Testimony of

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Economic Advisability of Increasing Loan Guarantees for the Construction of Nuclear Power Plants

Domestic Policy Subcommittee
Committee on Oversight and Government Reform
U.S. House of Representatives

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My name is Dr. Mark Cooper. I am a senior fellow for economic analysis at the Institute for Energy and the Environment at Vermont Law School. In my 30 years of public policy analysis, I have testified approximately 350 times before federal and state legislatures and regulatory bodies on energy and communications issues, always on behalf of consumer, low income and public interest groups, as well as People's Counsels and Attorneys General.

The Committee has requested that I address four questions about the economics of nuclear reactors and loan guarantees. I will do so on the basis of my two recent reports on these topics – *The Economics of Nuclear Reactors: Renaissance or Relapse*[1] and *All Risk, No Reward: The Economics of Subsidizing the 'Nuclear Renaissance' with Loan Guarantees and Construction Work in Progress.*[2] These are publicly available at the Vermont Law School web site and I have submitted copies for the record. I have presented the results of my analyses in briefings on Capitol Hill, in the Indiana legislature, and to the San Antonio City Council, as well as presentations to academic and trade conferences, and in testimony before the Florida Public Service Commission.[3]

I commend the subcommittee for asking the hard questions about the cost of nuclear reactors and the impact that subsidies will have on taxpayers and ratepayers. As a lifelong consumer advocate, I believe that the fundamental economics of nuclear power should determine whether a new generation of reactors is constructed in the United States. In answering the Committee's questions, I take a broad view of the issues raised. I change the order slightly to address the basic supply and demand side fundamentals of nuclear reactor economics first. Then I explain why Wall Street will not put up the funds to finance new reactors and why policy makers in Washington, D. C. should not force taxpayers to do what the capital markets will not. I also show why state legislatures and regulatory commissions should not force ratepayers to bear the extraordinary risk of nuclear construction projects that Wall Street has rejected.

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[1] http://www.vermontlaw.edu/Documents/Cooper%20Report%20on%20Nuclear%20Economics%20FINAL[1].pdf
[2] http://www.vermontlaw.edu/Documents/11_03_09_Cooper%20All%20Risk%20Full%20Report.pdf
[3] http://www.eesi.org/can-addressing-climate-change-provide-economic-benefits-06-nov-2009, http://www.terry.uga.edu/exec_ed/bonbright/docs/Cooper_Keynote_Providing_Affordable_Energy.pdf, http://www.floridapsc.com/library/filings/09/07157-09/07157-09.pdf

Are cost overruns in the construction of nuclear power plants a thing of the past, or a recurring, present day problem?

The problems of cost escalation and cost overruns are endemic to the nuclear industry. Cost escalation and overruns afflicted the industry during the construction boom of the 1970s and 1980s, with the final reactors built in the U.S. costing more than seven times as much as the initial cost projections offered for the first reactors in the building cycle. As I showed in my first paper, and summarize in Exhibit 1, the escalation of projected costs since the early 2000s (the beginning of the so-called "nuclear renaissance") has rivaled the historical experience of the industry. In less than a decade, projected costs have quadrupled.

Contrary to the claims of the industry that costs will come down because there will be learning effects or economies of scale will be achieved, there are strong economic reasons and processes that push costs up, which overwhelm any tendency for learning or scale effects to reduce costs. Inherent cost escalation afflicts mega projects, a category into which nuclear reactors certainly fall. The endemic problems that affect nuclear reactors take on particular importance in an industry in which the supply train is stretched thin.

- Reactor design is complex, site-specific, and non-standardized.
- In extremely large, complex projects that are dependent on sequential and complementary activities, delays tend to cascade into interruptions.
- These one of a kind, specialized products have few suppliers. Any increase in demand or disruption in supply sends prices skyrocketing.
- Any interruption or delay in delivery cannot be easily accommodated and ripples through the supply chain and the implementation of the project.
- Material costs have been rising and skilled labor is in short supply.
- The energy intensive materials and construction process that nuclear reactors entail are likely to suffer disproportionate upward pressures in a carbon-constrained environment.

There is a second reason – a political reason – that the industry has been afflicted by cost escalation compared to the original cost projections, which is also highlighted in Exhibit 1. The industry tends to lowball the original estimates to get its foot in the door. Quoting extremely low estimates induces public utility commissions to allow the projects to commence. Once public utility commissions allow utilities to begin to incur costs to build nuclear reactors, there is a tendency to not want to abandon costs that have been sunk into the project, even when the costs to complete the project are above the total cost of feasible alternatives. One of the strongest findings in the burgeoning field of behavioral economics is that that people are loss averse. The initial lowball estimates are a form of bait and switch that play on human nature.

I conclude that these problems are endemic to nuclear reactor technology because the same problems that afflict the U.S. industry also afflict the French nuclear program, which is frequently held up as a "model" for others to follow. Exhibit 2 compares the results of a recent study of French nuclear reactor construction costs to my analysis of U.S. costs. For a short period the French managed to control costs. They did so with a state run monopoly, a licensed U.S. technology, and by keeping their reactors small. However, when they sought to increase the capacity of a design that was more original – i.e. a "Frenchified" version of the existing design -- they lost control of costs. The two large French reactor projects that are currently under construction, one in France and one in Finland, have run into severe design, cost and delay problems. The French model, which is so highly touted by some in the U.S., does not work much better than the U.S. model at controlling cost escalation, i.e. it does not work very well at all.

Thus, historical and contemporary experiences suggest that, if the US industry ever begins to actually build new reactors, costs will escalate farther. In sum, the current cost projections make power from nuclear reactors extremely expensive and uneconomic and those costs are likely to escalate, not decline, if these reactors are ever built.

Do we currently have such a demand for electric power plants that we need to rush into construction of multiple nuclear plants, or do we have time to experiment and to see what does work and what does not?

There is no need for these reactors today, nor is their likely to be one, if policy makers in Washington and utility regulators in the states pursue a least-cost approach to meeting the needs for electricity in the future, even if policies are adopted to reduce carbon emissions. The lack of demand for nuclear reactors stems, in part, from the recent downturn in the economy and likely long-term shift of demand growth and, in part, from the fact that there are so many lower-cost alternatives available that it does not make economic sense to build nuclear reactors.

Exhibit 3 shows historical data on the consumption of electricity in the U.S. since the end of World War II. This highlights the impact of the oil price shocks of the 1970s on demand. It hypothesizes a shift in demand in the wake of the great recession. Many analysts have suggested that the bursting of the financial and housing bubbles and the devastating hit that household wealth has taken may cause a fundamental shift in behavior. Exhibit 3 also includes an estimate of where demand would be if we were to achieve a 20 percent additional contribution of energy efficiency/renewables, which has been called for by some analysts and included in some versions of climate change legislation.

The Exhibit includes a similar analysis for Florida. Many of the utilities that have proposed nuclear reactors did so on the basis of the decade or so just prior to the bursting of the financial and housing bubbles. For many of these utilities, the shift in demand has pushed the peaks that had been projected in the near term out substantially. Moreover, climate polity that includes a substantial amount of efficiency will push the need even farther into the future.

In fact, as shown in Exhibit 4, whether or not climate policy is enacted, efficiency and several widely available renewables (e.g. biomass, wind, geothermal) are substantially less costly than nuclear. If low-cost policies can push out peak demand by decades, the rational approach would be to pursue the lower cost alternatives, during which time new, lower cost technologies will certainly be developed.

The Lawrence Berkeley National Laboratory and McKinsey and company have recently estimated that efficiency alone could lower demand 20-30 percent below business as usual in the next two decades. Adding in low-cost renewables, as shown in Exhibit 5, suggests that the demand for electricity from low-carbon sources would be met at lower costs than building nuclear reactors for decades at least. The increasing availability and declining price of natural gas also make it an increasingly attractive transitional source of energy. Pursuing low-cost alternatives in the short and middle term means that ratepayers and taxpayers pay less while a variety of new technologies including next generation efficiency, renewables, and energy storage, are developed.

Why won't Wall Street invest in nuclear power plants, and why does Moody's call then a "bet-the-farm" investment?

Exhibits 3, 4 and 5, which demonstrate the supply and demand side factors that make nuclear reactors uneconomic, suggest why Wall Street has refused to underwrite these projects. The nuclear reactors are far more costly and will not be needed for decades, and there is little likelihood that things will get any better for nuclear reactor economics any time soon. The challenges that nuclear reactor construction faces go well beyond these two factors. As shown in Exhibit 6, there are over three-dozen specific risk factors that nuclear reactors face that fall into six broad categories – technology, policy, regulatory, execution, marketplace, and financial risk.

Technology risk stems from the fact that the new generation of nuclear reactors are just that, new and uncertain. Cost estimates have increased dramatically over the past five years, doubling, tripling or even quadrupling. At the same time, the technologies of alternatives, efficiency and renewables, are stable and well known, with their costs are declining and availability is rising

Policy risk stems for the fact that federal policy is in flux. It is ironic that nuclear advocates have looked to climate policy, which may put a price tag on carbon emissions, as a primary driver of the opportunity to expand the role of nuclear power, but they have failed to take account of the equally strong possibility that climate policy will create a very substantial mandate for conservation and renewables, which will dramatically shrink the need for new, nonrenewable generating capacity. It is not only renewable portfolio standards and energy efficiency resource standards that will have this effect; it is also building codes, appliance efficiency standards, and huge increases in the commitment of funds for weatherization and energy retrofitting of buildings that will have this effect.

Regulatory risk stems from the chance that regulators will move slowly in approving reactors or authorizing their cost recovery. The fact that these are new designs has proven challenging. The reference designs that were supposed to be the templates to speed the future regulatory approval process have gone through numerous revisions. Site-specific issues, which cannot be standardized, have proven contentious. While a few states have approved construction work in progress (including full recovery of the cost of cancelled plants) and other measures to ensure utility cost recovery, the vast majority has not.

In the economic **marketplace**, demand-side risks flow from the current recession, the worst since the Great Depression, which has not only resulted in the largest drop in electricity demand since the 1970s, but also appears to have caused a fundamental shift in consumption patterns that will lower the long terms growth rate of electricity demand dramatically. On the supply-side of the market, there are a host of alternatives that have lower cost to meet the need for electricity in a carbon-constrained environment and there is growing confidence in the cost and availability of alternatives.

Execution risk stems from the fact that these reactors are new and the industry does not have a great deal of capacity. Of the 18 projects that have applied for licenses at the Nuclear Regulatory Commission, 16 have suffered from one or more of the following problems: delay, cancellation, cost escalation or financial downgrade.

All of the above risks create a huge **financial risk** for utilities contemplating building reactors. The nature of the projects imposes additional financial risks, so much so that, for most utilities, the projects are so large that Moody's has called them "bet the farm" decisions.

The historical experience in the nuclear industry also deserves mention. The industry made similar "bet the farm" decisions in the face of adverse circumstances in the 1970s and 1980s and the results were disastrous for the industry and consumers with half the reactors originally ordered cancelled or abandoned and the remainder suffering severe cost overruns. A combination of risks similar to those we observe today created a financial disaster for utilities and a rate shock for consumers.

Given these risks and this experience, it is not surprising that Moody's concluded that the decision to build a nuclear reactor is a "bet the farm" decision or that another financial analyst has suggested that the risk premium necessary to make nuclear construction projects attractive to utilities would be two to three times the normal risk premium. Thus, there is little wonder that capital markets are hesitant to finances the construction of new nuclear reactors.

Do increased loan guarantees for nuclear power plants misdirect resources that could be better used for energy efficiency and renewables power projects?

Loan guarantees are an effort to override the judgment of Wall Street. It is ironic that as the nation continues to suffer from the misallocation of risk by companies in the financial sector, some of the strongest supporters of free markets and critics of government action are urging a massive federal subsidy for nuclear power.

The nuclear industry would like new rules that would allow it to gobble up funds earmarked for clean energy technologies; elimination of conditions that would protect taxpayers in the event of loan defaults; dramatic increases in tax and insurance subsidies; and accelerated and assured recovery of construction costs from ratepayers authorized by state regulators.

These direct subsidies would total in the hundreds of billions of dollars. Yet the stakes for consumers would be still higher. Nuclear subsidies would induce utilities to choose high capital-cost nuclear reactors that expand their rate base and forego much lower-cost alternatives, such as greater energy efficiency and renewable energy, imposing excessive costs on consumers that eventually could run into the trillions of dollars.

In an attempt to circumvent the sound judgment of capital markets, advocates erroneously claim that subsidies lower the financing costs for nuclear reactors and are good for consumers. However, shifting risk does not eliminate it, and subsidies induce utilities and regulators to take greater risks that will cost taxpayers and ratepayers dearly.

- Because the subsidy induces the utility to choose an option that is not the least-cost option available, ratepayers will bear a higher burden.
- Because subsidies induce the utility to undertake risky behaviors that they would not have engaged in, when those undertakings go bad, the costs of the failures will be born by taxpayers and ratepayers in the form of expenditures on facilities that do not produce a flow of goods and services.
- If the pre-approval process reduces scrutiny over cost escalation and overruns, ratepayers will end up paying a higher price than anticipated.
- Even with subsidies, these project are so risky and large, they tend to have adverse impacts on the utility's financial rating, which results in substantial increases in the cost of service.
- For cash strapped consumers, taking after-tax dollars out of their pockets is a severe burden. If taxpayers and ratepayers have a higher discount rate than the utility rate of return, they would be better off having the present use of their money.

There is a high probability that some or all of these factors will impose high costs on taxpayers and ratepayers (as described in Exhibit 7).

The Bottom Line on Nuclear Subsidies

From the societal point of view, the push to subsidize large numbers of reactors in the next couple of decades is not compelling. While it can be argued that some of the challenges that nuclear reactors face can be seen as "market failures" that might justify government intervention, most of the obstacles are not market failures: they are a reflection of the market's sound judgment about the nature of the technology and the economic conditions new nuclear reactors face. The rejection of nuclear reactors by financial markets is not a case of market failure, it is an example of market success, markets properly assessing risk and acting accordingly by refusing to underwrite unacceptable risks. The existence of numerous lower-cost, lower-risk options to meet the need for electricity in a low carbon environment undercuts the claim that nuclear reactors are a solution to the externality problem of climate change.

It is critically important to get the fundamental economic analysis correct by having realistic estimates of nuclear costs and considering the full range of alternatives. The CBO analysis on the subject from 2008, vastly underestimated the cost of nuclear reactors (see Exhibit 8) and failed to consider the full range of alternatives (see Exhibit 4). As a result, it reached the incorrect conclusion that nuclear reactors might be cost competitive at modest levels of carbon dioxide costs. When the CBO analysis is adjusted for these flaws, nuclear reactors would not be built on economic grounds for the foreseeable future (see Exhibit 9).

All of these indicators of risk call to mind the previous effort to build nuclear reactors in the U.S., when

- half of the reactors ordered were cancelled or abandoned;
- those that were completed took, on average, twice as long to build as originally planned and cost twice as much as originally estimated;
- four-fifths of the utilities that undertook nuclear construction suffered large financial downgrades and all suffered substantial financial distress; and
- there were spectacular bankruptcies of both investor owned and publicly owned utilities.

The last time the nuclear industry circumvented the judgment of the marketplace it resulted in what Forbes magazine called the "largest managerial failure in American history." The past could be prologue and lead to a repetition of that history with taxpayers and ratepayers as the underwriters of nuclear reactors. This time the failure could cost not just hundreds of billions in losses on reactors that are cancelled, but also trillions in excessive costs for reactors that are brought to completion by utilities that fail to pursue the lower cost, less risky options that are available.

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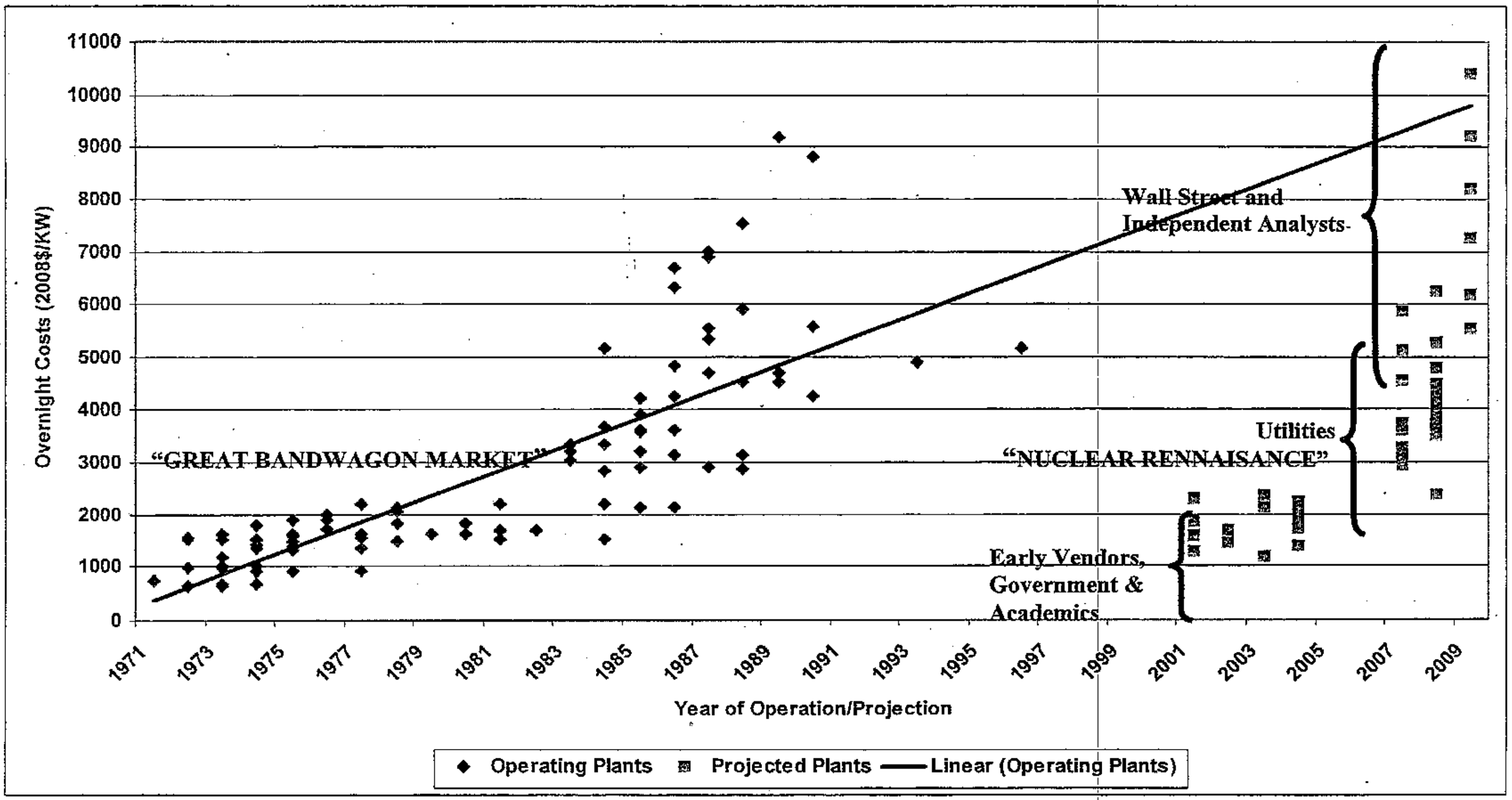
Exhibits

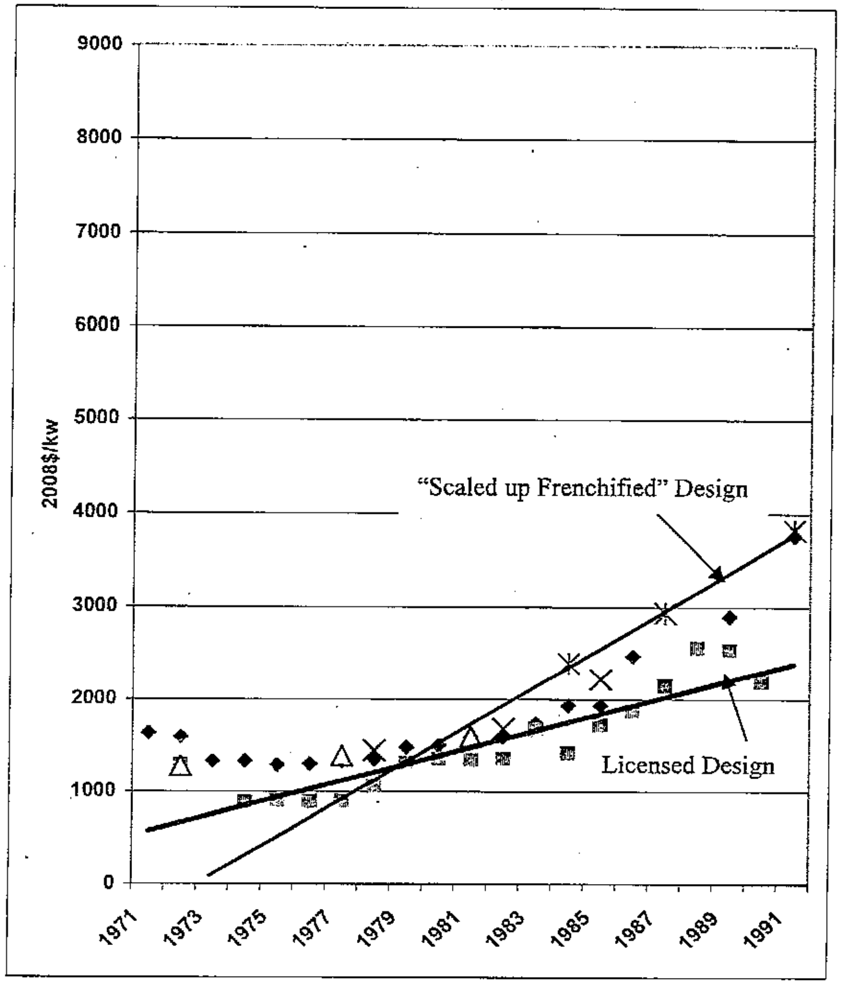
Exhibit 1: Completed Nuclear Reactors Compared to Projected Costs of Future Reactors



Sources: Cooper, 2009a, p. 3; Koomey and Hultman, 2007, Data Appendix; University of Chicago 2004, p. S-2, p. S-8; University of Chicago estimate, MIT, 2003, p. 42; Tennessee Valley Authority, 2005, p. I-7; Klein, p. 14; Keystone Center, 2007, p.42; Kaplan, 2008 Appendix B for utility estimates, p. 39; Harding, 2007, p. 71; Lovins and Shiekh, 2008b, p. 2; Congressional Budget Office, 2008, p. 13; Lazard, 2008, p. 2; Lazard, 2009, p. 2; Moody s, 2008, p. 15; Standard and Poor, 2008, p. 11; Severance, 2009, pp. 35-36; Schlissel and Biewald, 2008, p. 2; Energy Information Administration, 2009, p. 89; Harding, 2009. PPL, 2009; Deutch, et al., 2009, p. 6. California Energy Commission, August 2009, p. 18; see Bibliography for full citations.

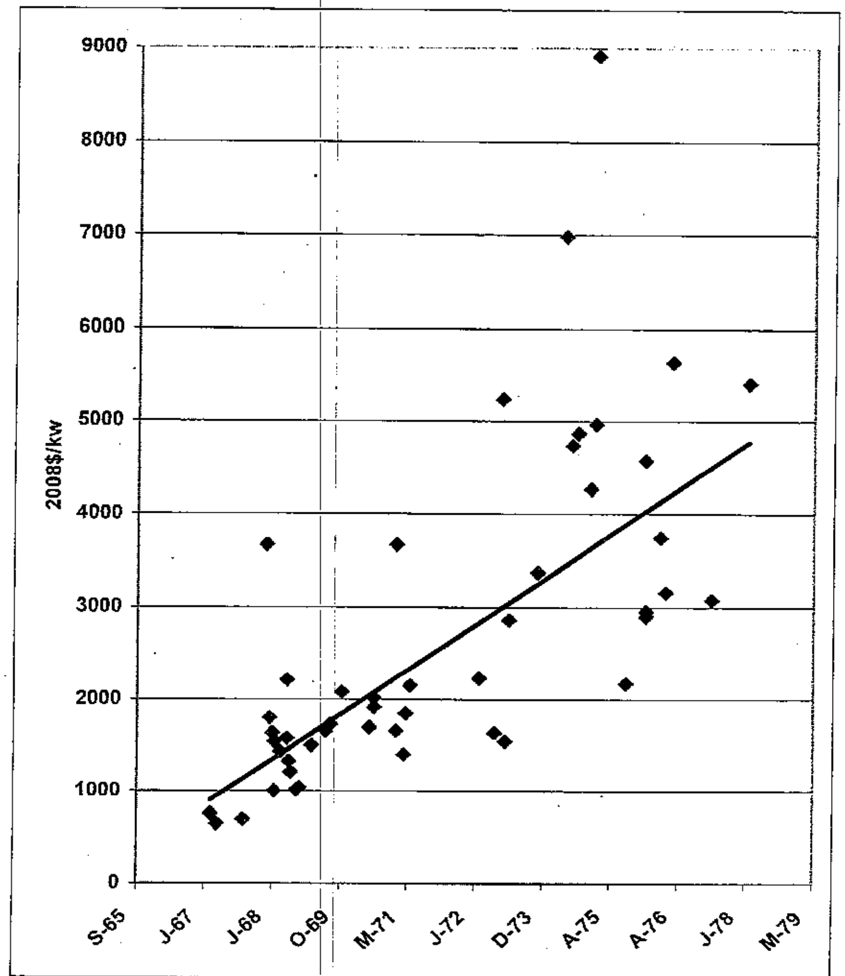
Exhibit 2: Pressurized Water Reactor Cost Treads

France



Source: Grubler, 2009, Figure 8; Komanoff, 2010, Figure 1

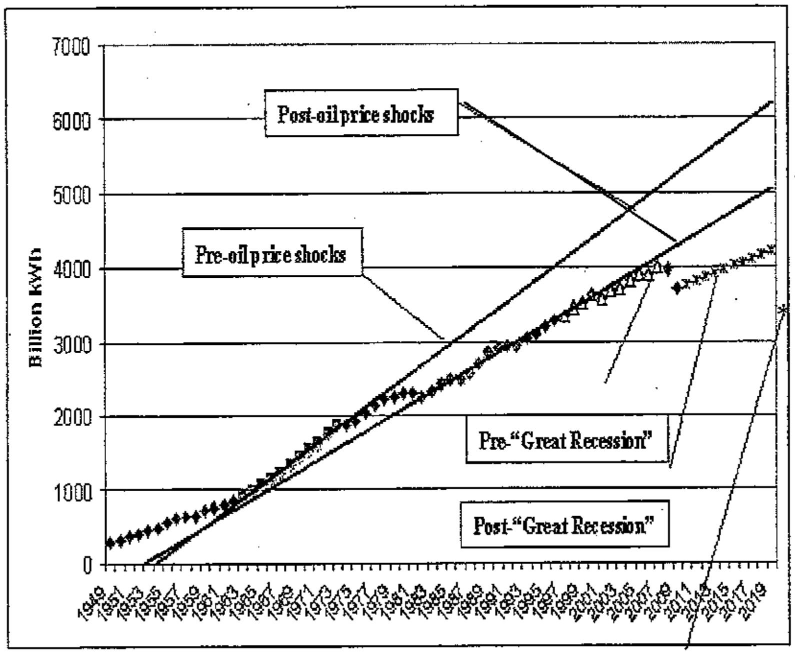
United States



Source: Cooper, 2009a, database, updated

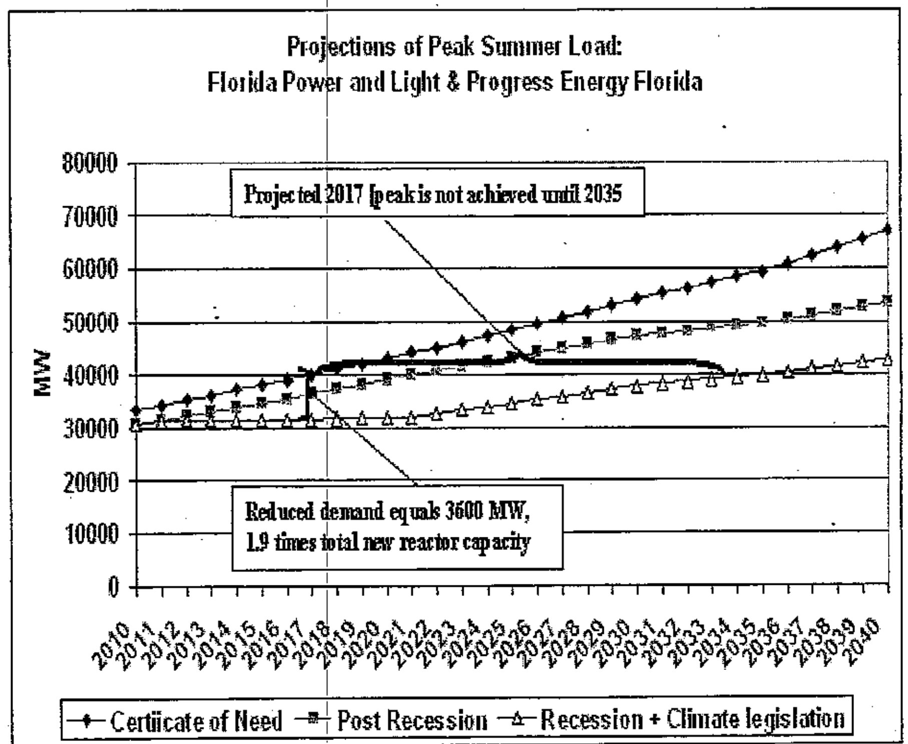
Exhibit 3: The Impact of Declining Demand and Potential Efficiency on Electricity Load

External Shocks and Public Policy Shift the Level and Growth Rate of Demand



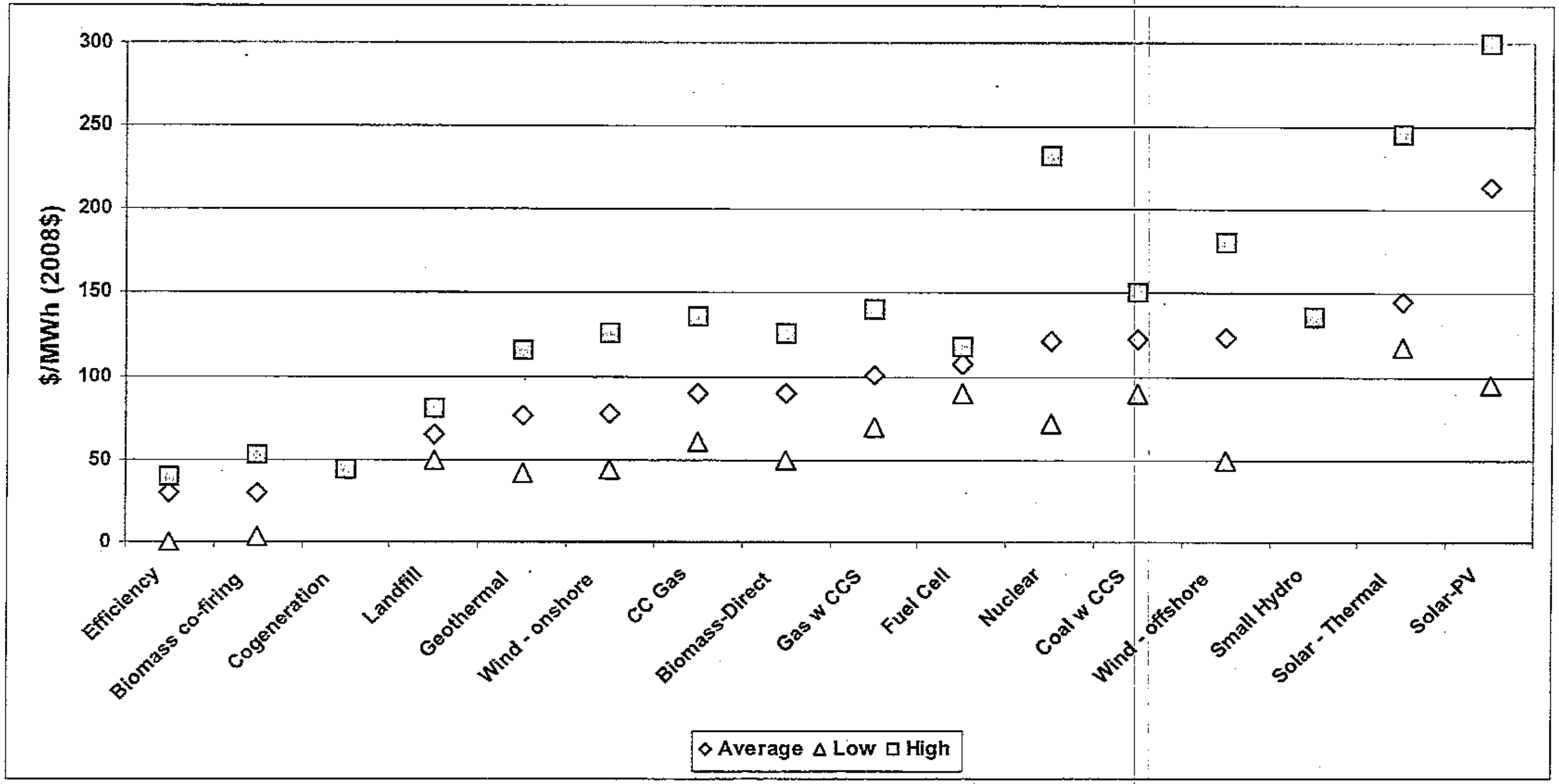
20% efficiency & renewable driven reduction in demand for central station capacity

Sources: Cooper, 2009b, p. 33. U.S. Energy Information Administration, *Monthly Energy Review*, various issues author calculation



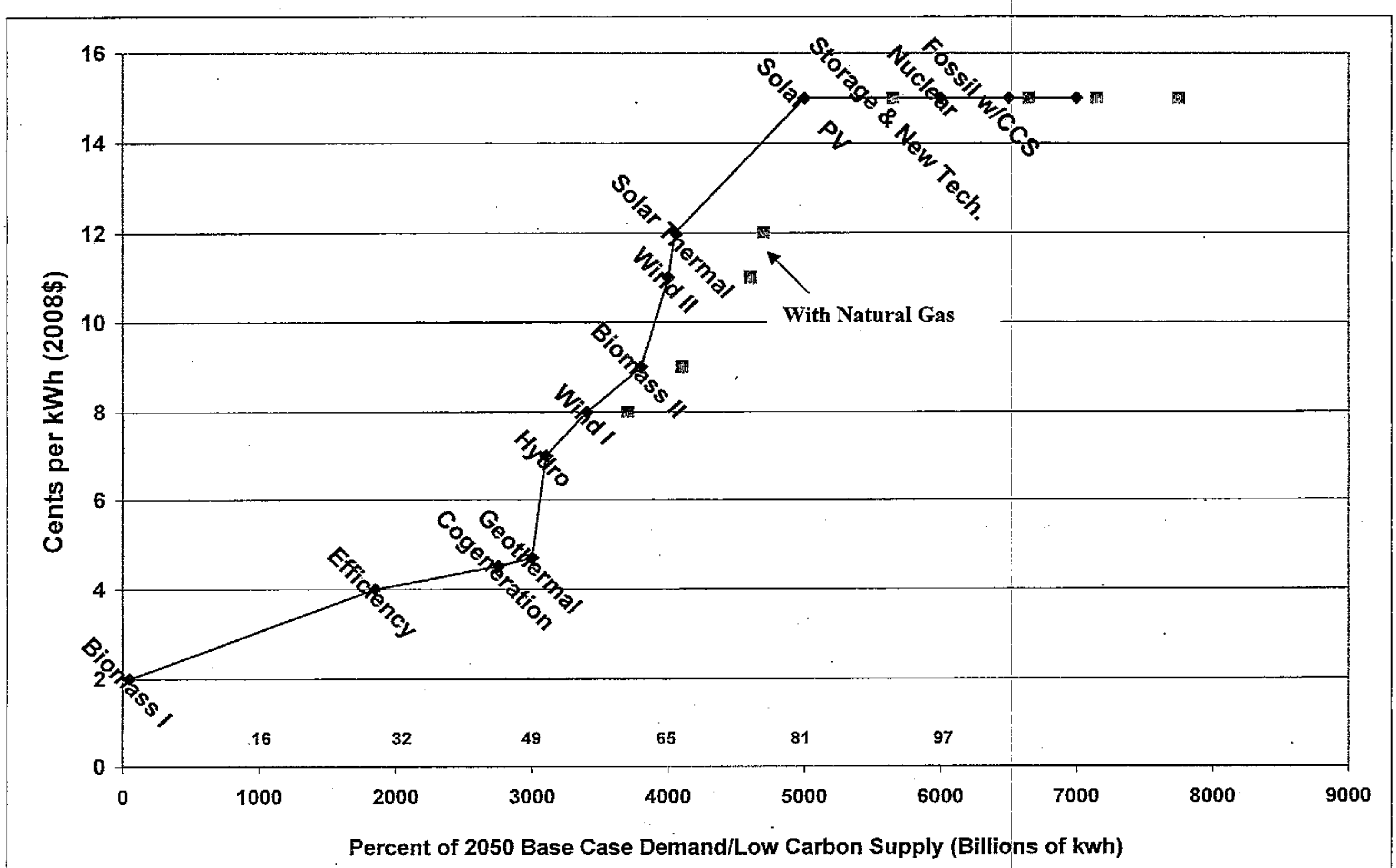
Source: Cooper, 2009c, Exhibits MNC-7 and MNC-8.

Exhibit 4: Levelized Cost of Low Carbon Options to Meet Electricity Needs



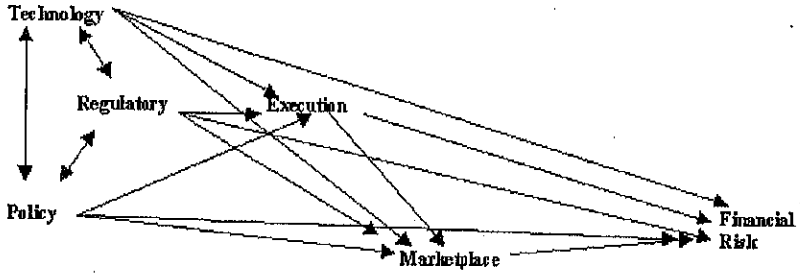
Sources: Cooper, 2009b, p. 30; Congressional Budget Office, May 2008, p.13; Kaplan, Stan, November 13, 2008, Appendix B; California Energy Commission, August, 2009, p. 18; Lazard, June 2008, p. 10; Lovins, Shiekh, and Markevich, December 31, 2008. p. 2; Moody's, May 2008, p. 15; National Research Council of the National Academies, 2009, p. 58; Renewable Energy Policy Network for the 21st Century, 2008; Standard and Poors, August 13, 2008, p. 11.

Exhibit 5: Meeting Electricity Needs in a Carbon Constrained Environment (Cost of Alternatives Substitution Curve)



Source: Cooper 2009a, p. 52

Exhibit 6: The Economic Risks of Nuclear Reactor Projects



Risk Category	Source	Specific Risks
Technology	New Technology Risk	First of a kind costs
		Long Lead times
	Alternative technologies	Efficiency potential identified
		Renewable cost declines
Policy	Shifting focus	Emphasis on efficiency reduces need
		Renewables reduce need
	Flexible GHG reductions	Lowers carbon cost
Regulatory	NRC Regulatory Reviews	Lack of experience
		Change of requirements
		Design flaws and revisions
		Site-specific conditions
	Loan Guarantee Conditions	Taxpayer protections inhibit loan
	Rate Review	Recovery of costs challenged
Execution	Construction Risk	Lack of experience
		Counterparty risk
	EPC contract uncertainties	Cost escalation and volatility
	Size, cost and complexity	Cost overruns
		Delays
		Rework costs
Marketplace	Uncertain demand growth	Slowing due to recession
		Shifting due to wealth loss
	Uncertain fuel costs	Natural gas price decline
	Reactor Costs	Long lead times
		Cost overruns
		Rate shock reduces demand
Financial	General Conditions	Tight money
		New liquidity requirements
		High-risk premiums
	Utility Finance	Increased nuclear exposure
		Finance ratio deterioration
		Rising cost of debt
		Declining cash & equivalents
		Weak balance sheets
		Underfunded pension plans
	Project Finance	High hurdle rates
		Impact of large project
		Debt load and service burden
		Capital structure distortion

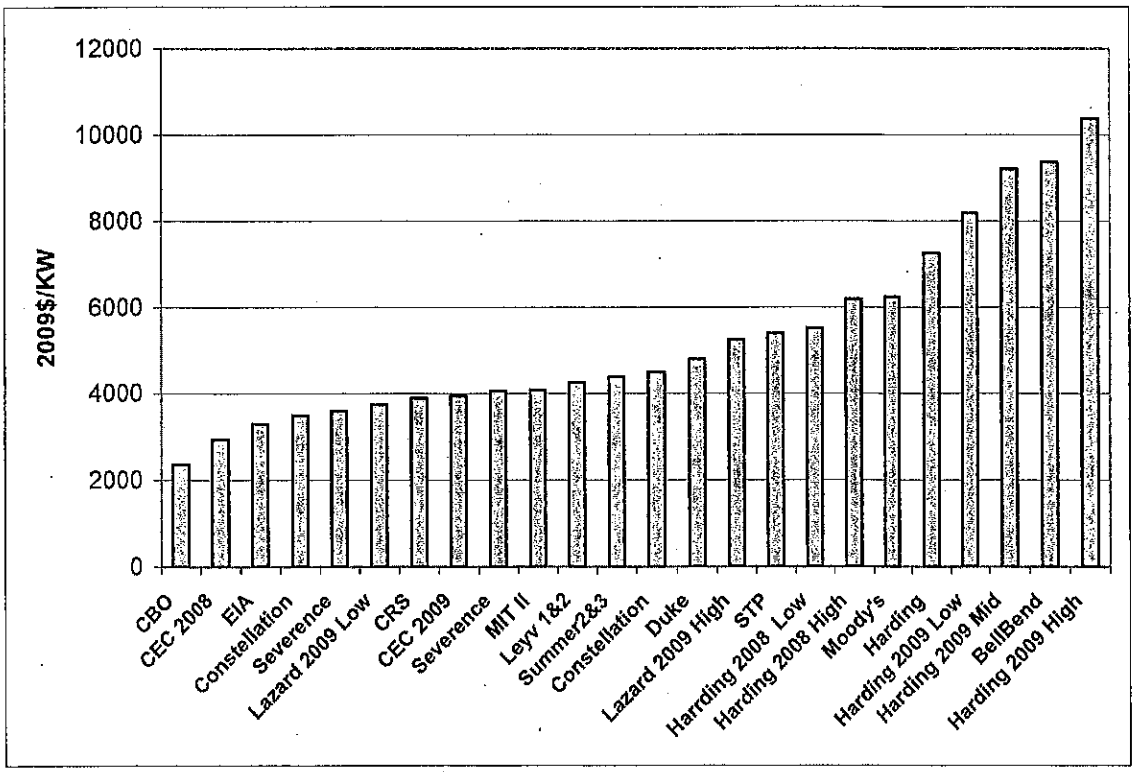
Source: Cooper, 2009b, pp. 11, 13.

Exhibit 7: Threats to Taxpayers and Ratepayers from Nuclear Reactor Subsidies

Area of Impact	Threat to Taxpayers and Ratepayers	Likelihood of Impact
Technology choice	Failure to adopt least cost approach	Certain
Project completion	Burden of failed projects	Highly likely
Project oversight	Lax review of project management	Highly likely
Financial ratings	Downgrade or Negative	Near certainty
Discount rate	Misallocation of resources	Certain

Source: Cooper, 2009b, p. 17.

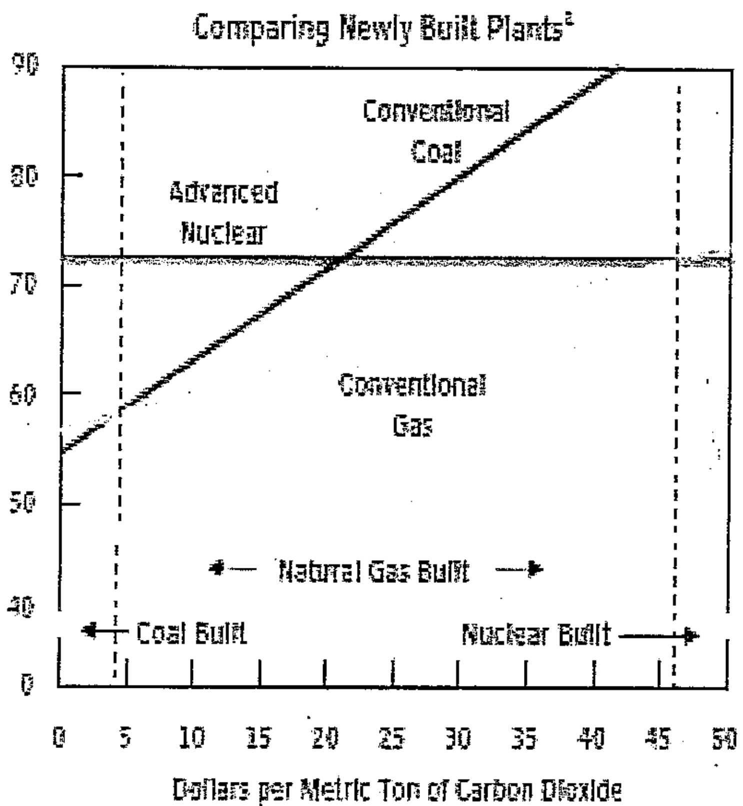
Exhibit 8: CBO vastly underestimated the capital cost of new nuclear reactors compared to other cost estimates in 2008-2009



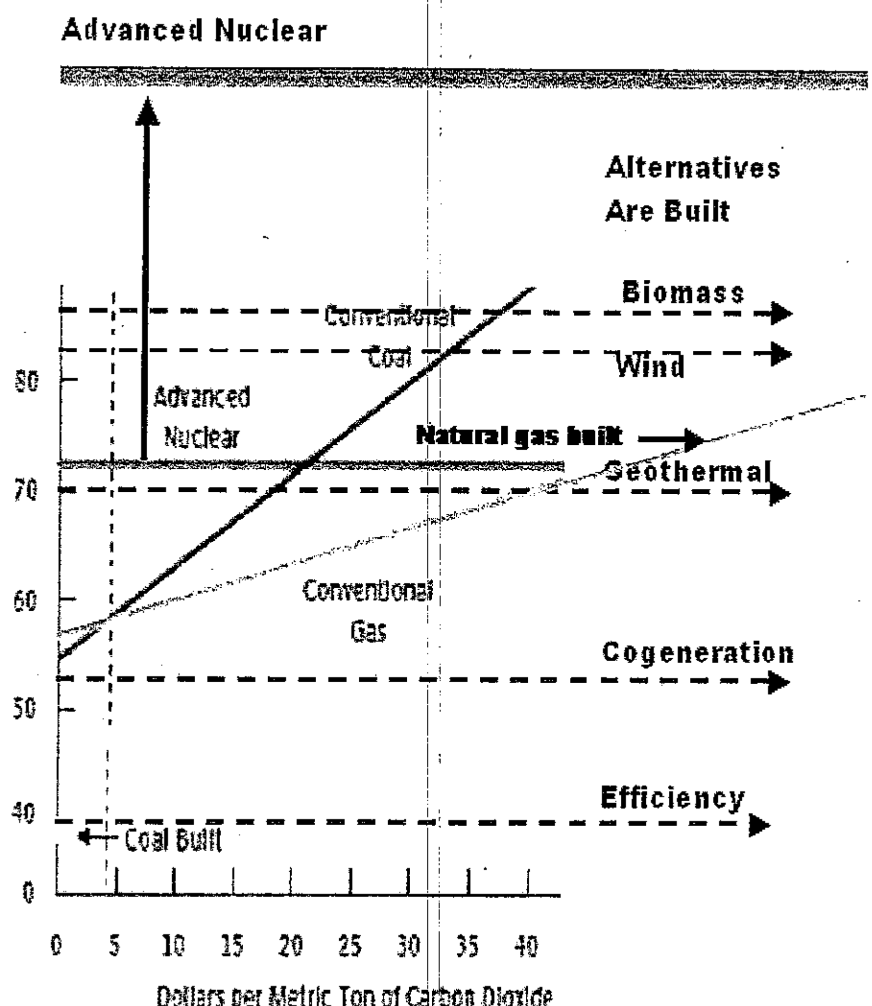
Sources: See Exhibit 1

Exhibit 9: CBO's conclusion that nuclear would be built at CO2 costs above $45 is wrong because higher nuclear costs and abundant lower cost, low carbon alternatives mean nuclear is not needed for the foreseeable future.

CBO original technology choice analysis



CBO adjusted for higher nuclear costs and more alternatives



Source: Lazard 2009 overlaid on CBO