisions *now* for needs projected a decade or more away. Of course, the further the planning horizon, the more speculative the need.

New Nuclear Power as a Business Proposal

A proposal to build a new nuclear power plant is a major business proposal involving commitment of literally billions of dollars. The cost estimates for new nuclear power plants put them among the most expensive private projects ever undertaken in the history of the world.

In the U.S., these projects are typically constructed by private utilities, which operate as businesses traded on the stock exchanges and whose bonds are subject to ratings in the bond markets. Failure of a major business proposal can adversely affect stock prices and bond ratings, thus increasing costs of capital and restricting the utility's access to capital markets. In the worst scenario, as a private company a utility can experience bankruptcy.

It is essential to consider a new nuclear facility as a *business proposal*, to judge what it may mean for the profitability, financial security, and survival of the utility company.

Rationale for the Proposal

A utility proposing a nuclear plant cannot proceed on its own. It must win a vote of confidence from various players. The utility must obtain the approval of the financial community. It also must win state regulatory approval for inclusion of the costs of the facility in customer rates. As this is a public arena, the utility will often seek to win over public opinion.

This all requires the adoption of a public argument for the nuclear facility. In today's economic crisis, it may not be convincing to admit the nuclear plant is *more costly* than other options, but is nevertheless being pursued . Utilities proposing new nuclear plants, therefore, have argued the nuclear option is the *least costly* of the options considered.

The Primacy of Prudence

An electric utility serves a unique role, as it impacts the economy of its entire service area. If a utility chooses an option with significant risks of failure to meet its projected costs and timetable, severe consequences for its customers could ensue in the form of higher rates or, in the worst case, service interruptions. The credit rating of the utility could be seriously downgraded, affecting its ability to obtain financing for needed projects. Economic growth may be stymied in the local economy if electric rates end up significantly higher than other parts of the country.

If choices begin to prove more difficult because of changing world conditions, the utility must return to its primary requirement, which is to act with *prudence*. This is not only sound business practice, but for public utilities it is a matter of law. Utility rate-making law is founded on the principal that a utility is allowed to recover from ratepayers all costs which are *prudently* incurred. If costs are judged to be imprudent, they are excluded from recovery from ratepayers. For instance, Union Electric lost the ability to recover hundreds of millions spent on its Callaway nuclear plant when these costs were ruled *not* to be prudent.[14] In the 1980's alone, state commissions disallowed more than $7 billion of nuclear costs from recovery in the utility rate base, due to construction imprudence. Another $2 billion in nuclear costs were disallowed due to imprudence of building new capacity that was physically in excess of needs when completed.[15]

The availability of Federally guaranteed loans, and/or a guarantee of the ability to charge ratepayers (often during construction) for the costs of a new facility, are no substitute for prudent business judgment. Simply shifting the burden of risks from the utility's shareholders and executives, to the taxpayers and ratepayers does not make any risks go away. It simply sets up yet another situation where profits are privatized while risks are socialized, allowing those who make bad decisions to walk away from the effects of their own imprudence. After hundreds of billions of such outcomes this year alone, the public has no stomach for more of this.

What is prudent business judgment? In practice, prudence means avoiding the choice of high-risk options, when a lower-risk option will "get the job done". Most Americans have been conditioned to consider prudence, by the sports we enjoy. For instance, if it is the last minute of the football game and you are down by just 1 point, it is Fourth Down and you are on the 20 yard line, we all know the surest way to win the game is to kick a field goal. It would be *imprudent* to risk everything on a much riskier play. While the riskier play may be more glamorous, it has a far lower chance of success and the *prudent* decision is to pick the less glamorous but more predictable field goal.

While utility management should be a rewarding field, it is not good for the utility or for its customers for the management of the utility to become *too* interesting. Low cost and stability of utility rates and service are the outcomes most desired.

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[14]Union Electric Company Opinion #279, Docket No. ER84-560, July 20, 1987, Federal Energy Regulatory Commission (FERC)

[15]"The Risks of Building New Nuclear Power Plants", Presentation of David Schlissel, Synapse Energy Economics, Inc. before Utah State Legislature Public Utilities and Technology Committee, September 19, 2007.

Clouds Over the Nuclear Parade

While utilities campaigning for new nuclear power claim it is the least expensive electricity source, independent evaluations of the economic competitiveness of new nuclear power have come to the opposite conclusion.

A major MIT study entitled "The Future of Nuclear Power" was published in 2003. Although it recommended "the nuclear option be retained" strictly because of global warming concerns , MIT also stated "Today, nuclear power is not an economically competitive choice. Moreover, unlike other energy technologies, nuclear power requires significant government involvement because of safety, proliferation, and waste concerns." The study outlined four challenges — costs, safety, proliferation, and wastes – that would all need to be overcome for nuclear power to be a viable option. Its economic analysis was done *before* recent capital cost escalations occurred, that now indicate much higher construction costs for nuclear plants. Nevertheless even with low capital cost projections, the MIT economic analysis found nuclear power to be a more costly method of power generation than coal or natural gas. (The study specifically did not consider other energy generation options such as wind, solar, or geothermal.) Only with a *combination* of very high carbon taxes *and* several "plausible but unproven" possibilities to *reduce* nuclear power costs did the study find the cost per kWh of nuclear power could be competitive with coal or natural gas.[16]

Although the MIT study advocated exploring whether nuclear power costs could decrease, what has in fact occurred since the study was published is a rapid increase in nuclear power plant costs.

The year 2007 was marked by nuclear industry leaders announcing new cost estimates, and declaring not a single new nuclear power plant could be built unless Federally Guaranteed Loans were available for construction costs.[17] The nuclear lobby did in fact succeed in obtaining authority for $18.5 Billion in Federal loan guarantees. The need for government backing is extraordinary, as the utility industry is normally considered to be one of the safest of investments. We do not see industries constructing coal, natural gas, or even solar or wind generation facilities declaring they have been unable to obtain private financing and must now rely on Federally Guaranteed Loans.

Early in 2008, the *Wall Street Journal* and several other publications carried headline news stories about skyrocketing cost projections for new nuclear power plants, indicating new projections it may cost $9 billion to $12 billion to build a single new nuclear power plant[18] (the estimates were for different size reactors, therefore both translate into $8000 - $8500 per KW of capacity).

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[16] *The Future of Nuclear Power, Overview and Executive Summary*, p.3, Massachusetts Institute of Technology, 2003, and Chapter 5, "Nuclear Power Economics".

[17] See, e.g., *The New York Times,* July 30, 2007: http://www.nytimes.com/2007/07/31/washington/31nuclear.html

[18] "New Wave of Nuclear Plants Faces High Costs", *Wall Street Journal*, May 12, 2008

In June 2008 Lazard, a preeminent financial advisory and asset management firm, published "Levelized Cost of Energy Analysis – Version 2.0" comparing recent estimates of the cost/kWh of various power generation sources including renewables, coal, natural gas, and nuclear.

Lazard's analysis indicated the range of costs/kWh for new nuclear power plants, estimated by Lazard to be approximately 10 to 13 cents/kWh in 2007 levelized dollars, are now projected to be *higher* than the price available for virtually any other power generation option.

The Lazard analysis compared the costs of technologies already widely in service by U.S. utilities — wind power, natural gas combined cycle, and coal's current technology. Lazard's projections of 2007 levelized costs for these existing technologies, which already have well-known costs from actual experience, indicated new nuclear's projected costs were *significantly higher* than costs for wind power (4 to 9 cents/kWh), natural gas combined cycle (6 to 12 cents/kWh which includes a wide range of prices for natural gas fuel), and coal's existing technology (approximately 7 to 10 cents/kWh also incorporating a range of fuel prices for coal).

Lazard also examined costs/kWh in 2007 levelized dollars for several other generation technologies which are now becoming more widely utilized: geothermal electric power generation (4 to 7 cents/kWh), landfill gas (5 to 8 cents/kWh), biomass direct (5 to 10 cents/kWh), and solar thermal electric generation (9 to 15 cents/kWh).

Significantly, some new electric generation technologies are on *downward* cost curves because they are primarily *not* built on-site, but instead are mass produced in factories. For example, Lazard's analysis projected costs by 2010 for solar photovoltaic - thin film technologies should be in the range of 8 to 12 cents/kWh. Lazard also noted that solar manufacturing costs are actually projected to further *decrease* – indicating a projected generation cost in the range of only approximately 6 cents/kWh by 2012 for solar thin-film photovoltaic.

Because many are not yet ready to give up on America's abundant coal reserves , the Lazard analysis also examined the additional anticipated costs to a coal plant for 90% carbon capture and compression. According to the Lazard analysis, the total projected cost/kWh for "clean coal" (expressed as the "high end" for coal costs on Lazard's graphs) was in the same range, or only slightly higher (approximately 11 to 14 cents/kWh expressed in 2007 dollars levelized costs) than the projected cost/kWh for Lazard's nuclear scenario.[19]

Important studies have concluded that several already existing technologies have *significantly* lower cost per kWh than new nuclear power – including technologies fully compatible with a carbon-reduced future, such as wind power, biomass, land fill gas, and natural gas combined cycle.
If there were a need for a utility to bypass these well-proven existing technologies, these same studies indicate that among the range of new technologies (new nuclear, new solar electric, and coal with carbon sequestration), new nuclear power is *not* expected to show a cost advantage, and is in fact projected to be at least as costly if not more costly than other new technologies.

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[19] Levelized Cost of Energy Analysis - Version 2.0", Lazard, June 2008

Business Risk #1: Costs to Build the Nuclear Plant May Exceed Estimates

There is a clear discrepancy between independent evaluations indicating nuclear power is *not* economically competitive, and utility company assertions that nuclear is their least cost option.

The first Business Risk, therefore, is that utility and nuclear industry cost estimates for new nuclear power plants may be understated.

History of Cost Overruns

It is more than legend that the original wave of U.S. nuclear power plants ordered in the 1960's and 1970's experienced massive cost overruns compared to original estimates.

The U.S. Energy Information Agency (EIA) studied the record of this generation of plants (but did *not* include the worst cases such as Comanche Peak, Seabrook, and Vogtle), breaking up the results into two-year periods. EIA set out to compare original estimates to actual costs (levelized to constant dollars), and the results were dramatic. It was not a few isolated cases, but a clear pattern of an industry that regularly and catastrophically underestimated its costs:

The EIA found average *actual realized* nuclear construction costs were 209% - 380% , i.e. over 2 to almost 4 times, the estimates originally presented at start of construction:

Average Estimated and Realized Overnight Costs of Nuclear Power Plants By Year of Construction Start, 1966-1977 (1982 Dollars per Kilowatt-Electric)

		Estimated Per-Plant Costs at Different Stages of Completion					
Year of Construction Start	# of Plants	0%	25%	50%	75%	90%	Realized Costs
1966–1967.........................	11	298	378	414	558	583	623
1968–1969.........................	26	361	484	552	778	877	1,062
1970–1971.........................	12	404	554	683	982	1,105	1,407
1972–1973.........................	7	594	631	824	1,496	1,773	1,891
1974–1975.........................	14	615	958	1,132	1,731	2,160	2,346
1976–1977.........................	5	794	914	1,065	1,748	1,937	2,132

Source: Energy Information Administration, An Analysis of Nuclear Power Plant Construction Costs, DOE/EIA-0485 (Washington, DC March 1986) p. 18, as quoted in "Commercial Nuclear Power in the United States Problems and Prospects", U.S. Energy Information Administration, August 1994

If you hired a contractor to build homes for you and he regularly ran 2 to 4 times his budget, you would fire him. We know the utility industry did in fact walk away from the nuclear industry, for 30 years.

“Demonstration Plants” for New Designs

Proposals to build a new generation of nuclear reactors, with entirely new designs, mean each of these projects is essentially a “Demonstration Project”, because no such reactors have yet been completed anywhere in the world. Therefore no one has real experience to know the actual costs.

Normally, when an industry develops a new product, a prototype is built. If that is too expensive, a Demonstration Plant may receive a research grant. Now, however, the nuclear industry is seeking to have utility ratepayers and shareholders fund this experiment.

Nuclear Engineering International on 20 November 2007 commented directly on the additional risks posed by *new generation* designs in its article “How Much?” regarding escalating nuclear construction costs (after first discussing TVA’s efforts to finish abandoned old-generation nuclear plants): “While these [TVA restart] projects give some indication as to how much a utility is willing to spend on new nuclear capacity, the figures give no indication as to how highly TVA values the lower level of risk associated with these projects compared to so-called Generation III+ plant. Lowering the risk was also a main consideration behind NRG Energy’s decision to choose the ABWR design in its ... application .. NRG spokesman David Knox told *Nuclear Engineering International* : “We chose the ABWR technology because of the certainty it provides.”.”[20]

Inability to Develop a Reliable Cost Estimate

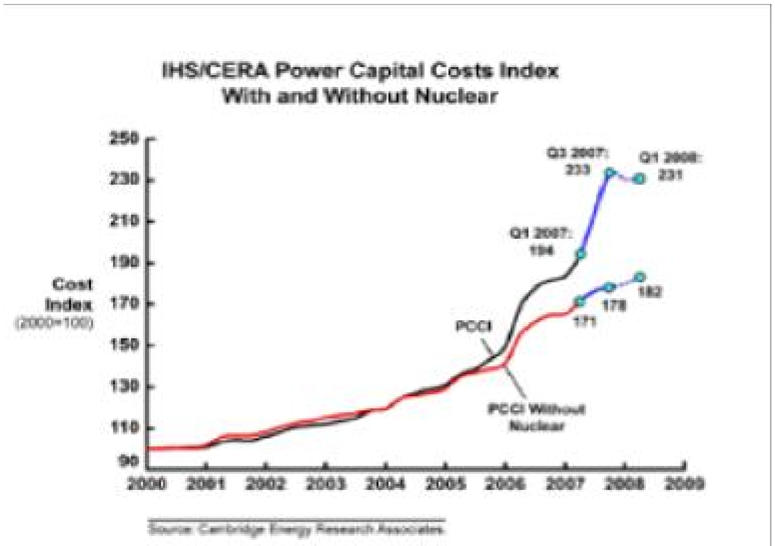
Those close to the nuclear industry argue that because the new generation of nuclear plants are entirely new designs, and it has been some three decades since anyone has started a new nuclear plant in the U.S., it is actually impossible at this time to develop a reliable cost estimate
.
When Moody’s Investor Service produced its estimate in October 2007 of all-in costs between $5000 - $6000/KW they stated: “While we acknowledge that our estimate is *only marginally better than a guess;* it is a more conservative estimate than current market estimates.”.[21]
Nuclear Engineering International (22 August 2008), in an article titled “Escalating Costs of New Build: What Does it Mean?” wrote “What is clear is that *it is completely impossible to produce definitive estimates for new nuclear costs at this time*. The fact that the USA and other leading nuclear nations have not been building plants for some time, and also that most current reactor designs have not yet been built to completion, suggests there is considerable uncertainty with respect to the capital cost of new nuclear and other generating technologies.” (Emphasis added) This article went on to discuss several reasons for the rapid escalation, including “lack of skilled workers, supply bottlenecks for imported heavy components, significant increases in key commodity prices and, in the case of the USA, perhaps the devaluation of the dollar ...”[20]

[20] *Nuclear Engineering International*, 20 Nov 2007, “How Much?”

[21] *Nuclear Engineering International,* 22 August 2008, “Escalating Costs of New Build: What Does it Mean?” (Moody’s analysis as quoted in this article.)(Emphasis Added)

Rapidly Escalating Costs to Construct New Power Plants

The electric utility industry has been experiencing rapid escalations in the cost indicators to construct new power plants of all kinds, and particularly nuclear. The Power Capital Costs Index (PCCI), a product of Cambridge Energy Research Associates (CERA), an IHS company, shows a cost escalation from Year 2000 costs to first Quarter 2008 costs of 2.31:



CERA stated in its May 15, 2008 Power Market Review and public release of the updated index, "This report of the Power Capital Costs Index (PCCI) registers a 131 percent increase in the cost to construct power plants since the year 2000. The latest release of the IHS/CERA PCCI for North America shows a new index point at first quarter 2008 of 231, indicating that a power plant that cost $1 billion in 2000 would, on average, cost $2.31 billion today. Costs, on an upward trend since 2000, have surged in recent years, rising 19 percent in the past year and 69 percent since 2005."[21]

CERA's PCCI tracks a "virtual" portfolio of 30 power plants in North America at the time of proposal – just prior to the start of construction. It is a proxy for EPC (Engineering & Procurement Contract) "hard costs" (thus does not include EPC soft costs such as contingency, fees, risk premiums, etc., and non-EPC costs e.g. owner's costs, land costs, permitting costs, etc.) It tracks costs as of the year indicated, and shows how these have escalated over time.

While the costs of all power plants are rising rapidly, the PCCI indicates a higher cost escalation for nuclear plants**.**

Because U.S. utility experience (as tracked by CERA's PCCI) shows very high annual cost escalations**,** a proposal to build a new nuclear facility *cannot rely on "today's costs" to continue over the time period it will take to construct the nuclear plant.* It is very important to project the impact of construction cost escalations especially if construction extends over several years.

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[21]Cambridge Energy Research Associates website: http://www.cera.com/aspx/cda/client/report/reportpreview.aspx?CID=9491&KID=209

A failure to project realistic escalations for construction costs can result in vastly misleading *completed* cost estimates for a new nuclear facility. For instance, in Florida Power & Light Company's recent Docket before the Florida Public Service Commission for a need determination on its proposal to build two Westinghouse AP-1000 reactors, FP&L projected an escalation rate of only 2.5%/year.[22] This is even lower than general economy inflation rates over the last several years.[23] Projecting such a low escalation in construction costs is highly misleading considering the vastly higher cost escalations tracked for *power plant construction costs*, e.g. by CERA's PCCI.

The U.S. Consumer Price Index from 2000 to 2007 increased by a factor of 1.2, while in the same period the Power Capital Costs Index increased by a factor of 2.3. If one were to rely on general economy inflation rates, you would think a power plant that cost $1 billion to build in the Year 2000 would only cost $1.2 billion to build in 2007. However, CERA has noted the same power plant would actually cost $2.3 billion to build. Picking a realistic escalation rate is very important.

Inability to Contractually Guarantee Construction Costs

In the early 1960's, U.S. nuclear vendors wrote "turnkey" fixed-cost provisions for several of the first commercial reactors., and reportedly lost enormous sums of money. After that experience, they moved to firmly place cost overruns on the utilities. Today, French vendor AREVA is losing an estimated one billion euro on cost guarantees for its Finnish project now under construction.[24] Given these experiences, it is unlikely U.S. nuclear vendors will once again risk *losing* money on a nuclear contract.[25] The U.S. utility which has perhaps spent the most effort attempting to gain cost guarantees is South Carolina Electric & Gas. SC E&G reports in its application before the South Carolina PSC it spent over two years negotiating a contract with Westinghouse, including breaking off talks. Nevertheless, SC E&G obtained provisions reportedly covering just over half of EPC costs. The actual provisions are confidential, however their efficacy is questionable in that SC E&G also reports the contract contains a "profit minimum" provision for Westinghouse.[26]
While the contract may contain "incentives and penalties" for the vendor to meet cost goals, it is difficult to see how the vendor can be held responsible for significant cost overruns if the vendor is not at risk of *losing* money.

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[22]Florida Public Service Commission Docket 070650-EI In Re: Florida Power & Light Company's Petition to Determine Need for Turkey Point Nuclear Units 6 and 7 Electrical Power Plant, Direct Testimony & Exhibits of Steven D. Scroggs, 10/16/07; p. 250 of 251 pg. PDF file

[23]For instance, annualized rate for the Consumer Price Index 2000 - 2007 was 2.69%.

[24]http://www.bloomberg.com/apps/news?pid=20601090&sid=aNHcrUQUJmu0

[25]As a case in point, Westinghouse has said it will not bid on a new Finnish reactor (see previous footnote). The Finns required French vendor AREVA to commit to cost guarantees.

[26] SC E & G's Docket # 2008-196-E before the SC PSC, Exhibit C "Information Concerning the Engineering, Procurement, and Construction Contract (EPC Contract)". That Exhibit notes (bottom of p. 3 - top of p. 4) there is a "profit minimum established" in the EPC.

The prevalence of rapidly escalating costs to construct new power plants indicates the longer the construction lead time, the greater the Business Risk that a proposed facility will exceed its estimated cost. Technologies with very short lead times (e.g. solar, wind, gas turbines) are exposed to the risk of cost escalations far less than power plants with long (e.g. coal or nuclear) construction periods. This is therefore a very significant additional Business Risk of nuclear power compared to other options available to a utility.

Estimate of Nuclear Power Capital Costs Using Realistic Cost Escalation Rates

It is useful to run an analysis of nuclear plant construction costs to completion, using power plant construction cost escalation factors more consistent with actual utility experience.

Effect of Economic Downturn

One might say that with a severe U.S. recession and worldwide downturn apparently underway, that price escalations may cease. However, if there is a severe U.S. recession, then the proposal to build a new power plant *would need to be re-examined as a whole* because the projected growth in customer demand for electricity, which the plant is built to serve, may also evaporate during this downturn.

Both the increased demand for electricity, and the increased cost of those factors feeding power plant construction cost escalations are tied to a growing U.S. and world economy. In particular, the growth of the Chinese and Indian economies have been noted as major underlying factors in the rapid cost escalations worldwide for a wide range of commodities, and increased competition for skilled labor and technical resources. No one expects these overall trends to abate, although they may certainly be slowed temporarily.[27] . Given nuclear's long lead time and the fact most nuclear costs occur after year 5, construction of a nuclear power plant will outlast any normal length recession. If other countries suffer less than the U.S., cost escalations may actually return even before the U.S. economy recovers.

Starting Point: "Overnight" Cost Estimates

The starting point for a capital cost estimate is the "overnight" cost – what it would cost to build the power plant "overnight"– i.e. at "today's prices" – with no further cost increases, and zero cost of capital (financing costs) during construction (since the plant is built "overnight"). Overnight cost estimates are developed, because we can best determine "today's prices". It is very important this "overnight" cost estimate not be confused with *total* capital costs. Rome wasn't built in a day, and a nuclear plant also takes considerably longer than a day to build.

[27]CERA's Power Capital Costs Index for 2008 3rd Qtr has now slowed to a point of 224, a 3% decline since 2008 1st Qtr's 231. However, during this same period most worldwide commodity, stock market etc. indices fell much more drastically, by double digits, indicating underlying forces pushing power plant construction costs upward are still strong.

Range of "Overnight" Cost Estimates for New Nuclear Power

A number of estimates of "overnight" costs to build a new nuclear power plant have been published in recent years:

Estimates of "Overnight" Construction Costs For New Nuclear Power

Source	Year of $	"Overnight" Cost
2003 MIT Study "The Future of Nuclear Power"	2002 $	$2,000 /KW
Escalate MIT estimate to 2007 $ using CERA PCCI Index 2002 - 2007	2007 $	$3,882 /KW
Actual Realized Cost of Last Generation Nuclear Plants Started 1976-1977	1982 $	$2,132 /KW
Escalate Actual Realized Cost of Last Gen. Nuclear Plants Started 76-77	2007 $	$7,697 /KW
Keystone Center 2007 Study	2007 $	$2,950 /KW
Florida P&L October 2007 Docket - Case A	2007 $	$3,596 /KW
Florida P&L October 2007 Docket - Case C	2007 $	$4,540 /KW

See below for footnotes on above sources[28]

Picking an Overnight Cost Estimate

With such a wide range of indicators of possible overnight construction costs for new nuclear, to be conservative we will use $4,070/KW in 2007 Dollars – midway between FP&L's Case A and Case C estimates, for a "Most Likely " estimate, and FP&L's Case A estimate of $3,596 for a "Low Cost" scenario.

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[28]The Future of Nuclear Power, Ch. 5, p. 39 of Study, MIT, 2003; escalated to 2007 dollars using CERA's Power Capital Costs Index; Actual Realized Cost last generation nuclear is from Energy Information Administration, "An Analysis of Nuclear Power Plant Construction Costs, DOE/EIA-0485 (Washington, D.C. March 1986) p. 18, as quoted in "Commercial Nuclear Power in the United States Problems and Prospects", U.S. Energy Information Administration, August 1994; actual realized costs were in 1982 dollars – escalated to "2007 Dollars" using a rough calculation 1982-2002 escalation equal to same multiplier as Consumer Price Index then 2002-2007 using CERA PCCI 2002-2007 multiplier; Florida P&L estimates quoted from Florida Power & Light, Docket 070650-EI, Direct Testimony & Exhibits of Steven D. Scroggs for FP&L before FLA Public Service Commission, Oct. 16, 2007; Exhibit SDS-8

A Well-Known Admonition

Scripture tells the story of a man who began to erect a tower, but because he did not "count the costs" to finish the tower, had to abandon the project, to the ridicule of his neighbors. We are admonished: *"For which one of you, when he wants to build a tower, does not first sit down and calculate the cost to see if he has enough to complete it."*[29]

The Rest of the Story: Other Costs to Complete Construction

Explicit in the above description of "overnight" cost are the costs *not* included in "overnight" cost but which certainly become part of the project's capital costs. (The discussion below discusses details of the "Most Likely" estimate – see Appendices for details of "Low Cost" scenario):

Construction Cost Escalations: Clearly, it is too late to build a nuclear plant for "2007 Dollars" – as each year goes by, costs increase. As the PCCI tracks "hard costs" of construction covered in EPC's, the PCCI average cost escalation 2000 - 2007 of 12.76%[30] is used for future cost escalation for these costs, which comprise approximately 51% of the total "Overnight " Cost Estimate.

Other costs included in the "Overnight" Cost Estimate – e.g. fees, owners' costs, and transmission integration, may be less affected by rapid worldwide cost escalation. For 45% of the Overnight Cost Estimate, a moderate escalation, equivalent to the Handy-Whitman "All Steam Plus Nuclear Generation Plant" last 7 year average[31] of 4.85%/year may be more appropriate. The remaining 4% of "Overnight" Costs will be set to inflate at an assumed 3% general economy inflation rate.

Cost of Capital: If you wanted to build a house and it took 10 years to build it, you can easily see how the cost of interest during construction would be a major component of the construction cost. This is exactly the situation with the costs of building a new nuclear power plant. As both equity and borrowed funds are used, and both expect requisite returns, an average weighted cost of capital of 14.5% is assumed .[32] The Cost of Capital *never goes away* – money always has its cost. Some utilities propose to "lower costs" by charging financing costs to ratepayers *during* construction. However, "early recovery" charges simply force *ratepayers* to pay extra financing costs to make ends meet. You can hide, but not eliminate the Cost of Capital.

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[29]Luke 14:28

[30]Note the PCCI showed low cost escalation from 2000 to 2002, and much higher cost escalations in more recent years. Using the full 7 years avg. may thus approximate a 2 year recession followed by a resumption of rapid cost escalations.

[31]Handy Whitman "All Steam Plus Nuclear Generation Plant" index was 353 for 2000 and had risen to 490 by 2007. This is equivalent to avg. escalation factor of 4.85%/year.

[32]15% after-corporate-tax ROE (As assumed by the MIT study, which includes a 3% "risk premium" on equity for nuclear utilities), payout from facility before 39% corporate taxes is thus 24.59%; 6.25% interest on debt portion; 45% equity/55% debt. Avg. Weighted Cost is thus = (.2459 x .45) + (.0625 x .55). Note the 6.25% interest rate is *below* recent bond rates.

<u>"All-In" Cost Estimate for New Nuclear Power Cost to Build ("Most Likely" Case)</u>

As noted previously, an "Overnight" cost estimate is not intended to be an indication of total costs to build a nuclear plant. Since construction takes place over a long period, annual cost escalations and the Cost of Capital each become major components of the total capital costs[33]:

"Overnight" Cost Estimate (in 2007 Dollars):	$ 4,070/KW
Construction Cost Escalations	$ 3,370/KW
Cost of Capital Used During Construction:	$ 3,114/KW
Total Estimated "All In" Capital Costs:	**$10,553/KW**

<u>Capital Cost Component Per KWh ("Most Likely" Case)</u>

Converting the total Capital Costs into the Capital Cost Component in cents/kWh requires the application of a "Capital Cost Recovery Factor" to the total capital costs – effectively converting the total Capital Costs into a "mortgage payment".[34] It is then necessary to spread this "payment" over the number of kWh's expected to be generated[35], to arrive at a Capital Cost Component/kWh:

ESTIMATED CAPITAL COST/KWH NEW GENERATION NUCLEAR POWER
CAPITAL RECOVERY PERIOD YRS: 40
WEIGHTED AVG COST OF CAPITAL 14.50%
CAPITAL COSTS COMPONENT PER KWH- NOMINAL DOLLARS

$10,553 PER KW COST MULTIPLIED TIMES CAPITAL RECOV. FACTOR = .1457 = $1,537.40 PER KW/YR

DIVIDE BY:	NUMBER OF KWH's GENERATED PER YEAR/PER KW CAPACITY
AVG. CAPACITY FACTOR OVER PERIOD	80%
NUMBER OF HOURS IN ONE YEAR	X 8,760 HRS/YR
EQUAL KWH/YR	7,008 KWH/YR
CAPITAL COST COMPONENT	**$0.22 PER KWH**

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[33]**See detailed Appendices. A = "Most Likely"($0.22/kWh) (above), B = "Low Cost" ($0.17/kWh)**. This is just the Capital Cost Component.

[34]Application of a Capital Cost Recovery Factor is one method commonly used by state utility regulators. This is essentially equivalent to a mortgage payment formula, using the cost recovery period as the "term", and the avg. weighted Cost of Capital as the "mortgage interest". An alternative method is to record annual depreciation expense, and apply the Cost of Capital to the remaining un-depreciated balance. Both methods result in similar amounts.

[35] The MIT Study's 85% C.F. in their "low cost" case is used here also for the "Low Cost"case; MIT used a 75% C.F. for their "High"cost. "Most Likely" case here uses an 80% midpoint. While U.S. nuclear plants have recently reached higher capacity factors, this was only after decades of "tinkering & training" on last generation units, which began with 50-60% C.F.'s.

Business Risk #2: Construction Schedules May Be Delayed

The capital cost estimate above assumed the same beginning and ending dates as the most optimistic schedule put forth in new U.S. nuclear plant applications. It is therefore still a very conservative cost estimate.

If the project were to be delayed for any reason, “brick & mortar” costs would rise significantly, as every year that goes by brings more increases in construction costs, and these cost escalations have been running very high for power plant construction costs. As noted by CERA in its May 2008 Press Release on the PCCI data, “a power plant that cost $1 billion in 2000 would, on average, cost $2.31 billion today.”

The Costs of Capital for funds used during construction (financing costs) would also dramatically increase, as each year of delay involves more financing costs, for a project that is still unproductive until it comes on line.

As overall costs spiral upward, they may materially exceed available funding lined up to finance a project. It could then become impossible to raise enough funds to complete the project, and the project may need to be abandoned partway after billions have already been spent. This actually happened with several nuclear projects in the last generation.

<u>History of Nuclear Construction Delays</u>

The nuclear industry’s long delays in the 1970's and 1980's are legend. Nuclear plants typically took at least 10 years and in some cases almost 15 years to complete. A classic example was the Vogtle facility near Augusta, GA whose 2 Westinghouse plants (2400 MW total) took over 14 years to complete, and cost $8.87 billion by the time they were finished in 1989 .[36]

Many utilities did not even finish their projects. After literally spending billions, those utilities abandoned or suspended their nuclear projects, as allocated funds ran out, and it proved more feasible to find alternatives than to finish the nuclear projects. The worst example was the Washington Public Power Supply System (WPPSS) which experienced massive cost overruns and scheduling delays. At the same time, load growth came in lower than projected. WPPSS abandoned construction on 4 of the 5 reactors it had begun, and defaulted on $2.25 Billion in bonds, the largest default in the history of the municipal bond market. [37]

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[36]*New York Times*, “Atomic Balm?”, 16 July 2006. http://www.nytimes.com/2006/07/16/magazine/16nuclear.html

[37]HistoryLink.Org, “Washington Public Power System” http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=5482

A Bad Start for New Generation Nuclear

Will it be any better for new generation reactors? Current experience with projects now underway indicates the nuclear industry's pattern of extensive delays may be repeating itself. Finland's effort to build the world's first new generation nuclear reactor at Olkiluoto is now over 2 years behind schedule after beginning in 2005, and construction cost estimates have already overrun by at least one billion euro. The recently-released "2008 World Nuclear Industry Status Report – Global Nuclear"(16 Sep 2008) surveyed the current global status of all new nuclear projects, and states "two thirds of the under-construction units have encountered significant construction delays, pushing back officially announced start-up dates." [38]

The Wild Card: Organized Opposition

An unpredictable but highly significant factor that has historically affected nuclear plant construction schedules is the existence of organized opposition. Moody's Investor Services has stated "We believe the first COL filing will be litigated, which could create lengthy delays for the rest of the sector." If organized opposition once again uses all available avenues to try to stop nuclear power, this may pose a highly significant Business Risk of delay in project schedules.

Theory Vs. Reality When Sunk Costs are Massive

Economic theory says when making a decision about what to do next (e.g when you realize the project is coming in much more costly than planned), you should ignore "sunk costs" because regardless of what you do now, you cannot "unspend" those monies. The reality, however, is that abandoning a project you have already spent a lot of money on can be next to impossible. As a nuclear reactor is all one unit, you cannot build 'half a reactor" and ever get any electricity. Pressure to continue the uneconomical course is therefore intense, precisely because so much money has already been spent which will all be wasted if the project is not finished.

Contrast this to a Demand Side Management/Renewables scenario, whose costs are modular and short-term. If course corrections are needed, it is possible to quickly change course, without abandoning an expensive asset that will never produce any electricity. A utility might build 100 MW of solar, which will produce electricity whether or not the utility builds another 100 MW.

Nuclear power's greatest costs are its capital costs, which are highly sensitive to construction delays. The prospect that nuclear construction schedules will prove to be optimistic therefore poses a significant Business Risk. If delays or other reasons cause significant cost overruns, the cost to complete a nuclear project may materially exceed funds lined up to finance the project. Yet, an unfinished reactor produces zero kWh's. A utility may not be able to withstand the impact of such a failure and remain a viable business entity. [39]

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[38] 2008 World Nuclear Industry Status Report, 16 Sep 2008, Bulletin of Atomic Scientists http://www.thebulletin.org/web-edition/reports/2008-world-nuclear-industry-status-report

[39] "Bankruptcy Filed by Leading Utility in Seabrook Plant", *NY Times*, Jan 29, 1988

Business Risk #3: Downgrading the Utility's and/or Customers' Credit Ratings

In its 2003 study "The Future of Nuclear Power", MIT included a 3% risk premium in its calculations of projected Cost of Capital for nuclear projects, because of the extra business risks projected for nuclear.[40] MIT's concerns were valid.

Florida Power & Light has stated: "In general, the rating agencies (such as Moody's Investor Services) view new nuclear construction as a higher risk than other technologies. This view is primarily driven by the long approval and construction process associated with new nuclear construction as well as the size of the capital requirements in relation to the utility as compared to capital requirements for other generation technologies. Rating agencies also recall the difficulties of the 1970's and 1980's."[41]

On June 2nd of this year, Moody's Investor Services Global Credit Research issued a public Announcement entitled "Moody's: Nuclear Plant Construction Poses Risks to Credit Metrics, Ratings".[42] Per the Announcement: "Moody's examines the effects of a new nuclear facility on the credit metrics of "NukeCo", a hypothetical electric utility. Through this illustrative model, Moody's suggests that a utility that builds a new nuclear power plant may experience an approximately 25% to 30% deterioration in cash-flow-related credit metrics. In the case of "NukeCo", cash flow from operations as a percentage of debt falls from roughly the 25% level to the mid-teens range."

The Moody's simulation begins with the fictional utility "well-positioned within the single-A ratings category before building a nuclear plant....", however "... in years 5-10, when construction costs reach their peak and key credit metrics begin to deteriorate significantly, the fictional company would be better positioned in Baa-rating category."

In today's nervous credit climate, downgrading a corporation to a more risky Baa rating (the lowest tier of investment grade debt) may carry serious consequences. Moody's Seasoned Baa Corporate Bond Yield: Percent http://www.economagic.com/em-cgi/data.exe/fedstl/baa+2 , shows that in October 2008 the Baa yield climbed to 8.88 percent, compared to only 7.31 percent in September 2008, the highest relative monthly jump since the table began in 1919, indicating investors have extreme default risk concerns. The fact a Baa bond will have a higher effective interest rate is not even the biggest concern. The very ability to sell downgraded bonds in a credit market already termed "dysfunctional" may be the more critical factor.

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[40] "The Future of Nuclear Power", MIT, Chapter 5, Table 5.3

[41] Florida Power & Light, Docket 070650-EI, Direct Testimony & Exhibits of Steven D. Scroggs for FP&L before FLA Public Service Commission, Oct. 16, 2007, pp 66-67.

[42] http://www.amicidellaterra.it/adt/images/stories/File/downloads/pdf/Energia/Energia%20Nucleare/rassegna%20stampa%20nucleare/Moodys-Nuclear-risks-to-credit-metric-ratings.pdf

The Moody's Announcement also notes a risk to the shareholders of the utility: "The technology is very costly and complex, and the 10- to 15-year duration of these construction projects can expose a utility to material changes in the political, regulatory, economic and commodity price environments, as well as new alternatives to nuclear generation. These potential changes in the landscape could prompt regulators to disallow certain cost recoveries from ratepayers after a plant is built[43], or lead to market intervention or restructuring initiatives by elected officials."

Industry commentators have also noted these financial risks. *Nuclear Engineering International* noted on 22 August 2008: "Companies that build new nuclear plants will see marked increases in their business and operating risks because of the size and complexity of these projects, the extended time they take to build, and their uncertain final cost and cost recoveries. To the extent that a company develops a financing plan that overly relies on debt financing, which has an effect of reducing the consolidated key financial credit ratios, regardless of the regulatory support associated with current cost recovery mechanisms, there is a reasonably high likelihood that credit ratings will also decline. So 'thinking caps' must now certainly go on amongst US boards of management – credit ratings are important and taking a punt on a new nuclear plant may not be the first priority of a CEO in his late 50s with a distinguished career behind him."[44]

"Fixing" Problem By Charging Ratepayers Early Just Transfers Risk

The "fix" that utilities and the nuclear industry have proposed for the negative impact on utility cash flow and its attendant effect on credit ratings is to implement substantial advanced charges to ratepayers *during construction* of the plant.[45] Typically such charges ,variably referred to as Early Cost Recovery, or Construction Work in Progress (CWIP) charges, pass through, with immediate rate increases, the full Cost of Capital used during construction of the plant. (As noted previously this is roughly a third of the total Capital Cost, e.g. approximately $7 Billion ("Medium" case) in recovery charges levied on ratepayers early, for a 2-unit 2,234 MW new nuclear facility.)

Note that such early charges to ratepayers are in exchange for *zero* kWh's delivered by the facility, as it is not yet in service – *nothing* but a hope of future kWh's is delivered. [46]

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[43] As previously noted this actually happened with Union Electric's Callaway nuclear plant and hundreds of millions spent on the plant were disallowed by FERC as not being prudent.

[44] *Nuclear Engineering International,* "Escalating Costs of New Build: What Does it Mean?", 22 August 2008

[45] It is telling that state laws allowing such early cost recovery charges have been adopted specifically to aid *nuclear* power plants, and in some cases "clean coal", while other types of power plants must actually deliver kWh before costs can be assessed on utility customers.

[46] Delivering "NoWatts" in exchange for billions in charges is a more radical idea than Amory Lovins' "NegaWatts". With "Negawatt" programs, customers at least receive *immediate* benefits in the form of energy efficiency improvements, greater comfort, and *reduced* utility bills.

Levying additional charges , with nothing at all yet delivered in return, places a financial strain on all the ratepayers in the service territory, similar in many ways to a tax increase.[47]

Virtually all households and small businesses are already carrying debt loads, including high cost debts such as credit cards. The average American household now carries $8,700 of credit card debt,[48] much of it at interest rates from 18% to 29%. While consumers want to pay down their debts, every additional dollar taken from them is a dollar that cannot be devoted to debt payments, and therefore at a minimum will increase consumer interest costs. For many, a $100/month increase in their home electric bill may make the difference between meeting or defaulting on an existing credit card's minimum monthly payment. This can destroy a family's credit rating.

In today's economic climate where homeowners are already struggling to make payments, and most businesses are in similar straits, imposing significantly higher electric charges now will likely increase consumer debt loads and interest costs. For those closest to the edge, or who have higher electric use, a rapid increase in electric rates may cause an increase in credit card payment defaults and home mortgage defaults. When businesses are affected similarly by increased demands on their cash flow, the effects can include employee layoffs and business bankruptcies.

Credit ratings are very important. The prospect that undertaking a single project could have such a major impact on a utility company's balance sheet and cash flow that company credit ratings would be downgraded, should give pause to any executive, or oversight regulator, contemplating the wisdom of undertaking such a project.

Attempting to "fix" this problem by levying billions of early charges on ratepayers during construction, with zero electricity delivered in return, simply shifts the cash flow and credit rating problems to the utility's customers. **This is the worst possible time to do so, given the precarious state of the economy.**

If these extra burdens cause already-strapped customers to damage their own credit ratings, it can take years to recover. A noticeable blow to the local economy could be felt, likely a significant multiplier of the direct charges levied.[49]

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[47]Progress Energy, for instance, has recently requested a 31% electric rate increase for 2009 , approximately one third of which is for early cost recovery charges for future nuclear plants. These early charges will rise significantly as the project progresses.

[48]http://www.money-zine.com/Financial-Planning/Debt-Consolidation/Credit-Card-Debt-Statistics/

[49]Note, for instance, the entire U.S. and world economy is now in crisis, initially set in motion because a small percent of homeowners experienced problems paying their home mortgages. A similar effect could occur on a local economy levied with billions in extra charges (with no benefits yet delivered in return) if high levies push even more homeowners and businesses into defaults on credit cards, mortgages, or other consumer and business debts.

Business Risk #4: New Nuclear Will Require Very High Electric Rates

It was shown above, under Business Risk #1, that just the **Capital Cost *component* of new nuclear power's cost/kWh is likely to be from 17 cents/kWh to 22 cents/kWh** at the power plant[50] when a new nuclear facility comes on line.[51] This is not the full rate, however. We must also account for[52] operations and maintenance, property taxes, waste disposal and decommissioning costs, and fuel cycle costs to project the full cost/kWh of generation when the facility comes on line:

<u>Operations & Maintenance Costs Per KWh</u>

Operations & Maintenance costs include "Fixed O&M" costs such as plant staffing & security, and "Variable O&M" – costs that vary with output, such as supplies & chemicals. "Fixed" O&M costs are assumed to equal $23/KW in 2007 dollars (e.g. $51.4 M/yr in 2007 $ for a 2,234 MW 2-unit facility– note at least $8 M/year would be needed for annual NRC regulatory fees alone for a 2-unit facility), and escalate at 1% *above* general inflation, because of shortages of nuclear-trained personnel. It has been noted the current generation of nuclear operators is nearing retirement age, and there are not enough nuclear-trained personnel coming up through nuclear engineering programs to replace current operators, let alone expand the industry. Therefore, staffing a new facility may be a challenge involving extensive recruitment, scholarship, etc. costs. "Fixed" O&M in the first full year are thus estimated at $0.005/kWh. Variable per kWh O&M costs other than fuel, plus return on working capital etc. are assumed to equal $0.0035/kWh in 2007 dollars, and assumed to escalate the same as the general inflation rate, to equal approx. another $0.005/kWh. Total first year **O&M costs (not including fuel) are therefore estimated at approximately $0.01/kWh**.

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[50] "A range of capital cost estimates, from 17 to 22 cents/kWh capital cost is presented in the Appendices. "At the power plant" (often referred to as "busbar" costs) do not include additional costs of the transmission and distribution network, running the company, etc,

[51] These cents/kWh are stated in nominal dollars in the assumed first full year of operation (i.e. in "2018 dollars" which include an assumed general economic inflation rate of 3%/year). Note that previous cost/kWh estimates cited in this Paper from Lazard were in 2007 dollars of "levelized cost"/kWh, so the numbers are not directly comparable. The costs here stated are an estimate of the "actual" (nominal) dollars that would have to be charged to consumers on utility bills. PSC rate hearings, stock prices, contract pricing, government and corporate budgets, and essentially all normal economic activity actually takes place in nominal dollars.

[52] The assumptions used for all estimates in this Paper are specified. This is an open process – if evidence indicates a particular assumption is too optimistic or too pessimistic, reviewers can easily recalculate using a different assumption. However, as the *most optimistic* analyses (those presented by utilities now seeking approval in needs determination dockets) already have indicated a single new nuclear plant may cost $9 billion to construct (over $8,000/KW), it is doubtful any "playing around the edges" will affect the overall conclusions of this Paper.

Property Tax Costs Per KWh

Because property taxes are based upon value, as nuclear construction costs are now much higher than the previous generation of nuclear plants, property taxes should also run higher. Property taxes follow a serpentine logic wherein an "appraised value" is multiplied times an "assessment ratio" which is then multiplied times a "millage (1/1000 of a dollar) rate". We will assume $10,500/KW (cost to construct) x 65% (appraised value/cost to construct) x 6% (assessment ratio) x $.350 (millage rate of 350) = $143/yr per KW. Using the 80% capacity factor assumed previously there are 7,008 kWh/yr per KW. So $143/7,008 = **$0.02/kWh property tax component.**

Waste Disposal and Decommissioning Costs Per KWh

To proceed with a nuclear plant, one must *assume* that after decades of failure, *all* the technical and political problems in the way of nuclear waste disposal will be quickly resolved.[53] Failure to solve this problem is akin to building an apartment building, installing the toilets, and yet having no sewer available to carry away the waste.

Moody's Global Project Finance in a May 2008 report cited estimates equating to approx. $1,000 per KW (approx. $300/KW for the high level waste and approx. $700/KW for decommissioning of the plant, in 2007 "Overnight" Dollars) for expected costs of disposal of high-level nuclear waste, and decommissioning of the nuclear plant.[54] This equates to a total of $2.2 B in 2007 "Overnight" Dollars for a proposed 2,234 MW 2-unit nuclear facility. Note the bulk of this (70%) is for decommissioning of the reactor itself, which is considered the direct responsibility of the individual utility – which should be listed as an unfunded material liability on its Balance Sheet.

While many countries are requiring a specific fund be set aside at the outset to provide for the massive costs of plant decommissioning and high level nuclear waste disposal, in the U.S. no such requirements have been established. For instance, in its needs application before the Florida PSC, Florida Power & Light specifically stated : "Those costs were explicitly considered as costs that are accrued for or expended during facility operation ...". [55]

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[53]This is a big *assumption.* After over 50 years there is still no approved facility for high-level nuclear waste disposal. The U.S. government has for decades investigated disposal in Yucca Mountain in Nevada, however Senate Majority Leader Harry Reid from Nevada has consistently opposed the proposal, and is quoted as saying "Yucca Mountain is dead. It'll never happen."(UPI Intl, Dec 4, 2006). Also, an expansion of the nuclear industry will exceed Yucca Mountain's capacity and require even *more* "Yucca Mountains" (see, e.g.,"GNEP and Yucca Mountain, Victor Gilinsky at the American Association for the Advancement of Science San Francisco Meeting, February 17, 2007".) This is all inconsistent with Congressional mandates that *only* Yucca Mountain be considered – there is a clear impasse caused by NIMBY politics.

[54]"Decommissioning and Waste Costs for a New Generation of Nuclear Power Stations", Moody's Global Project Finance, May 2008

[55]FP&L witness Scroggs testimony, p. 46 (p. 47 of PDF). Docket 070650-EI.,10/16/07.

U.S. utilities pay a fixed \$0.001/kWh to the U.S. government for nuclear waste disposal, however actual costs are expected to be much higher (see next paragraph), and therefore the current rate is a large Federal subsidy to the nuclear industry. (As national leaders go "line by line" through the Federal budget, this subsidy may well come under scrutiny.) Perhaps more significantly as a Business Risk, the utility itself is expected to be responsible for the (materially larger) decommissioning costs of the nuclear reactor, which itself becomes a form of nuclear waste. The reactor decommissioning process will require billions be spent on a highly complex process expected to take as much as 50 years to complete after the shutdown of the facility.

One approach cited by Moody's to fund such material future costs is a Trust Fund to accumulate funds for these purposes. If the estimates cited by Moody's are correct, and all other problems are quickly solved, an assessment of approx. **\$0.02/kWh (\$0.014 for decommissioning and \$.006 for nuclear waste) would be needed to fund both waste disposal, and plant decommissioning costs.**[56]

Fuel Cycle Costs Per KWh

Estimates for each stage of the nuclear fuel cycle were originally delineated in detail, in the 1976 book *The Economics of Nuclear and Coal Power.*[57] For the elements of the nuclear fuel cycle apart from the price of U_3O_8, a modest cost escalation from 1976 to approximate 2007 costs, is here assumed, using the 1975-2007 Consumer Price Index multiplier.

In 2007 dollars, the minor elements of nuclear fuel cycle costs (i.e. *not* for mining & milling of U_3O_8 or enrichment) -- conversion of U_3O_8 to UF_6, fabrication of fuel rods, and fuel inventory carrying charge – are estimated to total only \$0.003/kWh in 2007 dollars.

The largest elements of costs in the nuclear fuel cycle are the cost of the mined and milled U_3O_8, and the costs of uranium enrichment.

The U_3O_8 price, expressed as "2007 Dollars" (Term Price as opposed to Spot Price) cost/lb for U_3O_8, of \$95/lb is quoted from a *Nuclear Engineering International* article "Mining the Supply Gap" dated 01 September 2008., which noted this \$95/lb term price "remained at that level for 11 months", i.e. a fair indication of U_3O_8 prices in 2007 dollars. This portion of fuel cycle costs – for mining and milling of U_3O_8 – is therefore approximately \$0.006/kWh in 2007 dollars.

The cost of enrichment typically accounts for about half the cost of uranium fuel, even though its cost is currently subsidized by the U.S. government. In *The Economics of Nuclear and Coal*

[56]Assuming funds begin to be set aside when plant begins operation, earn 4%/year (because safe investments would be mandated), and costs to perform the disposal and decommissioning escalate at a nominal 5%/year from the "2007 Dollars" estimates.

[57]*The Economics of Nuclear and Coal Power*, Miller, Saunders assisted by Craig Severance, Praeger Special Studies in U.S. Economic, Social, and Political Issues, 1976. The analysis herein updates the major cost – uranium fuel – with current data; enrichment is not privately run so its unsubsidized cost is difficult to find. The remainder (small portion) of fuel cycle costs is very conservatively updated to 2007 using only general economy inflation factors.

Power an estimate of $187.82 per Separative Work Unit (SWU), in 1975 dollars, was developed for a privately run gaseous diffusion enrichment facility if it were run without government subsidy, equivalent to $0.0027/kWh in 1975 dollars. If this estimate were escalated very conservatively, using general economy (Consumer Price Index) inflation rates from 1975 to 2007, it would equal $0.0104/kWh in 2007 dollars.

However, for this paper, an enrichment cost of only $0.005/kWh in 2007 dollars is assumed – which assumes that at least in the near future the government will continue to heavily subsidize uranium enrichment costs, and/or that different uranium enrichment technology with potentially lower costs (e.g. centrifuges) will be employed. [58]

Recapping nuclear fuel cycle costs – in 2007 dollars -- there are a total $0.006/kWh for mined and milled uranium, $0.005/kWh for enrichment, and $0.003/kWh for miscellaneous other costs of the nuclear fuel cycle. Thus, in 2007 dollars total fuel cycle costs (not including transportation & disposal of spent fuel) are estimated to total approximately $0.014/kWh in 2007 dollars.

It is uniformly agreed uranium price increases will be necessary to stimulate new world uranium production. Current worldwide uranium mines are *now only capable of supplying 71% of 2008 reference requirements – i.e. to supply worldwide nuclear power plants already operational.* Existing inventories, nuclear weapons fissile materials, etc. are being utilized at present to meet this already-existent supply shortfall, but *new mining capacities will be needed* in the next decade after these stores have been exhausted, *just to supply existing demand.*[59] Expansion of nuclear power will require an even greater effort to open new uranium mines on an expedited schedule.

It is expected ongoing real price increases will be needed to continue to drive expansion of worldwide uranium mining capacity. Also, much of the new uranium supplies are of significantly lower grade ore, which will naturally require more expense to recover. Of note also is that large portions of the world's remaining uranium deposits (accounting for 24% of 2007 world uranium extraction) are in areas previously under Soviet rule (Uzbekistan, Kazakhstan, Ukraine), and it is therefore significant Russia has made it clear it expects to continue to exercise dominance over its "sphere of influence". Another area of major uranium deposits (Niger) is currently experiencing a significant local armed conflict which has already disrupted uranium mining activities, including the mining of railroad tracks serving the uranium mines, and the capture by rebels of a Chinese uranium mining official. [60] While these difficulties could be overcome, they imply potential instability of worldwide uranium prices and supply.

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[58]Congress has already authorized a subsidy of $2 billion in Federally guaranteed loan guarantees for a new private uranium enrichment facility utilizing centrifuge technology, however the plant promoters have announced this will be less than half the cost of the new facility, and since no private financing has been found, its future is currently uncertain.

[59]"Mining the Supply Gap", *Nuclear Engineering International,* 01 September 2008

[60]See "The Second Tuareg Rebellion" http://en.wikipedia.org/wiki/Second_Tuareg_Rebellion#Niger:_Uranium_Mines_Crises

Because of the continuing need for price escalations to drive suppliers to develop new uranium mines and other fuel cycle capacity, and an expected push to cut the Federal government's subsidy of uranium enrichment, price escalations for all components of the nuclear fuel cycle taken together, were assumed to equal an average weighted 8%/year nominal dollar escalation rate (5%/year "real" dollar escalation) until 2018, from the 2007 dollar estimates cited above.

Therefore, **total uranium fuel cycle costs are estimated to equal approx. $0.03/kWh in the first full year of operations.**

Putting it All Together – Total Generation Costs/kWh

"MOST LIKELY" SCENARIO
Projected Total Generation Cost/kWh of New Nuclear Power
(In Nominal Dollars in Projected 2018 First Year of Full Operation)

COST COMPONENT	$/KWH
CAPITAL COST	$0.22
OPERATION & MAINTENANCE W/O FUEL	$0.01
PROPERTY TAXES	$0.02
DECOMMISSIONING & WASTE COSTS RESERVE	$0.02
FUEL CYCLE COSTS	$0.03
TOTAL DOLLARS/KWH	$0.30

The **"Lower Cost" Case** has Capital Costs of $0.17/kWh, thus a total **$0.25/kWh**.

Most ratepayers nationwide are now paying *retail* electricity rates (*including* distribution & transmission & G&A costs) equal to ***6 cents/kWh to 15 cents/kWh current retail electric rates.***[61]

Adding new nuclear power – with costs for generation alone, that are 2 to 5 times total retail electric rates now in place – will have a dramatic upward effect on electric rates.[62]

[61] See, e.g. , U.S. Energy Information Administration, "State Electricity Prices, 2006", http://www.eia.doe.gov/neic/rankings/stateelectricityprice.htm

[62] The impact upon each utility's retail rates will vary. While distribution & G&A costs would be *added* to the "generation only" cost, making it *higher*, the utility will also have other generation sources, presumably at a lower cost/kWh, resulting in lower cost/kWh overall for ratepayers than if all kWh's were supplied by the nuclear plant. Nevertheless, *all* the costs of the new nuclear plant *will need to be charged to ratepayers* or the utility would risk bankruptcy.

Business Risk #5: Higher Electric Rates May Destroy Projected Demand

Traditionally, every time an electric utility needed to raise new revenue, e.g. to fund a new power plant, it would simply go to its public service commission and justify a rate increase. Since electricity was a necessity people could not live without, and the utility had a complete monopoly on supplying electricity to its customers, a rate increase would bring in the desired revenue. As the only source of a needed commodity, the utility had a captive customer base – similar to the "Company Store" in the Merle Travis "16 Tons" song popularized by 'Tennessee' Ernie Ford.

Almost nothing in the above paragraph is still true, even for utilities in states that still practice traditional "cost of service" utility regulation.[63]

Electric customers from all sectors now have innumerable cost-effective options to *reduce* their electricity use. Energy efficiency is now a major growth market, pursued by corporate giants such as Chevron and IBM[64], and local firms such as "house doctors"[65] Although some level of electricity use is certainly still a necessity, virtually all existing electric customers can find a very significant portion of their usage they can now quite comfortably "live without". [66]

The local electric utility is also no longer the only way a customer can purchase a *supply* of electricity. Distributed power generation (i.e., a source of electricity located on the customer's own site, and usually owned by the customer) is now widely available. Industries can efficiently supply their own electricity through co-generation facilities that also recapture heat for use in processing, hot water, or space heating.[67] All levels of customers, down to the single homeowner, can now purchase solar

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[63]After the Federal Energy Regulatory Commission (FERC) deregulated the wholesale electricity market, several states followed suit and deregulated their electric markets, requiring vertically-integrated utilities to sell their generating plants – thereby creating a "wheeling" electric market with transmission/distribution companies vs. electric generation companies, similar to telephone service deregulation. For a discussion of the apparent failure of electricity deregulation see http://www.citizen.org/documents/USdereg.pdf

[64]IBM's energy efficiency tv commercials are well known, see, e.g. http://www.youtube.com/watch?v=VSNFE6eUjfY

[65]See, e.g. http://www.frostbusters.com/

[66]Typical savings advertised are 30-40% of existing usage. The Rocky Mountain Institute compiled a resource base of already existing technologies which if applied could eliminate 75% of current electricity usage in the U.S. (See e.g. http://www.orionmagazine.org/index.php/articles/article/262/

[67]The Lazard study cited earlier, estimated 2007 levelized cost/kWh for biomass co-firing co-generation ranging from approximately 1 to 4 cents/kWh.

photovoltaic panels to generate electricity from the sun.[68] Rural customers with micro hydro or wind resources can access those technologies to supply their own electricity. These are all mass-produced products, many with costs still on a downward trend.

With options such as energy efficiency and distributed power generation now widely available to all electric customers, a utility no longer has a “Company Store”. *Customers now can, so they will* reduce their purchases of electricity if high electric rates provide an incentive. You can’t expect to run a “Company Store”, if a Walmart has just moved in across the street.

This trend may already be underway, even with today’s relatively low electric rates. The Wall Street Journal recently reported “An unexpected drop in U.S. electricity consumption has utility companies worried that the trend isn’t a byproduct of the economic downturn, and could reflect a permanent shift in consumption that will require sweeping change in their industry.”[69]

A nuclear power plant is built to serve a projected future *increase* in customers’ demand for electricity. There is, however a “Catch-22", because of the high cost of the nuclear plant (capital costs of 17-22 cents/kWh , overall costs 25-30 cents/kWh): **The very act of building the nuclear power plant and increasing electric rates to attempt to pay for it, is highly likely to destroy the increased customer demand the plant was built to serve.**

If the utility finds this out *after* they have already built the plant and committed themselves to pay for all its costs, a calamitous “death spiral” could ensue:

- Electric rates/kWh are increased in an attempt to raise the revenue to pay for the nuclear plant, based upon the originally projected base of kWh usage
- The increased electric rates, however, cause customers to *decrease* kWh’s purchased
- As almost all of the costs for the nuclear plant are *fixed* costs, there is no option to cut costs if fewer kWh’s are needed
- With fewer kWh’s sold to customers than projected, the needed revenue is *not* raised[70], so electric rates/kWh would have to be *increased again*
- With even higher electric rates/kWh, customers have even greater incentives to cut usage and *further decrease* their kWh usage
- Those who can afford to take measures to reduce the kWh’s purchased from the utility will likely do so. However, poorer customers, who can least afford higher electric rates, will also likely be least able to invest in energy efficiency or alternative power sources.

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[68]A 10 KW photovoltaic system in Grand Junction, CO, for instance, now supplies all the net energy needed by a 1,500 sq. ft. medical office owned by myself and my wife. The office utility bills are only $9.94/month, which is for the metering & billing only, as the system actually is a net producer, feeding in slightly more kWh to the electric grid than it draws off the grid.

[69]“Surprise Drop in Power Use Delivers Jolt to Utilities”, Wall Street Journal, 11/21/08

[70]Either selling fewer kWh, or being forced to sell the excess kWh production from the plant at wholesale power prices in competition with cheaper sources such as wind farms, would have the same result – revenue needed to support the plant would fall short.

- The utility may enter into a spiral where it attempts to collect higher and higher electric rates from poorer and poorer customers, who because they lack the resources, or do not own their own properties, can do nothing about it.

Normally, the addition of an incremental amount of higher-cost generation has not resulted in this downward spiral .[71] However, the magnitude of the rate increases that would be needed to pay for a new generation nuclear facility are so large, and the range of options now available to customers to cut their kWh purchases is so cost-efficient, that initiation of this downward spiral is now a distinct possibility.

If a utility builds a nuclear plant, and then tries to recover costs in the range of 25-30 cents/kWh from its customers, what will these customers do*?* Will they still buy the electricity from the utility in the quantities projected?

If the utility does not <u>know</u> the answer to this question with any certainty, then the proposal to build a new nuclear power plant carries with it a high level of Business Risk. As almost all of the nuclear plant's costs are *fixed,* the utility has to pay them regardless of how many kWh's are sold. If the utility cannot sell enough kWh's at high enough rates to raise the revenue needed, it may face reduced returns on investment or even insolvency.

Business Risk #6: High Electric Rates' Impact on Economy of Service Area

This Business Risk is simple to state, yet important especially regionally.

Many parts of the U.S. are now developing lower-cost sources of electricity, e.g. wind farms, which are now quite cost competitive. The electric rates in these areas are therefore *not* likely to increase as significantly as those for customers served by a nuclear utility. If trends continue, the total differences in electric rates could be dramatic over time.

While electric rates are just one of many factors that affect a location decision by businesses and families, they could become more important if they begin to take a noticeable chunk out of a family or small business budget. Existing businesses already located in the service area will have their costs of production impacted, in comparison with competitors in other, lower-cost regions.

The competitiveness of the local economy in the nuclear utility's' service area could suffer, compared to other regions of the U.S. which are developing lower cost electricity.

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[71] The Washington Public Power Supply System (WPPSS) experience from the 1970's and 1980's was however an exception. WPPSS was so inaccurate with its demand forecasts that a significant decrease in kWh consumption compared to forecasts actually did occur. As previously discussed, enough had already been spent to cause WPPSS to default on $2.25 Billion in bonds. See <u>http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=5482</u>

CONCLUSIONS

This Paper has identified the following significant Nuclear Business Risks:

1. *Costs to Build the Nuclear Plant May Significantly Exceed Estimates*

Capital costs to build all power plants have been rising much faster than inflation. A power plant with a long lead time (e.g. nuclear or coal) is exposed to much greater risks of cost overruns, than generation units with short lead times (e.g. natural gas, wind, or solar). Total "all-in" costs to build new nuclear are likely to equal approx. $8,900- $10,500/KW. Paying for this capital cost alone would cost approximately 17- 22 cents/kWh.

2. *Nuclear Construction Schedules May Be Delayed*

The nuclear industry has a history of major construction delays causing billions in cost overruns. New generation nuclear has gotten off to a bad start, with delays occurring on facilities now under construction worldwide. The industry still faces substantial organized opposition. If costs exceed funds lined up to fund the project, a project may be abandoned after billions have already been spent, as has occurred with past nuclear plants.

3. *The Utility's and/or Customers' Credit Ratings May be Downgraded*

The very high capital costs and long lead times to construct a nuclear facility are expected to result in a "risk premium"affecting the cost of capital for nuclear utilities. Attempting to "fix" the utility's cash problems by assessing billions on ratepayers years before any kWh's are delivered simply shifts the cash flow and credit rating problems to the utility's ratepayers. The cost of capital never goes away – money always has its cost.

4. *New Nuclear Will Require Very High Electric Rates*

Costs at the power plant (not including distribution & G&A costs) of new nuclear power are likely to be 25-30 cents/kWh in the first year of full operation of the facility: 17-22 cents/kWh for capital costs; 1 cent/kWh O&M; 2 cents/kWh property taxes; 2 cents/kWh to fund plant decommissioning & nuclear waste; and 3 cents/kWh for nuclear fuel.

5. *Higher Rates May Cut Customer Demands But Not Utility's Costs*

Energy efficiency and distributed power sources offer new ways for customers to buy fewer kWh's. High rates needed to fund a nuclear plant may drive customers to cut use. As almost all nuclear costs are fixed, the utility has to pay these costs even if demand falls. If the utility cannot sell enough kWh's at a high enough rate to pay these costs , it may face insolvency.

6. *Local Economy Could Be Rendered Less Competitive*

High electric rates may make the local economy less competitive with other areas of the U.S., whose utilities are developing low-cost electricity sources (e.g. wind power).

RECOMMENDATIONS

1. *Pursue a Least Cost Approach to Meet Needs*

A "Least Cost" approach allows the utility to employ non-conventional methods to meet the needs of its customers, and save money for all ratepayers in the process.

For instance, 25 compact florescent light bulbs which save 40 watts each compared to a 60 watt light bulb, can eliminate 1,000 watts (one KW) for a total cost of approximately $50. The same KW in new power plant capacity could cost over $10,000 if it was nuclear.

Utilities employing the Least Cost approach ask themselves – which of these options has the Least Cost? Utilities nationwide employing this approach are now paying customers to implement measures which are known to decrease demand for new power plants – rebates for more efficient a/c units, insulation, solar panels, Energy Star appliances, etc.

The "Least Cost" approach also allows a utility to consider new technologies, or new combinations of technologies, as ways to meet needs, because they are more cost effective .

2. *Switch to Shorter Lead Time Technologies*

The very long lead time to pursue a nuclear project forces utilities to make major commitments *now*, to meet projected customer needs at least a decade from now.

This very long lead time exposes the utility to uncertainties about the accuracy of the demand forecast. As new energy technologies are now aggressively entering the marketplace, if there was ever a time to avoid being forced to act on a 10 year forecast, it would certainly be *this next 10 years.*

The long construction time also exposes the project to a severe risk of cost overruns, as utilities have been experiencing double-digit inflation in costs to build new power plants. A technology with a short construction time (e.g. wind, solar, natural gas) is far less exposed to cost increases than projects with long construction times (e.g. coal, nuclear).

3. *Use the Strengths of a Diverse Portfolio of Technologies*

A combination of technologies, rather than reliance on one technology to do everything, may prove the best choice to meet future KW capacity and kWh generation needs.

For instance, it may soon become common to refer to a *system* of Combined Cycle Gas and Wind Turbines (CCGWT) which would employ wind turbines at zero fuel cost, supplemented by natural gas turbines as needed. Such a *system*, *taken as a whole,* would minimize fossil fuel consumption and total fuel costs. The total costs to construct would be moderate, and would be "modular", i.e. able to be deployed more closely in alignment with needs curves. This *system* may often have the lowest *overall* costs per kWh delivered.

The systems approach addresses the fact that with increasing fuel costs and environmental concerns, each technology has its strengths and weaknesses, and a combination may be necessary to achieve system reliability, lowest overall cost, and greenhouse gas reductions.

4. *Share Resources Across the Country*

America has abundant solar, wind, and geothermal energy resources. However, the most abundant renewable energy resources are typically located in areas of low population, far from the load centers where the electricity is most needed.

An efficient national transmission grid is clearly needed, to carry electricity from areas with abundant zero-fuel-cost resources and deliver it to high-usage areas.

Even without this improvement, however, utilities can already take advantage of the existing *natural gas* distribution network. If a Midwest utility installs thousands of MW of wind farms, it will use less natural gas than it might have otherwise. If a Nevada utility installs solar farms, that Nevada utility will also use less natural gas to meet its needs. As these utilities in renewable resource-rich areas cut their natural gas usage, the natural gas "freed up" will be more available to be used by utilities elsewhere, helping to alleviate concerns about natural gas supplies and pricing.

5. *Get the Job Done, With the Least Business Risks*

As noted earlier in this paper, an electric utility is in a unique position, with the critical responsibility to "keep the lights on" at the most reasonable cost, for everyone in its service territory.

Utilities must legally and ethically put a priority on *prudence,* and should therefore "get the job done" choosing the options and systems which pose the least business risks.

The goal should be a reliable and cost effective utility network. This is the goal – not a particular type of power plant or a particular set of plans to defend.

Utility management shouldn't be *too* exciting. If an idea starts to look like it could have excessive business risks and costs, it is best to re-assess and find less risky ways to meet the goals. The last generation of utility managers nationwide reached this conclusion about nuclear power. This Paper has shown reasons why these executives were right, even though they had to cancel nuclear plans they themselves, plus a powerful nuclear lobby and a pro-nuclear government, had at one point advanced.

If current-day utility executives and utility regulators will now consider these facts, the nation can proceed to address the energy challenges we face, with far less rancor and risks, and lower costs overall, than if a futile attempt is made at great cost to revive a nuclear industry that has never kept its promises to provide a competitive and viable generation source.

APPENDIX A - "ALL IN" ESTIMATED CONSTRUCTION COST "MOST LIKELY" CASE

New Nuclear Power
2 - 1,117 MW Units
(Outlays in Thousands of Nominal Dollars)

Year	% Unit 1 Const.	% Unit 2 Const.	Escalation Factor- Constr. Costs	Cumulative "Brick & Mortar" Costs	Cumulative Cost of Capital	Cumulative Total "All-In" Costs
2007	0.4%	0.4%	1.00	35,460	1,767	37,227
2008	3.0%	3.0%	1.09	332,263	20,086	352,349
2009	2.0%	0.0%	1.18	439,914	58,556	498,470
2010	3.0%	1.0%	1.29	674,183	114,059	788,242
2011	5.0%	0.5%	1.40	1,024,682	198,696	1,223,378
2012	10.0%	0.5%	1.53	1,960,793	347,430	2,308,223
2013	36.6%	5.0%	1.66	5,100,294	699,210	5,799,504
2014	27.0%	10.0%	1.81	8,137,916	1,358,730	9,496,646
2015	10.0%	36.6%	1.96	12,301,625	2,377,016	14,678,641
2016	3.0%	27.0%	2.14	15,217,653	3,748,010	18,965,663
2017	0.0%	10.0%	2.33	16,275,298	5,316,970	21,592,268
2018	0.0%	3.0%	2.53	**16,620,545**	**6,955,822**	**23,576,367**

"OVERNIGHT" COST	$4,070 PER KW	$7,440 PER KW BRICK & MORTAR W/ESCALATIONS	$3,114 PER KW COST OF CAPITAL	$10,553 PER KW "ALL-IN" COST TO BUILD

ASSUMPTIONS ON COST ESCALATION RATES FOR CONSTRUCTION COSTS

COST ESCAL. FACTORS		% OF CONSTR.	NOMINAL WGHTD AVG
HW 00-07 AVG	4.85%	45%	2.18%
PCCI 00-07 AVG.	12.76%	51%	6.51%
GEN. INFLATION	3.00%	4%	0.12%
WEIGHTED AVG ESCALATION			8.81%

ASSUMPTIONS FOR WEIGHTED AVG. COST OF CAPITAL

	Net of Corp Tax	Before-Tax Gross	% of Funding	Weight
Equity	15.00%	24.59%	45.00%	11.06%
Interest	6.25%	6.25%	55.00%	3.44%
WEIGHTED AVG. COST OF CAPITAL =				14.50%

CAPITAL COST/KWH = $10,553/KW x .1457 Cap. Recovery /(8760 hrs/yr x 80% C.F.) = **$0.22/KWH**

APPENDIX B - "ALL IN" ESTIMATED CONSTRUCTION COST "LOW COST" CASE

New Nuclear Power
2 - 1,117 MW Units
(Outlays in Thousands of Nominal Dollars)

Year	% Unit 1 Const.	% Unit 2 Const.	Escalation Factor- Constr. Costs	Cumulative "Brick & Mortar" Costs	Cumulative Cost of Capital	Cumulative Total "All-In" Costs
2007	0.4%	0.4%	1.00	31,331	1,561	32,891
2008	3.0%	3.0%	1.08	291,661	17,652	309,313
2009	2.0%	0.0%	1.17	385,396	51,383	436,779
2010	3.0%	1.0%	1.26	587,901	99,872	687,772
2011	5.0%	0.5%	1.36	888,673	173,434	1,062,107
2012	10.0%	0.5%	1.47	1,686,134	301,709	1,987,843
2013	36.6%	5.0%	1.59	4,341,191	601,987	4,943,178
2014	27.0%	10.0%	1.72	6,891,416	1,161,589	8,053,005
2015	10.0%	36.6%	1.85	10,361,631	2,021,126	12,382,757
2016	3.0%	27.0%	2.00	12,774,308	3,173,745	15,948,052
2017	0.0%	10.0%	2.16	13,643,025	4,489,841	18,132,865
2018	0.0%	3.0%	2.34	**13,924,539**	**5,863,241**	**19,787,779**

"OVERNIGHT" COST = **$3,596** PER KW	**$6,233** PER KW BRICK & MORTAR W/ESCALATIONS	**$2,625** PER KW COST OF CAPITAL	**$8,858** PER KW "ALL-IN" COST TO BUILD

ASSUMPTIONS ON COST ESCALATION RATES FOR CONSTRUCTION COSTS

COST ESCAL. FACTORS		% OF CONSTR.	NOMINAL WGHTD AVG
HW 00-07 AVG	4.85%	55%	2.67%
PCCI 00-07 AVG.	12.76%	41%	5.23%
GEN. INFLATION	3.00%	4%	0.12%
WEIGHTED AVG ESCALATION			8.02%

ASSUMPTIONS FOR WEIGHTED AVG. COST OF CAPITAL

	Net of Corp Tax	Before-Tax Gross	% of Funding	Weight
Equity	15.00%	24.59%	45.00%	11.07%
Interest	6.25%	6.25%	55.00%	3.44%
WEIGHTED AVG. COST OF CAPITAL =				14.50%

CAPITAL COST/KWH = $8,858/KW x .1457 Cap. Recovery /(8760 hrs/yr x 85% C.F.) = $0.17/KWH

APPENDIX C: SUMMARY OF DIFFERENCES IN CAPITAL COST SCENARIOS

ASSUMPTION	"LOW COST"	"MOST LIKELY"	COMMENTS
OVERNIGHT COST/KW	$3,596	$4,070	1
WEIGHTED AVG ESCALATION:	8.02%	8.81%	2
% OF DEBT	55.00%	55.00%	3
AVG CAPACITY FACTOR	85%	80%	4
DELAYS IN CONSTRUCTION	NONE	NONE	5

COMMENTS

1 FLORIDA P&L ESTIMATES: CASE A (LOW COST), AND MIDPOINT OF FP&L CASE A & CASE C ESTIMATES (MOST LIKELY)

2 BOTH ARE LOWER THAN RECENT EXPERIENCE - ASSUME DECREASE IN ESCALATIONS

3 BOTH ARE SOMEWHAT HIGHER DEBT RATIOS (THUS LOWER COST OF CAPITAL) THAN MORE TRADITIONAL UTILITY DEBT/EQUITY STRUCTURES

4 MIT STUDY USED 75% AND 85% SCENARIOS - "MOST LIKELY" USES MIDPOINT OF MIT'S TWO SCENARIOS FOR CAPACITY FACTORS

5 NEITHER CASE ASSUMES ANY DELAYS WHICH WOULD INCREASE COSTS FURTHER