Testimony of

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on

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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 over 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. Over the past three years I have been examining the issue of how to meet the need for electricity in a carbon-constrained environment through my affiliation at the Vermont Law School.

I appreciate the opportunity to testify at the hearing today to answer the question. "Should Minnesota lift the moratorium on nuclear reactor construction in the state?"

My answer is an unequivocal no. Based on several major analyses of the economics of nuclear reactor construction and alternatives that I prepared in the past three years, I conclude that Minnesota should not lift the moratorium on nuclear construction. Nuclear reactors are completely uneconomic – excessively costly and extremely risky – and lifting the moratorium will expose Minnesota ratepayers to billions of dollars of escalating electricity costs.

I realize that the moratorium was enacted for environmental reasons, but my research shows that the moratorium has a major economic benefit for consumers and that alone would justify not lifting the moratorium. Indeed, if Minnesota did not have a moratorium on nuclear reactor construction in place, my analysis would support the recommendation that the state enact one, so that it could focus the attention of policy makers and utilities on an approach that meets the need for electricity in the most consumer friendly, environment friendly manner. That approach would not include new nuclear reactors for decades, if ever.

I have attached to my testimony several updated exhibits from my research to support my conclusions and provide references to the underlying documents, all of which are available online.

My analysis of *The Economic Cost of Nuclear Reactors* (June 2009)[1] shows that the projected cost of new nuclear reactors has been increasing by 10 to 15 percent per year over the past decade because the nuclear advocates low-balled the initial estimates (see Exhibit 1). As a result, power from new nuclear reactors today is vastly more expensive than other options Minnesota has for meeting the need for power, even in a carbon-constrained environment (see Exhibit 2).

My analysis of the history of reactor construction cost in the U.S. and France (*Cost Escalation, Diseconomies of Scale and Negative Learning In Nuclear Reactor Construction*)[2] shows that there is no reason to believe that the cost will come down. Over the construction boom of the 1970s and 1980s, the cost of building nuclear reactors in both the U.S. and France, the two countries that built about half of all nuclear reactors in capitalist economies, costs increased steadily once construction began (See Exhibit 3). The pattern has been repeated in across developed economies in the construction of nuclear reactors in the past and the present because these projects involve extremely complex engineering and construction tasks that are technology- and site-specific. Consequently, there is little learning and standardization, and few economies of scale. Nuclear advocates claim and hope costs will come down over time, but the opposite is the case.

My analysis of the high cost and severe risks of building new nuclear reactors (*All Risk, No Reward*)[3] identifies dozens of issues and factors that raise the risk of nuclear reactor construction (see Exhibit 4), which explains why Wall Street refuses to fund the construction of new nuclear reactors. As a result of the high risk, utilities will not build unless they can shift the risks and costs of construction from utility stockholders to ratepayers and taxpayers to build them. This has led utilities in states that allow construction of nuclear reactors into a frantic political campaign to get subsidies from federal taxpayers, state ratepayers, and foreign equipment vendors, as well as foreign governments.

Thus, if the moratorium is lifted, anyone wanting to build a nuclear reactor in Minnesota will begin pushing for advanced recovery of construction costs from ratepayers – so-called Construction Work in Progress. Recovering costs from ratepayers before the reactor is producing electricity is essentially a no-interest loan from ratepayers to utilities that shifts all the risk onto ratepayers (see Exhibit 5). It encourages utilities to undertake risky projects and gives those projects an unfair advantage over lower cost alternative technologies. The distorted decision making process inevitably imposes severe harm on ratepayers.

One of the key factors that led to the nuclear "fiasco" of the mid-20th century[4] and has burst the nuclear bubble at the start of the 20th Century[5] is the lack of need for new nuclear

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[1] Available at http://www.vermontlaw.edu/students/Documents/Cooper%20Report%20on%20Nuclear %20Economics%20FINAL%5B1%5D.pdf

[2] Available at http://www.vermontlaw.edu/students/Documents/IEE/20100909_cooperStudy.pdf

[3] Available at http://www.vermontlaw.edu/Documents/11_03_09_Cooper%20All%20Risk%20 Full%20Report.pdf

[4] As described in *The Economics* and *Cost Escalation*

reactors. These huge, inflexible projects require long lead times and massive sunk costs. If demand shifts, as it has in the past few years, utilities and ratepayers (in the case of construction work in progress) are stuck with assets that have no market. The external shocks to the economy that have reduced demand (in the 1970s the oil price shocks; in the 2000s the Great Recession, as shown in Exhibit 6) are compounded by the high cost of power from new nuclear reactors.

The harm to ratepayers will be magnified because utilities will become totally preoccupied with building nuclear reactors. My analysis shows that utilities prefer to build large central station facilities because it builds the rate base, increases utility income, and ensures centralized control over generation (see Exhibit 7).[6] Utilities that become committed to nuclear reactors will fight tooth and nail against alternatives that might reduce the need for these large projects, such as efficiency measures and renewable energy. Nuclear reactors will crowd out the lower-cost, low-carbon alternatives available in the state (see Exhibit 8). Historically, with respect the choice of generation and currently with respect to construction plans, greater reliance on nuclear reactors and central station facilities is associated with less renewables and weaker efficiency programs.

Building new nuclear reactors is a bad economic investment that not only will require ratepayer subsidies, but crowds out good economic investment.[7] The legislation before you today is the first step in opening the door to immense pressure from the nuclear industry, who will ask state ratepayers to assume the risks and uncertainties that have impacted the nuclear industry since 1973. With limited federal loan guarantees and fervor in Washington to cut federal spending, even more burden will be put on ratepayers.

In the remainder of my testimony I briefly elaborate on these points based on my recent analyses.

Rising Cost

Ten years ago when nuclear advocates seized onto the idea of a "nuclear renaissance," vendors and the federal government estimated the cost of building a new nuclear reactor at $1,500 to $2,000 per kilowatt, which put the overnight cost of a new, typical two-unit, reactor project at about $4 billion to $5 billion. There was no historical, real world, or engineering evidence to support these cost estimates, which were a fraction of what it cost to build the nuclear reactors that were completed in the 1990s (see Exhibit 9). Nevertheless, nuclear advocates began dreaming and talking about the day when nuclear reactors would be cost competitive with coal and gas-fired plants.

Today, most utilities proposing to build new nuclear reactors are using a cost estimate of $5,000 per kilowatt, while Wall Street and other independent analysts use $6,000 to $8,000 per kilowatt. In other words, the estimated cost of constructing nuclear reactors has tripled and the typical new, two-unit project is projected to cost in the neighborhood of $20 billion. As I

[5] As described in my Testimony on Behalf of the Southern Alliance for Clean Energy *In re: Nuclear Plant Cost Recovery Clause,* Docket No. 10009-EI, July 8, 2010, available at http://www.psc.state.fl.us/library/FILINGS/10/05610-10/05610-10.pdf

[6] As described in *Cost Escalation* and *A Consumer Analysis of Energy Efficiency and Renewable Energy Standards,* available at http://www.consumerfed.org/elements/www.consumerfed.org/file/CFA-EERS-RESReport5-25.pdf

[7] As demonstrated in *Cost Escalation*

showed in my analysis of *The Economics of Nuclear Reactors*, this bait and switch tactic is deeply engrained in the nuclear industry.

Unbearable Risk

As the projected costs of nuclear reactor construction have escalated, demand for electricity has declined as a result of the recession, which also appears to be affecting future growth patterns. At the same time, the cost of efficiency has been flat, the cost of some alternatives (like natural gas) have plummeted, while the cost for other alternatives has been much more stable than nuclear construction costs. The nuclear industry has recognized that new nuclear reactors are simply uneconomic and impossible to fund in the capital markets. There are over three dozen specific risk factors that fall into six broad categories – technology, policy, regulatory, execution, marketplace, and financial risk – that have led Moody's to conclude that the decision to build a nuclear reactor is a "bet the farm" decision.

Seeking to override the verdict of the marketplace, the industry's lobbying arm has demanded massive increases in subsidies from taxpayers and ratepayers to underwrite the industry. It demands:

- A huge increase in loan guarantees and rules that protect utilities, rather than taxpayers, should projects go bad, with 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 (via "construction work in progress").

Harmful Subsidies

Attempting to circumvent the sound judgment of capital markets, advocates of loan guarantees and construction work in progress claim that they lower the financing costs of nuclear reactors and are good for consumers, but shifting risk does not eliminate it and taxpayers and ratepayers will pay the price.

- Because the subsidy induces the utility to choose an option that is not the least-cost option available, ratepayers will bear a higher burden.
- Subsidies induce the utility to undertake risky behaviors that they would not otherwise have engaged in. When those undertakings go bad, the costs of the failures will be borne 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 for loan guarantees and/or construction work in progress reduces scrutiny over cost escalation and overruns, ratepayers will end up paying a higher price than anticipated.
- Even with subsidies, these projects are so risky and large that 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.

Stifling Better Alternatives

Because nuclear power has never been economic, nuclear advocates hide the real cost of the initial units behind subsidies and try to get utilities hooked on the technology, hoping that by the time the reality dawns on policymakers it is too late to change directions and the public is forced to swallow the overpriced power. One of the key ingredients in the strategy of making the public swallow the overpriced nuclear reactors is the steadfast resistance to lower cost alternatives.

As I showed in *Cost Escalation*, the commitment to nuclear reactors and central station facilities crowds out deployment of alternatives. States that do not have a nuclear reactor had almost three times as much renewable generation in 1990 as states that had nuclear reactors. States without nuclear reactor licenses pending at the Nuclear Regulatory Commission have Renewable Portfolio Standard goals that are fifty percent higher than states that do. States without nuclear licenses pending had much better utility energy efficiency programs that achieved energy savings in 2006 that were 2.5 times as great as states that do have licenses pending, enabling them to avoid the need for costly central station facilities...

Utilities prefer central station approaches for a number of reasons. First and foremost, central station units enable them to increase their income by significantly building their rate base with one facility. Second, they have greater control over central station facilities. Third, these large projects require intensive oversight to execute, which elevates the standing of management.

There are a number of downsides to the commitment to nuclear reactors. The size of nuclear projects is so large that resources are always constrained and choices are biased in favor nuclear reactors. Utility financial resources are tied up for a decade or more. Management time is focused on the large project, particularly in the construction phase.

Alternatives become a threat to the large facilities because reductions in demand raise questions about the need for large additions to supply. The nuclear industry opposes legislation that seeks to promote alternatives. They manipulate tariffs and power purchasing authority to undermine the alternatives. They encourage building excess capacity of large central station facilities, to dampen demand for alternatives. They put extremely high price estimates on alternatives like efficiency, while low-balling the cost of new nuclear reactors.

Crowding out not only imposes higher costs on ratepayers, but it also does damage to another public policy goal of great current importance, job creation. My analysis demonstrates that building nuclear reactors is not only bad utility policy and bad energy policy, it is also bad jobs policy (see Exhibit 10). The inherent characteristics of nuclear reactors – huge capital costs and long, slow construction periods resulting in expensive power – mean they are an extremely poor approach to addressing the current concern of unemployment. Because they are capital intensive, they produce relatively few jobs per dollar invested. Because they result in high-cost power, they drain resources from household budgets, which means consumers have less to spend on other goods and services that have much higher economic multipliers, particularly in the local economy. Because they raise the cost of doing business, they tend to hamper the ability of other enterprises in the state to compete in regional, national and global markets. Because the equipment vendors are foreign corporations and the capital expenditures generate high levels of income, the drain on the local economy is compounded. Given the long licensing and slow ramp up in construction, they are the antithesis of “shovel ready” projects. In short, choosing nuclear reactors over efficiency and renewables not only produces many fewer local jobs in the aggregate, but takes much longer to get those jobs.

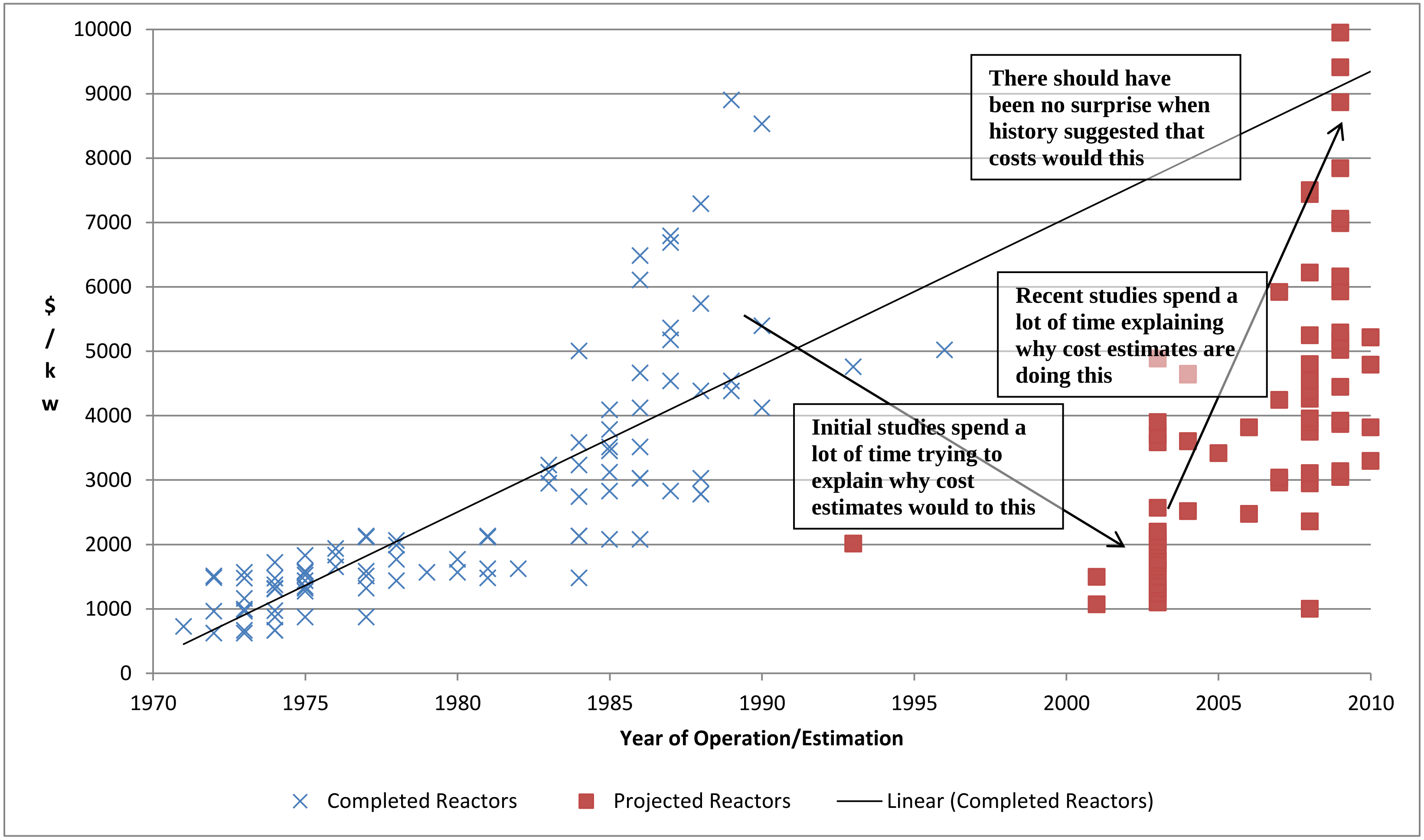
The high cost of power from new nuclear reactors also has an economic implication for environmental policy. It is a very expensive way to lower carbon emissions (see Exhibit 11).

Conclusion

I believe that all of these factors that make construction of new nuclear reactors a bad idea regionally, nationally and globally apply to Minnesota. There is no need for central station generation in Minnesota. Minnesota has good prospects to improve its energy efficiency and develop alternatives. Nuclear reactor construction will be just as complex and risky in Minnesota as it is elsewhere.

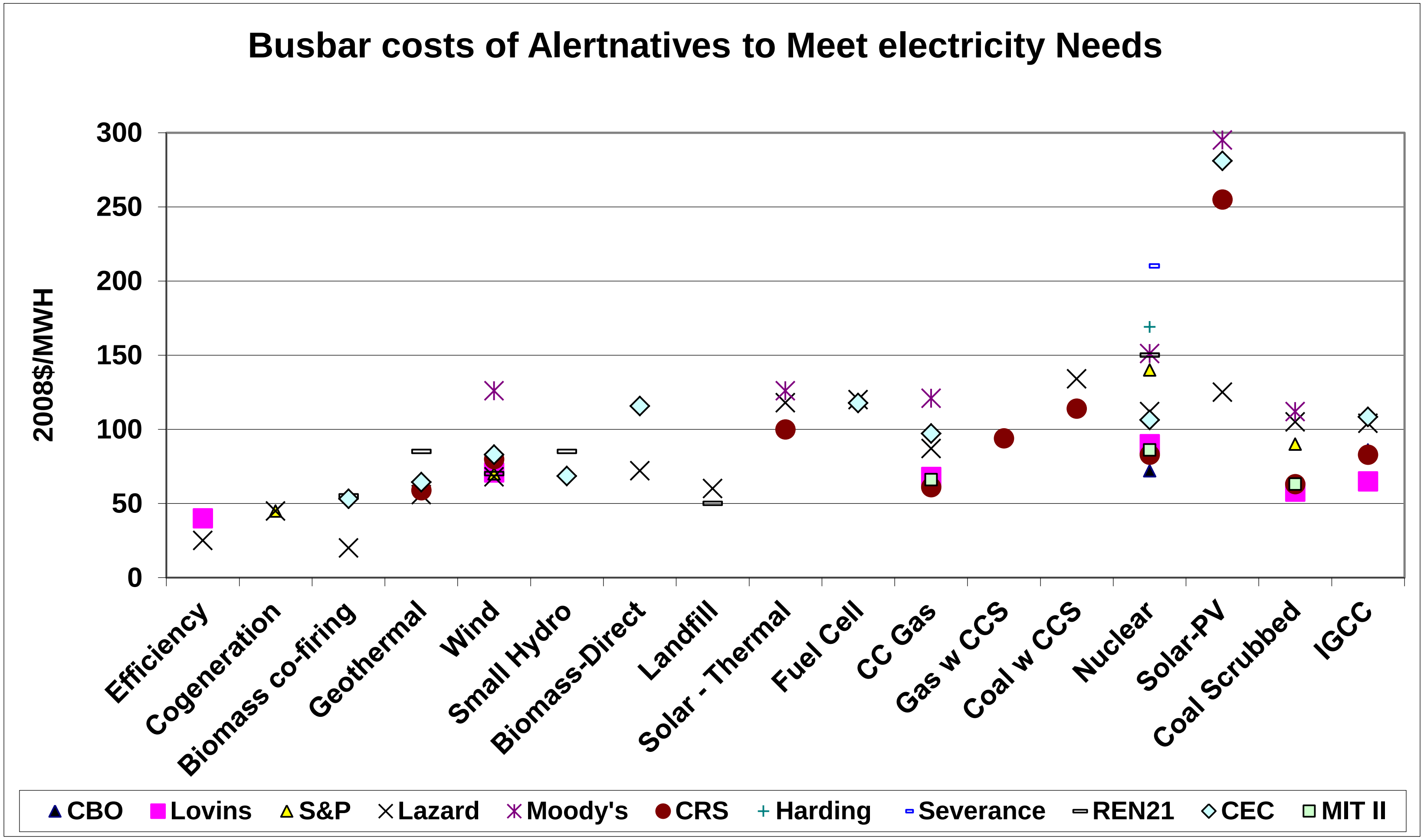
When a public policy analysis is as crystal clear as it is in this case, simple and blunt policy instruments are the best approach. New nuclear reactors have little chance of becoming economically competitive for decades, but inserting them into the policy mix poses a severe threat to the alternatives that are economically superior at present. I cannot predict when, if ever, nuclear reactors will become economically competitive, but I can say with a great deal of confidence that they are not economically rational today and that Minnesota has alternatives available to it that are preferable and capable of meeting its needs for electricity, even in a carbon-constrained environment. The moratorium is good public policy and should not be lifted.

EXHIBIT 1: COST ESCALATION IS ENDEMIC TO NUCLEAR CONSTRUCTION INITIAL 'NUCLEAR RENAISSANCE' COST PROJECTIONS WERE UNREALISTICALLY LOW (OVERNIGHT CONSTRUCTION COSTS)



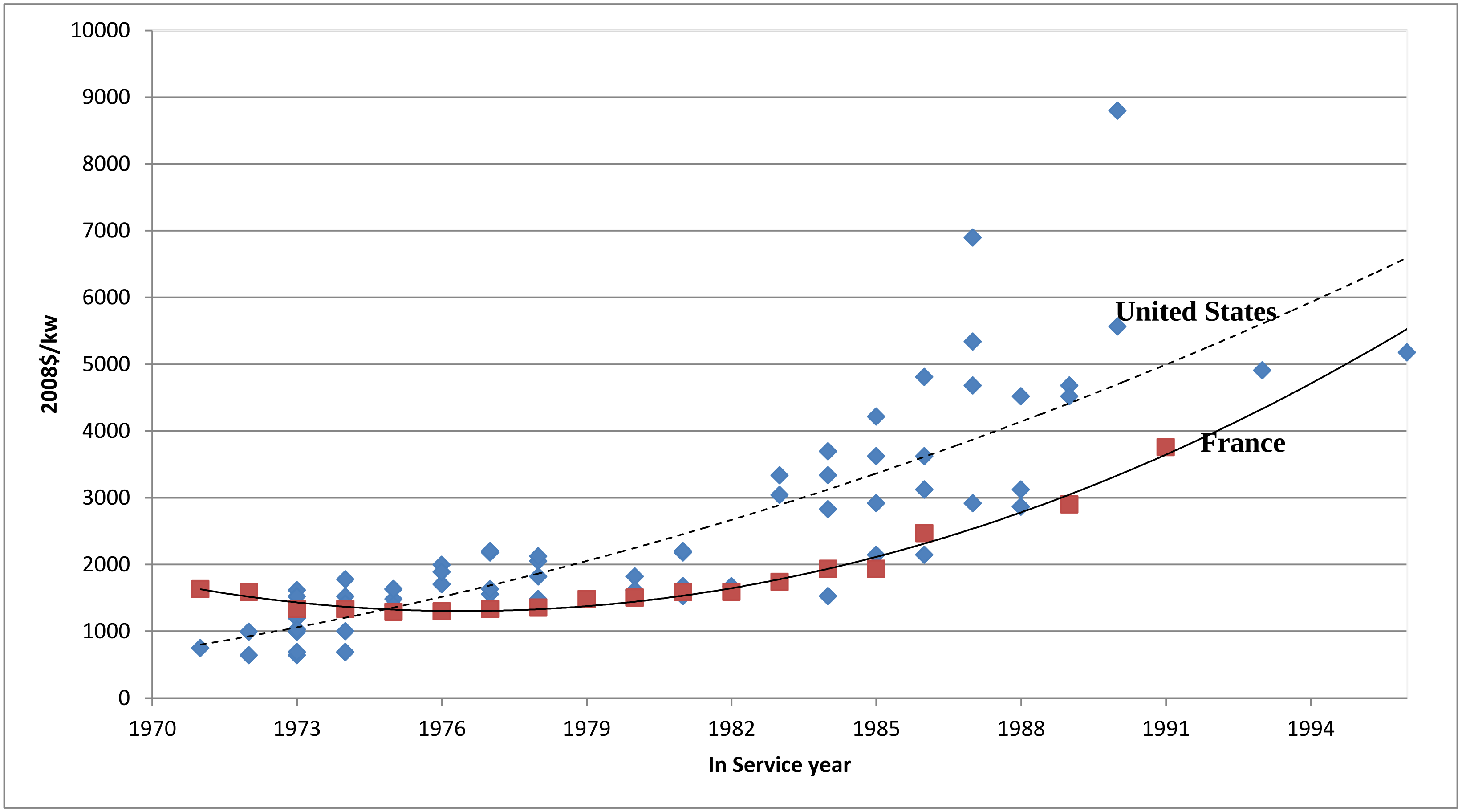
SOURCE: Mark Cooper, *The Economic Cost of Nuclear Reactors* (June 2009)

EXHIBIT 2: ESTIMATES OF COSTS OF ALTERNATIVES TO MEET ELECTRICITY NEEDS



SOURCE: Mark Cooper, Testimony on Behalf of the Southern Alliance for Clean Energy *In re: Nuclear Plant Cost Recovery Clause,* Docket No. 10009-EI, July 8, 2010

EXHIBIT 3: OVERNIGHT COSTS OF PRESSURIZED WATER REACTORS (2008$)



SOURCE: Mark Cooper, ***Policy Challenges of Nuclear Reactor Construction: Cost Escalation and Crowding Out Alternatives: Lessons from the U.S. and France for the Effort to Revive the U.S. Industry with Loan Guarantees and Tax Subsidies*** **(September 2010)**

EXHIBIT 4: THE TYPES OF RISKS AFFECTING NEW NUCLEAR REACTOR PROJECTS

Category	Source	Specific Risk
Technology risk stems from the fact that the new generation of nuclear reactors is new and uncertain. Cost estimates have increased dramatically over the past five years, doubling or tripling. At the same time, costs of efficiency and renewable technologies declining and availability is rising.	New technology risk Alternative technologies	First-of-a-kind costs Long lead-time Efficiency potential identified Renewable cost declines
Policy risk stems from the fact that federal policy is in flux. While 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, 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, large base load capacity.	Shifting focus Flexible GHG reductions	Emphasis on efficiency reduces need Emphasis on renewables reduces need Lowers carbon cost
Regulatory risk stems from the chance that regulators will move slowly in approving reactors or authorizing their cost recovery. The new design have proven challenging, with the reference designs going through numerous revisions. Site-specific issues, which cannot be standardized, have proven contentious. While a few states have approved construction work in progress and other measures to ensure cost recovery, the vast majority has not.	Loan guarantee conditions Rate review NRC regulatory reviews	Taxpayer protections inhibit guarantees Recovery of costs challenged Lack of experience Change of requirements Design flaws and revisions Site-specific contentions
Execution risk stems from the fact that reactors have not been built in the U.S. in decades and the industry does not have a great deal of capacity. Of the 19 projects that have applied for licenses at the Nuclear Regulatory Commission, 17 have suffered from one or more of the following problems: delay, cancellation, cost escalation or financial downgrade.	Construction risk Engineering, procurement & construction contract uncertainty Size, cost and complexity	Lack of experience Cost escalation and volatility Cost overruns Delays, Rework costs
Marketplace risk on the demand-side flows 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 dramatically lower the long-term growth rate of electricity demand. 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 these alternatives.	Uncertain demand growth Uncertain fuel costs Reactor costs	Slowing due to recession Shifting due to debt and loss of wealth Natural gas price decline Long lead time, Cost overruns Rate shock reduces demand
Financial risk stems from all of the above risks and are magnified by tight conditions in money markets and the fact that utility balance sheets are weak and too small to support the large size of nuclear reactor projects. 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.	General conditions Utility finance Project finance	Tight money, High-risk premiums New liquidity requirements Rising cost of debt, Weak balance sheets Limited & declining cash & equivalents Financial ratio deterioration, Increased operating exposure High hurdle rate for risky projects, Impact of large project Impact of large project, Capital structure distortion Debt load and service burden impact

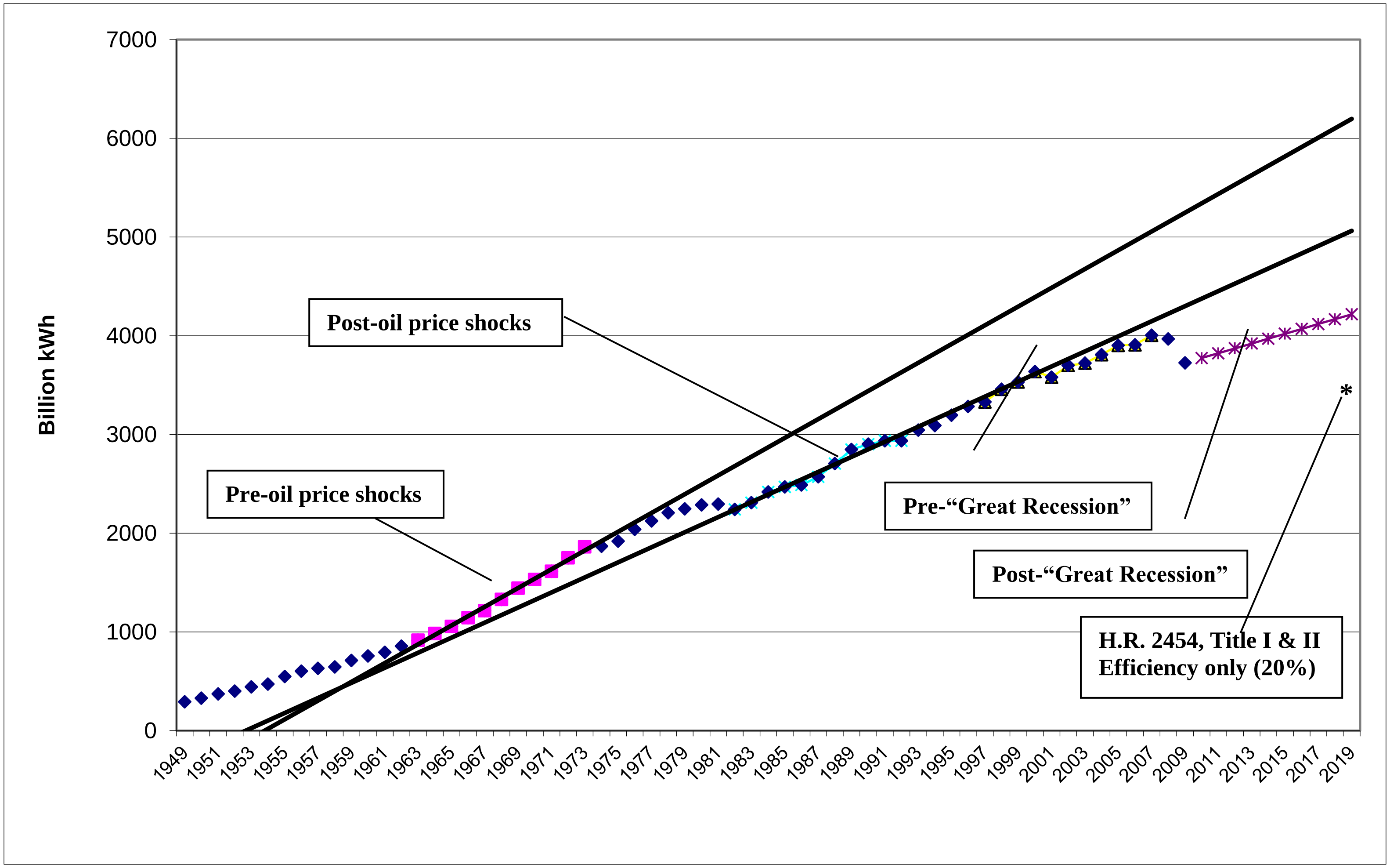
SOURCE: Mark Cooper, *All Risk, No Reward* (December 2009)

EXHIBIT 5: THREATS TO RATEPAYERS

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

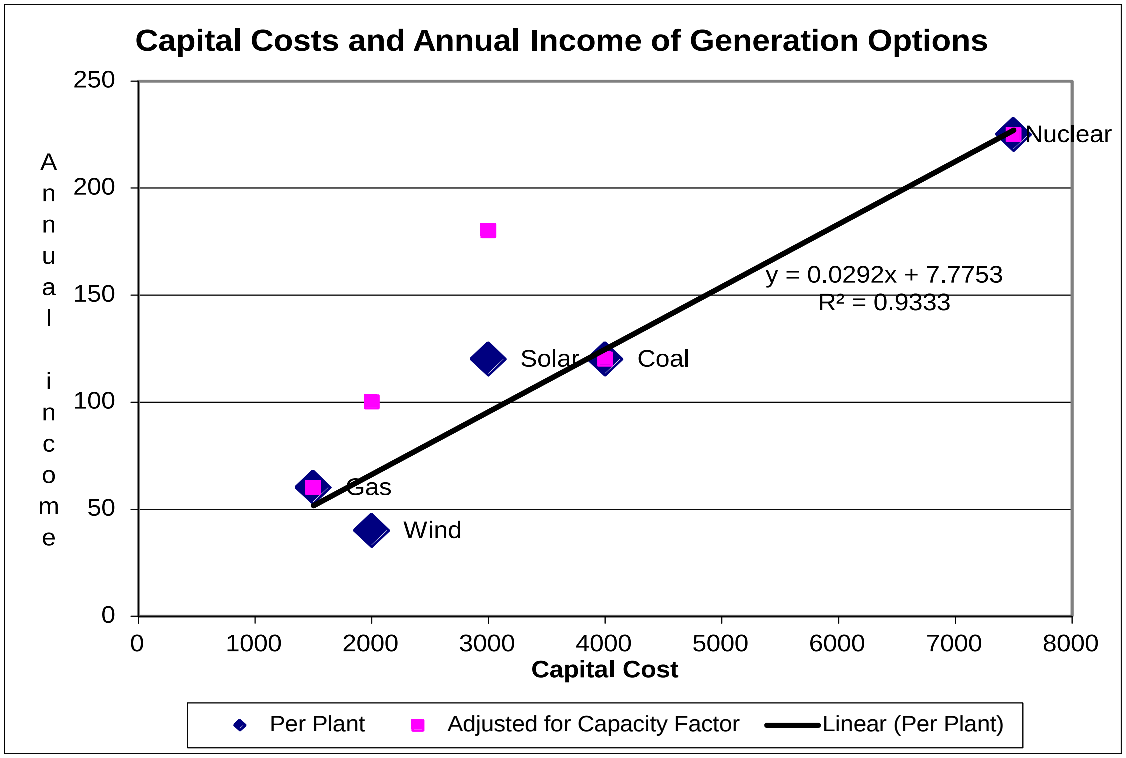
SOURCE: Mark Cooper, *All Risk, No Reward* (December 2009)

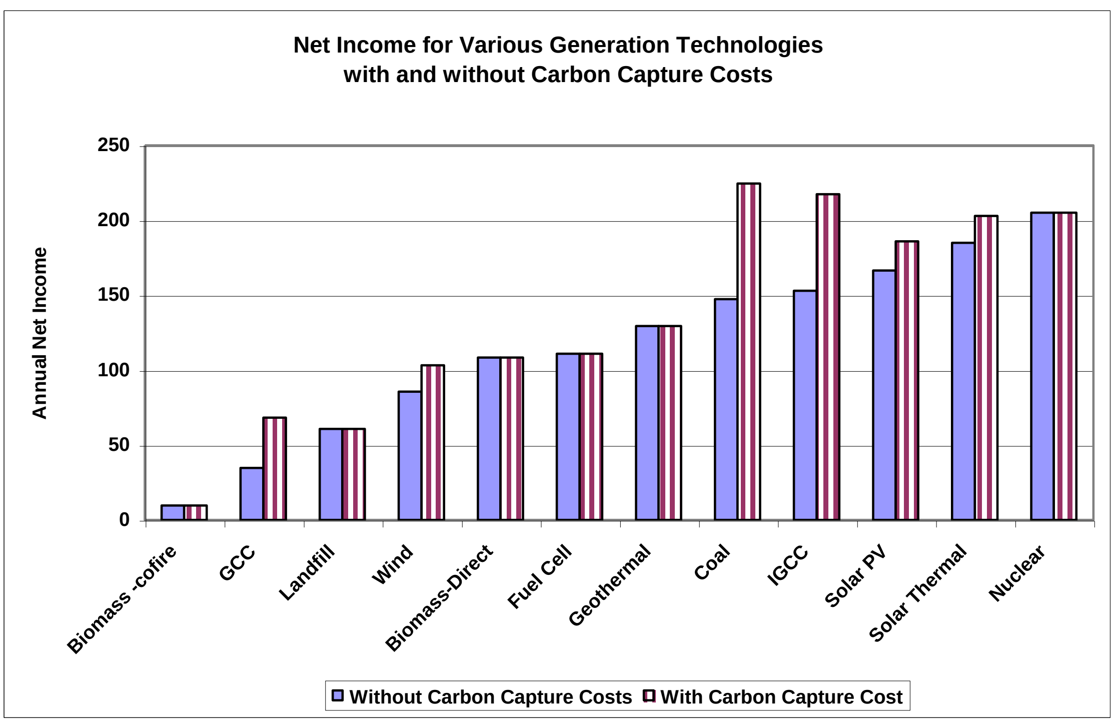
EXHIBIT 6: EXTERNAL SHOCKS AND PUBLIC POLICY SHIFT THE LEVEL AND GROWTH RATE OF ELECTRICITY DEMAND



SOURCE: Mark Cooper, *All Risk, No Reward* (December 2009)

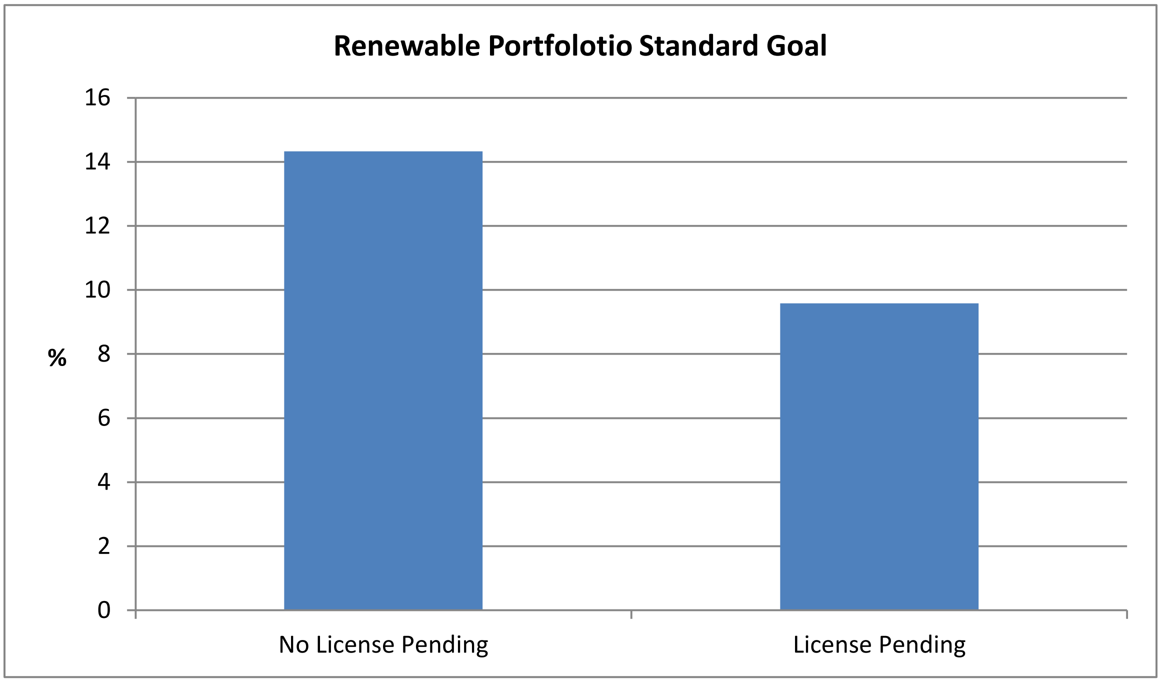
EXHIBIT 7: BUILDING THE RATE BASE PROVIDES THE KEY INCENTIVE TO FAVOR NUCLEAR INSTEAD OF LOWER COST OPTIONS

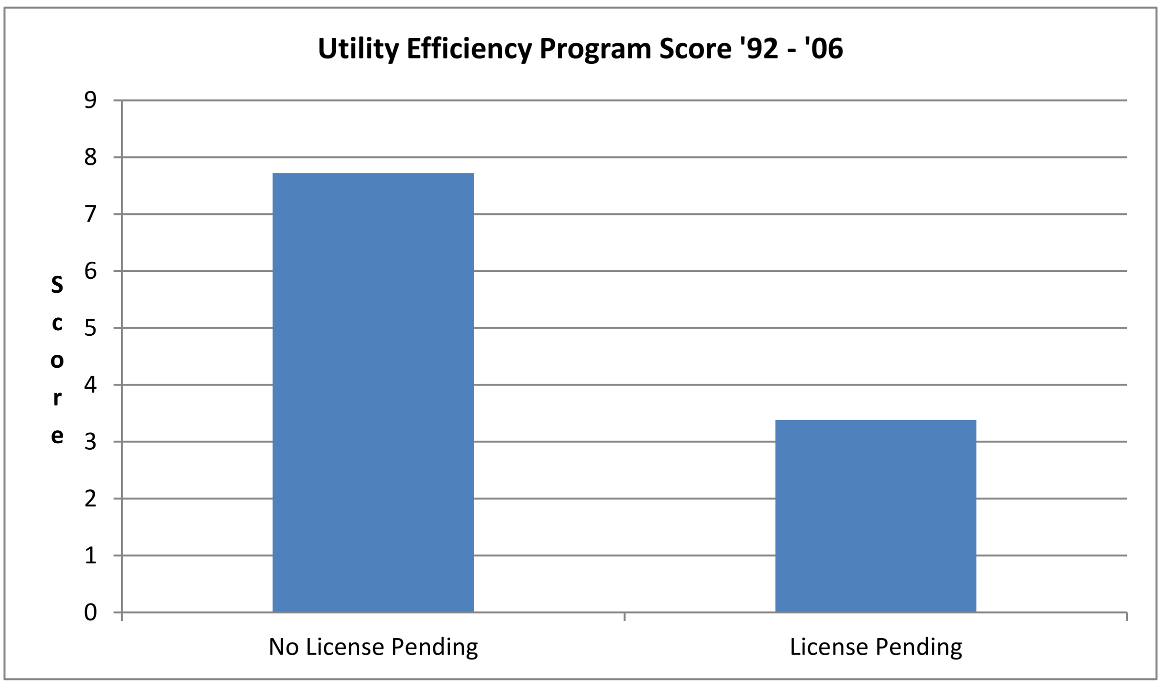




SOURCE: Mark Cooper, *A Consumer Analysis of Energy Efficiency and Renewable Energy Standard* *(May 2009)*

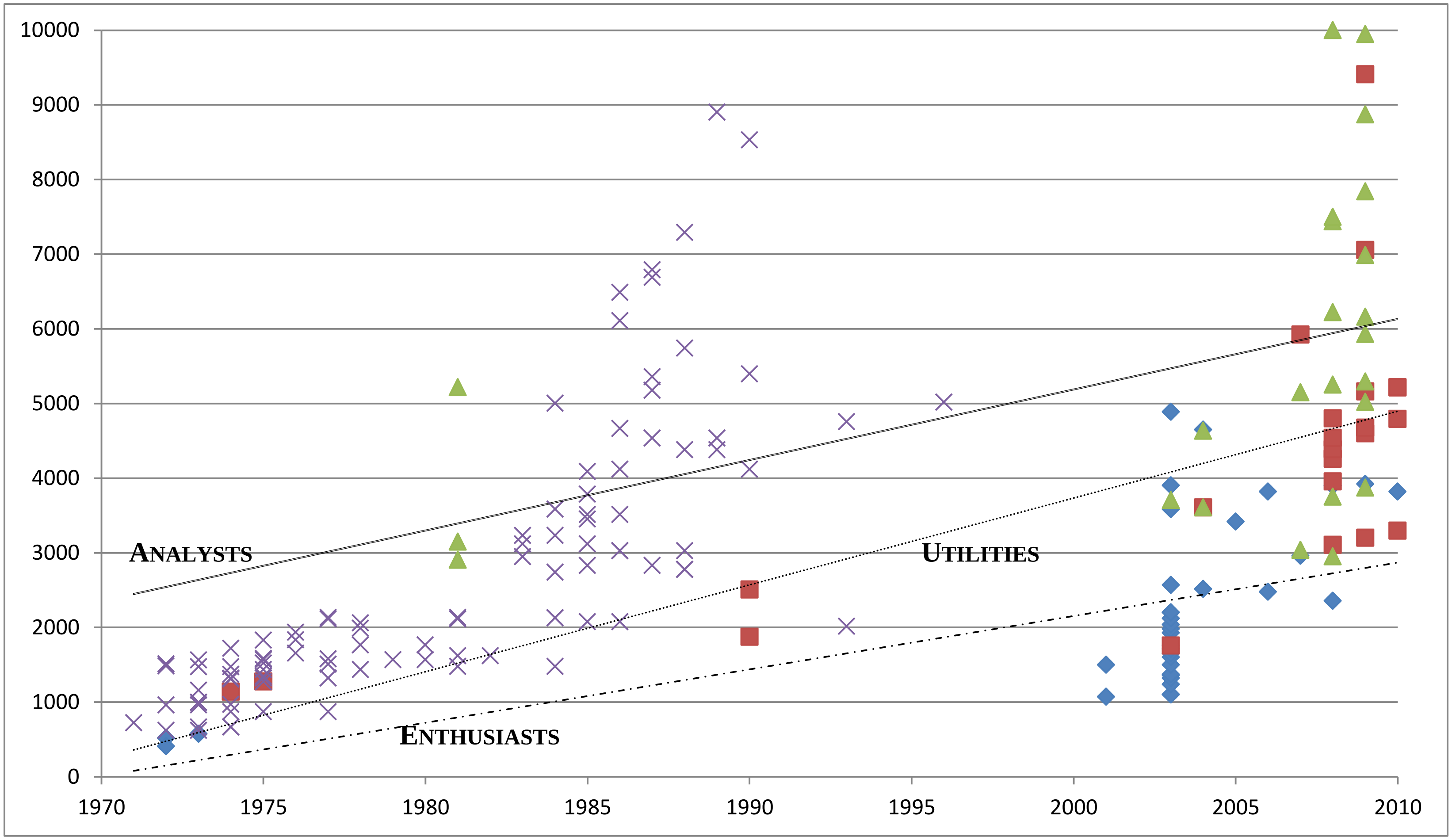
Exhibit 8: Testing the Crowding Out Hypothesis





SOURCE: Mark Cooper, ***Policy Challenges of Nuclear Reactor Construction: Cost Escalation and Crowding Out Alternatives: Lessons from the U.S. and France for the Effort to Revive the U.S. Industry with Loan Guarantees and Tax Subsidies*** **(September 2010)**

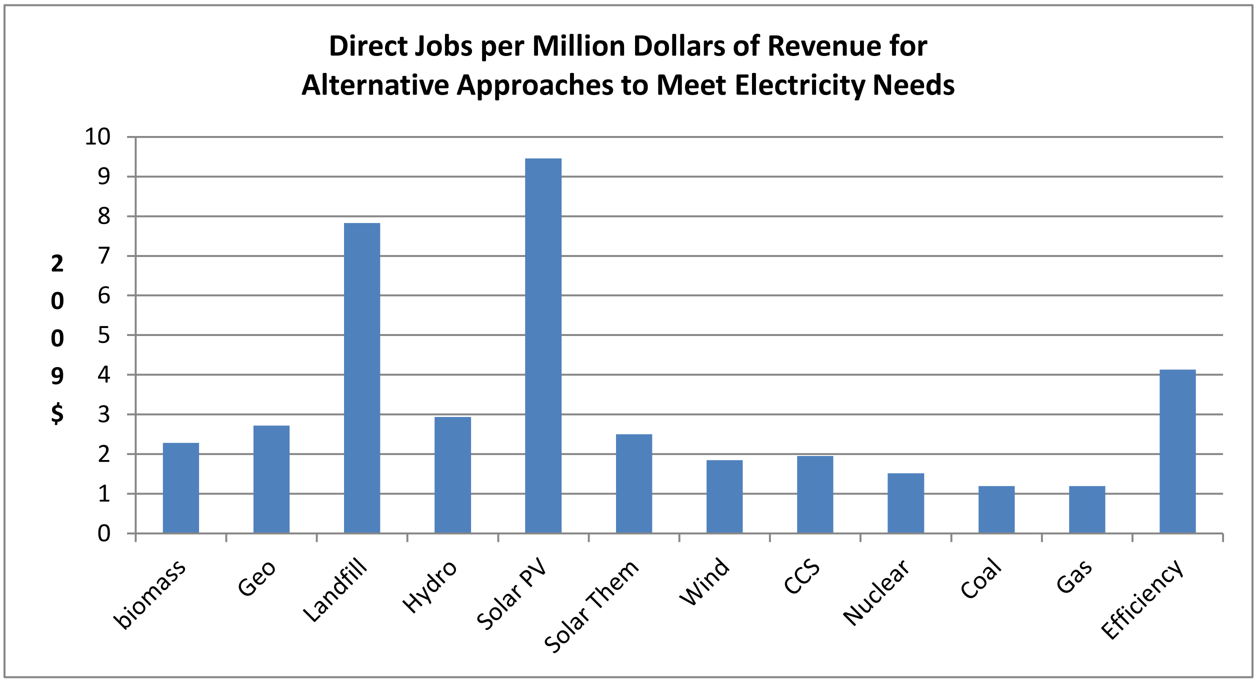
EXHIBIT 9: INITIAL COST PROJECTIONS FROM NUCLEAR ENTHUSIASTS VASTLY UNDERESTIMATE COSTS (OVERNIGHT CONSTRUCTION COSTS)

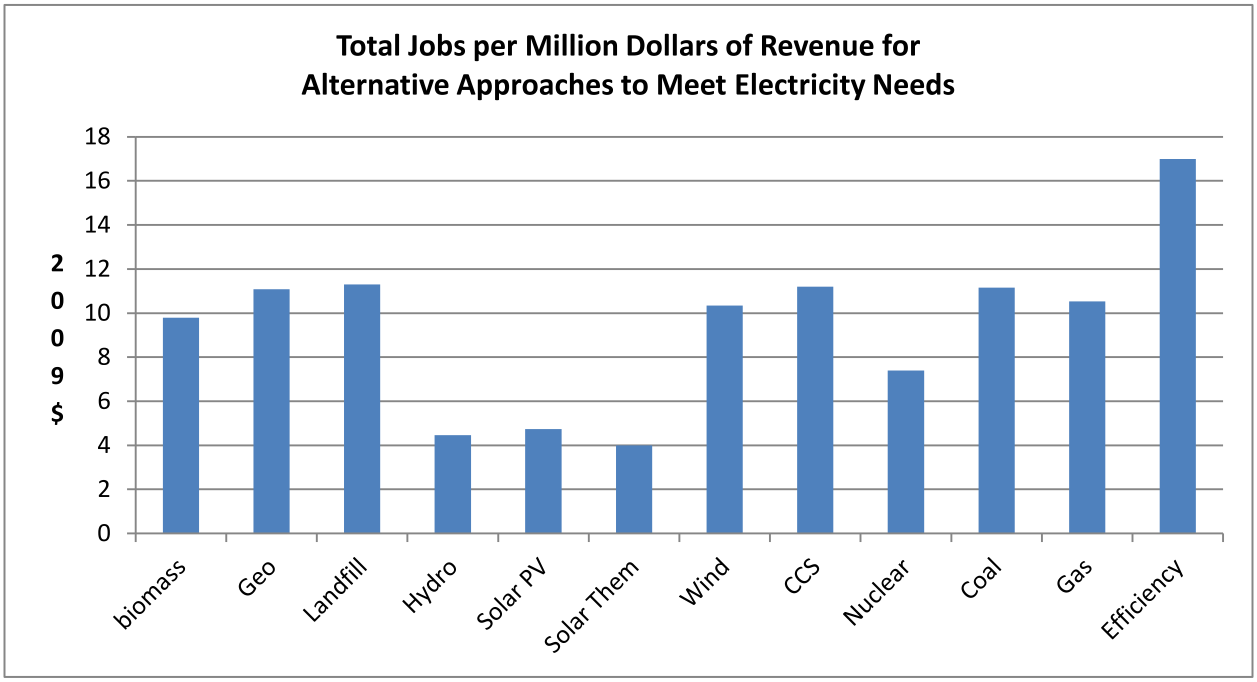


LEGEND: X = COMPLETE REACTORS; ▲ = ANALYSTS; ■ = UTILITIES; ◆ = ENTHUSIASTS

SOURCE: Mark Cooper, *The Economic Cost of Nuclear Reactors* (June 2009)

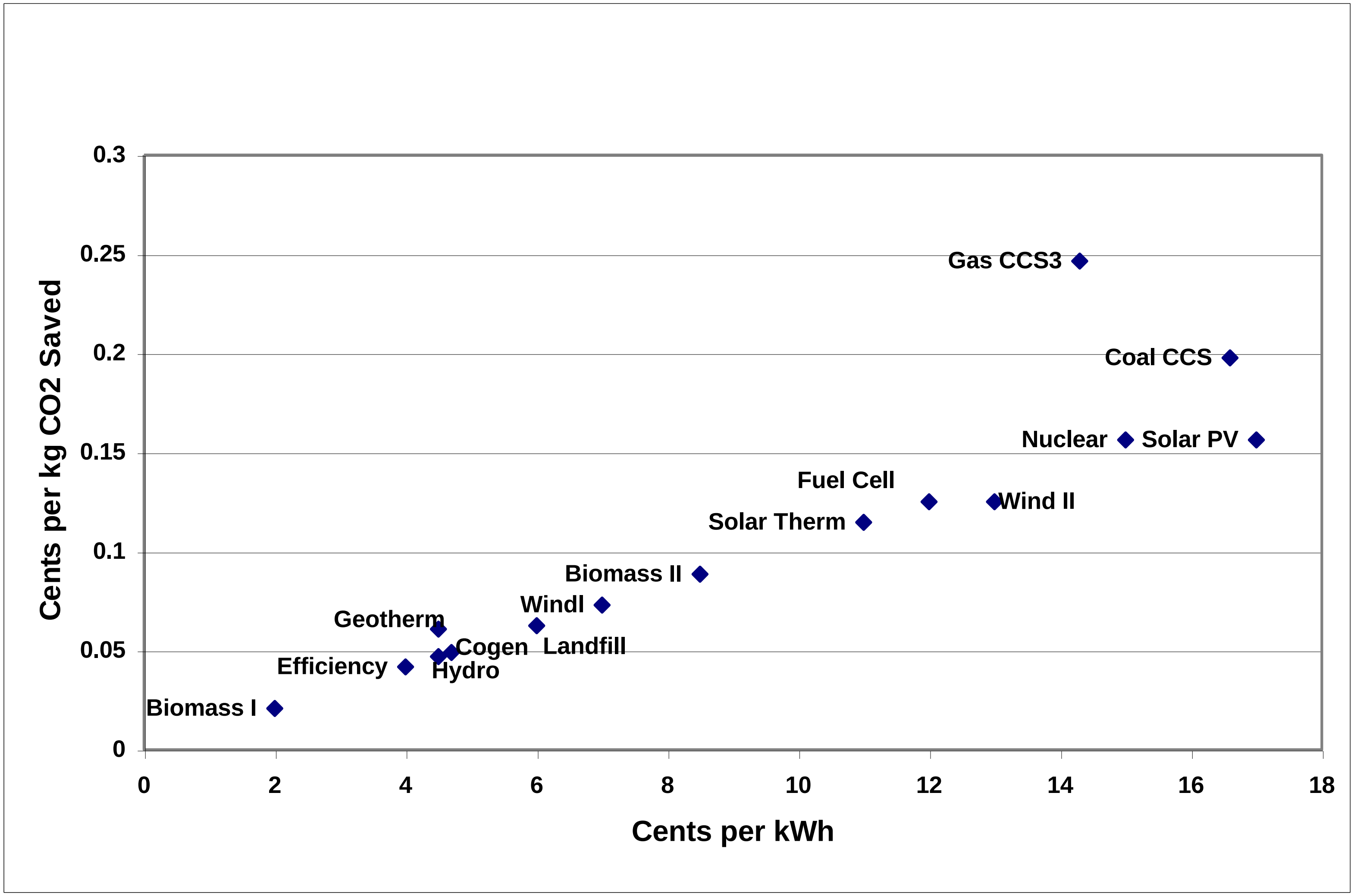
EXHIBIT 10: JOB CREATION BY ALTERNATIVE APPROACHES TO MEET ELECTRICITY NEEDS





Sources: Direct jobs: Max Wei, Shana Patadia and Daniel Kammen, :Putting Renewables and Energy Efficiency to work: How Many Jobs can the Clean energy Industry Generate in the US?", *Energy Policy,* 38(2010); Total Jobs: Rachel Gold, et al, *Appliance and Equipment Efficiency Standards: A Money Maker and Job Creator,* (American Council for an Energy-Efficient Economy, January 2010); Lazard, *Levilized Cost of Energy Analysis – Version 3.0,* June 2009.

EXHIBIT 10: THE ENERGY AND ENVIRONMENTAL COST EFFECTIVENESS OF ALTERNATIVE MEANS OF MEETING THE NEED FOR ELECTRICITY



SOURCE: Mark Cooper, *The Economic Cost of Nuclear Reactors* (June 2009)