PUBLIC RISK, PRIVATE PROFIT
RATEPAYER COST, UTILITY IMPRUDENCE

ADVANCED COST RECOVERY FOR REACTOR CONSTRUCTION CREATES ANOTHER NUCLEAR FIASCO, NOT A RENAISSANCE

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March 2013

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EXECUTIVE SUMMARY

In recent weeks, much attention has focused on the woes of the nuclear industry in Florida and the increasing number of delays and cost overruns associated with the Vogtle project in Georgia. This fragmented focus on nuclear power may create the impression that the industry's challenges vary widely and are localized to specific reactor sites. They are not.

This paper presents an economic analysis of the new nuclear reactors being built in the South East United States, specifically South Carolina and Florida, where advanced cost recovery statutes to subsidize nuclear reactor construction have been enacted. It shows that industry-wide problems have undermined the economics of two of the three projects – the Summer reactor project in South Carolina and the Levy reactor project in Florida. South Carolina is used as the focal point of the analysis for two reasons.

- The advanced cost recovery statute under which the nuclear project is being developed is South Carolina is typical of the few such statutes that have been enacted in recent years, primarily in the Southeastern U.S., but with expression of interest surfacing in state legislatures as far flung from the Deep South as Utah, Iowa, and Missouri.
- The South Carolina utility's projected construction costs are substantially below other estimates for new reactor construction; yet, the economics of the project are abysmal from the ratepayer point of view.

The economic harm that nuclear reactor construction imposes on ratepayers can be summarized as follows:

- Given the facts on the ground today, the utilities that rushed to sign engineering, production, and construction (EPC) contracts to build new nuclear reactor will impose billions of dollars of excessive costs on their ratepayers.

The exact amount will vary depending on the assumptions made about the construction costs, the discount rate (cost of capital), the projected cost of gas, and the cost and availability of other alternatives.

- The best estimate of the excess costs that will be borne by South Carolina ratepayers and the South Carolina economy is in the range of $10 billion.
- With future cost overruns and adjusting for the discount rate, the Levy reactors in Florida would have a similar level of impact.
- Other states implementing an advanced cost recovery statute today would likely face even larger excessive costs.

Time is of the essence in conducting prudence review of these massive construction projects since the statutes guarantee cost recovery and costs mount quickly. Although the estimated costs for reactors in the Southeast are in the range of $60-$70 billion today, less than $6 billion has been spent to date. The excessive costs of completing the reactors far exceed the sunk costs at present, which means they should be cancelled. However, as more and more is spent, under the perverse logic and incentives of advanced cost recovery those sunk costs become a burden that ratepayers will have to shoulder for decades.

The facts on the ground that have created this economic fiasco for ratepayers include:

- Nuclear cost overruns,
- Declining natural gas prices,
- The falling cost of other alternatives like wind and solar,
- Slowing demand growth; and
- Climate change policy that is emphasizing targeted incentives and performance standards for low carbon resources, rather than hefty carbon costs.

The critically important role of advanced cost recovery (sometimes called "construction work in progress" or CWIP) in creating the new nuclear fiasco is demonstrated by the behavior of utilities.

- All of the projects for which EPC contracts have been signed involve guaranteed advanced cost recovery.
- Three-quarters of the states where advanced cost recovery quickly saw an EPC contract signed.
- Not one of the projects proposed in a state without advanced costs recovery has moved to the EPC phase.

In other words, although projects in non-advanced cost recovery states constituted three quarters of the total projects proposed, all of the projects under an EPC contract are in advanced cost recovery states.

While the economic case against nuclear reactor construction was strong in 2008 when these EPC contracts were signed and the construction approved, a dramatic change in material conditions was evident by 2009-2010 and the reactors should have been cancelled. The primary reason that the reactor projects were proposed and allowed to continue far past any remote chance they would be economically justifiable is the fact that advance cost recovery for nuclear reactors shifts the risk of construction from stockholders to ratepayers.

- Utilities had a huge incentive to construct reactors that would dramatically expand their rate base with full, guaranteed return on investment and virtually no risk to stockholders.
- Guaranteed advanced cost recovery undermined the ability of public utility commission to protect ratepayers from excessive costs because it undercut the two most important principles of consumer protection in utility ratemaking – the requirements that facilities be used and useful before costs are recovered from ratepayers and that only just, reasonable and prudent costs be recovered.
- With neither stockholder risk nor utility commission oversight disciplining utility management behavior, imprudent decisions, including continuing expenditures on projects that are clearly uneconomic, are a virtual certainty.

Advance cost recovery destroys the consumer protection that lies at the heart of utility regulation, as a 2012 analysis prepared by the staff of the Iowa Utilities Board concluded. In a comprehensive assessment of a proposed advanced cost recovery statute in that state, which was ultimately rejected by legislators, the staff found the following problems with advanced cost recovery:

- Advanced cost recovery alters the most fundamental principle of rate-setting by shifting the risk of construction so dramatically that the resulting scheme of cost recovery virtually eliminates stockholder risk in the investment.
- Because nuclear reactors are so risky and impossible to finance in normal capital market, the utilities push for advanced and guaranteed recovery of all costs, but the certainty given to utilities denies regulators the flexibility that is needed in an uncertain and rapidly changing environment.
- Advanced cost recovery ties the hands of regulators in the effort to balance the interest of ratepayers and utility shareholders.
- By conferring a special advantage on nuclear, the utility regulatory decision making process is distorted and utilities get an incentive to choose investments and make construction decisions that benefit stockholders at the expense of ratepayers, which virtually ensures that less costly alternatives will be passed over.
- Beyond the initial choice of projects, shifting the risk of nuclear reactor construction creates an ongoing problem because it diminishes the utility's incentive to drive a hard bargain with vendors and joint owners to control costs.
- Having guaranteed utilities cost recovery on an annual basis, the regulator will be under greater pressure to approve "incremental" additions to cost even when those costs are the result of utility error.
- The acceleration of cost recovery creates severe intergenerational inequities, violating the fundamental principle that those who consume the output of a plant should bear its costs.

The economic analyses presented by utilities under the lax review of advanced cost recovery were marked by important flaws from the outset and, as the economics of continued construction have deteriorated, the flaws have been expanded and magnified.

- The analyses failed to consider future cost overruns, even though overruns occurred in the past and utilities continue to see significant risk of overruns in the future, while they refuse to shoulder any of the responsibility for cost overruns, past or future.
- They projected unrealistically high gas prices (especially including carbon costs) in the past and have not fully incorporated the much lower gas price trajectory that is widely recognized throughout the industry at present.
- They do not consider lower-cost, smaller scale low-carbon alternatives like efficiency, wind, and solar and the value that shorter lead times and small increments of capacity delivers to ratepayers.
- They do not fully reflect declining demand, the excess capacity that results from huge nuclear reactors and the value of flexibility in adding alternative supplies.
- They do not reflect the reality that it looks increasingly likely that climate policy will include much greater reliance on targeted incentives for low-carbon resources, above all mandates for efficiency and performance standards that reduce the need for new nuclear reactors.

Although the regulatory analysis inevitably focuses attention on the economic cost, which

makes it clear that new reactor construction wastes a great deal of money, there may be an even more important cost imposed on ratepayers and resource that is wasted.

- With the utility focused on building its rate base with a huge new reactor project, management has little interest in aggressively developing and may become hostile to alternatives.
- The greatest long-term harm inflicted as a result of the incentives that advanced cost recovery gives to utilities to pursue new nuclear reactors and the most valuable asset may be time to implement and develop more consumer-friendly, low carbon alternatives.

In a remarkably short period of time, the "nuclear renaissance" has suffered the same fate as the construction boom of the 1970s (that came to be known as the "Great Bandwagon Market"). The failure of nuclear economics is not just bad luck.

- Nuclear power is inherently uneconomic because it relies on a catastrophically dangerous resource that is vulnerable to human frailties and the vicissitudes of Mother Nature.
- The severe threats to public safety posed by nuclear power and the evolving demands of safety result in an extremely complex technology that requires long lead times and large sunk capital costs.
- The technology suffers constant cost escalation and does not exhibit cost reducing processes that are observed in other industries.

Therefore, any nation that claims to have the wherewithal (technical expertise and economic resources) to build a "safe" nuclear reactor will have the wherewithal to meet its needs for electricity with alternatives that are less costly and less risky. Thus, at present and for the foreseeable future, it is a virtual certainty that nuclear power is not going to be the least cost option or close to it, even in a low carbon utility sector. Providing powerful incentives to pursue economically uneconomic projects will inevitably saddle ratepayers and economy of any state that enacts advanced cost recovery laws with tens of billions of unnecessary costs.

I. INTRODUCTION

A. ADVANCED RECOVERY, RATEPAYER RISK AND UTILITY IMPRUDENCE

This paper is primarily based on testimony[1] and other documents placed in the record of the recent review of the South Carolina Electricity and Gas (SCE&G) request for recovery of a $283 million cost overrun on the Summer 2 & 3 nuclear reactor construction project. The reactors are being constructed under South Carolina's Base Load Review Act (BLRA), which allows guaranteed, advanced recovery of costs from ratepayers.[2] It is one of only three such state statutes under which advanced costs for nuclear reactor construction are being recovered in the U.S. at present.[3]

The testimony presented evidence that the cost of electricity for SCE&G's ratepayers would be billions of dollars lower over the next forty years if the construction of Summer units 2 & 3 is stopped and SCE&G meets the need for electricity with less costly alternatives. It urged the South Carolina Public Service Commission (SCPSC or the Commission) to require SCE&G to present a complete and comprehensive review of the economic reasonableness and prudence of continuing with the construction of the new reactors in comparison to the full range of alternatives available.

Across the Southeast utilities are recovering costs for nuclear projects whose "overnight"[4] construction costs are now projected to be in the range of $60 to $70 billion, if they are completed.[5] The revenue requirement created by these projects will be tens of billions of dollars above the costs of alternatives.[6] Lowering the cost of electricity by billions of dollars in South Carolina would be a major accomplishment, but the implications of the South Carolina proceeding could reach far beyond the borders of South Carolina.

The paper also reviews recent regulatory and legal proceedings in the case of the Levy reactors in Florida.[7] It shows that the evidence leads to the same conclusion.

Due to the high cost and risk of nuclear reactor construction, shifting the risk to ratepayers with advanced cost recovery is the only way reactors will be built in the U.S. and the nuclear industry

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[1] Mark N. Cooper, "Direct Testimony, Surrebuttal and Additional Testimony on Behalf of the Sierra Club," *Petition of South Carolina Electric &Gas Company for Updates and Revisions to Schedules Related to the Construction of a Nuclear Base Load Generation Facility at Jenkinsville, South Carolina,* Docket No. 2012-203-E

[2] South Carolina Code of Law, Chapter 33, Article 4. Base Load Review Act Section 58-333-210, May 2, 2007.

[3] The other two states are Georgia and Florida. North Carolina has an advanced cost recovery statute, but costs are not being recovered from ratepayers through early 2013.

[4] Overnight cost is the cost of a construction project if no interest was incurred during construction, as if the project was completed "overnight." An alternate definition is: the present value cost that would have to be paid as a lump sum up front to completely pay for a construction project. http://en.wikipedia.org/wiki/Overnight_cost

[5] The cost estimates for the reactors for which revenues are being collected under advanced cost recovery statutes by investor owned utilities are Summer 2 & 3, $10.4 billion, Vogtle $14.5 - $18.2 billion; Levy, $15.1 to $21.6 billion, Turkey point $12.8 to $18.7 billion; with TVA's Watts Barr costs put at $4.5 billion.

[6] The Summer (SCE&G/SCANA), Vogtle (Georgia Power/Southern company) and Levy (Progress recently acquired by Duke) and Turkey Point (FPL) projects are typical investor owned undertakings subject to regulatory oversight, as amended by recent advanced cost recovery legislation. Watt Bar is a TVA project which is a publicly owned entity not subject to regulatory over sight. It is also being pursued as a continuation of a previously existing project.

[7] Direct Testimony of Dr. Mark Cooper on behalf of the Southern Alliance for Clean Energy, In re: Nuclear Plant Cost Recovery Clause, before the Florida Public Service Commission Docket no. 090009-EI, July 15, 2009; Direct Testimony of Dr. Mark Cooper on Behalf of Southern Alliance For Clean Energy (SACE), In Re: Nuclear Plant Cost Recovery Clause, Before The Florida Public Service Commission, Docket No. 100009-Ei, Filed: July 8, 2010.

is constantly pushing state policymakers to authorize it. The severe harm that advanced cost recovery will impose on South Carolina ratepayers is a strong signal to other states not to go down this path. Building on the real world impact of advanced cost recovery in South Carolina and Florida, this paper offer a cautionary warning to other states to reject this approach. It demonstrates that the "nuclear renaissance" never got off the ground in the United States because the cost of power from nuclear reactors is substantially higher than other low carbon alternatives available. The paper also demonstrates that the primary cause of the economic fiasco is the decision to encourage nuclear construction with guaranteed advanced cost recovery because it undermines the normal consumer protections afforded to utility consumers and inevitably exposes ratepayers to bearing the burden of excess nuclear power costs.

B. IMPRUDENCE AND THE COLLAPSE OF THE "NUCLEAR RENAISSANCE"

Ultimately, this paper is about prudent decision-making in a circumstance where consumers do not enjoy the benefits and protection of vigorous competition for the delivery of electricity service. The prudence standard requires reasonable decisions based on what is or should be known at the moment of decision-making. As knowledge changes, decisions must be revisited, not to look backward at what was prudently decided yesterday, but to look forward to ensure that the path chosen is prudent today.

Prudence in the marketplace is a potent and vigilant disciplinary force that requires constant evaluation of projects. When things change, prudent managers and investors subject to market discipline take notice and reevaluate their plans or adjust their portfolios in light of the new knowledge. The application of this principle in utility regulation is straightforward. In the regulatory arena prudence review must be ongoing, particularly when outcomes are uncertain or large changes happen quickly. The commission continues to have the responsibility and duty of ensuring that the costs of the project that have not been spent, the "going forward" or "to go costs" are prudent.

Some stakeholder blame bad management for the problem, but this misrepresents the fundamental situation.[8] While it is certainly true that bad management contributed to the problem and better management would have performed better, management is not the only or even the primary problem. The underlying problem is bad incentives interacting with a technology that simply cannot deliver on its promises. Perfect management might have avoided the reactors in the first place or, having chosen to build a reactor, quickly realized that the prospects for success had become so small that the project should be abandoned. But, when advanced cost recovery shifts the risk of construction to ratepayers and guarantees cost recovery for stockholders, utility management has a powerful incentive to move the project forward at all costs. Commissions have not been able to address the problem because a huge construction project gains momentum that is difficult to reverse and the legal tools necessary to do so have been weakened by advanced cost recovery statutes. The failure of utility management to behave prudently and the inability of regulatory commissions to protect the public from massive cost overruns is the inevitable result of a flawed policy – advanced cost recovery – not bad management.

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[8] Jim Warren, *Costly Incompetence: The top four U.S. nuclear construction projects are already mired in costly problems*, NC WARN, June 24, 2012.
http://www.southeastgreen.com/index.php/news/southeast/6321-costly-incompetence-the-top-four-us-nuclear-construction-projects-are-already-mired-in-costly-problems

C. WHY STUDY SOUTH CAROLINA

The analysis focuses on South Carolina for several reasons. First, SCE&G claims construction costs for its nuclear reactors that are substantially below the figures that have been put forward by other utilities and analysts -- with others estimating the construction costs to be 25% to 80% higher. Yet, even with this low estimate, the cost of power from the Summer 2 & 3 reactors will be substantially higher than other options that are available, like efficiency, cogeneration, gas, and some renewable sources. The prospects for ratepayers in the other states where reactor costs are being recovered under advanced cost recovery statues (i.e. Georgia and Florida) are even worse. Cost overruns in Georgia are likely to be more than those in South Carolina. The reactors in Florida are projected to cost much more than those in Georgia and there is a high likelihood that billions will be spent without any real prospect of reactors being completed.

Second, the South Carolina Base Load Review Act is fairly typical of advanced cost recovery statutes. Its impact on utility management decision-making, regulatory oversight and ultimately on ratepayers is indicative of what can happen under such laws. The South Carolina Base Load Review Act is an example of legislation that alters the principles of consumer protection at the heart of utility regulation by guaranteeing the utility advanced recovery of costs for nuclear reactor construction. Advanced cost recovery is the main cause of the unfolding nuclear economic fiasco.

- Three-quarters of the projects proposed as part of the "nuclear renaissance" were put forward in states without advanced costs recovery, but not one of those projects advanced to the stage of signing an engineering, procurement, and construction (EPC) contract and not one of those projects is moving forward today.
- On the other hand, all three of the projects that have moved to the EPC stage are in states with advanced cost recovery.
- In only one state with an advanced cost recovery statute in place are ratepayers not being charged for new nuclear reactor construction costs because the utility in that state wants a sweeter deal.[9]

Third, the recent cost overrun proceeding in South Carolina provided the opportunity to acquire key data sets and explore important issues in a typical quasi-judicial regulatory review, subject to discovery and cross examination. To some extent, the veil of secrecy that has been used to shroud the costs and risk of nuclear reactor construction at the federal and state levels, secrecy that adds insult to injury when ratepayers and taxpayers are bearing the bulk of the risk of these projects,[10] was lifted slightly.

Fourth, the circumstances in South Carolina highlight the need for constant vigilance in

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[9] Bruce Henderson, Advocates plan fight over nuke plant bill: Consumer, environmental and anti-nuclear advocates said Monday they will fight proposed state legislation allowing Duke Energy to more easily pass costs of a new nuclear plant on to N.C. customers, May 15, 2012, http://www.charlotteobserver.com/2012/05/15/3239817/advocates-vow-to-fight-nuke-costs.html

[10] Mark Clayton, "Georgia nuclear power plant could be Solyndra redux, report says, *Christian Science Monitor,* January 30, 2013, reflects years of Freedom of Information Act Requests and litigation to secure access to documents http://www.csmonitor.com/Environment/2013/0130/Georgia-nuclear-power-plant-could-be-Solyndra-redux-report-says?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+feeds%2Fenvironment+%28Christian+Science+Monitor+|+Environment%29; At the state level, the EPC contracts "are being kept secret." Jim Warren, Costly Incompetence:

prudence review and the important ways in which advanced cost recovery undermines consumer protection.

While a very small number of states have enacted advanced cost recovery, utilities tend to mimic one another in their push for legislation that favors the technologies they prefer. Duke, which pushed through a weaker form of the Base Load Review Act in North Carolina and now owns the troubled Levy reactors in Florida, has said it needs more concessions to build a new reactor to serve ratepayers in North Carolina[11] Florida's weak form of prudence review for nuclear reactors, labeled "economic feasibility," is being challenged as unconstitutionally vague.[12] Advanced cost recovery has been proposed repeatedly in several other states, like Iowa and Missouri, although those efforts have not been successful.[13] The difficulties and excess costs that are mounting in every one of the states that has allowed the expenditure of funds under advanced cost recovery and the pervasive problems that have derailed the "nuclear renaissance" should be a loud, cautionary alarm signal for other states to avoid advanced cost recovery because it undermines the key elements of consumer protection in utility regulation and inevitably hurts consumers and is not in the public interests.

Finally, South Carolina underscores that time is of the essence in conducting prudence reviews of these massive construction projects, since the statutes guarantee cost recovery and costs mount quickly. Although the projected costs in the South East are in the range of $60-$70 billion, less than $6 billion has been spent to date. The excessive costs of completing the reactors far exceed the sunk costs at present, which means they should be abandoned. However, as more and more is spent under the perverse logic and incentives of advanced cost recovery, those sunk costs become a burden that ratepayers will have to shoulder for decades, regardless of the choice of generation resources.

The analysis also shows that the factors that have affected reactor construction in South Carolina and each and every conclusion reached about the Summer project also apply to the Levy reactor construction project in Florida.

D. OUTLINE

The analysis begins in Section II with an overview of the context in which the decisions to commence and continue the construction of reactors were made. It begins by recounting the rapid deterioration of the circumstances of nuclear reactor construction in the Southeast and the nation. It then compares the failure of the "nuclear renaissance" to the developments of the nuclear sector during the 1970s and 1980s. This is the context in which the decision to commence and continue construction must be placed. Because prudence review is about what management knew and when it knew it (or should have), the context is of extreme importance.

Section III describes the impact of advanced cost recovery on consumer protection in the regulated utility context. It shows that the flawed incentives provided by advanced cost recovery led to action by utilities that place ratepayers at risk and that weakened oversight reduces the ability of regulators to protect consumers from excessive costs.

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[11] Bruce Henderson, 2012.
[12] Bruce Ritchie, "Justices hammer group challenging nuclear cost recovery law," *The Florida Current,* October 10, 2012.
[13]See the Appendix to Section II; A; http://www.psr.org/nuclear-bailout/resources/the-renaissance-that-wasnt.pdf

The economic analysis is divided into two sections. Section IV discusses the resource costs of nuclear and alternatives, focusing first on natural gas, which was the primary alternative identified by the company. To compensate for the company's failure to consider other alternatives, costs for a dozen resources prepared by half a dozen different analysts are also examined, as are various aspects of cost comparisons and cost trends. The section also considers the impact of slowing demand growth on the decision making process and the value of the full range of alternatives available, These are the factors that directly affected the comparative economics of nuclear reactor construction in the first decade of the 21st century. They constitute the knowledge that decision makers must use in reaching prudent decisions.[14]

Section V examines the role of climate policy, especially carbon and sunk costs in the analysis. These are key policy factors that affect the relative economics of nuclear reactor construction compared to the alternatives. It turns out that, in spite of dubious assumptions about high gas costs and low nuclear costs (to name just two), the assumption that a substantial carbon cost would be levied was the factor that tipped the economic analysis in favor of nuclear. Section V shows that it was a mistake to allow the price of carbon to play such a large role in the analysis, especially when all of the low carbon options were not considered. Section V also looks at the role of sunk costs and shows that even with $2.5 billion sunk, it would still be to the benefit of South Carolina ratepayers to cancel the project. This underscores the obvious importance for states that have not adopted advanced cost recovery to refuse to do so and avoid the sinking of billions of dollars into nuclear reactors to protect their ratepayers.

Section VI examines the Levy reactor project in Florida. It shows that the analysis and conclusion reached for the Summer reactor project in South Carolina apply to Levy in Florida. The Levy case adds significant depth to the qualitative understanding of the harm that advanced cost recovery does to consumer protection mechanisms. It shows that even under assumptions that are much more favorable to nuclear reaction construction, building new reactors imposes billions of dollars of excess costs on ratepayers.

[14] Prudence requires both recognition of the facts on the ground and a decision making framework that carefully weighs and organizes the facts. The latter is described in Cooper, Mark, 2011, *Least-Cost Planning For 21st Century Electricity Supply Meeting the Challenges of Complexity and Ambiguity in Decision Making,* Mid-America Regulatory Utility Conference, June 5, 2011 and "Prudent Resource Acquisition in a Complex Decision Making Environment: Multidimensional Analysis Highlights the Superiority of Efficiency," *Current Approaches to Integrated Resource Planning, 2011 ACEEE National Conference on Energy Efficiency as a Resource*, Denver, September 26, 2011.

II. THE RUSH TO BUILD REACTORS

A. THE COLLAPSE OF THE "NUCLEAR RENAISSANCE"

After the Federal government offered large subsidies for nuclear power in 2005 and the Base Load Review Act gave nuclear reactors a long list of special benefits in South Carolina in 2007, in 2008 SCE&G rushed to sign a contract to build new nuclear reactors, filed a license application at the Nuclear Regulatory Commission (NRC) and sought advanced cost recovery at the SCPSC. It argued that the "nuclear renaissance" would result in a rush of orders for new reactors across the country that would drive the cost up as demand increased,[15] so ratepayers would save money if it moved quickly to sign an EPC contract.

Contrary to that assumption (and just about every other assumption SCE&G made in justifying the construction of new reactors in South Carolina), the "nuclear renaissance" fizzled. Several factors are behind the collapse of the "nuclear renaissance," many of which occurred in South Carolina and the other states in the South East. The factors that have undermined the "nuclear renaissance" are summarized in Table II-1.

- Designs were not ready and had to undergo numerous revisions.
- At each step of the initial construction, problems were encountered.
- Design and construction problems resulted in severe slippage of schedules at all the reactors for which revenues were being collected under advanced cost recovery statutes.
- As a result of all of the above, projected costs increased.
- Marketplace and regulatory factors also undermined the economics of nuclear reactor construction.
- Sources of subsidized funding beyond advanced cost recovery proved difficult to obtain.

In light of these dramatic changes in material conditions, the companies that had not signed EPC contracts scaled back or abandoned their plans. The companies that had rushed to sign contracts were stuck with costly overpriced projects that likely would have been cancelled quickly if stockholder funds were at risk.

This list of factors that affected the Southeast projects with EPC contracts is part and parcel of a broader narrative of the collapse of nuclear renaissance, as shown in Appendix A. This steady drumbeat of failure of the "nuclear renaissance" is the context in which the refusal of the utility to conduct a careful prudence review must be placed. It is also the context in which states that are being pressured by utilities to grant advanced costs recovery should consider the dangers of undermining the fundamental consumer protections of their utility statutes.

[15] Direct Testimony of Stephen A. Byrne on Behalf of South Carolina Electric & Gas, Docket No. 20008-196-E, Exhibit J: Risk Factors Related to Construction and Operation of the Facility; also attached to Mr. Byrnes Rebuttal Testimony in Docket No. 2012-203-E.

TABLE I-1: FACTORS THAT UNDERMINED THE "NUCLEAR RENAISSANCE"

Designs were not ready and had to undergo numerous revisions.

Contracts were signed on the basis of the 15th design revision for the AP-1000, with the 16th pending, but it took several years and the 19th revision to get the design approved. (1)
The initial reference plant was dropped. (2)

The hope that multiple utilities would share the burden of getting the design to the finish line evaporated as the vast majority of utilities that were contemplating building nuclear reactors realized that nuclear construction was not economic and cancelled their projects. (3)

At each step of the initial construction, problems were encountered:

Site specific problems like excavation, (4) initial concrete pour. (5)

Component quality problems, (6) transportation of major components to the construction site, (7)

Procurement and training problems arose, (8) problems that had been predicted given the lack of a well-developed supply chain in the U.S. or globally, (9) and

Lack of a fully integrated project schedule, incorrect construction techniques and faulty quality assurance paperwork. (10)

As a result of the above problems, there was severe slippage of schedules at all the reactors for which revenues were being collected under advanced cost recovery statutes.

Summer, (11),Vogtle, (12) Levy, (13) Turkey Point(14)

Within a couple of months of the issuance of the license, the utilities that were moving ahead aggressively with construction were already haggling with the vendors over cost overruns, including a court case. (15)

As a result of all of the above, projected costs increased.

The projected increases in construction costs for the three EPC contracts that were signed ranged from half a billion to as much as six billion, even though fairly small percentages of total costs have been incurred to date (ranging from 4% to about 20%). (16)

Marketplace and regulatory factors also undermined the economics of nuclear reactor construction.

The price of natural gas plummeted. (17)

The cost of alternatives, like wind and solar also dropped. (18)

Demand growth slowed dramatically. (19)

Climate change policy proceeded with targeted incentives, (20) standards, and technology specific mandates, rather than a big carbon costs. (21)

Sources of subsidized funding proved difficult to obtain.

Federal loan guarantees became a focal point of attention, which made negotiation of terms more difficult, because the Federal government felt compelled to build in at least minimal protections for taxpayers. (22)

Public power partners reduced their commitments to or backed out of nuclear construction projects, demonstrating the lack of a market for expensive nuclear power. (23)

Sources of subsidized funding proved difficult to obtain.

Public power backs out. (23)

Florida utilities shift to "option" mode. (24)

EPC suspended. (24)

Sources and Notes:

[1] The 15th revision of the AP1000 design was accepted by the NRC and the 19th was finally approved. Between these two actions, every revision became the basis for utilities moving ahead with advanced cost recovery – revision 15 (Levy County Units 1 and 2); Revision 17 (Turkey Point Units 6 and 7); Revision 18 (Vogtle Units 3 and 4 and Summer Units 2 and 3). The revision after the EPC contracts were signed reflected concerns about the shield building and other issues. World Nuclear News, More shield work on AP1000, 16 October 2009, http://www.world-nuclear-news.org/RS_More_shield_work_on_AP1000_1610091.html, World Nuclear

News, Westinghouse could suffer a setback in plans to deploy its AP1000 reactor after US regulators required more work on the shield building. http://www.world-nuclearr ews.org/RS_More_shield_work_on_AP1000_1610091.html; Nuclear Engineering International News AP1000 shield building made 'regulatory issue' in UK, 16 February 2010 http://www.neimagazine.com/story.asp?storyCode=2055489, Nuclear Engineering International, AP1000 containment insufficient for DBA, engineer claims, 29 April 2010, http://www.neimagazine.com/story.asp?storyCode=2056229, ; Simon Lomax, Toshiba Design Questions May Slow U.S. Regulator's Nuclear Plant Approvals, Bloomberg, May 20, 2011 http://www.bloomberg.com/news/2011-05-21/toshiba-design-questions-may-slow-u-s-regulator-s-nuclear-plant-approvals.html, NRC Holds Up Westinghouse AP1000 Design Certification, Citing New Technical Issues, May 25, 2011, http://www.powermag.com/POWERnews/3751.html; Matthew l. Wald, Regulators Find Design Flaws in New Reactors May 20, 2011 , http://www.nytimes.com/2011/05/21/business/energy-environment/21nuke.html?pagewanted=all&_r=0; Direct Testimony And Exhibits Of William R. Jacobs, Jr., Phd. On Behalf Of The Georgia Public Service Commission Public Interest Advocacy Staff, Before The Georgia Public Service Commission, *In The Matter Of: Georgia Power Company's Seventh Semi-Annual Vogtle Construction Monitoring Report,* Docket No.: 29849, December 7, 2012, http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=145142

[2] NuStart COL Project - NRC Project No. 740, Transition of AP1000 Reference Plant COL Application, April 28, 2009, http://pbadupws.nrc.gov/docs/ML0912/ML091210083.pdf

[3] The owners group was scuttled when Westinghouse refused to let utilities that had not signed EPC contracts participate in the development of the design. By kicking them out of the group, Westinghouse raised the cost of the reactors to the remaining utilities, which increased the burden on the ratepayers of those utilities (See Cooper Testimony, 2012).

[4] Backfill: Kristi E. Swartz, "Utilities sue vendors in dispute at Vogtle," Atlanta *Journal Constitution*, August 27, 2012, http://www.ajc.com/news/business/utilities-sue-vendors-in-dispute-at-vogtle/nRMTK/; Bed rock: SCANA Corporation. "South Carolina Electric & Gas Company Reaches Preliminary Agreement on Negotiated Nuclear Costs." 29 March 2012.

[5] Direct Testimony And Exhibits Of William R. Jacobs, Jr., Phd. On Behalf Of The Georgia Public Service Commission Public Interest Advocacy Staff, Before The Georgia Public Service Commission, *In The Matter Of: Georgia Power Company's Seventh Semi-Annual Vogtle Construction Monitoring Report,* Docket No.: 29849, December 7, 2012, http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=145142; Mud Mat: Rob Pavey, "Vogtle expansion sits under microscope," *Augusta Chronicle*, May 5, 2012 5:47 PM http://chronicle.augusta.com/latest-news/2012-05-05/vogtle-expansion-sits-under-microscope Southern Nuclear Operating Company. Electric Generating Plant Units 3 and 4 License Amendment Request Planning Information. 23 March 2012; ; Roddie Burris, Slowdown at V.C. Summer nuclear plant brings layoffs, *The State,* Jan. 25, 2013, http://www.thestate.com/2013/01/25/2603871/slowdown-at-vc-summer-nuclear.html

[6] Direct Testimony And Exhibits Of William R. Jacobs, Jr., Phd. On Behalf Of The Georgia Public Service Commission Public Interest Advocacy Staff, Before The Georgia Public Service Commission, *In The Matter Of: Georgia Power Company's Seventh Semi-Annual Vogtle Construction Monitoring Report,* Docket No.: 29849, December 7, 2012, http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=145142; Rebar: Pavey, Rob. "NRC says Vogtle rebar differs from approved design." *The Augusta Chronicle*. 26 April 2012. http://chronicle.augusta.com/news/government/2012-04-26/nrc-says-vogtle-rebar-differs-approved-design; Faulty Modules: United States Nuclear Regulatory Commission. Inspection Report No. 99901401/2011-202 and Notice of Nonconformance; Steel Plates": Rob Pavey, "Steel plates sent to Plant Vogtle fail NRC inspections," *The Augusta Chronicle*. Thursday, Sept. 20, 2012;,http://chronicle.augusta.com/news/metro/2012-09-20/steel-plates-sent-plant-vogtle-fail-nrc-inspections

[7] Thomas Clements "Vogtle Nuclear Reactor Still Stranded in Savannah; Pouring of "Nuclear Concrete" for Reactor's Basemat Delayed Yet Again as Embarrassment and Costs Mount," Aiken Leader, Jan 22, 2013, http://aikenleader.villagesoup.com/p/vogtle-nuclear-reactor-still-stranded-in-savannah-pouring-of-nuclear-concrete-for-reactor-s-basema/951066

[8] Kristi Swartz, "Contractors at Vogtle Nuclear Plant Signal More Delays," *Atlanta Journal Constitution,* November 28, 2012, http://www.ajc.com/news/business/vogtles-contractors-signal-more-delays/nTGzZ/; Direct Testimony of Stephen A. Byrne on Behalf of South Carolina Electric & Gas, Docket No. 20008-196-E, Exhibit J: Risk Factors Related to Construction and Operation of the Facility; also attached to Mr. Byrnes Rebuttal Testimony in Docket No. 2012-203-E.

[9] The problems were widely anticipated early in the "nuclear renaissance," see for example, the Keystone Center, *Nuclear Power Joint Fact-Finding,'* June 2007, pp. 34-35 and the sources cited therein.

[10] Direct Testimony And Exhibits Of William R. Jacobs, Jr., Phd. On Behalf Of The Georgia Public Service Commission Public Interest Advocacy Staff, Before The Georgia Public Service Commission, *In The Matter Of: Georgia Power Company's Seventh Semi-Annual Vogtle Construction Monitoring Report,* Docket No.: 29849, December 7, 2012, http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=145142

[11] Summer Unit 1 is nine months behind schedule, Ryan, Margaret. "Summer nuclear unit already behind as it gets federal green light;" SCANA Corporation. "South Carolina Electric & Gas Company Reaches Preliminary Agreement on Negotiated Nuclear Costs." 29 March 2012; Roddie Burris, Slowdown at V.C. Summer nuclear plant brings layoffs,

[12] Pam Sohn, Delays mire nuclear plant construction, *Times Free Press*, June 4th, 2012; http://www.timesfreepress.com/news/2012/jun/04/delays-mire-nuclear-plant-construction/ Rob Pavey, "Georgia Power Reports Costs, Challenges of Vogtle Expansion," September 1, 2012, *Augusta Chronicle,* http://chronicle.augusta.com/news/business/local-business/2012-08-31/georgia-power-reports-costs-challenges-vogtle-expansion; Ray Henry, "Watchdog: Ga. nuclear plant will exceed budget," Associated Press, May 31, 2012;

[13] Penn, Ivan. "Progress Energy raises price tag, delays start date of Levy nuclear plant." *The Tampa Bay Times*. 2 May 2012.http://www.tampabay.com/news/business/energy/progress-energy-raises-price-tag-delays-start-date-of-levy-nuclear-plant/1227830; Ivan Penn, May 29, 2012, "Progress Energy's Levy County Nuclear Project Carries On Despite Setbacks," *Tampa Bay Times,* http://www.tampabay.com/news/business/energy/progress-energys-levy-county-nuclear-project-carries-on-despite-setbacks/1232464

[14] The FPL Turkey Point project has been placed in a limbo mode, where the utility wants to continue spending money to obtain the license without committing to actually constructing the facility, a status that the Southern Alliance for Clean Energy contends violates the explicit language of the statute which allows advanced cost recovery only for facilities that the utility "intends" to construct. http://blog.cleanenergy.org/2012/10/22/sace-protects-consumers-challenges-florida-nuclear-tax/

[15] Kristi Swartz, "Contractors at Vogtle Nuclear Plant Signal More Delays," *Atlanta Journal Constitution,* November 28, 2012, http://www.ajc.com/news/business/vogtles-contractors-signal-more-delays/nTGzZ/; Direct Testimony of Stephen A. Byrne on Behalf of South Carolina Electric & Gas, Docket No. 2012-203-E.

[16] Direct Testimony And Exhibits Of William R. Jacobs, Jr., Phd. On Behalf Of The Georgia Public Service Commission Public Interest Advocacy Staff, Before The Georgia Public Service Commission, *In The Matter Of: Georgia Power Company's Seventh Semi-Annual Vogtle Construction Monitoring Report,* Docket No.: 29849, December 7, 2012, http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=145142 ; Sohn, Pam. "Cost of completing reactor at Watts Bar Nuclear Plant rises by up to $2 billion," *Chattanooga Times Free Press.* 6 April 2012.http://www.timesfreepress.com/news/2012/apr/06/watts-bar-2-billion-more-and-three-years/; Rob Pavey, "Georgia Power Reports Costs, Challenges of Vogtle Expansion, September 1, 2012, *Augusta Chronicle,* http://chronicle.augusta.com/news/business/local-business/2012-08-31/georgia-power-reports-costs-challenges-vogtle-expansion; *Tom Crawford ,* Ga. Power filing hints at $2 billion overrun on Vogtle nuke project, Georgia Report, *September 3, 2012;* Ray Henry, "Watchdog: Ga. nuclear plant will exceed budget," *Associated Press,* May 31, 2012; Ryan, Margaret. "Summer nuclear unit already behind as it gets federal green light;" SCANA Corporation. "South Carolina Electric & Gas Company Reaches Preliminary Agreement on Negotiated Nuclear Costs." 29 March 2012; Penn, Ivan. "Progress Energy raises price tag, delays start date of Levy nuclear plant." *The Tampa Bay Times*. 2 May 2012.http://www.tampabay.com/news/business/energy/progress-energy-raises-price-tag-delays-start-date-of-levy-nuclear-plant/1227830; Fred Hiers, "Progress asks for Nuke Fee Hike," May 1, 2012, *Ocala.com, http://www.ocala.com/article/20120501/wire/120509987;* Ivan Penn, May 29, 2012, "Progress Energy's Levy County Nuclear Project Carries On Despite Setbacks," *Tampa Bay Times,* http://www.tampabay.com/news/business/energy/progress-energys-levy-county-nuclear-project-carries-on-despite-setbacks/1232464; Trigaux, Robert. "Is nuclear power industry poised to repeat 'managerial disaster'?" *The Tampa Bay Times*. 8 April 2012.http://www.tampabay.com/news/business/energy/is-nuclear-power-industry-poised-to-repeat-managerial-disaster/1224045; The Southern Company. Form 10-Q (Quarterly Report for period ending 31 March 2012) filed with the United States Securities and Exchange Commission, pp. 137-140. 7 May 2012; SCANA Corporation. "South Carolina Electric & Gas Company Reaches Preliminary Agreement on Negotiated Nuclear Costs." 29 March 2012. The French have experienced similar problems with their advanced design reactors in construction projects in Finland and France.

[17] The most compelling evidence comes from the utility industry itself where the largest utilities concluded that building new nuclear reactors was not economic. The most prominent among these was the CEO of Exelon, the nation's largest nuclear utility, John Rowe, "Fixing the Carbon Problem without Breaking the Economy," Resources for the Future Policy Leadership Forum Lunch, May 12, 2010; "Energy Policy: Above All, Do No Harm," *American Enterprise Institute,* March 8, 2011;. Equally significant is the understanding of this process that had spread across the decision makers in other industries (see for example, Steel Manufacturers Association, May 2012, *Energy Update* http://www.steelnet.org/new/20120500.pdf,

[18] Galen Barbose, Naim Darghouth and Ryan Wiser, *Tracking the Sun V: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2011,* Lawrence Berkeley Laboratory, November 2012; Ryan Wiser, et al., Recent Developments in the Levelized Cost of Energy from U.S. Wind Power Projects, Lawrence Berkeley National, February 2012, http://www.nrel.gov/docs/fy12osti/53510.pdf; Ryan Wiser, and Mark Bollinger, *2011 Wind Technologies Market Report*, EIA August 2012, http://emp.lbl.gov/sites/all/files/eetd.lbl_.gov_EA_EMP_reports_lbnl-5559e.pdf

[19]The Economist, "Constellation's cancellation: America's nuclear renaissance is mighty slow in coming," October, 14, 2010, http://www.economist.com/node/17254442 The economic slowdown has reduced electricity consumption, which remains below the peak it reached in 2007. At the same time, there has been a sharp increase in the supply of non-nuclear electricity (gas, coal and wind) from plants built to meet a wrongly predicted spike in demand. Gas prices, which a few years ago were high enough to make power firms consider the nuclear option, are now much lower. Pessimism about the economy makes corporate America reluctant to undertake long-term capital investments. None of this bodes well for nuclear power. To make matters worse, America has failed to adopt a coherent energy policy, let alone one that imposes a price on carbon. Everyone in the energy business believes that carbon-pricing will come, but when? Wikipedia, *Prospective nuclear units in the United States, "*the case for widespread nuclear plant construction was eroded due to abundant natural gas supplies, slow electricity demand growth in a weak U.S. economy, lack of financing, and uncertainty following the Fukushima nuclear disaster, http://en.wikipedia.org/wiki/Prospective_nuclear_units_in_the_United_States

[20] Roger Avant, Roger, "Creating the Clean Economy," The Economist, June 11, 2011, http://www.economist.com/blogs/freeexchange/2011/01/climate_policy; David Leonhardt, "There's Still Hope for the Planet," New York Times, July 21, 2012, http://www.nytimes.com/2012/07/22/sunday-review/a-ray-of-hope-on-climate-change.html?_r=0.

[21] See Sections IV and V for a discussion of the importance of the carbon price assumptions. .

[22] Edward Felker, "Poneman, Fertel Spar over Nuclear Loan Guarantees," *Energy Guardian,* September 18, 2012; http://www.energyguardian.net/poneman-fertel-spar-over-nuclear-loan-guarantees; Reuters, RPT-Southern Co CEO says US nuclear loan guarantee less enticing, July 19, 2012, http://www.reuters.com/article/2012/07/19/utilities-southern-idUSL2E8IJ1QM20120719

[23] http://www.businesswire.com/news/home/20120327006867/en/Fitch-Rates-South-Carolina-Public-Service-Auths; http://www.columbiabusinessreport.com/news/42877-duke-energy-moving-ahead-to-buy-stake-in-v-c-summer-nuclear-station; https://www.santeecooper.com/portal/page/portal/santeecooper/aboutus/newsroom/santeecoopernewsreleases/bd9094aabb8529bde044001a4b08f969; http://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2012/04/25/santee-cooper-signs-letter-of-intent-with-american-municipal-for-v-c-summer-reactors-042502.aspx;

[24] Initial Brief of Appellant Southern Alliance for Clean Energy, *Southern Alliance for Clear Energy v. Florida Public Service Commission, et al.*, Case.: No. SC11-2465, PSC Docket No.: 11---9-EI

The collapse of the "nuclear renaissance" was highlighted by the decision of Exelon; the largest nuclear utility in the United States, to officially pull the plug on the only new reactor it had briefly contemplated building.[16] The official exit of Exelon from new nuclear construction prompted the observation that, "Two projects, each with two reactors, are under way, one in Georgia and one in South Carolina, but no additional groundbreakings seem very likely soon."[17] Thus, Summer 2 & 3 went from being among the first reactors ordered during the "nuclear renaissance" to likely being the last two, if they are completed.

B. "DÉJÀ VU ALL OVER AGAIN," THE NUCLEAR "FIASCO AND THE "NUCLEAR RENAISSANCE"

1. The First Nuclear Fiasco

The dramatic shift in the economic prospects of nuclear power in such a short period of time may seem quite unusual, but, in fact, it is not. In less than a decade, and long before even one reactor had come on line, the "nuclear renaissance" suffered the same fate as the "Great Bandwagon Market," as the flood of nuclear reactor orders in the 1970s came to be known [18]

An April 1975 Public *Utility Fortnightly* article gushed about the benefits of nuclear reactors, presenting a positive view of nuclear power that reflected a spurt of orders for new reactors.

> The enormous benefits of nuclear power were reflected in an early 1975 Public Utilities Fortnightly survey of all American utilities that operated nuclear power plants as part of their electrical generating systems. The 24 companies concluded that "the peaceful atom" had saved their customers more than $750 million in their 1974 bills that they would have owed had their electricity come from fossil fuels. They also reported that in the same year "power from the atom" had saved "the equivalent of more than 247 million barrels of oil."[19]

A decade later, in February 1985, a dramatic story appeared in *Forbes* magazine, with the work "Fiasco" emblazoned across the front cover. It painted a completely different picture of nuclear power in America.

> The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale. The utility industry has already invested $125 billion in nuclear power, with an additional $140 billion to come before the decade is out, and only the blind, or the biased, can now think that most of the money has been well spent. It is a defeat for the U.S. consumer and for the competitiveness of U.S. industry, for the utilities that undertook the program and for the private enterprise system that made it possible.[20]

As shown in Figure II-1, in the decade from the late 1960s to the late 1970s, utilities had proposed the construction of over 250 reactors.[21] By 1978, however, the amount of capacity that

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[16] Reuters, Exelon drops Texas reactor plan, cites cheap natgas, Tue Aug 28, 2012**,** http://www.reuters.com/article/2012/08/28/us-utilities-exelon-texas-idUSBRE87R1AD20120828

[17] Matthew L. Wald *,"*Unraveling the Nuclear Renaissance" *New York Times,* August 31, 2012, http://green.blogs.nytimes.com/2012/08/31/unraveling-the-nuclear-renaissance/

[18] This history is examined in Mark Cooper, 2012, *Nuclear Safety And Nuclear Economics, Fukushima Reignites the Never-Ending Debate:,* Symposium on the Future of Nuclear Power, University of Pittsburgh, March 27-28.

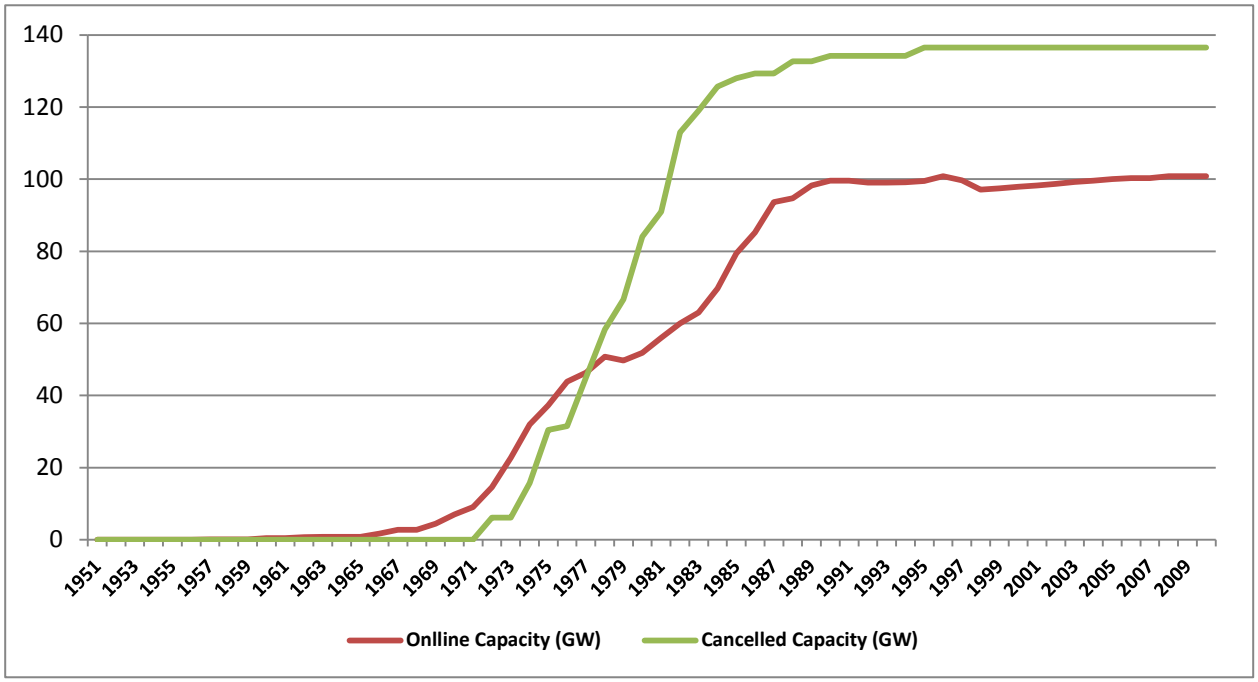
[19] April 24, 1975, cited in I. Bupp and J Derian, 1981 *The Failed Promise of Nuclear Power,* New York: Basic Books, pp. 7-8

[20] J. Cook, "Nuclear Follies," *Forbes*, February 11, 1985.

[21] Mark Cooper, 2012, Nuclear Safety.

had been cancelled exceeded the amount of capacity that had been completed. No new reactor orders were placed for 30 years after 1978 and the amount of completed capacity in the U.S. never exceeded the amount of cancelled capacity.

FIGURE II-1: CUMULATIVE NUCLEAR CAPACITY COMPLETED AND CANCELLED



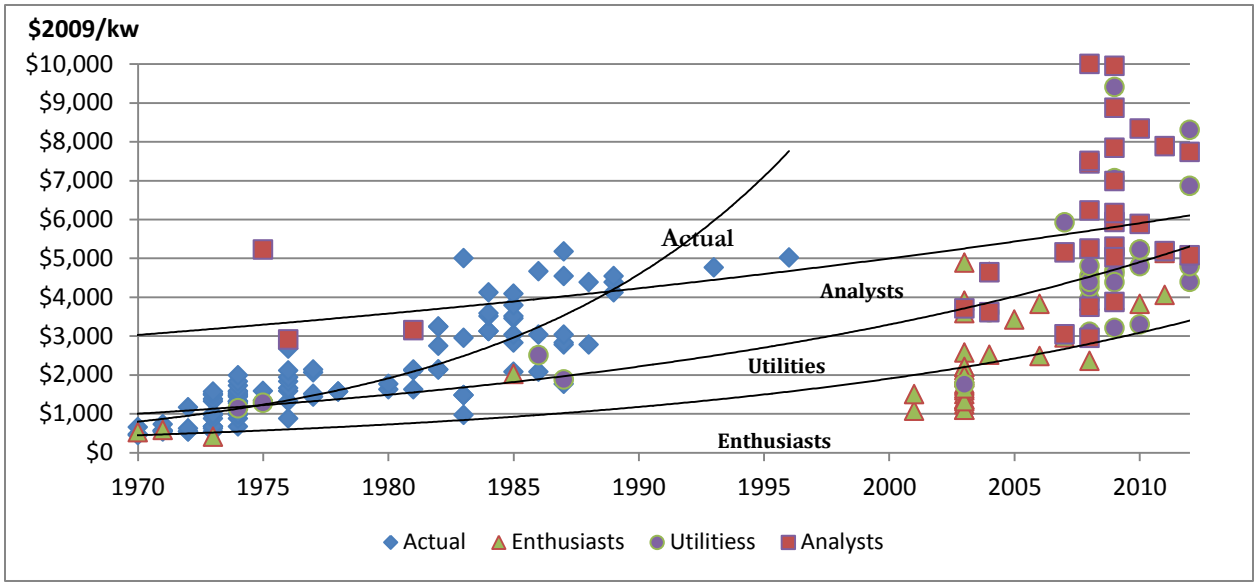
Sources: Jonathan Koomey, and Nathan E. Hultman, "A Reactor Level Analysis of Busbar Costs for US Nuclear Plants, 1970-2005," *Energy Journal,* 2007. Fred A. Heddleson, *Summary Data for U.S. Commercial Nuclear Power Plants in the United States,* Nuclear Safety Information Center, April 1978; U.S. Energy Information Administration, *Nuclear Generating Units, 1955-2009; Nuclear Power Plant Operations, 1957-2009.*

One of the key causes of the decision to cancel or abandon so much nuclear capacity was the dramatic increase in the projected cost of nuclear reactor construction (see Figure II-2). From the earliest days of the industry, it could not deliver on the initial cost estimates. Costs had doubled in the decade before the 1979 accident at Three Mile Island and they doubled again in the decade after.

While the slowing of demand growth after the first Arab oil embargo is frequently seen as another cause of the crash of the "Great Bandwagon Market," the continued expansion of the electricity sector casts doubt on that explanation (see Figure II-3). Over the period in which nuclear reactors were being cancelled in the U.S., the growth in the amount of new fossil fuel-fired capacity online was over twice as large as the amount of nuclear capacity that was cancelled. With retirements of fossil-fired capacity taken into account, the new fossil fuel-fired capacity brought online was about three times as large as the amount of cancelled nuclear capacity.[22]

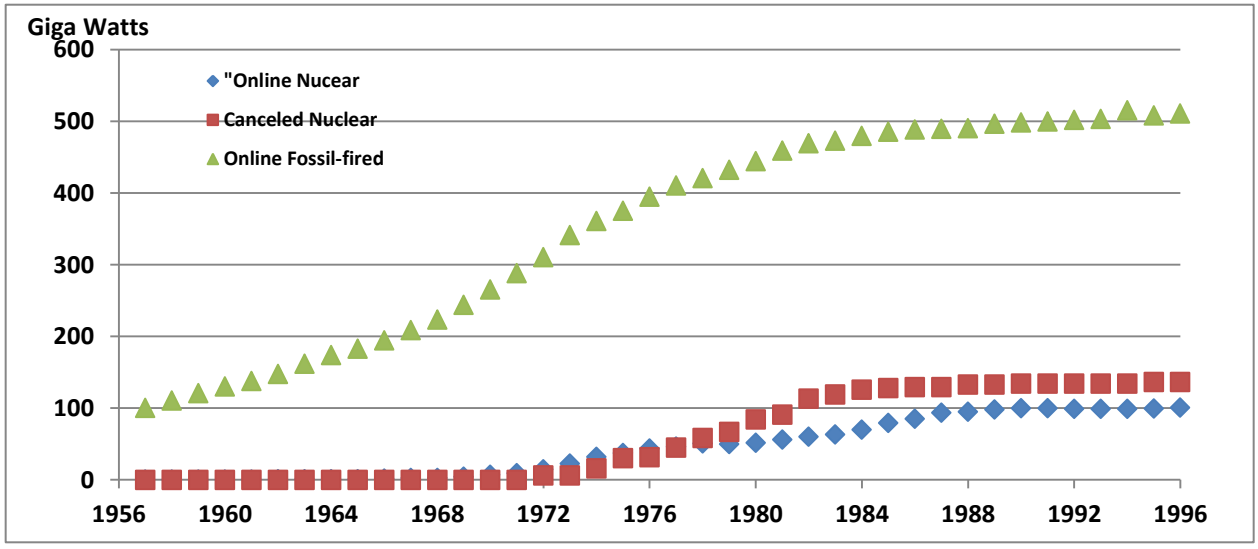
[22] Energy Information Administration, *Annual Energy Review: 1996,* Washington D.C., July 1997, p. 241, shows 150 GW of conventional steam and combustion turbines in 1963 and growth to 505 GW by 1996 (the year in which the last reactor of the "great bandwagon" era was completed. If half of the fossil fuel capacity online in 1963 was retired over the ensuing 33 years, the amount of new fossil capacity added would equal 420 GW compared to 140 GW of nuclear capacity cancelled or abandoned.

FIGURE II-2: OVERNIGHT COST: U.S. ACTUAL AND "RENAISSANCE" ESTIMATES



Sources: Actual Costs from Jonathan Koomey, and Nathan E. Hultman, 2007, "A Reactor Level Analysis of Busbar Costs for US Nuclear Plants, 1970-2005," *Energy Journal,* 2007; Projections updated from Mark Cooper, *The Economics of Nuclear Reactors: Renaissance or Relapse* (Institute for Energy and the Environment, Vermont Law School, June, June 2009).

FIGURE II-3: COMPLETED AND CANCELLED NUCLEAR CAPACITY COMPARED TO FOSSIL-FIRED CAPACITY: 1963-1996



Sources: Jonathan Koomey, 2011, Was the Three Mile Island accident in 1979 the main cause of US nuclear power's woes? June 24; Mark Cooper, 2012, Nuclear Safety And Nuclear Economics, Fukushima Reignites The Never-Ending Debate, Symposium on the Future of Nuclear Power, University of Pittsburgh, March 27-28.

Nuclear power simply could not compete with the alternatives available. The cost of electricity from a new nuclear reactor was between 25% and 50% higher than the cost of power from a new coal-fired plant in the 1980s.[23] Section IV show that today nuclear power suffers a similar (or larger) cost disadvantage compared to a number of resources that are widely available.

Thus the problem was not a lack of need for generation capacity; it was that nuclear construction was too costly. If demand growth had been much higher, perhaps more reactors would have been pulled into the market, if the supply of fossil fuel-fired generation was constrained or exhibited rising costs, but that seems unlikely. Nuclear power simply could not deliver on its promise and compete with fossil fuels.

2. The Nuclear Renaissance

Figure II-2 above allows a comparison of the actual cost of construction from the "Great Bandwagon Market" period to the estimates of costs for the" Nuclear Renaissance" period. The rising cost projections took a heavy toll on plans to build new nuclear reactors. Figure II-4 plots the "nuclear renaissance" cost estimates as well as a measure of nuclear construction intentions – license applications and EPC contracts signed. There are remarkable similarities in the collapse of the "nuclear renaissance" and the "Great Bandwagon Market." The initial cost estimates were extremely low and stimulated a lot of interest, but the industry could not deliver on those rosy cost projections. The amount of new nuclear capacity that was listed as pending in license proceedings mounted quickly in 2007-2009. Outside of the regulatory process nuclear advocates began pushing for hundreds of reactors.[24]

However, over the course of a decade, cost projections increased at least three fold and very few of the projects moved from press releases to the planning phase to the execution phase. Over four-fifths of the pending licenses are dormant or have been cancelled. Only one-seventh of the licenses identified by the NRC have moved to the stage of having an EPC contract.

C. THE INESCAPABLE ECONOMIC FAILURE OF NUCLEAR POWER

The reversals of fortune that nuclear reactor construction suffered in the collapse of the "Great Bandwagon Market" and the failure of the "nuclear renaissance" are not just bad luck. They stem from the fact that nuclear power is a complex, risky technology that requires long lead times and large sunk capital costs. The nature of the technology has prevented the processes found in other industries that reduce costs, like learning by doing, modularization and economies of scale.[25] As a result, nuclear power suffers persistent cost escalation and is exposed to a variety of risks

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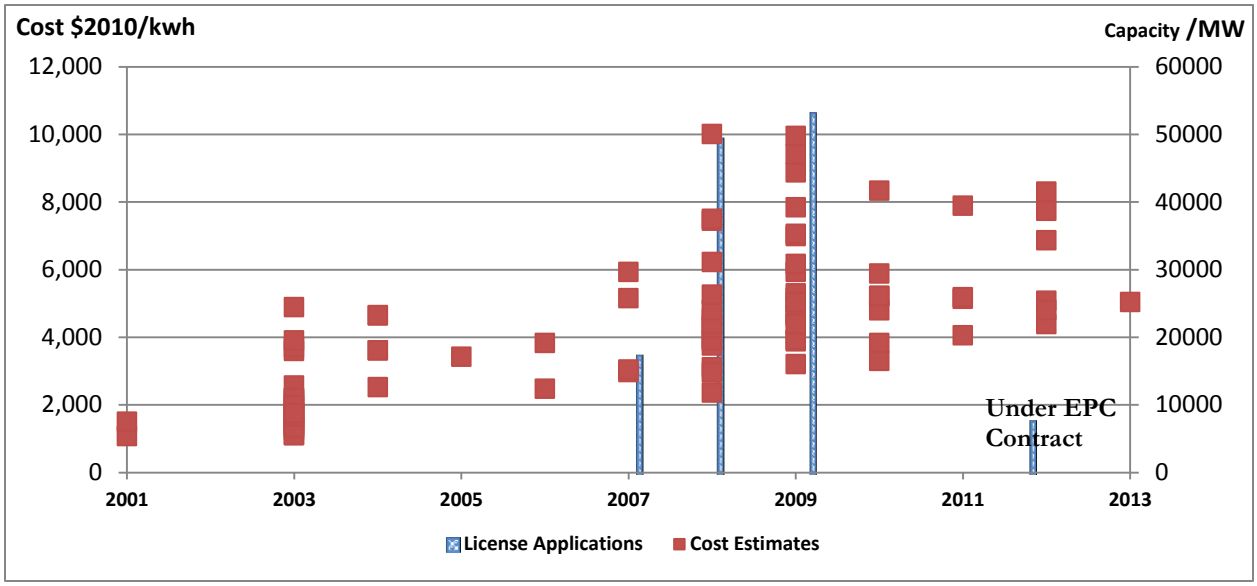
[23] Charles Komanoff, 1981, *Power Plant Cost Escalation: Nuclear and Coal Capital Cost, Regulation, and Economics* (New York, Van Nostrand Reinhold), p. 287, the former estimate is without a cost impact from TMI, the latter with a cost impact. The latter is closer to the actual cost, although it is not clear TMI was the cause, see Cooper, 2012.

[24] Lamar Alexander, 2010, *Going to War in Sailboats: Why Nuclear Power Beats Windmills for America's Green Energy Future.* Over this period, the EIA reduced its estimates of new nuclear reactor capacity to be brought online by the 1930s from 17 GW to less than 5 GW.

[25] The literature on learning and innovation is huge. Appendix C includes citations on the importance of learning and innovation in the context of the climate change debate. The failure of nuclear reactors to exhibit these characteristics is demonstrated in Mark Cooper, 2009, *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*, Institute for Energy and the Environment, Vermont Law School September, 2009, and the sources cited therein. http://www.vermontlaw.edu/Documents/IEE/20100909_cooperStudy.pdf.

including technology, execution, marketplace, regulatory, policy, and financial risks.[26] Private capital markets have long refused to bear the risks so the nuclear industry must press policy makers and regulators to subsidize nuclear reactor construction by shifting the risk to taxpayers and ratepayers.[27]

FIGURE II-4: ESCALATING COST ESTIMATES IN THE COLLAPSE OF THE NUCLEAR RENAISSANCE



Sources: Costs see Figure II-2, Licensed from NRC, *Combined License Application for New Reactors,* 2012

To the extent that there is a significant difference between the crash of the "Great Bandwagon Market" and the collapse of the "nuclear renaissance" it lies in the fact that the first nuclear "fiasco" alerted ratepayers and analysts to the potential economic harm of nuclear cost escalation. The challenge to and debate over costs came much earlier in the "nuclear renaissance." Moreover, the experience of the first nuclear fiasco also exposed the uneconomic nature of nuclear power, so utilities did not even pretend to build them with market capital at the start of the "nuclear renaissance." They demanded massive, direct subsidies from the outset. While the scope of the "fiasco" was contained by the early recognition and resistance to uneconomic reactors, the cost to consumers in the small number of states that moved ahead with advanced cost recovery is substantial. Shifting risk does not eliminate it; it simply places the burden on different people when the gamble goes bad.

Figure II-5 captures the similarities and difference in the collapse of the "Great Bandwagon Market" in the 1970s-1980s and the collapse of the "nuclear renaissance" in the past decade. The top graph shows the rapid increase in planned capacity when costs are assumed to be low and then the cancellation of planned capacity as the reality of nuclear costs are recognized. Note also that the run up in cost estimates in the "nuclear renaissance" was much larger in absolute value. On a

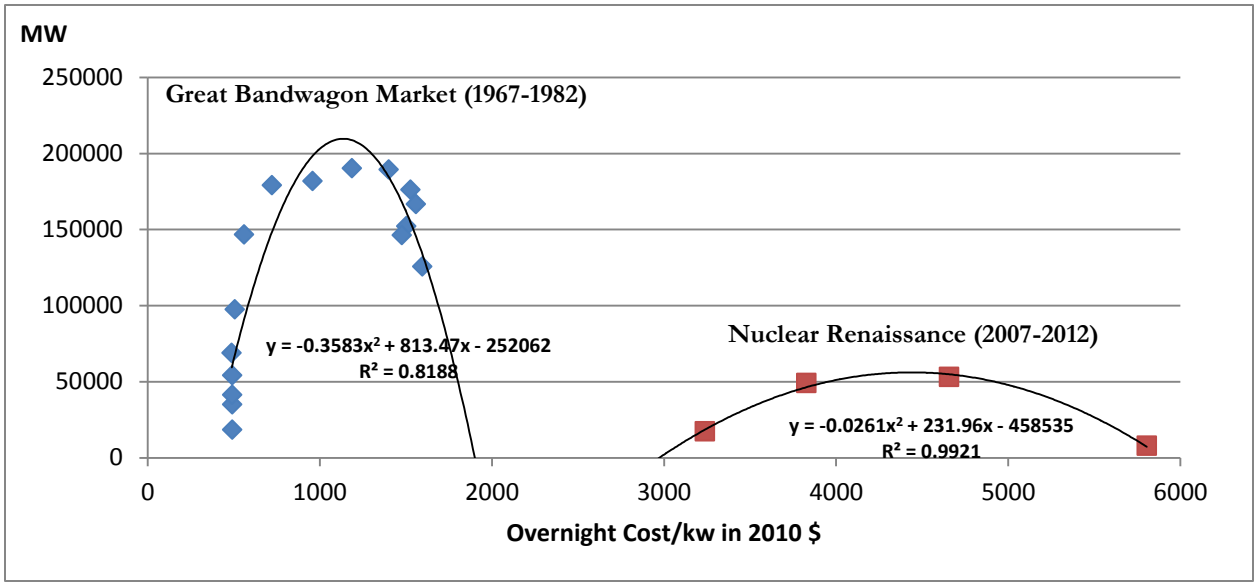
[26] Mark Cooper, *All Risk No Reward for Taxpayers and Ratepayers* Institute for Energy and the Environment, Vermont Law School, December 2009,.http://www.vermontlaw.edu/Documents/11_03_09_Cooper%20All%20Risk%20Full%20Report.pdf.

[27] Mark Cooper, "Nuclear liability: The market-based, post-Fukushima case for ending Price-Anderson," *Bulletin of the Atomic Scientists,* 5 October 2011 http://www.thebulletin.org/web-edition/features/nuclear-liability-the-market-based-post-fukushima-case-ending-price-anderson; Mark, Cooper, 1012, *Nuclear Safety.*

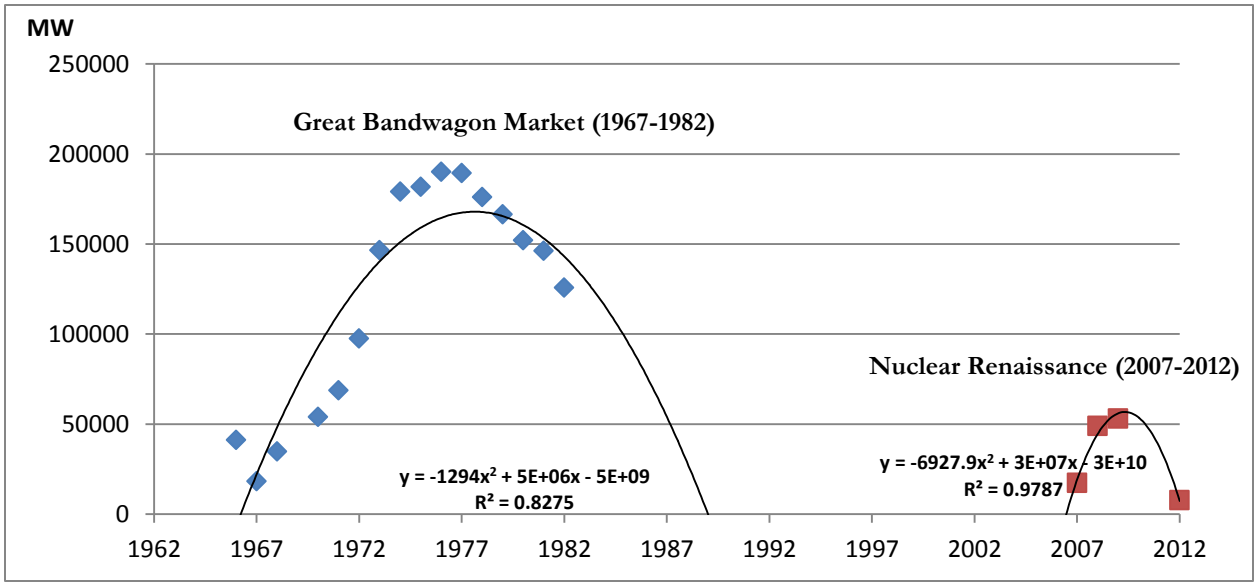
percentage basis, the increase was similar in both cases, about a doubling of costs. The lower graph shows that in the "nuclear renaissance" the run up in cost estimates was much faster and the collapse much quicker, about on third the time.

FIGURE II-5: THE REPEATED COLLAPSE OF NUCLEAR REACTOR CONSTRUCTION

Overnight Cost and Planned Construction (2010$ averaged cost/estimate for 3 prior years)



Planned Construction Across Time



Source: Updated U.S. reactor database. Based on 224 reactors as described in Mark Cooper, 2012, *Nuclear Safety And Nuclear Economics, Fukushima Reignites the Never-Ending Debate:,* Symposium on the Future of Nuclear Power, University of Pittsburgh, March 27-28.

Moreover, when society is sufficiently concerned about the supply of electricity that some policy-makers decide to extend subsidies to nuclear power, others will look to alternative sources of energy that are less risky and exhibit much greater potential for cost reduction. The availability of

preferable alternatives that results makes nuclear reactor construction even less attractive and more risky.

Thus, nuclear power is inherently uneconomic for a simple reason: it relies on a catastrophically dangerous resource that is vulnerable to human frailties and the vicissitudes of Mother Nature. As a result, the demands for safety evolve with the deployment of the technology and the experience of operating reactors, it is very difficult and costly to try to build a "safe" reactor or make existing reactors "safe." Any nation that claims to have the wherewithal (technical expertise and economic resources) to build a "safe" nuclear reactor will have the wherewithal to meet its needs for electricity with alternatives that are less costly and less risky. Thus, at present and for the foreseeable future, nuclear power is not going to be the least cost option or close to it.

III. THE IMPACT OF ADVANCED COST RECOVERY ON THE CONSUMER PROTECTION FUNDAMENTALS OF UTILITY REGULATION

Because electric utility service has long been viewed as a natural monopoly, it has been delivered to consumers in areas where utilities are given franchises as the monopoly service provider. The rates, terms and conditions of service are regulated, since the delivery of service to consumers is not a competitive activity. With a monopoly provider, consumers must be protected from the natural tendency of service providers to charge whatever the market will bear or provide poor service. Thus, public utility ratemaking is fundamentally about consumer protection and it is designed to give consumers the same protections that a competitive market would. To understand how advanced cost recovery affects the process of consumer protection it is necessary to review several of the key principles of consumer protection that usually guide public utility regulation.

A. RECOVERY OF JUST, REASONABLE, AND PRUDENTLY INCURRED COSTS FOR USED AND USEFUL FACILITIES

In traditional utility rate-making, the utility makes all the investment in the plant necessary to bring it on line with shareholder resources. When the plant is ready to go on line, the utility seeks to put it into the rate base. Only when the plant is ready to deliver electricity is it considered to be "used and useful" to the captive customers of the utility. In a general rate case, the utility will seek to charge ratepayer for the sum it has invested in the plant, as well as recover the operating (variable) costs of generating power. The sum invested is also allowed to earn a return on capital (including the period during the construction phase, when costs are entered into a separate account for funds used during construction – allowance for funds used during construction, AFUDC). The rates charged to consumers also include depreciation of the plant as it is produces electricity, which returns the capital investment to the utility. Thus the utility gets a return of and on its capital while the plant is operating, in addition to all operating costs that are prudently incurred.

This is exactly what sellers in a competitive market receive. In a competitive market, competition drives the least-cost, most efficient technology to the consumer. Suppliers who are inefficient and have costs above the market price or who try to earn above-normal profits by setting prices above costs will not be able to recover those excess costs from consumers. Consumers would not purchase the overpriced products because they would have lower cost options in the market place. A supplier's inefficiency will come out of the supplier's pocket in the form of a lower rate of return earned on the investment. If all sellers suffer similar problems in a competitive market, market elasticities of supply and demand will determine the extent to which the costs will be recovered.

Emulating a competitive market, the public utility commission will consider whether the costs the utility seeks to recover from ratepayers are "just, reasonable, and prudent." The task of public utility commissions is generally to ensure that the utility delivers the least cost power, subject to the need for reliability (and other) considerations, since that would be the outcome in the marketplace. The commission oversees the decision about which technologies to use and which costs utilities are allowed to recover. Even where the construction of new facilities takes place within the parameters of an Integrated Resource Plan, which is a long term energy plan, the fact that the utility has been allowed to build a certain type of plant does not alter the fact that the costs cannot be recovered from ratepayers until the plant is used and useful and the cost (including the return on investment) are found to be just, reasonable, and prudent.

These two principles of utility regulation protect consumers from different potential abuses. Used and useful ensures that ratepayers receive service in exchange for the recovery of costs, while just, reasonable, and prudent ensure that the costs recovered are not excessive. This pattern of cost recovery reflects what would happen in a competitive market, which is why it is used as a ratemaking standard. When a product is sold to the consumer, the consumer almost invariably has the immediate use of the product and the price includes only a normal return on investment (if the market is competitive). Utility regulation uses these principles to balance the interest of utility stockholders, who receive a fair rate of return for the risk they take, and ratepayers, who receive useful products at just and reasonable prices. If projects are cancelled or abandoned they do not become used and useful and their costs would not normally be recovered in the marketplace. Similar to the market outcome, under some circumstances utilities may recover the costs associated with abandoned projects, if they can show that the decision to commence the project was prudent and the cause of the termination of the project is not imprudence on the part of the utility.

The obligation that a project be prudent is continuous, not a one-shot determination. When economic conditions change, projects that have become economically unattractive should be abandoned. The constant review of the prudence of projects is exactly what happens in a competitive marketplace. In a competitive market, when a firm finds that a project is no longer economic, it must abandon that project because it will not be able to recover the costs. Firms must make decisions on a forward looking basis, regardless of sunk costs. Emulating a firm in the competitive market, the utility should be constantly evaluating the economic prudence of its going forward investment decisions. The fact that economic analyses conducted between four and seven years ago concluded that the Summer 2 and 3 reactors were prudent does not mean they are prudent today.

B. ADVANCED COST RECOVERY WEAKENS CONSUMER PROTECTION

Allowing utilities early cost recovery dramatically alters the aforementioned consumer protection process in a number of ways. Because the underlying public utility regulation may be different between states and any changes in a state's public utility statute are crafted to redefine the basic concepts of public utility ratemaking, comparing early cost recovery policies across states is difficult. Regardless of the details, however, the fundamental point is that early cost recovery is a radical departure from normal utility practice that dramatically alters the relationship between the utility and the ratepayer and abandons the logical tie between utility regulation and normal marketplace dynamics.

The concerns raised by the Staff of the Iowa Utilities Board in response to a proposal to allow advanced cost in that state,[28] which was rejected, present a road map to the dramatic impact advanced cost recovery can have on costs and consumer protection (see Table III-1).[29]

[28] IA House File (HF) 5612011-2012, 84th General Assembly, passed the House April 28, 2011, http://legiscan.com/IA/text/HF561/id/276989

[29] Iowa Utilities Board Staff Comments on HF 561 as amended by S3380, DECEMBER 23, 2011, http://www.iaenvironment.org/documents/2012/nuclear%20IUB%20memo%202011%2012%2023%20public.pdf , HF 561 relates to the permitting, licensing, construction and operation of potential new nuclear-related electric generation facilities in Iowa. It also affects the way that customers would pay for those facilities by shifting the allocation of risk between the utility and the customers (p.1).

TABLE III-1: THE IOWA UTILITY BOARD ANALYSIS OF THE PROBLEMS WITH ADVANCED COST RECOVERY

Advanced cost recovery alters the most fundamental principle of rate setting by shifting the risk of construction so dramatically that the resulting scheme of cost recovery virtually eliminates stockholder risk in the investment.[1]

Because nuclear reactors are so risky and impossible to finance in normal capital market, the utilities push for advanced and guaranteed recovery of all costs,[2] but certainty for utilities denies regulators the flexibility that is needed in an uncertain and rapidly changing environment[3] and ties the hands of the regulator in the effort to balance the interest of ratepayers and utility shareholders.[4]

By excusing nuclear reactors from rigorous comparative analysis of alternatives and conferring a special advantage on nuclear,[6] it all but guarantees less costly alternatives will be passed over.[5]

It threatens to distort the utility and regulatory decision making process[7] and gives utilities an incentive to choose investments and make construction decisions that benefit stockholders at the expense of ratepayers.[8]

Beyond the initial choice of projects, [9] shifting the risk of nuclear reactor construction creates an ongoing problem because it diminishes the utility's incentive to drive a hard bargain with vendors and joint owners to protect ratepayers.[10]

Having guaranteed utilities cost recovery on an annual basis, the regulator will be under greater pressure to approve "incremental" additions to cost even when those costs are the result of utility error.[11]

The acceleration of cost recovery creates severe intergenerational inequities in cost recovery, violating the fundamental principle that those who consume the output of a plant should bear its costs.[12]

Sources and Citations:

Iowa Utilities Board Staff Comments on HF 561 as amended by S3380, DECEMBER 23, 2011, http://www.iaenvironment.org/documents/2012/nuclear%20IUB%20memo%202011%2012%2023%20public.pdf; IA House File (HF) 5612011-2012, 84th General Assembly, passed the House April 28, 2011, http://legiscan.com/IA/text/HF561/id/276989;

1 HF561 (as amended) would shift nearly all of the construction, licensing, and permitting risk associated with one or more nuclear plants from the company to its customers. This is done, in part, by pre-approving the company's spending in annual proceedings throughout the construction, licensing, and permitting period and then guaranteeing recovery of pre-approved prudent costs including a profit on capital investments (p. 3).

2 It is staff's understanding that the companies looking to invest in nuclear energy argue that it would be difficult, if not impossible to finance one or more new nuclear plants without a greater level of assurance of cost recovery than is provided by traditional utility regulation. However, the precise extent of the required risk shifting may be difficult to determine. (p. 1)

3 The inflexible nature of some of the bill's provisions may be a problem if the market develops in an unforeseen manner, particularly if rapid adjustments are needed to respond to the unpredicted changes (p. 3).

4 Proper rate treatment of early retirements is usually a rate case issue and in the past the Board has typically allowed recovery of the remaining investment in a prudently retired plant but has not always allowed the company to earn a return on the investment, effectively balancing the interests of customers and stakeholders. This provision would prohibit consideration of that balancing of interests (p.7).

5 The provision would exempt nuclear plants from the existing requirement that a public utility that proposes a new plant must show that it has considered other feasible source of long-term supply and the proposed plant is reasonable when compared to those alternatives (p. 7)

6 Staff believes some provisions of HF 561 go beyond leveling the playing field and could give nuclear power plants unintended advantage over alternative sources of electric power (p. 6).

7 Prudent planning for these long-term investments should involve consideration of all reasonable alternatives. It appears that current and future developments may make carbon-emitting generating resources uneconomical and, as a result, make nuclear power plants a more viable alternative for serving customer needs than they have been in the last few decades. However, it may be that additional regulatory certainty is required to create a level playing field for all of the reasonable alternative (p. 1).

8 Some of these provisions could create incentives for the company to engage in behavior that could be contrary to the public interest in certain situations (p. 3).

9 One of the effects of guaranteed cost recovery is that the utility will have a reduced incentive to write contracts that place appropriate amounts of risk with vendors. (p. 4)

10 For example, a utility that owns and operates a nuclear plant would not have a strong incentive to pursue a joint owner for nonpayment if the joint owner claimed mismanagement of the facility and refused to pay all or part of its share of the cost of the facility, given that the owner-operator utility would be held harmless by its customers. The utility could avoid litigation with its joint owner without losing money (p.4)

11 For example, imagine that at some point a few years into the project the utility has spent $1 billion, on the proposed plant, all of which was determined to be prudent during the annual review proceedings. That year the company makes a mistake during construction that is entirely the company's responsibility and will cost $50 million to correct. Normally, the cost of correction would most likely be paid by the company and its shareholders. However, with this provision the company could come to the broad for preapproval of the recovery of the cost of correction. The company would be guaranteed a profit on all spending up to that point. This could create a stronger incentive to walk away from the plant than to complete it. Given that knowledge, the Board would be faced with the choice of (a) making customers pay for the utility's mistake (in order to receive the future benefit of a plant for which customers have already been committed to the tune of $1 billion) or (b) making retail customers pay $1 billion (plus profits), to the utility for a plant that will be abandoned. Under the circumstances, this would likely cause the Board to approve recovery of the $50 million cost of correction, even though it is entirely a result of the company's own error in the hypothetical example (pp. 3-4).

12 This provision requires that all costs associated with US NRC permitting or licensing must be recovered over a period not to exceed the estimated construction period. Under normal ratemaking principles, these costs would typically be capitalized and recovered over the useful life of the facility, so that the customers who benefit from the plant pay the costs associated with obtaining the benefit (p. 7).

This general view of advanced cost recovery fits the South Carolina Base Load Review Act. On the one hand, the Base Load Review Act gave strong incentives for the utility to choose to build nuclear reactors to meet the future need for electricity. The statute gave a utility investing in a new nuclear reactor a remarkably good deal:

- advanced cost recovery,
- no challenge of individual cost elements as imprudent,
- guaranteed cost recovery as long as the utility adhered to the construction schedule and cost estimates,
- flexible scheduling contingencies,
- an automatic rate of inflation,
- the choice of advanced cost recovery or normal utility cost recovery,
- the full commission approved rate of return, even though substantial risk had been transferred to ratepayers through all of the above mechanisms; and
- allocation of recovery of costs of a base load facility according to peak load demand.

On the other hand, the Base Load Review Act did not alter or eliminate many of the features of utility regulation that are intended to protect consumers.

- The definitions of just, reasonable, and prudent were not amended.
- The initial decision to build a reactor with advanced cost recovery is subject to the traditional principles that require the costs associated with the project to be just, reasonable, and prudent, even though that decision was before the reactor became used and useful.
- Cost increases above the initial level approved are also subject to full prudence review.
- If a project is abandoned, recovery of costs is subject to prudence review.
- The Integrated Resource Planning (IRP) process was not altered.

C. THE IMPACT OF PERVERSE INCENTIVES ON UTILITY BEHAVIOR

SCE&G responded to these incentives as theory and experience suggests. Appendix B includes two lengthy excerpts from cross examination of company witnesses in the proceeding in which SCE&G sought $283 million of cost overruns under the Base Load Review Act. They provide clear evidence that advanced cost recovery affects utility behavior in a manner that exposes ratepayers to greater risk from the construction of nuclear reactors.

In the first excerpt, the CEO states that in his opinion in four years he has not found it necessary to re-examine the decision to build Summer 2 & 3. All he is obligated to do is provide quarterly reports on the progress of the project. The CEO said if he saw factors that made it necessary to re-examine the project, he would, but he had not seen any such changes. As the discussion throughout this paper shows, the facts that led to a broad consensus inside and outside of

the industry that nuclear reactor construction is uneconomic, did not matter enough to compel management to re-examine the prudence of construction. Those facts include the following:

- an 80% drop in natural gas prices, which resulted in more than a 50% decline in the cost of gas-fired electricity.
- a 15% reduction in projected peak demand brought on by the worst recession since the Great Depression,
- the worst accident in the history of the nuclear industry,
- a year delay in the schedule,
- the collapse of the owners group that was sharing the costs of refining the design chosen by the utility,
- the decision of utilities across the country to abandon their plans for nuclear reactor construction, and
- the desire of his public power partner to cut back its share of the reactor.

The CEO admits that the threat of a prudence challenge was the only thing that moved him to conduct such a review.

> **Q** Okay. Now, aside from that submission, that update, that review of the decision to go forward with the plant, have you communicated -- have you submitted any other such complex, multi-scenario analysis of the decision to go forward, to the Public Service Commission?
>
> **A** To my knowledge, there's not a requirement under the Base Load Review Act for us to do that on a regular, consistent basis. Our commitment under the BLRA is to provide you with monthly -- I mean, quarterly reports to give you status updates on where the project is, on the issues we've got, how things are going. We are required to give the Commission an annual update, which we've done every year since the project was started. Mr. Byrne's testimony will satisfy that requirement with the Commission today. ORS is on-site on a regular basis; they look at the information and they monitor the project. So there is ongoing oversight of this project. And as I said earlier, it's not a requirement that we do that, but I feel it's my obligation, as CEO of the company, that if something rose to the level that would convince me that the project, you know, may not be prudent, then I feel like I would have an obligation to revise the evaluation, bring that to the Commission, and make the decision in conjunction with the testimony we presented before them. You know, we did that. While I don't think we were required to do that, we did that, in response to the surrebuttal from Dr. Cooper. And lo and behold, it confirmed exactly what we thought, based on our experience and evaluation of the project today.[30]

As the analysis in Sections IV and V show, the CEO's conclusion that the hastily prepared prudence review proved that he was right in not bothering to prepare a prudence review in advance is an affirmation of the perverse incentives created by advanced cost recovery. With a powerful incentive to keep the project going, the company delivered an incomplete, results driven analysis, rather than an objective, comprehensive review of the alternatives available.

In the second excerpt, the senior financial officer responsible for the project describes how

[30] See Appendix B.

management had signed its EPC contract before they knew what the costs were and rushed to the PSC to get their estimate costs approved,

- even though they did not have a handle on the costs yet,
- the cost responsibilities between the utility and the vendor had not been determined, and
- the project was very large compared to the size of the utility.

Management felt compelled to immediately seize the opportunity to shift the risk to ratepayers.

> **Q** All right. And that's still your testimony, looking back on it? It would not have been reasonable to have asked the staff to ascertain your costs before you came in here for your Base Load Review application. That's still your testimony today, isn't it?
>
> **A** To try to go in and do a deep dive into owners' costs?
>
> **Q** Yes.
>
> **A** I still think that that would be an inefficient way to operate.
>
> **Q** Okay. And I think a deep dive would be -- to determine what your owners' costs were, that would be unreasonable to do.
>
> **A** A deep dive, in my mind, is to go cost center by cost center, and try to articulate what we consider our resource codes -- whether it be labor, nonlabor, outside services -- what costs were to be expected by various functional groups. The core group that negotiated the contract had representation from some of the major areas licensing, construction, engineering -- but they didn't have a lot of support from the Unit 1 personnel, who ultimately are going to have the responsibility to operate Units 2 and 3 when they come on-line.
>
> **Q** Okay. Thank you. I do want to ask: It was SCE&G's decision in May 2008 to apply for the Base Load order, wasn't it?
>
> **A** It was.
>
> **Q** I mean, it was -- there was -- you're not aware of anything in the statute that required them to file in May 2008, are you?
>
> **A** I'm not, but -- I mean, I think I understand where you're going to go with this. I think you've got to understand, from a financial market position, we had executed an EPC contract that obligated our company to build two new nuclear units that were relatively high in value relative to our balance sheet, and it would be a significant risk to the company to have a binding agreement of that magnitude and not have sought regulatory support. So the two needed to be close in time, so that we could continue to have the support of the credit agencies, as well as the analysts, to be able to support SCANA….
>
> **Q** And so it's fair to say that your estimates in 2008 were substantially short of what costs you actually -- today, at least -- feel you need? Isn't that fair to say?
>
> **A** I think that's fair to say.[31]

In both cases management refused to conduct critically important analysis to evaluate or estimate the cost of the project. Refusing to do the analysis that is necessary to get a much firmer handle on the costs, the company chose instead to move ahead in spite of the lack of information about the cost of the project and proposed an unspecified contingency fund of a billion dollars to protect stock holders from the risk of cost overruns. The South Carolina Supreme court rejected the contingency fund even under the Base Load Review Act. The company quickly sought a cost

[31] See Appendix to this section.

increase after the court ruling and two years later sought a second court increase.

The company position is that the $453 million requested in the two proceedings after the initial request are not "cost overruns," but the inevitable cost increases associated with a large nuclear construction project.[32] The unspecified risks have a tendency to come home to roost. The company argues that once it identifies a series of risks associated with the construction of nuclear reactors, it is exempt from bearing any of the costs of those risks even though it earns a full rate of return on its capital, which is supposed to reward it for risk, and has been afforded a variety of other incentives to invest in nuclear.

Up to this point, the company has shouldered none of the risks, as Table III-2 shows. The company points out that it negotiated a reduction in the vendor's claim for additional costs, although it made concession to the vendor that would have the effect of lowering the vendor's costs.[33] Compared to the costs that the utility has asked ratepayers to cover, the utility has asked for ratepayers to pick up six-sevenths of the total cost overruns. The utility has shouldered none of the cost overruns.

TABLE III-2: ALLOCATION OF COST OVERRUNS

	Change Orders	Owner Cost	Transmission	Total
Vendor	$76	0	0	76
Ratepayers	$156	276	21	453
Owner	$0	0	0	0

Sources and Notes: Total of increases in Order No. 2009-104(A), Exhibit 1 and 2012 requests as outlined in (Testimony of Kevin B. Marsh, pp.8, 9,19)

As the discussion of the role of prudence review above makes clear, producers are likely to bear some or all of the risk of cost overruns in competitive markets. Given that the utility is guaranteed a full rate of return in advance, allowing it to avoid any share of the cost overruns insulates it from the risks that ratepayers and even, to a lesser extent, the vendors are bearing.

D. CONCLUSION: CURRENT KNOWLEDGE AND PRUDENT DECISION MAKING

I believe it is safe to say that if risk could not have been shifted to ratepayers, the company

[32] SCE&G uses two arguments to claim that the cost increases are not cost overruns. First, it argues that cost increases that were anticipated, even though it could not pin them down. The company says it is just making up for the cost increases it anticipated in its proposed cost contingency fund, which the courts rejected. The company acts as if the initial proceeding created an unwritten account on which it can draw and it refuses to say that it will foreswear doing so. Second, even though SCE&G identifies the cost increase as an increase in construction costs, it argues that because the rate of inflation has decreased, lowering the projected escalation of costs and the total cost of the project has not increased, there is no cost overrun. This puts the ratepayer in a no-win situation. If inflation goes up, consumer bills increase. If inflation goes down, the utility asks for additional costs. If the construction costs had not increased, consumers would have enjoyed lower projected bills. (See Cooper, 2012, Surrebuttal and Additional Testimony).

[33] As part of the negotiations the gap between the completion of the first and second units was reduced from 18 months to 9 months. This allows the vendor to share the costs between the construction of the units in a manner that dramatically lowers the total cost, but those cost savings have not been passed through to the consumers. The value of that cost reduction is far greater than the cost overruns the vendor has taken responsibility for (see Mark Cooper 2010, *Policy Challenges of Nuclear Reactor Construction*.

might not have undertaken the project and it would have pinned down the costs before it signed the EPC contract. I also believe that if stockholder funds had been at risk, the company would have been much more inclined to see the dramatic shift in material conditions as a threat to the economic viability of the project and therefore the prudence of continuing. Thus, shifting risk from stockholders to ratepayers (or taxpayers) has severe consequences.[34] As indicated in Table III-3, they end up paying too much for the wrong technology.

Technology Risk, Choice of Technologies: Subsidies induce utilities 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 ratepayers in the form of cost overruns or expenditures on facilities that do not produce a flow of goods and services. The indirect effects of early cost recovery may even be greater, since alternative energy sources become a threat to large facilities. Reductions in demand for large central station facilities, like nuclear reactors, raise questions about the need for large additions to supply. The size of nuclear projects is so large that financial and managerial resources are always constrained and the commitment to nuclear reactors and central station facilities crowds out deployment of alternatives.[35]

Execution Risk, Project Execution: The risk is high that these expensive and complex reactor projects will suffer delays, resulting in cost increases, or be abandoned or cancelled and never come on line, resulting in charges for unproductive sunk costs. Ratepayers are not reimbursed for early cost recovery rates that do not result in the production of electricity.

TABLE III-3: THREATS TO RATEPAYERS FROM ADVANCED COST RECOVERY

Type of Risk	Impact	Threat to Taxpayers & Ratepayers
Technology	Technology choice	Failure to adopt least cost approach
Execution	Project delays	Carrying costs, intergenerational inequity
	Abandonment	Burden of failed projects
Weak cost control	Cost overruns	Excessive costs
Marketplace	Excess Capacity	Excessive cost
Regulation	Policies that alter costs reviews	Weak project oversight Lax review, Inability to reject costs
Financial	Financial ratings Misallocation of resources	Discount rate, Downgrade or negative
Policy	Long lead times & large sunk costs create policy risk	Excess cost
	Failure to adopt carbon tax	Excess cost
	Adoption of complementary Policies	Excess capacity

Source: Mark Cooper, 2009, *All Risk No Reward for Taxpayers and Ratepayers,* Institute for Energy and the Environment, Vermont Law School, December

Marketplace Risk, Inflexible investment: The large size and long lead times of nuclear

[34] Mark Cooper, 2009, *All Risk No Reward for Taxpayers and Ratepayers,* Institute for Energy and the Environment, Vermont Law School, December

[35] Mark Cooper, 2010, *Policy Challenges of Nuclear Reactor Construction: Cost Escalation and Crowding Out Alternatives,* Institute for Energy and the Environment, Vermont Law School, September, 2010

reactors require very large additions to the resource portfolio and lock utilities and regulators in to the project, making it difficult to respond to changing circumstances resulting in excess and expensive capacity.

Regulatory Risk, Project Oversight: The pre-approval process for early cost recovery reduces scrutiny over cost escalation and overruns. Ratepayers will end up paying a higher price than anticipated for the facility. Utilities steadfastly resist proposals to protect ratepayers from the risk of cost overruns.

Financial Risk, Ratings: 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. If the nuclear project is large relative to the size of the utility, or its economic conditions deteriorate, rating agencies may come to see the project as weakening the financial structure of the utility, which results in a lower rating and higher financing costs. Utilities demand higher rates, creating a spiral that increases the burden on ratepayers.

Discount rate: When consumers give up use of their funds (e.g. deposit it in the bank), they expect a return. Under early cost recovery, consumers are not compensated by the utility for giving up the use of their funds. Utilities claim that the consumer will benefit from lower bills in the future, but if the consumers' discount rate equals the utility's cost of capital, then the consumer does not gain anything in the net present value as the result of early cost recovery. If the consumers' discount rate exceeds the utility's cost of capital, consumers are worse off. For cash-strapped consumers, taking after-tax dollars out of their pockets to cover the rate increases resulting from early cost recovery can be a serious burden.

Policy Risk: The long lead times and large sunk costs expose ratepayers to the risk that public policy might not follow the path the utility assumed in evaluating the alternatives. Inflexible choices result in costs that are higher and/or benefits that are smaller than expected.

The CEO's claim that nothing sufficient has come to pass to require a thorough prudence review flies in the conclusion reached by a broad range of decision makers. Across the industry, from utilities, to consumers, to equipment vendors to regulators and federal information agencies, to public power entities, including SCE&G's public sector partner, the dramatic, deterioration in the economics of nuclear reactor construction has been recognized, resulting in widespread abandonment of plans to construct new reactors. General Electric, one of the largest vendors of generation technologies with a broad portfolio of wind, gas, and nuclear has concluded that nuclear is much less attractive than gas and wind.[36] The EIA, Exelon, and PJM analyses reach a similar conclusion, as do a number of other regulatory bodies and Wall Street analysts.[37] The recognition of the facts on the ground goes well beyond those directly involved in the industry. A 2012 report for steel manufacturers made the point crisply.

> In 2010, the Nuclear Regulatory Commission expected applications for as many as 20 new reactors. At this point, however, the combination of reduced demand for power following the recession, the dramatic drop in the cost of competing fuels (natural gas), and substantial increases in expected construction costs compared to original budgets have stopped the nuclear renaissance in its tracks. Last month, the NRC issued combined construction and

[36] http://www.ft.com/intl/cms/s/0/bd975d10-dd59-11e1-8fdc-00144feab49a.html#axzz22xSbueX4.
[37] See Figures IV-5 through IV-7.

operating licenses for the Vogtle project in Georgia and the VC Summer project in South Carolina. Both are twin 1,100 MW Westinghouse AP1000 pressurized water reactors. Beyond these two projects, it is unclear whether any of several other announced projects will actually proceed with construction.[38]

The next two Sections explore these factors and show that the CEO's claim that construction should continue is at odds with economic reality.[39]

[38] Steel Manufacturers Association, May 2012, Energy Update http://www.steelnet.org/new/20120500.pdf

[39] The South Carolina Public Service Commission chose to allow recovery of the cost overruns and continuation of the projects on two grounds that are fundamentally flawed and being litigated)Order of the Public Service Commission of South Carolina, Petition Of South Carolina Electric & Gas Company For Updates And Revisions To Schedules Related To The Constcuction of Nuclear Base Load Generation Facility t Jenkinsville, South Carolina, Docket No. 2012-203-E - Order No. 2012-884, November 12, 2012). The Commission accepts the company's error-riddled, eleventh-hour economic analysis with virtually no scrutiny, as discussed in Section IV and V. It did so in part based on a claim that the statute does not allow it to conduct reviews of the prudence of completing a project once it has been approved for cost recovery. These justifications for allowing the project to continue are wrong as a matter of law and good practice and will prove to be catastrophic for the ratepayer of South Carolina.

IV. ECONOMIC CAUSES OF THE COLLAPSE OF THE "NUCLEAR RENAISSANCE"

Viewed through the lens of advanced cost recovery, where all of the risk had been shifted to others and the utility has little or no risk, the CEO of SCE&G saw nothing that indicted the decision to build the nuclear reactors should be re-evaluated. He also believed that the Base Load Review Act did not impose an obligation to do so. With neither regulation nor stockholder interest pressing for prudence, it was easy to ignore the facts on the ground that had led every utility management that had not signed an EPC to conclude that moving ahead with a new nuclear reactor was a bad idea.[40] As noted above and discussed below, the key changes in the economic environment that led all the others to reject nuclear reactor construction included

- plummeting natural gas prices,
- other alternatives with lower and declining costs,
- shrinking demand, and
- a climate policy that was not as friendly to nuclear power as the utilities had assumed.

This section deals with the first three factors. The next section addresses the fourth. Individually, any one of these changes could have triggered a prudence review; taken together, they not only make a compelling case for a thorough prudence review, but they spell the collapse of the economics of nuclear reactor construction and dictate the abandonment of the project. When the utility came in for its first cost increase in 2010, the case for cancellation was already quite compelling. It did not conduct an economic review at that time.

Moreover, it is important to note that there were also fundamental flaws in the utilities original approach to decision making in the initial request for advanced cost recovery that should have been corrected from the outset. In the recent prudence review the company repeated the basic problems. It

- used an extremely narrow focus on three generation alternatives – nuclear, coal, and gas;
- took a rigid approach to capacity additions that did not recognizes the value of flexible alternatives;
- never considered the cost of excess capacity, and
- assumed utility-friendly, consumer-unfriendly recovery of nuclear costs.

A. NATURAL GAS PRICES

In the economic analysis to justify the request for advanced cost recovery, the company devoted all of its attention to coal and gas. It did not consider other alternatives in comparison to nuclear reactors. Coal quickly fell away and the analysis focused on the gas-nuclear comparison. Assuming a very high price for gas and a substantial price for carbon emissions, the company concluded that nuclear reactors would deliver less costly power than gas.

[40] Even FPL which continued to collect funds under Florida's advanced cost recovery statute, but had not signed an EPC shifted from saying it was going to build a reactor to saying it had not decided whether it would do so, but was keeping its option open.

The top graph in Figure IV-1 contrast the base case assumptions about natural gas costs that were used as the "decision point" in the 2008 proceeding to the current projected cost of natural gas. The bottom graph pinpoints the causes of the differences between the two. The very high cost of gas projected in 2008 was the result of a high wellhead price and a cost of carbon that was put at $15 per ton of CO_2, escalating at 7% per year, discussed in the scenario analysis. As shown in Figure IV-1, these two price assumptions, which were so central to the economic analysis, proved to be wrong.

The base case projections of prices used in the 2008 proceeding were far above the prices projected by the EIA at that time. By 2009-2010, gas prices had fallen dramatically and returned to their historic trajectory. Today's much lower base case projection for EIA is consistent with prices on the New York Mercantile Exchange. Today the company uses a projected cost of gas that is about one-third the level it used to justify the construction of Summer 2 & 3 four years ago. Today gas prices are well below even the low gas price projections from 2008.

The company also argued that a cost of carbon needed to be factored into the analysis. It presented a set of carbon price scenarios. In the case to which the company pointed as the "decision point" for gas the carbon cost was $15 per ton of carbon dioxide escalating at 7% per year. Over time, this has the effect of increasing the effective price of gas significantly. We will discuss the carbon price situation at great length in Section V. Here is suffices to say that no price has been imposed on carbon to date and it is unclear when, if ever, a price will be imposed or how high it will be.

Since fuel costs represent about three-quarters of the total cost of electricity from gas-fired generation, the large reduction in gas prices observed in the market would lower projected output costs dramatically, by one half or more. The dramatic increase in gas supplies and decline in gas prices got widespread attention as a major cause of the collapse of the "nuclear renaissance.[41] SCE&G and the SCPSC ignored it.

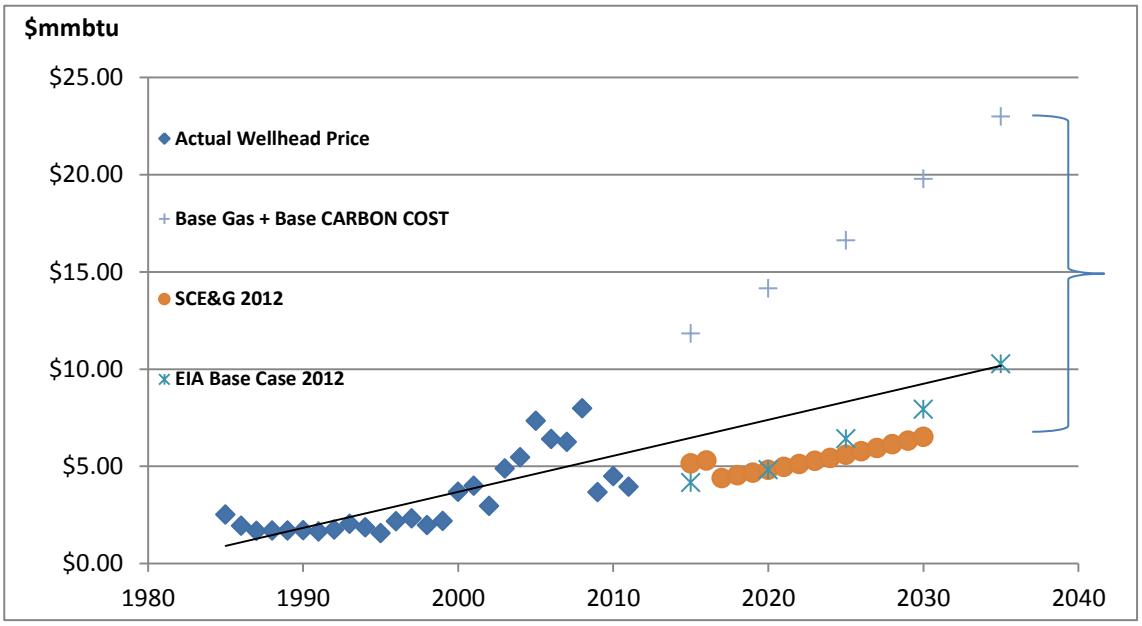
B. THE FULL RANGE OF ALTERNATIVES

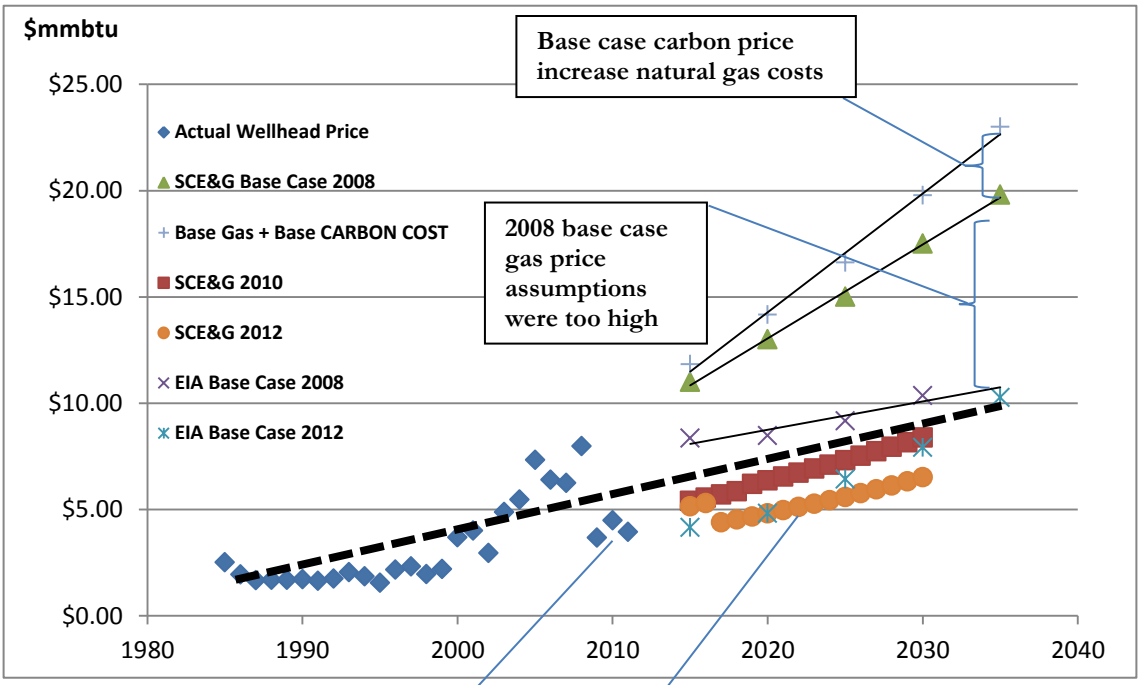
That current conditions lead to the conclusion that nuclear is not the preferred option on the company's own terms (i.e. compared to natural gas) is the first step in demonstrating that a careful and thorough prudence review is necessary, but it is not the last step. All of the available options should be considered on a going forward basis with their costs estimated based on the amount and time frame in which capacity will be needed.

There has been a bevy of cost estimates from within the industry as well as from outside analysts that makes it clear there are numerous alternatives, in addition to natural gas, that are less costly than nuclear. Figure IV-2 shows side-by-side costs estimates for eleven technologies offered by John Rowe, CEO of Exelon, which is the nation's largest owner of nuclear facilities. He expresses the cost of resources as the cost per ton of carbon emission reduction, which is a common way to frame the choice of resources in an environment where carbon emissions are an important

[41] See, .e.g. Reuters, 2012; John Rowe, "Fixing the Carbon Problem without Breaking the Economy," Resources for the Future Policy Leadership Forum Lunch, May 12, 2010; "Energy Policy: Above All, Do No Harm," *American Enterprise Institute,* March 8, 2011.

FIGURE IV-1: SUMMER: NATURAL GAS PRICES AND PROJECTION HAVE PLUMMETED SINCE 2007, RETURNING TO THEIR HISTORIC PATTERN





Base case carbon price increase natural gas costs

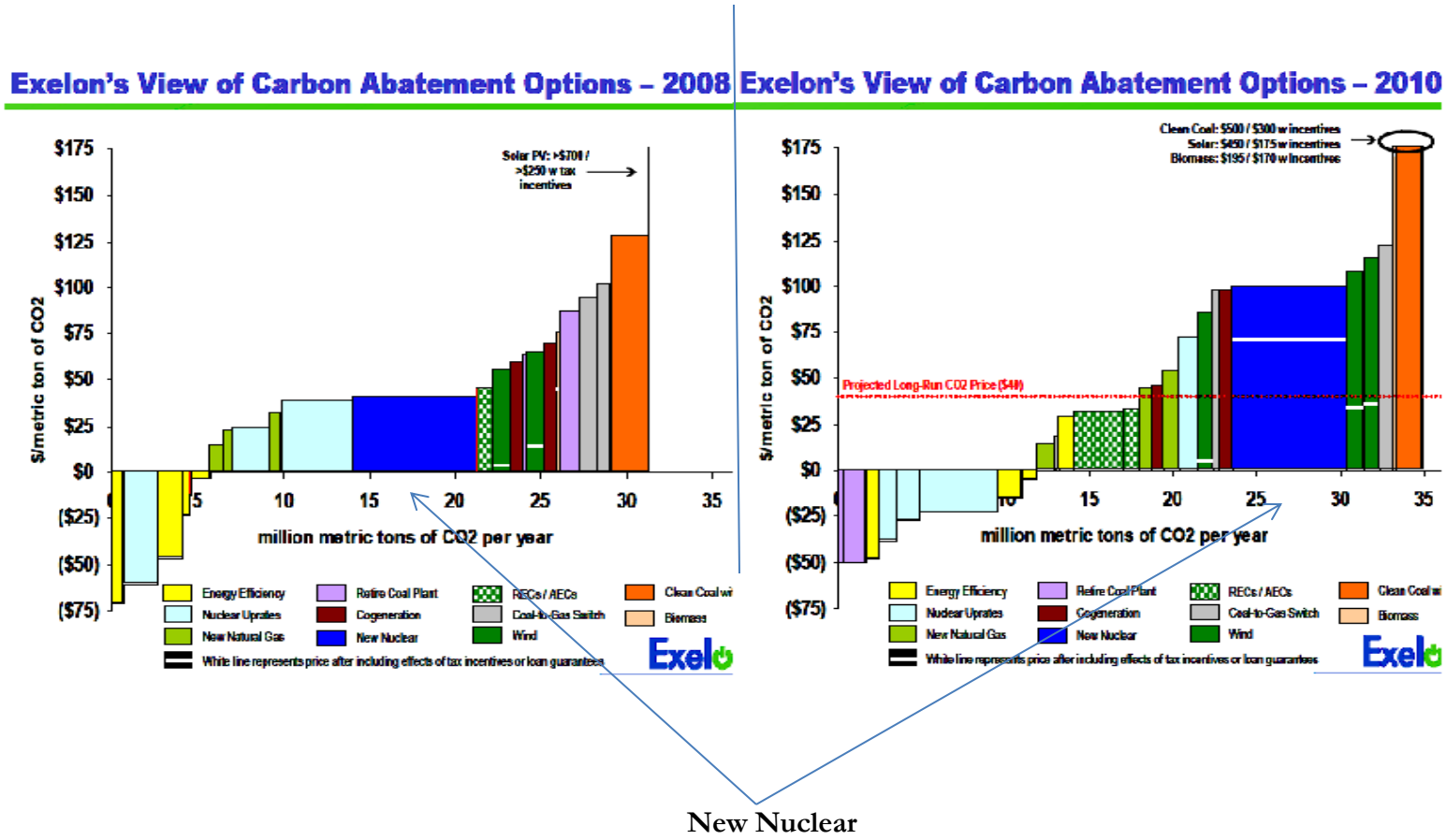
2008 base case gas price assumptions were too high

By 2009-2010, natural gas prices had returned to their long term trend

Current and projected natural gas prices undermine the economics of nuclear reactor construction

Source: Exhibit H (Lynch, 2008, Exhibit JML-2), pp. 9-10; *Petition of South Carolina Electric &Gas Company for Updates and Revisions to Schedules Related to the Construction of a Nuclear Base Load Generation Facility at Jenkinsville, South Carolina,* Docket No. 2012-203-E, Response to Sierra Club Interrogatories dated September 28, 2012, p. 157, Energy Information Administration, Annual Energy Outlook, 2008, 2012, Table A1.

FIGURE IV-2: EXELON'S INCREASINGLY DIM VIEW OF NUCLEAR ECONOMICS AND IMPROVING VIEW OF ALTERNATIVES



Source: John Rowe, *Energy Policy: Above All, Do No Harm,* American Enterprise Institute, March 8, 2011

consideration. He includes efficiency, which is an important resource.[42] In 2008, new gas was less costly than nuclear, as were a number of other alternatives. By 2010, the less costly alternatives had increased in number and quantity of supply available. Even with carbon dioxide at $40 per ton, nuclear is extremely costly compared to other low carbon alternatives.

Figure IV-3 shows cost curves from the East Coast Independent System Operator, PJM. It shows both the traditional measure of levelized cost per MWH and the cost per ton of carbon emissions reduced. It is similar to the Exelon analysis. In both of these analyses, by 2010 nuclear was close to the last resource a prudent decision maker would select either to meet the need for electricity or to reduce carbon emissions. Figure IV-4 shows four other estimates of the levelized cost of resources to meet the need for electricity. Two of them are national – EIA and Lazard – and two are regional – the California Energy Commission (CEC) and Synapse for the Southeast.[43] The top graph shows the estimates in $/MWH. The bottom graph shows the cost estimates expressed as a percentage of nuclear. Nuclear is among the most costly options and is relatively less attractive, compared to the alternatives available than it was in the 1980s, when the "Great Bandwagon Market" crashed.

It is also important to analyze the alternative at the point where they enter the utility grid. Some technologies should be evaluated at the retail consumer meter, rather than the utility wholesale busbar. Distributed applications that are likely to produce power at the peak and reduce consumer bills directly are especially attractive to consumers, as they should be to the Commission.[44]

C. COST TRENDS

Because nuclear reactors take so long to build, cost trends for alternative resources are extremely important. Slowing demand growth magnifies the importance of cost trends. It is not only important to know how alternatives fit into the resource mix in terms of where and when (time of day) they deliver power, but also when they can be brought online. Given the long lead times and large sunk costs of nuclear reactors, the future costs of alternatives – five to ten years hence – are the relevant comparisons for prudent decision making.

Longer-term cost trends reinforce the conclusion that alternatives to nuclear power are becoming more attractive options. As noted above, in contrast to nuclear reactor construction costs and cost estimates that have been rising dramatically, several of the alternatives are exhibiting reductions in cost, driven by technological innovation, learning by doing, and economies of scale.[45]

Figure IV-5 Presents cost trends for solar power. The top graph in Figure IV-5 shows forward looking cost trends for solar photovoltaics from Lazard. In the bottom graph, those projected trends are joined with recent, past cost trends as estimated by analysts at Lawrence Berkeley Laboratory. Lazard argues that in some situations solar power is already competitive with peak

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[42] Comparing these cost estimates to the cost estimates developed in the past for South Carolina is problematic. Given the fact that escalation is guaranteed and will be included in the cost that are entered into the rate base, it would appear that the total project cash flow (which does not include financing cost) is analogous to the overnight capital costs used in other analyses.

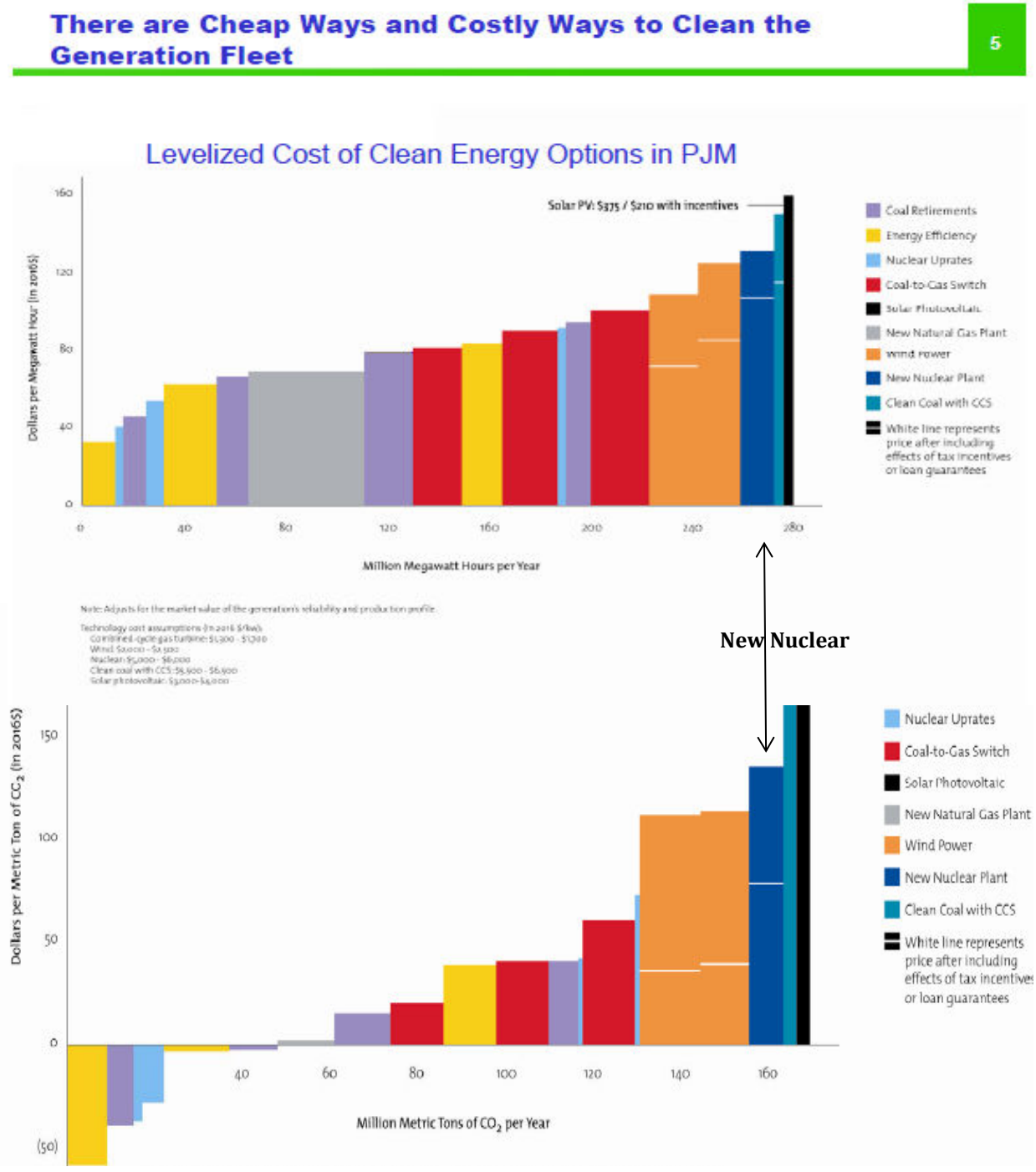
[43] With the addition of these two regions, this data provides two national estimates and four regional estimates – Midwest, Mid Atlantic, South East and California.

[44] SCE&G found that approach sufficiently significant to challenge such a business model in South Carolina. (Sammy Fretwell, "Scuttled Solar Deal Leaves Churches, Charities in the Lurch," *The State,* March 11, 2012).

[45] See Appendix C under learning

power and that several approaches to solar power will be cost competitive with natural gas combined cycle plants by the time the Summer units are online. The long term trend suggests that the latter is quite reasonable given recent history.

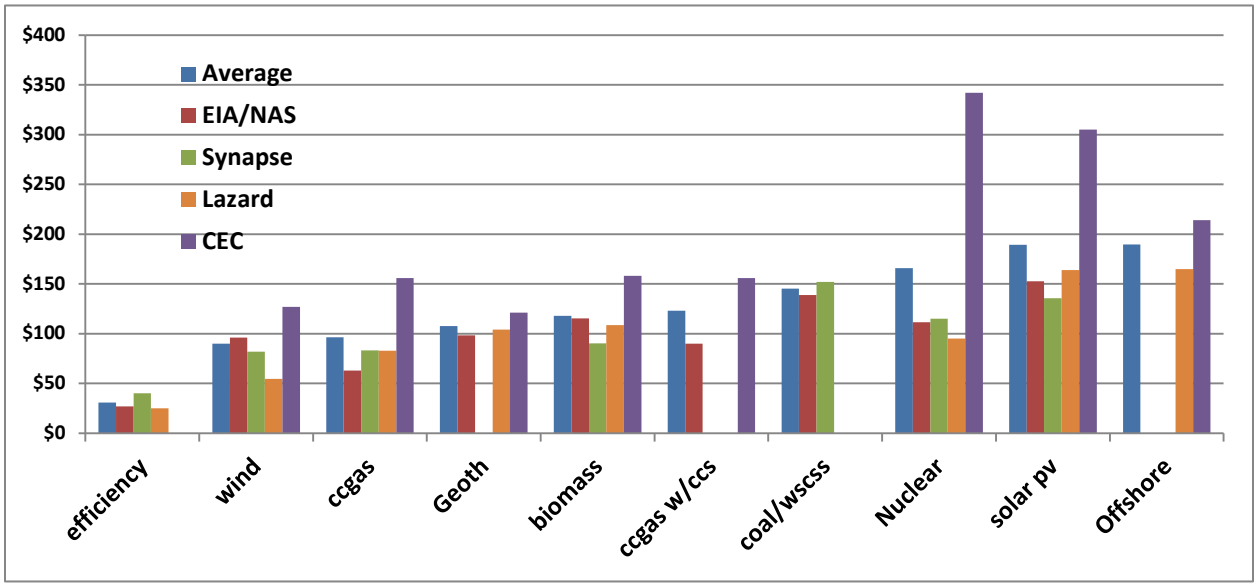
FIGURE IV-3: PJM RESOURCE SUPPLY CURVES



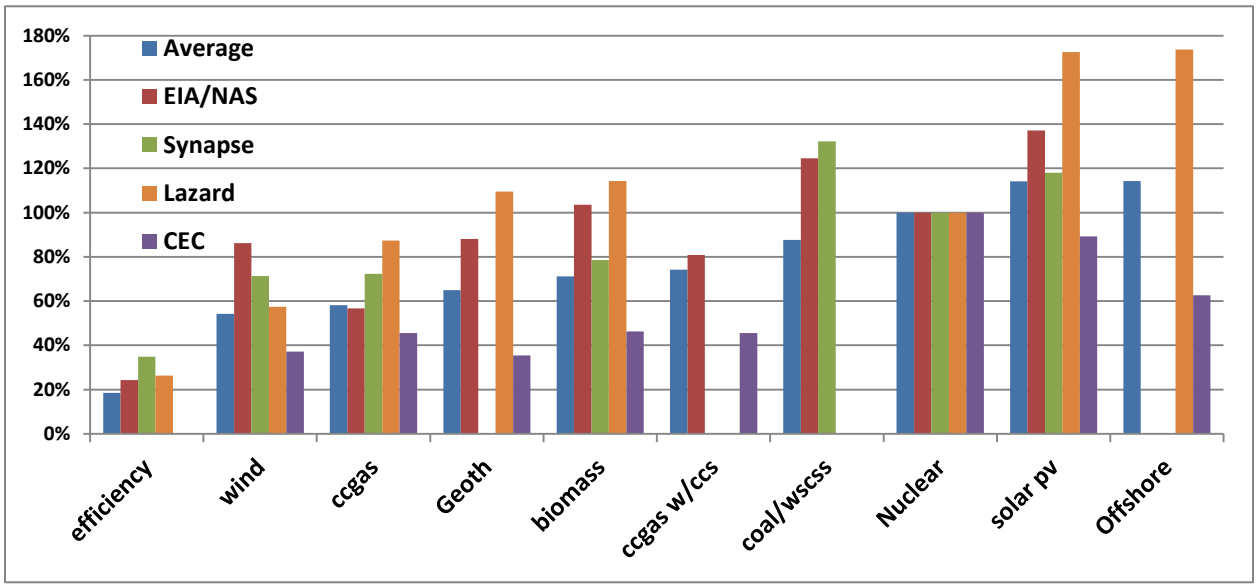
Source: John Rowe, *Energy Policy: Above All, Do No Harm,* American Enterprise Institute, March 8, 2011

FIGURE IV-4: NATIONAL AND REGIONAL ESTIMATES OF COST OF RESOURCE OPTIONS

Levelized Cost of Electricity LCOE) in Real $/MWH



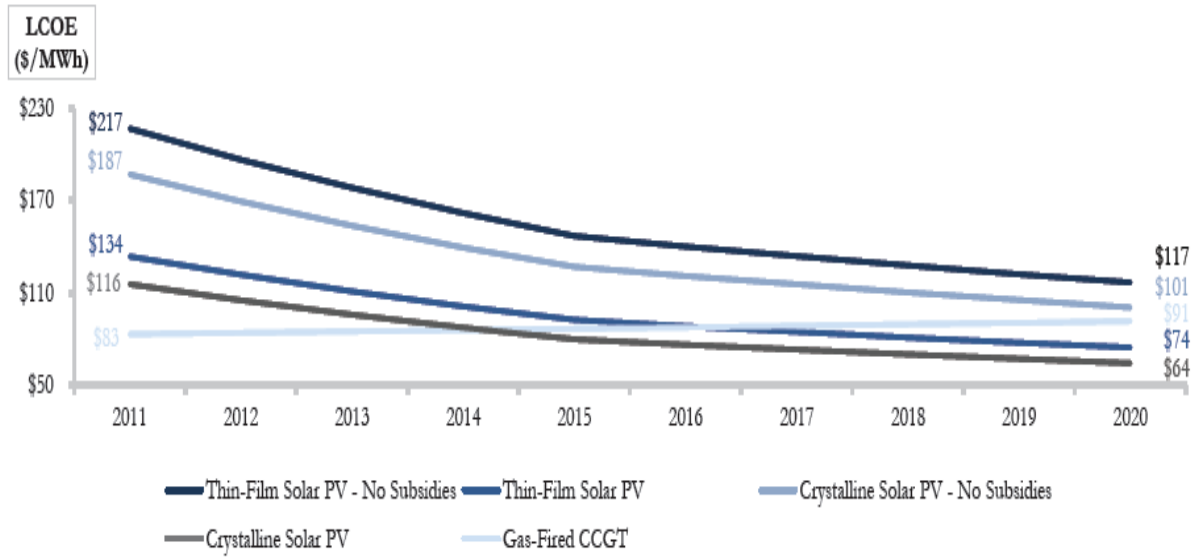
Percent of Nuclear LCOE



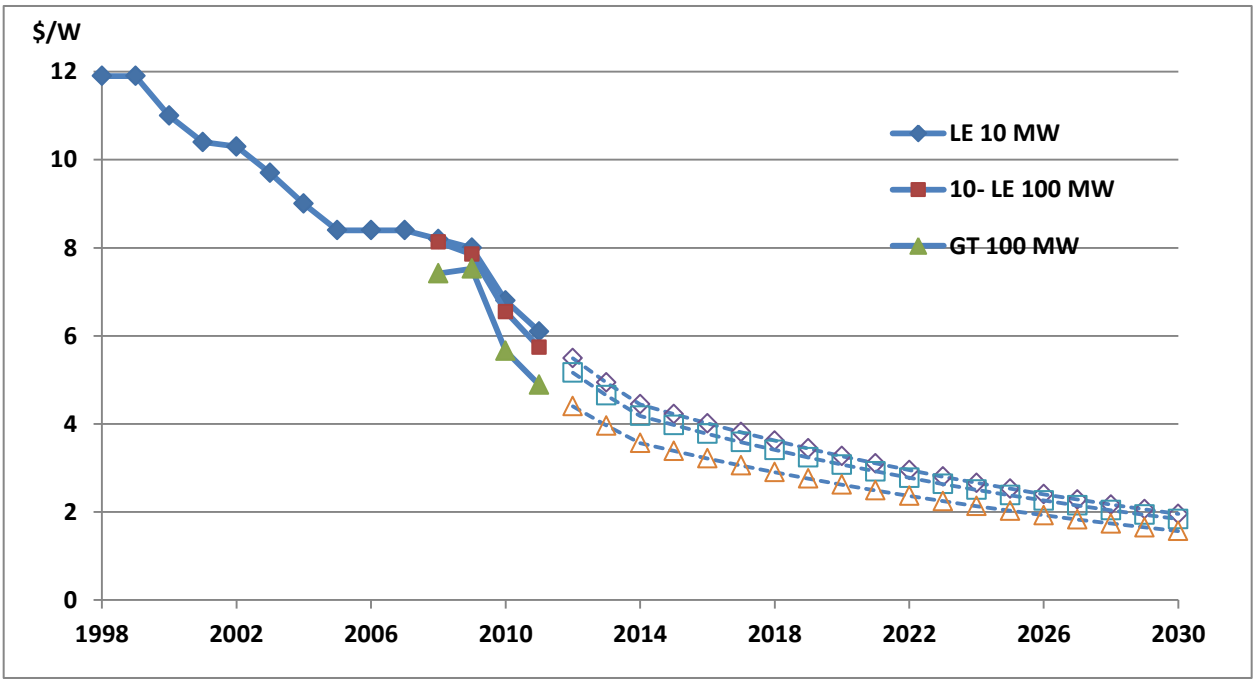
Source: California Energy Commission, *Cost of Central Station Generation,* January 2010Mott MacDonald, *Cost of Low-carbon Generation Technologies:* 201;1Lazard, *Levelized Cost of Energy Analysis* – Version 5.0, June 2011; Energy Information Administration, "Levelized Cost of New Generation Resources in the Annual Energy Outlook," *Annual Energy Outlook,* July 12, 2012, with the cost of energy efficiency from National Research Council, *America's Energy Future: Technology and Transformation,* National Academy of Sciences, 2011. Max Change, et al., *Big Risk; Better Alternatives: An Examination of Two Nuclear Energy Projects in the U.S.,* Synapse, October 6, 2011.

FIGURE IV-5: KEY COST TRENDS FOR SOLAR POWER

Lazard Levelized Cost for Solar and Combined Cycle



Recent Trends Extended with Lazard Projections



Source: Lazard, *Levelized Cost of Energy Analysis* – Version 5.0, June 2011; Galen Barbose, et al., *Photovoltaic (PV) Pricing Trends: Historical, Recent, and Near-Term Projections, LBL and NREL, November 2012,* http://www.nrel.gov/docs/fy13osti/56776.pdf

Figure IV-6 shows a broader range of estimates for generation that includes key renewables like wind and solar. The California Energy Commission projects dramatically declining costs for solar and wind technologies over the next two decades, which is consistent with other projections. The CEC projects dramatically rising costs for nuclear reactor construction. However, plotting those cost projections against Lazard's assumptions about the overnight costs of nuclear in the year in which the reactor could come on line, given the assumed construction period, suggests that they CEC estimates are consistent with other estimates. The cost trends clearly suggest that nuclear reactor construction is not only more costly than the alternatives today, but will be a great deal more costly than many more alternatives in the future.

D. EFFICIENCY AS A RESOURCE

One striking feature of the cost of carbon abatement supply curve is the fact that there are a number of options with substantial potential that have "negative" costs. This simply means that the cost of the resource is lower than the current cost of generation. Therefore, carbon emissions can be reduced and the average cost of generation will be reduced. These resource supply curves that include estimates of the cost of efficiency (Exelon, PJM, and Lazard) make it clear that the cornerstone of the resource supply-curve should be energy efficiency, whatever the approach to carbon policy is taken. The attractiveness and crucial role of efficiency in meeting future needs for electricity is widely recognized inside and outside of the electricity industry.[46] The company reports positive results from its DSM experiments,[47] but efficiency as a low cost resource has not been well developed in the Southeast (see Figure IV-7).

Comparative studies of the efficiency programs of states and utilities prepared by public interest groups and utility consultants all show that South Carolina and SCE&G are well below the national average in effort and results.[48] The current cost of efficiency is so much lower than the marginal cost of other supply-side options that there is a great deal of efficiency that SCE&G could

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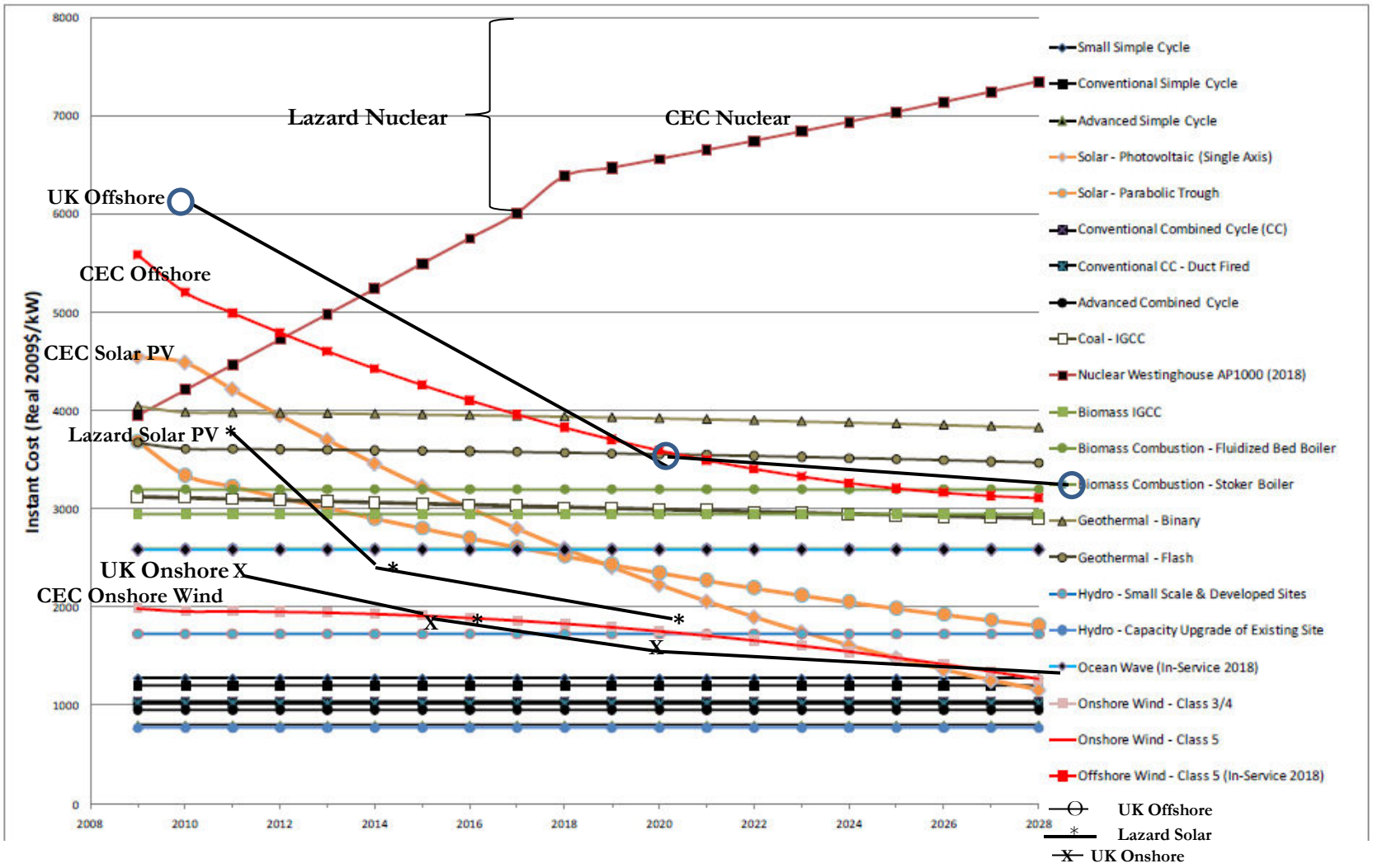
[46] McKinsey & Company, *Unlocking Energy Efficiency in the U.S. Economy*, 2009, http://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy; Elizabeth Doris, Jaquelin Cochran, and Martin Vorum, *Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government,* Technical Report NREL/TP-6A2-46532 , December 2009; http://www.nrel.gov/docs/fy10osti/46532.pdf; OECD, *Toward Green Growth,* 2011, mentions efficiency first, http://www.oecd.org/greengrowth/48224539.pdf; Lisa Ryan and Nina Campbell, *Spreading the Net: The Multiple Benefits of Energy Improvements*, International Energy Agency, 2012, http://www.oecd-ilibrary.org/energy/spreading-the-net-the-multiple-benefits-of-energy-efficiency-improvements_5k9crzjbpkkc-en.;

[47] Mr. Marsh testifies that DSM has delivered the equivalent of 10MW at a cost of $11 million, a cost of $1100 (Marsh, p. 24, $11million for 10 MW = $1100/kw). The full cost of Summer 2 and 3 is over four times as high (Walker, Exhibit 1; $5,761,910/1228MW = $4692/kw). American Council for an Energy Efficient Economy, http://aceee.org/sector/state-policy/scorecard; Charles, J. Cicchetti, *Going Green and Getting Regulation Right* (Public Utilities Reports, 2009), chapters 5 and 6.

[48] American Council for an Energy Efficient Economy, http://aceee.org/sector/state-policy/scorecard; Charles, J. Cicchetti, *Going Green and Getting Regulation Right* (Public Utilities Reports, 2009), chapters 5 and 6. http://www.aceee.org/sites/default/files/publications/researchreports/e126.pdf. The company claims that it is doing well compared to other utilities. However, many other utilities are doing much better, even those in South Carolina. For Example, a study of energy efficiency in the Southeast by the Southern Alliance for Clean energy (*Energy Efficiency: the New Energy Super Hero of the Southeast,* August 7, 2012) found that Duke Energy gets over twice the savings as SCE&G at half the cost. There is a great deal of difference between, where SCE&G is and where it could be.

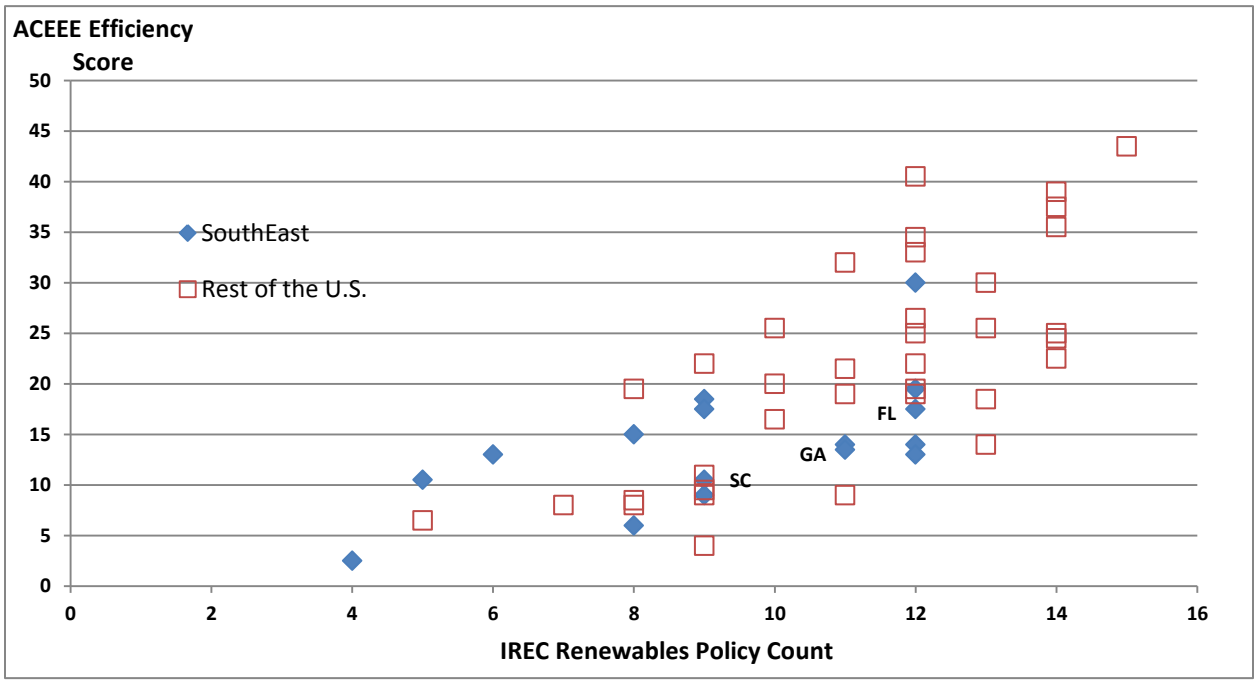
FIGURE IV-6: CEC AND OTHER OVERNIGHT COST TRENDS



Source: California Energy Commission, *Cost of Central Station Generation,* January 2010; Mott MacDonald, *Cost of Low-carbon Generation Technologies:* 2011; Lazard, *Levelized Cost of Energy Analysis* – Version 5.0, June 2011, Sensitivity to Cost of Capital

pursue that is cost effective.[49] These are issues that need to be carefully considered in the full prudence review.

FIGURE IV-7: EVALUATIONS OF STATE PROGRAMS TO PROMOTE EFFICIENCY & RENEWABLES



Sources: American Council for An Energy Efficient Economy, Scorecard, 2012, http://aceee.org/sector/state-policy/scorecard; Interstate Renewable Energy Council and Department of energy, *Database of Incentives for Renewables and Energy Efficiency;* http://www.dsireusa.org/summarytables/finre.cfm

E. SLOWING GROWTH OF DEMAND AND THE IMPORTANCE OF FLEXIBLE SUPPLY

Because nuclear reactors take so long to build and demand growth has slowed in recent years, it is important to look at future cost trends and to consider the value of adding resources in smaller increments over shorter periods. The slower the growth, the greater the flexibility in adding resources, which means that assets that can be added with much shorter lead times in much smaller increments are more attractive. As we have seen, slowing demand growth played a role in the crash of the "Great Bandwagon Market," because it forced nuclear to compete more intensively against coal. Slowing demand growth has played an important role in the collapse of the "nuclear renaissance," a role that was widely cited as a cause of the demise of the "nuclear renaissance."[50]

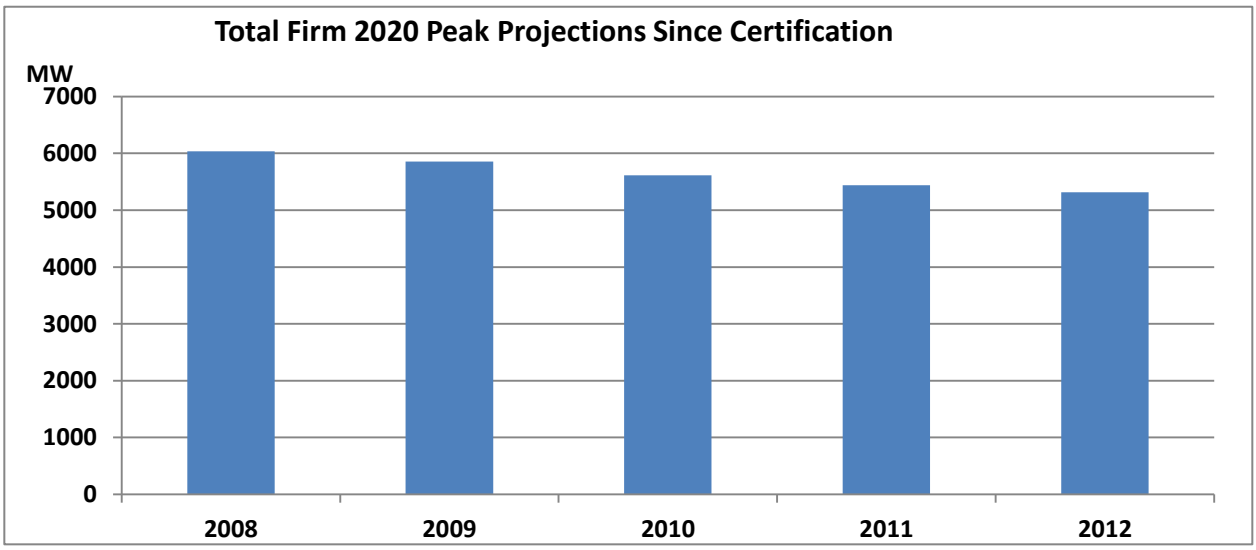
As shown in Figure IV-8, since the 2008 proceeding, the projected peak demand for 2020 is down by over 700 MW, when both planned reactors are supposed to be online. That reduction in demand equals substantially more than half of the capacity the nuclear project will bring on line for

[49] Larry Dale, et. al., "Retrospective Evaluation of Appliance Price Trends," *Energy Policy,* 37 (2009); Katherine Friedrich, Maggie Eldridge, Dan York, Patti Witte, and Marty Kushler, *Saving Energy Cost-Effectively: A National Review of the Cost of Energy Saved Through Utility-Sector Energy Efficiency Programs,* ACEEE, 2009; http://aceee.org/research-report/u092; Kenji Takahashi and David Nichols, *The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date,* ACEEE Summer study, 2008; http://www.eceee.org/conference_proceedings/ACEEE_buildings/2008/Panel_8/8_434;

[50] See, e.g. Steel Manufacturers, 2012.

SCE&G. This will result in a sharp increase in capacity above the reserve margin requirement, if the reactors are completed, which increases the cost to ratepayers. With the utility commitment to such a large addition to capacity, a dramatic reduction in demand growth represents the exposure to marketplace risk. Slowing of demand growth also increase technology risk, since a slower rate of growth makes the ability to add smaller increments of capacity in shorter time frames a more attractive investment strategy. With slower growth smaller, shorter lead time additions to the resource portfolio result in a better fit between need and capacity. Slow growth also can be used to buy **time so that ratepayers benefit from the declining cost trends exhibited by the other low carbon alternatives.**

FIGURE IV-8: DEMAND GROWTH HAD SLOWED DRAMATICALLY BY 2010



Sources: 2008: Exhibit H (Lynch, 2008, Exhibit JML-2); S.C. Coastal, Conservation League, et al., South Carolina Electric & Gas, Integrate Resource Plan, Docket No. 2012-9-E, Table 1.2009-2012; Response to Sierra Club Interrogatories, p. 326.

In evaluating options for inclusion in utility resource portfolios, time is of the essence. Adding smaller increments farther out in the future reduces both the level of capital spending and the present value of the revenue requirement. In fact, in situations where there is a great deal of uncertainty, time is an extremely valuable asset. The ability to wait to make decisions becomes crucial to maximizing performance. Real option analysis has been developed to measure the value of time in decision making.[51]

F. THE IMPORTANCE OF FLEXIBLE SUPPLY

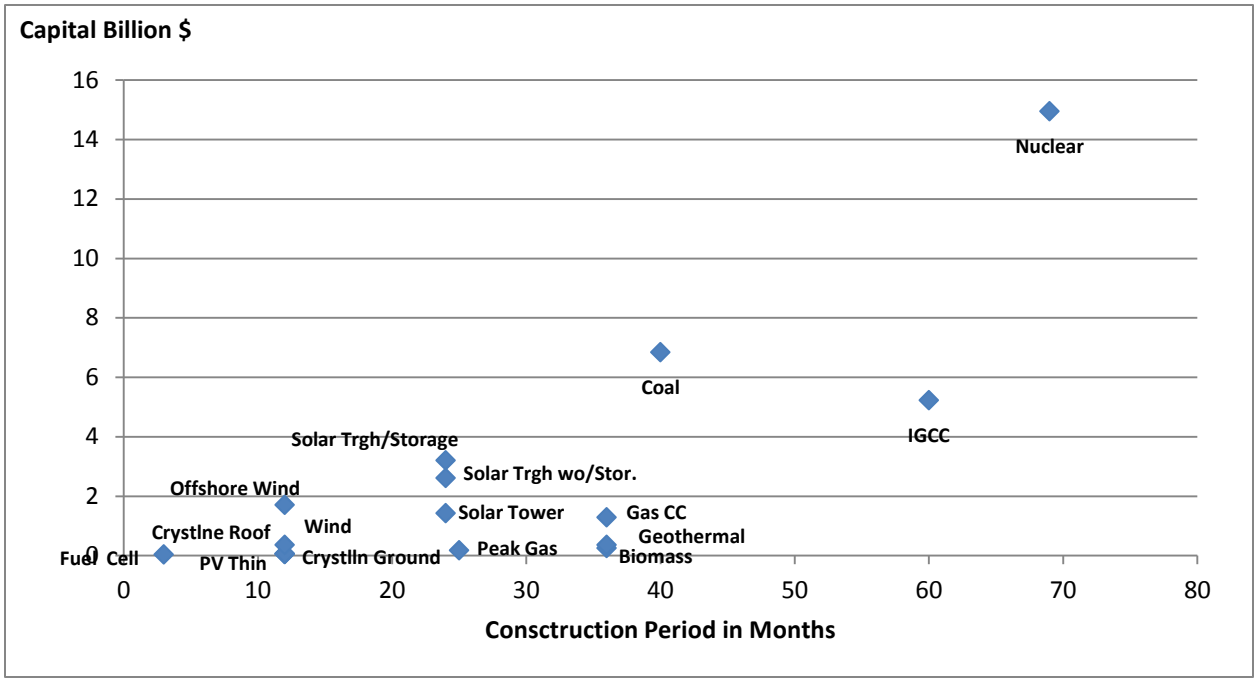
The discount rate is the primary instrument utilized to value time, but it does not treat time

[51] Applications of the concept to energy decision making can be found in William, Blyth, et al., 2007, "Investment Risk under Uncertain Climate Change Policy," *Energy Policy, 35;* Hiouska, Jaroslava et al., 2002, "Real Option Models and Electricity Portfolio Management," *OSCOGEN;* Pauli Murto, and Gjermund Nese, 2002, "Input Price Risk and Optimal Timing of Energy Investment: Choice Between Fossil and Biofuels," *System Analysis Laboratory, Helsinki University of Technology*; Michael Siclari, and Giuseppe Castellacci, N.D, "Real Options for Flexible Power Generation Modeling," *Energy Risk International;*

as a critical variable. In every scenario and sensitivity analysis the company conducted, it simply assumed that a quantity of natural gas generation capacity equal to the quantity of nuclear generation capacity was added in exactly the same year. Given the dramatic reduction in demand growth projections and the fact that natural gas plants can be acquired in much smaller increments over a much shorter time frame, gas can be added more flexibly.

Figure IV-9 shows the sunk cost associated with over a dozen technologies analyzed by Lazard. It plots the total (overnight) capital investment against the construction period. Nuclear reactors stand out as very large, long lead-time projects that create huge sunk costs, compared to the alternatives. Moreover, Lazard's nuclear reactor construction period of 69 months is wildly optimistic, given the current experience.

FIGURE IV-9: SUNK COSTS: TOTAL CAPITAL COSTS AND CONSTRUCTION PERIODS



Source: Lazard, *Levelized Cost of Energy Analysis* – Version 6.0, June 2011, Key Assumptions

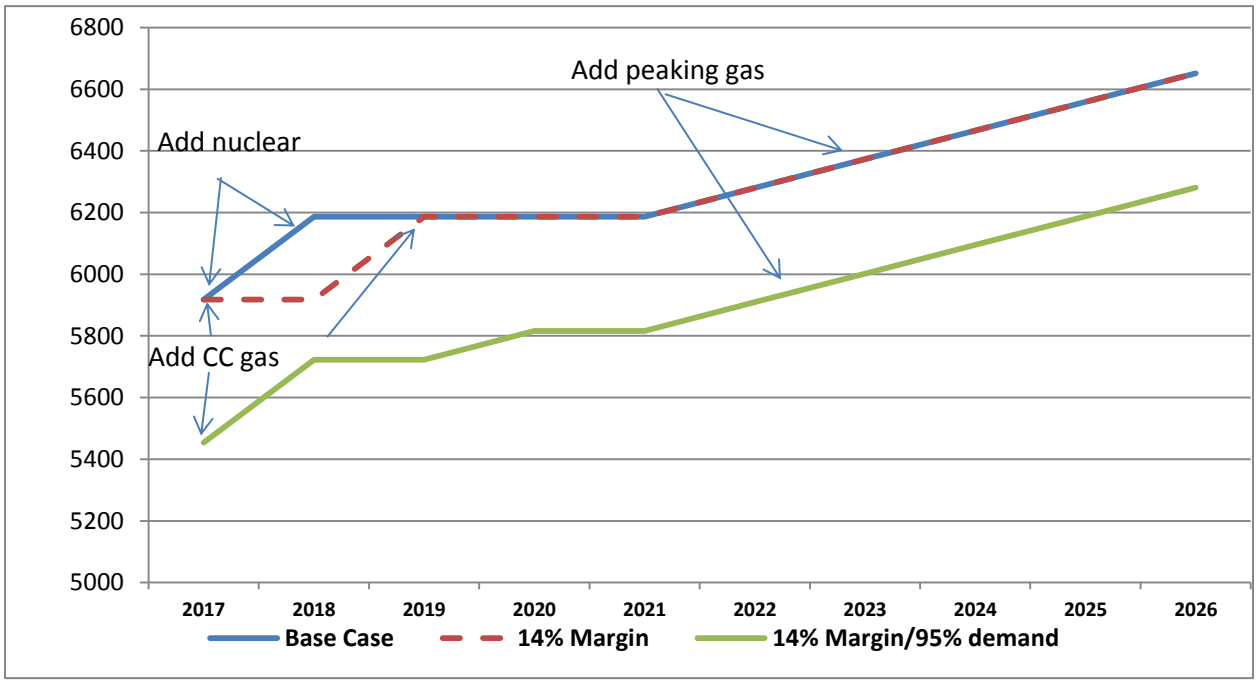
The real option value of gas and other flexible alternatives was not recognized in any of the company analysis and is not reflected in the discount rate. If anything the discount rate biases the analysis against gas, since lower rates increase the present value of future gas costs. Prudent decision making in an environment of great uncertainty requires careful consideration of the option value of resource choice.[52]

[52] Mark Cooper, "Prudent Resource Acquisition in a Complex Decision Making Environment: Multidimensional Analysis Highlights the Superiority of Efficiency,"2011 *ACEEE National Conference on Energy Efficiency as a Resource,* September 26, 2011; Least Cost Planning for 21st Century Electricity Supply: Meeting the Challenges of Complexity and Ambiguity in Decision Making, MACRUC Annual Conference, June 5, 2011; "Risk, Uncertainty and Ignorance: Analytic Tools for Least-Cost Strategies to Meet Electricity Needs in a Complex Age," *Variable Renewable Energy and Natural Gas: Two Great Things that Go Together, or Best Not to Mix Them*. NARUC Winter Committee Meetings, Energy Resources, Environment and Gas Committee, February 15, 2011.

One way to take the magnitude of the impact of slowing demand growth into account is to calculate the reduction of the present value revenue requirement that would result from waiting to acquire resources. Ultimately, if demand growth is slowed sufficiently, some generation capacity may never be needed. By freezing the supply side, the company analysis renders the demand-side analysis and the dispatch modeling irrelevant. Holding capacity constant, varying demand only allows the modeler to alter the variable (operating costs) in response to changes in demand. There can be no variation in capital costs. A prudent system designer would reduce capital expenditures if possible. A million PROSYM runs that do not consider changes in timing of capital investment cannot give the right answer because it has not been allowed to ask the right questions.

Figure IV-10 shows the impact of lifting the unwarranted assumption that gas plants must be added in the same year as the nuclear reactors. I assume a 14% reserve margin requirement, which is a level that occurs in several of the years analyzed, without triggering a decision to add capacity. Under that assumption, in the base case, SCE&G could delay adding the second combined cycle gas facility and would have flexibility to choose when to add the second combined cycle plant or peakers. In the low demand scenario I considered, the first gas combined cycle unit is moved back a year, the second gas combined cycle unit is never needed, and the need for three of the four peakers is eliminated. Modeling the benefits of demand reduction and natural gas flexibility could lower the capital requirements and costs in the gas scenario. Moreover, if larger reduction in the need for non-renewable capacity occur, the importance of incorporating the value of flexibility in supply becomes even more important.

FIGURE IV-10: GENERATION CAPACITY WITH VARIOUS RESERVE MARGIN AND DEMAND ASSUMPTIONS



Sources: ***Comparative Economic Analysis of Completing Construction or Pursuing a Gas Resource Strategy,*** **Appendix 1. (all scenarios include retirement of 640 MW of coal in 2017-2018)**

V. THE IMPACT OF CARBON POLICY AND SUNK COSTS

This section examines two policy issues that have a huge impact on the resource selection process – the handling of carbon costs and sunk costs. Both reflect policy choices. The carbon cost issue is broadly applicable to all states, whether or not they have adopted advanced cost recovery statutes. The sunk cost issue is specific to advanced cost recovery.

A. HOW THE ASSUMPTION OF A HEFTY CARBON COST MISLED DECISION MAKERS

The assumption that policymakers should insert a heavy cost of carbon into the analysis, even though no such cost has been imposed by policy is questionable for several reasons. First, a rising price of carbon makes all low-carbon resources more attractive. The failure to consider all low-carbon alternatives in an analysis that is dependent on a rising price for carbon is a substantial error. Second, as carbon prices rise, it is a mistake to assume that natural gas generation technology will simply "pay the carbon tax." Technology will be developed to lower the cost of gas with carbon capture. If the other lower cost, smaller scale alternatives are available (even mandated) for early compliance, then the later gas technology that becomes available will likely be substantially less costly than the unabated gas technology the company assumed in its analysis. Third, determining the price to place on carbon is a challenge. The preferred approach to setting a cost of carbon involves reliance on market forces. Therefore, the cost is dependent on the development of low carbon alternatives. If an administrative approach is taken to setting the cost of carbon, estimating the value of abatement is extremely difficult.

There is mounting evidence that hefty carbon costs, standing alone, are far from the optimum policy. A carbon cost addresses the fact that the harm of carbon emissions is an externality. As summarized in the Appendix C, the recent literature on climate change identifies a number of other market imperfections or barriers that cause the response to the imposition of a cost on carbon to be less than optimal. As a response to climate change, which requires a pervasive transformation of economic activity across all energy consuming sectors, policies that smooth the transition and reduce the disruption by speeding innovation lower the total social costs dramatically.[53]

The important point is not to debate whether a carbon cost should be adopted or how large it should be; rather, the bottom line for this analysis is that public policy is very likely to place much more emphasis on the "complementary" technology policies that incent innovation directly targeting technology development, lower costs in the mid and long term, and reduce demand for fossil-fuel

[53] Acemoglu, Daron, et al., 2012, "The Environment and Dedicated Technical Change," *American Economic Review*, 102:1. Nordhaus, Ted, Michael Shellenberger and Alex Trembath, 2012, "Carbon Taxes and Energy Subsidies: A Comparison of the Incentives and Costs of Zero-Carbon Deployment, *Breakthrough Institute*, September 12, estimate targeted subsidies yield three times the incentive to invest in low carbon alternatives as a general carbon tax. Findings that the social return to R&D is twice as large as the private return hold in the energy technology space (Qui, Yeuming and Laura D. Anadon, 2012, "The Price of Wind in China During its Expansion: Technology Adoption, Learning-by-doing, Economies of Scale, and Manufacturing Localization," *Energy Economics*, 34, 2012, Massetti, Emanuele and Lea Nicita, *The Optimal Climate Policy Portfolio*, CESifo working paper Energy and Climate Economics, No. 2988, 2010). Inertia can cause a one to two decade delay in the introduction of new technologies (Calel, Raphael and Antoine Dechexlepetre, *Environmental Policy and Directed Technological Change: Evidence from the European Carbon Market,* 2012). A swifter transition can cut the macroeconomic costs in half (Grubb, Michael, Thierry Chapuis and Minh Ha Duong, *The Economics of Changing Course: Implications of Adaptability and Inertia for Optimal Climate Policy,* 1995, p. 428).

powered generation. Nuclear power becomes even less attractive in such a policy context and erroneous assumptions about hefty carbon costs in the early phases of the transition when it is most important to stimulate innovation should not be allowed to distort decision making that results in a cost of electricity and carbon abatement that places an unnecessary burden on consumers and the economy.

B. MANDATES DIMINISH THE NEED FOR NEW NUCLEAR REACTORS

In the regulatory proceedings to justify construction of new nuclear reactors, the utilities argued that there would be a carbon cost. Subsequent proceedings to justify continued construction maintained this position. The utilities failed to respond to the reality that the climate policy that moved forward in the U.S. was long on complementary policies and short on carbon costs. In fact, policy makers across the globe have placed increasing emphasis on these alternative policies.[54] If projections of likely climate policy are going to be included in the analysis, then a likely place to start should be to include the complementary policies enacted in HR 2454 that passed the House of Representative in 2009. It reflected a much more nuanced approach that focuses on targeted policies and technology with the goal of lowering demand for nonrenewable generation resources. It could do so significantly with performance standards for power plant emissions, appliance efficiency standards and building energy codes, as shown in Figure V-1. Figure V-1 includes the earlier analysis of the trend of declining demand and then adds in an estimate of the impact of the efficiency and renewable mandates included in the climate change legislation that passed the House of Representatives.[55] Both reactors would be surplus if the utility were required to comply with such a mandate.

Figure V-2 shows the impact of a reduction in demand for non-renewable resources equal to 10 percent and 20 percent of the baseline projection of capacity needed that would result from efficiency and renewables mandated by HR 2454. Again, I assume a 14% reserve margin requirement. If the reactors are completed and a policy that mandates efficiency and renewables is adopted at the federal level, then South Carolina will have a massive amount of overpriced low-

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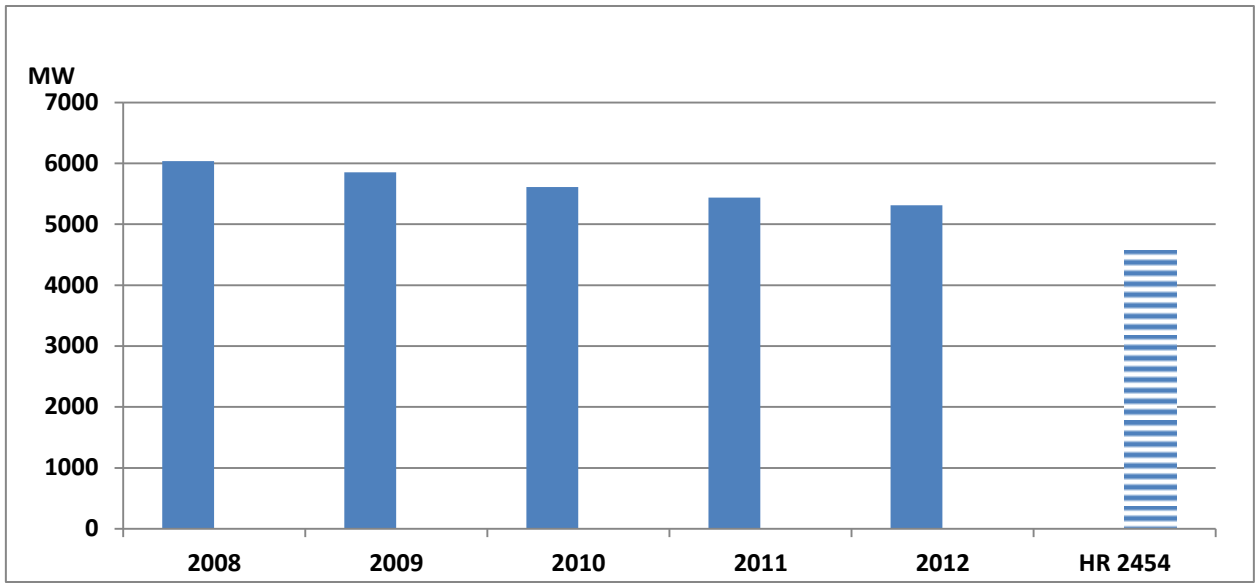
[54] Robert Gross, et al., On Picking Winners: The Need for Targeted Support for Renewable Energy, Imperial College London, October 2012

[55] Direct testimony of Dr. Mark Cooper on behalf of the Southern Alliance for Clean Energy, In re: Nuclear Plant Cost Recovery Clause, before the Florida Public Service Commission Docket no. 090009-EI, July 15, 2009, pp. 20-21, explained these two levels as follows. On a national average basis, the EPA projects a 10 percent reduction in demand and growth in renewables equal to 1.1 percent of demand (EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress, 6/23/09, p. 26). An earlier analysis suggests the weatherization program in the American Recovery and Reinvestment Act would lower demand by 1.4 percent (Contrast EPA Analysis of toe American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress, 6/23/09, p. 26, with EPA Preliminary Analysis of the Waxman Markey Discussion Draft: American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress, 4/20/09, p. 23). The former includes the effect of the ARRA in the reference case, the latter does not. I attribute the difference to the ARRA). The impact varies from state-to-state, however. The American Council for an Energy Efficient Economy estimated the impact of the improvement in building codes and appliance standards in Florida would be 20 percent above the national average (Energy Savings from Codes and Standards Count Towards EERS Savings Goals, available at http://www.aceee.org/energy/national/EERScssavings.pdf. Combining these factors, a reasonable range for the impact on South Carolina would be a 10 to 20 percent reduction in the demand for non-renewable generation (The American Council for and Energy Efficient Economy puts the savings from Title I and Title II of HR2454 at 5.4 quads in 2020 and 12.2 quads in 2030. These equal 12.2 percent of the energy consumed in the electricity sector in 2020 and 25.6 percent of the energy consumed in 2030 (see HR. 2454 *Addresses Climate Change Through a Wide Variety of Energy Efficiency Measures,* http://www.aceee.org/energy/national/HR2454_Estimate06-01.pdf).".

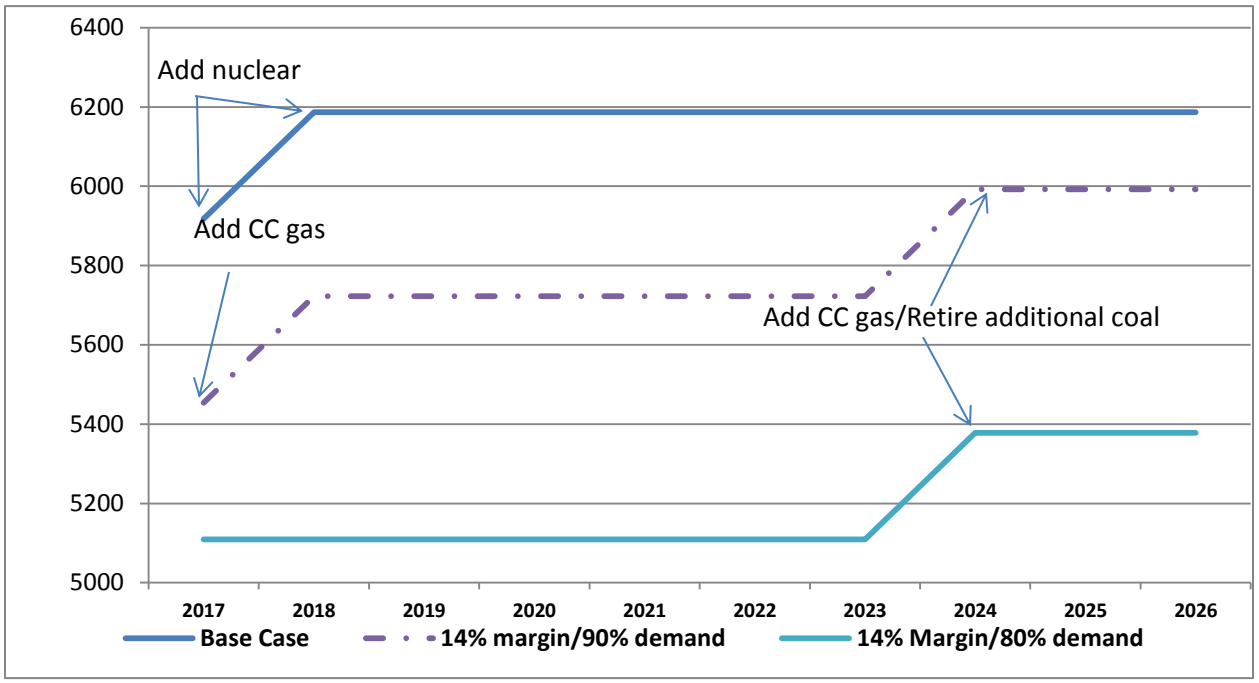
carbon resources. The state will be unable to recover the cost of the electricity generated, since the market price of low-carbon resources is certain to be less than the South Carolina cost of generation.

FIGURE V-1: PROJECTED PEAK DEMAND WITH AGGRESSIVE DEMAND REDUCTION MANDATES



Sources: 2008: Exhibit H (Lynch, 2008, Exhibit JML-2); S.C. Coastal, Conservation League, et al., South Carolina Electric & Gas, Integrate Resource Plan, Docket No. 2012-9-E, Table 1.2009-2012; Response to Sierra Club Interrogatories, p. 326.

FIGURE V-2: GENERATION CAPACITY NEEDS, WITH EFFICIENCY AND RENEWABLE MANDATES



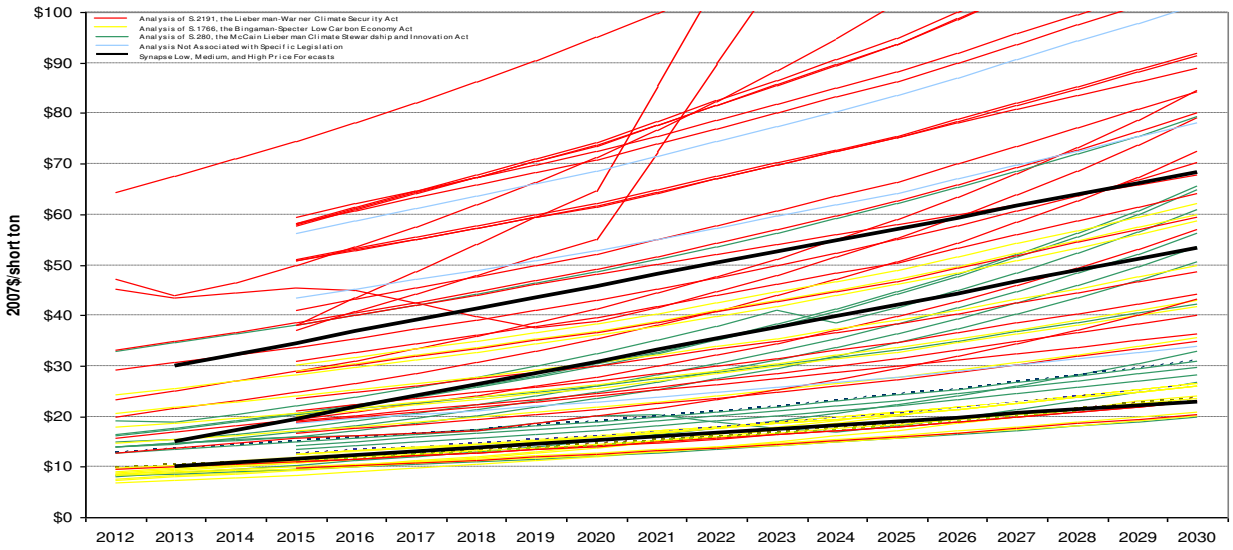
Sources: *Comparative Economic Analysis of Completing Construction or Pursuing a Gas Resource Strategy,* Appendix 1. (all scenarios include retirement of 640 MW of coal in 2017-2018)

C. Carbon Price Uncertainty and the Carbon Cost Scenario Analyses

Given the extreme difficulty of putting a value and a price on carbon and the impact of mandated efficiency and renewable resources, the wide range of estimates offered, as shown in Figure V-3, should not be surprising. Faced with extreme uncertainty and risk, the correct policy response is to start with the least cost alternatives and favor those that keep options open so that more information can be gathered to better inform decision-making. This approach is particularly important where no carbon cost has been imposed.

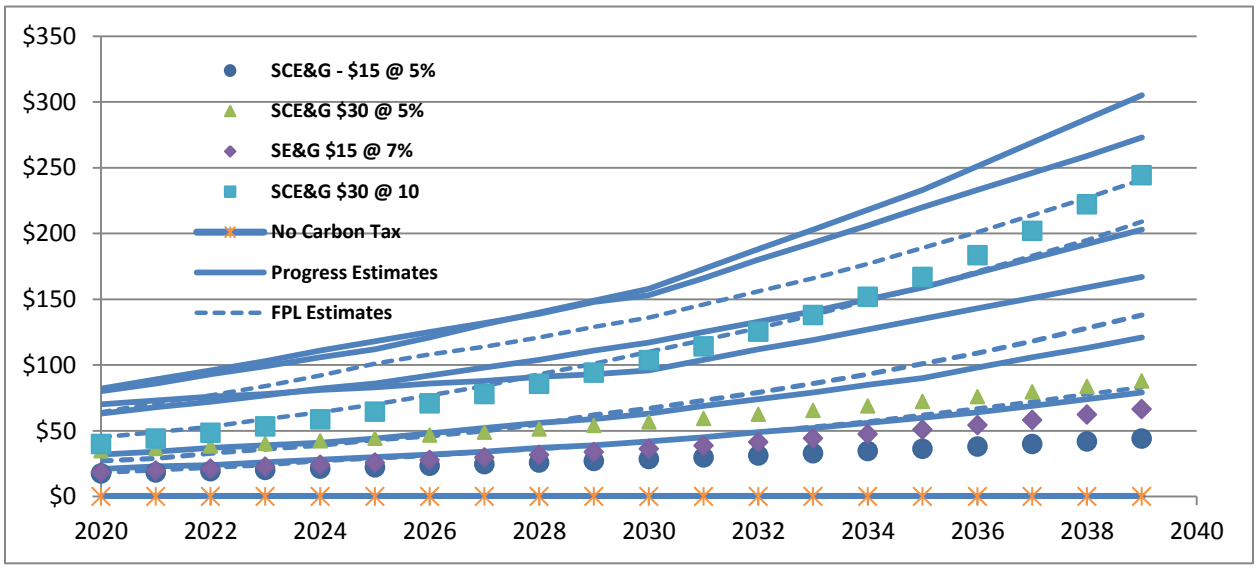
Figure V-3: Estimates of the Cost Of Carbon in the U.S. Cap and Trade Debate

National Estimates



Source: Bruce Biewald, *Economics of Electric Sector CO_2 Emissions Reduction: Making Climate Change Policy that People Can Live with,"* NASUCA 2008 Annual Meeting, November 18, 2008, p. 5.

Estimates Used in Southeast Certification and Cost Recovery Proceedings



Sources: SC Source: Exhibit H (Lynch, 2008, Exhibit JML-2), pp. 9-10; Response to Sierra Club Interrogatories, p. 157, Energy Information Administration, Annual Energy Outlook, 2008, 2012, Table A1;

The impact of climate change policy was taken into account in SCE&G's economic analysis by presenting a decision matrix in which a series of assumptions was made about which technology would be less costly depending on the price of carbon emissions. While it is certainly reasonable to encourage regulators to take climate change policy into account, this approach is totally inadequate to reach a prudent decision.

Figure V-4 shows the outcome of the 2008 carbon sensitivity analysis. The following risk evaluation was offered in text, explaining that it

> shows the sensitivity of the economic results to the price of a CO_2 credit…. The shaded area highlight the combination of CO_2 price and escalation which results in the gas strategy being more economical than the nuclear strategy.[56]

The company focused the discussion on a cost of CO_2 of $15 per ton escalating at 7 percent per year, which was, conveniently, just outside of the grey area in which gas was preferable to nuclear. It did not offer any probabilistic assessment of what the carbon price would be.

FIGURE V-4: THE CARBON PRICE-RESOURCE DECISION MATRIX: THE 2008 NET COST

Change in Levelized Rev. Req.: Gas Strategy Minus Nuclear Strategy
Positive Entries Represent Nuclear Advantage in Millions of Dollars

CO_2 Price / Escalation	$0	$5	$10	$15	$20	$25	$30	$35	$40	$45	$50
0%	-87	-75	-63	-51	-40	-28	-16	-5	7	19	31
2%	-87	-71	-55	-39	-23	-7	9	25	41	57	73
4%	-87	-64	-42	-20	2	24	47	69	91	113	135
5%	-87	-60	-34	-7	19	45	72	98	124	151	177
6%	-87	-55	-24	8	39	71	102	134	165	197	228
8%	-87	-41	5	50	96	141	187	233	278	324	369
10%	-87	-19	48	116	183	250	318	385	453	520	587

X

2008 Base Case

Source: Exhibit H (Lynch, 2008, Exhibit JML-2), p. 11.

That original analysis included the fundamental flaws that were identified in the earlier discussions.

- The price of gas was too high,
- the value of flexible additions to supply was not recognized,
- the risk of nuclear reactor construction cost overruns was ignored, and
- the development of alternatives was not considered, both lower cost alternatives like efficiency and renewables and a back stop carbon capture technology.

[56] Source: Exhibit H (Lynch, 2008, Exhibit JML-2), p. 11.

Figure V-5 reflects the current reality, most of which was in place by 2009-2010 with several of these factors considered. Figure V-5 shows how the decision matrix would look if the flaws in the approach to the analysis are corrected by considering lower gas costs, flexibility in capital cost and the potential adoption of carbon capture technology at high carbon prices. Nuclear was not a very good bet in 2008 and the chance that a carbon price would make nuclear less costly than gas are slim and none today. As we have seen, this is consistent with the widespread opinion throughout the industry.

FIGURE V-5: THE CARBON PRICE-RESOURCE DECISION MATRIX: CURRENT CONDITIONS AND CORRECTIONS OF ANALYTIC FLAWS

Change in Levelized Rev. Req.: Gas Strategy Minus Nuclear Strategy
Positive Entries Represent Nuclear Advantage in Millions of Dollars

CO_2 Price / Escalation	$0	$5	$10	$15	$20	$25	$30	$35	$40	$45	$50
0%	-87	-75	-63	-51	-40	-28	-16	-5	7	19	31
2%	-87	-71	-55	-39	-23	-7	9	25	41	57	73
4%	-87	-64	-42	-20	2	24	47	69	91	113	135
5%	-87	-60	-34	-7	19	45	72	98	124	151	177
6%	-87	-55	-24	8	39	71	102	134	165	197	228
8%	-87	-41	5	50	96	141	187	233	278	324	369
10%	-87	-19	48	116	183	250	318	385	453	520	587

Gas Price Lower | **Flexible Supply Valued** | **Nuclear Cost Risk Considered** | **Carbon Capture as a Backstop**

Source: Exhibit H (Lynch, 2008, Exhibit JML-2), p. 11.

D. THE ECONOMICS OF THE SECOND NUCLEAR FIASCO

The utility reaction to a vigorous call for a prudence review elicited a response that it claims supported the continuation of construction and justified its original decision not to conduct a prudence review. Upon close examination, however, we find that the study not only included the same problems from the original analysis, but it suffers from additional flaws.

The errors that were holdovers from the previous analysis included the following. The study:

- used the same inflexible assumptions about addition of natural gas generation.
- insisted on a cost of carbon and failed to take mandatory efficiency or renewables into account.
- did not examine other alternatives in addition to unabated natural gas.

The new errors introduced into the analysis included the following. The study:

- failed to consider future nuclear cost overruns, even though the company continues to emphasize risks and refuses to commit to not asking for additional cost increases;

- but did consider much higher gas costs than it assumed in its new base case analysis;
- amortized sunk costs in a manner that maximized the burden on ratepayers (and the return to utility owners) and
- shifted from a 12% reserve margin requirement to a 14% reserve margin, further obscuring the impact of excess capacity.

Table V-2 shows the 'decision matrix" that can be extracted from the SCE&G analysis. The facts on the ground today – base-case nuclear, base-case gas and no carbon cost – shows that gas is $237 million per year less costly in terms of the levelized cost per kWh. Over a 40 year period, the cost of electricity from a gas fired combined cycle strategy is projected to be $9.4 billion less than electricity from new nuclear reactors. Given that SCE&G is claiming construction costs that are far lower than other estimates, the prospects for other utilities contemplating new nuclear reactor construction are highly unfavorable to nuclear.

TABLE V-1: ANNUAL LEVELIZED COST COMPARISON: NUCLEAR AND GAS

Nuclear Price & Gas Flexibility	CO_2 $/ton	Gas Price Base	Base +50%	Base +100%
Base Case	$0	-$236	-$122	$1
	$15	-$161	-$47	$73
	$30	-$87	$27	$145
Nuclear +10%	$0	-$304	-$189	-$68
Capacity Cost	$15	-$228	-$114	$5
	$30	-$155	-$40	$77
Nuclear +20%	$0	-$371	-$256	-$135
Capacity Cost	$15	-$296	-$182	-$62
	$30	-$222	-$108	$10
Gas Supply	$0	-$374	-$260	-$139
Flexibility	$15	-$299	-$185	-$65
	$30	-$225	-$111	$7
Nuclear +10%	$0	-$442	-$327	-$206
Capacity Cost &	$15	-$366	-$252	-$133
Gas Flexibility	$30	-$293	-$178	-$61
Nuclear +20%	$0	-$509	-$394	-$273
Capacity Cost &	$15	-$433	-$319	-$200
Gas Flexibility	$30	-$390	-$245	-$128

***Source: Petition of South Carolina Electric &Gas Company for Updates and Revisions to Schedules Related to the Construction of a Nuclear Base Load Generation Facility at Jenkinsville, South Carolina,* Docket No. 2012-203-E, Response to Sierra Club Interrogatories dated September 28, 2012,**

With base case gas prices and no carbon cost tax, natural gas is always less costly. The company considered two sets of factors that would increase the cost of gas – fuel prices 50% and 100% higher than the base case and Carbon Dioxide costs of $15 and $30 per ton. With gas up to 50% higher than the base case and CO_2 up to $15 (the assumption from the analysis in which the

reactor was proposed), gas remains less costly. With gas prices assumed to be twice the base case, or carbon twice the original assumption, nuclear is less costly.

Ironically, although the SCE&G identified a large number of risks in the construction of reactors, it failed to consider a range of costs for completing the reactors. In only four years, those risks have raised the basic cost estimate by 10 percent. The construction phase, which has historically been the most challenging in terms of cost overruns, has only begun. Inexplicably and in direct contrast to its own risk analysis, the company treats nuclear costs as though they were a certainty and fails to consider future cost overruns or increases in escalation. This could add billions to the nuclear scenario revenue requirement. If additional nuclear construction cost increases of 10% to 20% are considered, nuclear becomes even less attractive. With high nuclear construction costs, the overwhelming majority of scenarios show gas to be less costly.

Adding in the other factors we have identified as important considerations, the economics of the nuclear reactor appear even less attractive. With the supply-side flexibility of natural gas is factored into the analysis, natural gas becomes the clear choice in almost every case.

Given the history of nuclear cost overruns and the current policy environment, nuclear is likely to be at least $10 billion more costly than gas for a two unit project and could be as much as $15 billion more costly. Compared to the alternatives that are less costly than gas, like efficiency, the excessive cost of nuclear would be even greater. Under these conditions, from the consumer/ ratepayer point of view, the word "fiasco" is too mild; nuclear construction is a catastrophe.

E. SUNK COSTS

It is obvious that construction of nuclear reactors was never the optimal decision, has been a very bad choice since 2010, and is abysmal today. Under approaches that guarantee recovery of advanced costs, the analysis is complicated by the fact that all of the sunk costs are added onto the cost of alternatives. The alternative must save enough to pay off the costs of the nuclear mistake and still deliver lower costs to the consumers. In South Carolina that is the case. Even with sunk costs of almost $2 billion and cancellation costs of close to another $500 million, it would still be less costly for ratepayers for SCE&G to abandon the nuclear reactor construction project and meet the need with gas, or the other alternatives.

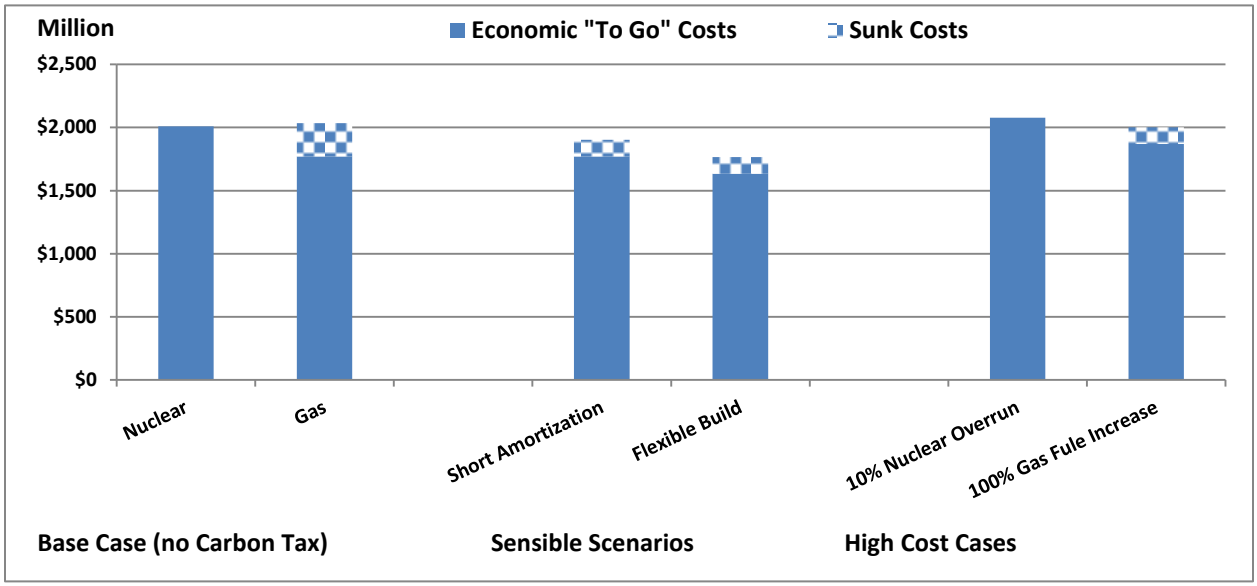
Figure V-5 shows the impact of sunk costs on the ratepayer analysis. The sunk costs include the $1.9 billion that will be spent by the end of 2012 and an estimated $500 million of cancellation costs. Starting from the base case of direct economic costs (i.e. no carbon taxes) the addition of the sunk costs pushes the natural gas case slightly above the nuclear case, by a mere $0.003 per kWh.

However, the company analysis amortized the sunk costs over the full forty years of the analysis, which increases the total financial burden on ratepayers and yields the maximum amount of income to stockholders. Abandonment costs are frequently amortized over much shorter periods. In Figure V-6, I assume a ten year amortization. Because the "To Go" costs of gas are so much lower, this results in natural gas being less costly by about $0.013 per kWh.

Moreover, the company analysis also fails to reflect the value of flexible additions to supply. I estimate a savings of just under 8% by delaying and reducing the addition of gas plants to reflect slower growth and eliminate excess capacity (above 14% as discussed earlier). Combining the

flexible build and consumer friendly amortization of sunk costs yields a substantial savings for consumers. In this scenario, even with a $30 per ton tax on Carbon Dioxide, natural gas would be less costly. Introducing additional cost increases, one can construct scenarios in which either nuclear or gas is more costly. If nuclear experiences another 10% increase in capital costs, even a doubling of the price of natural gas would not make nuclear less costly. The cancellation of the construction of Summer 2 & 3 is very likely to lower consumer costs. .

FIGURE V-6: LEVELIZED ANNUAL ECONOMIC "TO GO" COSTS AND SUNK COSTS



Sources and Notes: Base Case = Interrogatory Response to Sierra Club #1: $0CO_2$ Base Gas, Base Load; Sensible Case = Short Amortization Lowers cost 50%; Flexible Case = Matching Supply and Demand Saves One Year of New Gas Capital Cost; High Case = Interrogatory Response to Sierra Club #1: $0CO_2$, Gas 2 times base; High Nuke = Add 10% to new nuclear construction cost.

VI. THE RATEPAYER HARM AND ECONOMICS COST OF THE LEVY REACTORS

This section briefly reviews data from the Levy reactor project in Florida. The institutional issues with advanced cost recovery and the pattern of causes and consequences deteriorating nuclear economics are the same as in the case of Summer in South Carolina.

A. UNDERMINING CONSUMER PROTECTION WITH ADVANCED COST RECOVERY

Section III, above, started with an analytic evaluation of advanced cost recovery for nuclear reactors based on the comprehensive evaluation by the staff of the Iowa Utility Board of a bill proposed in that state. It then reviewed provisions of the South Carolina Base Load Review Act, providing specific examples of how utility behavior changed in response to the Act, to the detriment of ratepayers. The implementation of advanced nuclear cost recovery (ANCR) in Florida adds another layer of evidence that advanced cost recovery is detrimental to ratepayers. The evidence is crystalized in a court challenge to the statute.

The court challenge raises basic legal questions of constitutional law – i.e. the proper way to write laws, with several issues involved.

- Has the legislature improperly delegated decisions that should be made by the legislature to an administrative agency?[57]
- Is the law inconsistent with the guiding principles of the statute it claims to be implementing,[58]
- Does the law create "undefined, unchecked power"?[59]

The court challenge also raises questions of administrative law.

- Has the Public Service Commission followed the intent of the legislature in implementing the law?[60]

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[57] Brief *Amicus Curiae* of Representative Michelle Rehwinkel Vasilinda, Senator Michael Fasano, Senator Charles Dean, Sr. and Representative Mark Pafford on Behalf of Appellant (hereafter Vasilinda), *Southern Alliance for Clear Energy v. Florida Public Service Commission, et al.,* Case.: No. SC11-2465, PSC Docket No.: 11---9-EI, p. 6, "Advanced nuclear cost recovery as authorized by section 366.93, is an unconstitutional delegation of an essential legislative function from the Legislature to the Florida Public Service Commission (PSC). The statute as written constitutes an overly broad delegation of power and allows the PSC too much discretion in creating and implementing section 366.93…. Had the Legislature provided more definition, more clarity, the statute would pass constitutional muster."

[58] Amended Amicus Brief of the Village of Pinecrest Florida in Support of Appellant Southern Alliance for Clean Energy**.** *Southern Alliance for Clear Energy v. Florida Public Service Commission, et al.,* Case.: No. SC11-2465, PSC Docket No.: 11---9-EI (hereafter Pinecrest), p. 18, "A Commission interpretation that the statute prohibits it from applying the fair, just and reasonable rate standard will eliminate the balancing of interest which would otherwise occur outside of the nuclear context."

[59] Initial Brief of Appellant Southern Alliance for Clean Energy, *Southern Alliance for Clear Energy v. Florida Public Service Commission, et al.*, Case.: No. SC11-2465, PSC Docket No.: 11---9-EI (hereafter SACE)**,** p. 1, **"**Does not contain adequate standards to guide the Public Service Commission in its implementation and administration of the statute;" Vasilinda, p. 13, "The change, which appears to be at worst "whim" or "showing favoritism" and at best a grant of "unbridled discretion" can be attributed to the complete lack of definition in section 366.93. When the PSC cannot even be consistent within itself within the same year, it speaks volumes about the total failure of the statute to draft a workable statute."

[60] Vasilinda, p. 16, "The ANCR process has become little more than a *pro forma* session allowing the PSC to agree to the utilities requests for more funds. The process amounts to issuing a blank check to PEF and FPL allowing them to remain in a perpetual state of preconstruction. The interpretation that the PSC has given the ANCR statute cannot

- Has the Commission acted in an arbitrary and capricious manner.[61]

However, the primary focus in this section is on the substantive objections to advanced nuclear cost recovery that have given rise to the challenge to the statute. Legal technicalities are not the origin of the complaint; discontent with the actual and potential impact on ratepayers is what has animated the challenge.

The used and useful standard, as described in Section III, above, is grounded in the way markets deliver goods and services to consumers. The developments in Florida show that advanced cost recovery not only severs the link to the market paradigm, it also severs the link to reality. The law moved the standard from charging for a reactor once it is "actually built" to charging for in advance for a reactor that the utility intends to build. As the economics of nuclear reactor construction in Florida deteriorated, the utilities declared and the PSC accepted a shift in the standard from "intent to build" to "creating an option to build" a plant. With each step, the likelihood that consumers would pay their money for nothing increased.

> In February 2011, the PSC issued an order reaffirming that "a utility must continue to demonstrate its intent to build the nuclear power plant for which it seeks advanced recovery of costs…" However, just under nine months later, the PSC changed the meaning of the standard when it determine that FPL's "creating an option to build" approach was the same as showing continued intent to build. In the span of nine months, the standard changed from actually having to demonstrate a continued intent into simply showing a continued desire to have the option to build.[62]

At a minimum, the law leaves open a host of questions.

> Is there a cap on the total amount of recoverable costs for a particular nuclear project? Should a utility continue to be eligible for cost recovery if the cost estimate of a nuclear project has increased ten-fold? Should a utility be able to continue to recover cost if it is not adhering to its construction schedule? Are costs "prudently incurred" if they are incurred in the face of declining demand for the plant, declining costs of competing fuels, and lack of national policies that shift the economics for nuclear plants? By failing to even attempt to delineate such objective standards… the Legislature has impermissibly delegated the function to the Commission… the nuclear cost recovery statute is nothing less than a blank

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comport with the purported legislative intent… We may not know the precise legislative intent in drafting section 366.93, but we can say that the result of that decision cannot be what the Legislature intended."

[61] Pinecrest, p. 3, "Absent even minimal standards to govern advanced nuclear cost recovery, the Commission is left with unbridled discretion to set policy and assume functions reserved to the Legislature… As a result, the Commission has rendered inconsistent interpretations of the nuclear cost recovery law which flaunt the fair, just and reasonable standard of ratemaking should it be applied;

SACE, pp.7-8). The Commission's interpretation of the requirements necessary to qualify for cost recovery is a moving target…. The Commission has also found, year after year… that utilities have continued to demonstrate the long-term feasibility" of completing these proposed new nuclear reactors. The Commission has done this by changing it definition and approach to determining long-term feasibility each year and for each utility separately to fit the information provided by the utility

SACE, p. 44, In successive cost recovery dockets, the Commission has changed its interpretation of what activities a utility must be conducting in order to be eligible for cost recovery.

[62] Vasilinda, pp. 12-13; SACE, 6, "FPL resorted to what it calls its "option creation" approach, whereby FPL hopes to obtain a Combined Operating License (COL) … and then later make the final decision on whether or not to actually build the reactors… PEF negotiated a partial suspension of the EPC and resorted to its "COL-focused approach, with the same goal as FPL."

check for utilities who claim to be engaged in the activities contemplated by the statute.[63]

The answers to these questions to-date have resulted in heavy costs imposed on ratepayers with little prospect of benefit.

> In the order at issue in this case, Florida Power & Light Company (FPL) was granted $196 million in nuclear cost recovery funds and Progress Energy Florida, Inc. (PEF) granted almost $86 million. Those very large sums represent significant increases in utility bills of Floridians. Those very large sums represent cost recovery for projects that have no timeline for completion, no benchmarks to meet, no limits on the ever increasing expense, and no guarantee or requirement that they ever be completed.[64]

The reasons the answers to these questions are so negative from the ratepayer point of view is that advanced cost recovery undermines fundamental consumer protections in Florida, as it did in South Carolina and would do in every case. The briefs filed in the court challenge to the Florida statute cite, as actual harms suffered by ratepayers, the same factors that the staff of the Iowa Utility Board identified as the fundamental problems caused by advanced cost recovery. These include:

- Fundamental reduction in consumer protection[65]
- Shifting risk[66]
- Uncertainty in rapidly changing environment[67]
- Inability to balance stockholder and ratepayer interests[68]

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[63] SACE, p. 41; Vasilinda, p. 9, "It does not delineate what is a prudent cost, nor does it put any limit on recoverable cost… The statute instructs the PSC to develop "alternative cost recovery mechanisms" without giving any guidance as to what those mechanisms should look like."

[64] Vasilinda, 14.

[65] Brief *Amicus Curiae* of AARP in Support of Appellant Southern Alliance for Clean Energy, *Southern Alliance for Clear Energy v. Florida Public Service Commission, et al.,* Case.: No. SC11-2465, PSC Docket No.: 11---9-EI, (hereafter, AARP), pp. 3-4),"When the Florida Legislature… authorized the Commission to permit charges to "promote utility investment in nuclear power plants… the Legislature failed to provide guidance on how the Commission should further that goal while also meeting its duty to protect consumers from paying arbitrary and unfair rate.

[66] Brief *Amicus Curiae* of AARP in Support of Appellant Southern Alliance for Clean Energy, *Southern Alliance for Clean Energy v. Florida Public Service Commission, et al.,* Case: No. SC11-2465, PSC Docket No.: 11---9-EI, (hereafter, AARP), pp. 3-4),"When the Florida Legislature… authorized the Commission to permit charges to "promote utility investment in nuclear power plants… the Legislature failed to provide guidance on how the Commission should further that goal while also meeting its duty to protect consumers from paying arbitrary and unfair rate.

SACE, pp. 4-5, The financial risk of building power plants traditionally is borne by shareholders of regulated electric utilities in return for the payment of utility rates that return not only their investment, but also a profit on their investment. In a stark departure from traditional ratemaking, the Legislature shifted this risk to ratepaying consumers by permitting recovery of costs in advance of the operation of power plants… In shifting the timing of cost recovery, the Legislature abandoned fundamental principles that protect consumers from paying unreasonable rates

Vasilinda, p. 14, Utility companies pursuing new nuclear power plants, like FPL and PEF, may do so virtually risk free, unlike any other industry, even being allowed to recoup cost related to ANCR proceedings.

[67] AARP, pp. 12-13, Witnesses for both utilities would not rule out the prospect of further cost overruns as these projects develop… Accordingly, the statutory reiteration of the traditional prudence guidance is insufficient to protect consumers in the context of advanced cost recovery. By definition, regulators do not have access to all of the facts before evaluating the prudence of the utility's investment decisions.

SACE, p. 46, The Commission's failure to require FPL to submit, despite objections from numerous intervenors, an updated capital cost estimate… as part of its economic feasibility analysis; and… allowing PEF in the same docket to meet its burden to demonstrate economic feasibility through an answer to a Commission discovery response, after PEF refused to provide such analysis in its direct testimony.

- Passing over lower cost options[69]
- Distortion of the decision making process [70]
- Reduced utility incentive to keep costs to a minimum[71]
- Intergenerational inequities[72]

B. THE COLLAPSE OF "NUCLEAR RENAISSANCE" ECONOMICS

The factors that have affected the economics of the Summer project, discussed above, have affected the nuclear industry nationwide. The economics of the Levy reactors have deteriorated for the same reasons as in South Carolina. The details available through the cost overrun proceeding made it a good opportunity to examine the details in a specific case. Exactly the same factors have affected the other reactors under EPC contracts. A financial analyst, describing the "5 Facts that Sink Nuclear Power," chose the Levy project as the example,

> **Nuclear power isn't cost effective:** There is a reason natural gas, wind and solar power are now the most popular new power generation assets in the U.S. – they're cost effective. One

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[68] Pinecrest, p. 7, The Commission thus has been continually bound by the standard of fair, just and reasonable rates, and is constitutionally required to balance the competing interests of customers and shareholders

Pinecrest, p. 2, When the fair, just and reasonable standard is removed, the balancing of customer and shareholder interests is removed.

[69] Pinecrest, p. 10, [T]he nuclear cost recovery law contains no reference to the fair, just and reasonable standard… In fact, the Commission has interpreted the nuclear cost recovery law's silence in this regard to mean that the fair, just and reasonable rate standard does not apply to nuclear investments and costs.

Pinecrest, p. 2-3, Absent even minimal standards to govern advanced nuclear cost recovery, the Commission is left with unbridled discretion to set policy and assume functions reserved to the Legislature… As a result, the Commission has rendered inconsistent interpretations of the nuclear cost recovery law which flaunt the fair, just and reasonable standard of ratemaking should apply.

[70] SACE, p. 2, Has had the dramatic effect of transferring all risk for proposed nuclear projects of Florida utilities away from utility shareholders and onto the utility ratepayers, giving the utility a blank check to risk billions of dollars ratepayers' money on speculative projects that would not be financed by the private sector.

SACE, p. 11, The shifting sand underlying the Commission's interpretation… arises from the lack of adequate guidance. It also raises the stakes from consumers while shielding the utilities from the consequences of their current and future decisions surrounding these projects.

[71] AARP, pp. 11-12, An after-the-fact cost recovery in which the shareholders bear the risk of loss has long proven to be an appropriate incentive for the utility to pursue the most cost effective means of planning and constructing a power plant. Utilities know the consumers in the end will pay rates that provide shareholders full recovery of and appropriate returns on utilities prudently incurred investments. Recovery of other costs will be disallowed. Thus, utilities traditionally have a strong incentive to keep costs to a minimum.

The nuclear cost recovery mechanism at issue in this case significantly weakens the utility's incentive to "sharpen the pencil" and to aggressively pursue cost saving measures.

[72] AARP, pp. 14-15, Current ratepayers will be forced to pay for the power plant for at least ten years before receiving any benefits Current ratepayers will be forced to pay for the power plant for at least ten years before receiving any benefits… PEF entered into a Stipulation and Agreement regarding its plans to terminate its EPC contract and to delay indefinitely a decision about whether to further pursue any further construction on LNP

AARP, p. 20, [C]onsumers (are brackets correct?)are being saddled unfairly with billions of dollars of costs for power plants that may never be built in their lifetime, if ever.

AARP, pp. 3-4, Regulators of utility monopolies are obligated to protect captive consumers from paying unjust rates. Reliance on traditional prudence standards to protect consumers is only effective in the context of an after-the-fact review. Absent appropriate statutory guidance on how to protect consumers… consumers are substantially harmed because they are forced to pay for plants from which many will not live to receive any benefits…

thing the nuclear advocates never fully discuss is the cost of a nuclear plant or how much the power coming out of it will cost.

Let's take a look at one plant going through the approval process in Florida – **Progress Energy's** (NYSE: PGN)…

The Levy county project was originally supposed to cost $5 billion to build and be operational by 2016. Today the estimates by the company itself put the project costs at $19 billion-$24 billion and operation by 2024 at best. What does that mean to ratepayers (before added cost that I'll get to in a minute)?

At a nuclear plant there is a large capital expense and then ongoing cost for fuel, maintenance, etc. Let's just look at the capital expense of $24 billion (these projects are never under budget)..

If the nuclear plant were to be finished, the depreciation alone over 30 years would be $0.083 per KW-hr. That's assuming the plant would never shut down and doesn't include maintenance cost, profit, no interest cost, or fuel. Adding these costs would bring it closer to $0.20 per KW-hr, which brings me to…

The California Energy Commission did a study in 2011 that determined nuclear power would cost between $0.17 and $0.34 per KW-hr. That's nowhere near competitive with natural gas, wind or solar.

By comparison, **First Solar** (NASDAQ: FSLR) is building a plant in New Mexico that will be open 2014 and will cost ratepayers $0.0579 per KW-hr. Nuclear power is simply too expensive. [73]

The analysis in Sections IV and V showed that we do not have to assume future cost overruns or extremely low cost for alternatives to reach this conclusion. Given current cost estimates nuclear is not cost effective.

C. EXCESSIVE COST

Although the initial press release overnight cost estimate was for about $5 billion, the initial estimate in the Need Proceeding was $10 billion and the base case estimate in the most recent economic feasibility proceeding is $15 billion, as shown in upper graph Figure VI-1. Thus the official estimated construction costs have increased by 50%. This is more than the cost overruns observed in South Carolina, as discussed in Section III. Moreover, a further escalation of several billion dollars is possible.[74]

Natural gas costs have declined (as shown in the lower graph of Figure VI-1). The gas price projections used in the original Need Proceeding were higher than the EIA projections. The gas price projections used in the most recent economic feasibility assessment are much lower than the Need Proceeding, but still above the EIA projections. However, comparing the Levy projections to those for Summer in Figure IV-1, above, we find that the Levy projections were not as far off the mark as the Summer projections.

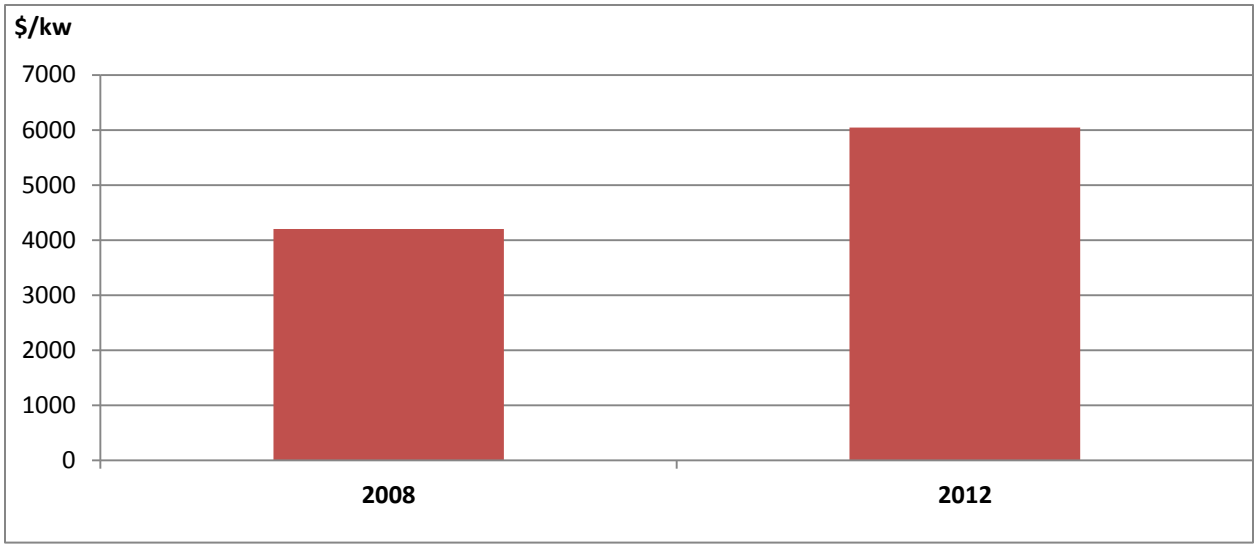
The dramatic slowdown in demand growth has reduced the need for more generation capacity substantially. The reduction in projected peak demand is larger than the total capacity that

[73] Travis Holum, "5 Facts the Sink Nuclear Power," Motley Fool, February 21, 2013, http://www.fool.com/investing/general/2013/02/21/5-facts-that-sink-nuclear-power.aspx

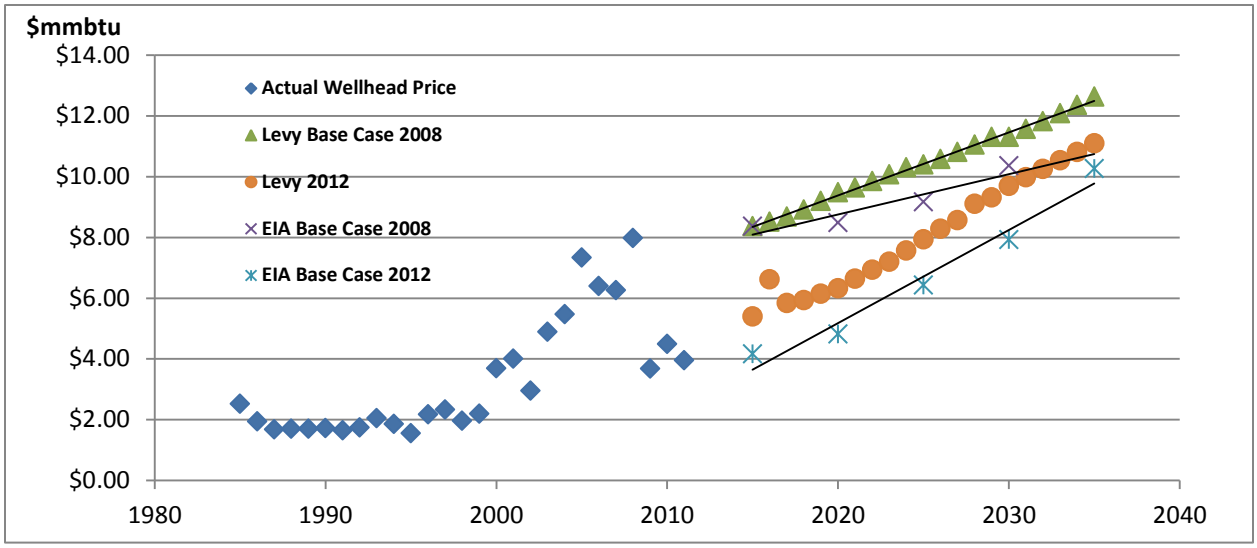
[74] World Nuclear News, "Levy nuclear project moved back by three years," 02 May 2012, http://www.world-nuclear-news.org/NN_Levy_nuclear_project_moved_back_by_three_years_0205122.html

FIGURE VI-1: LEVY: KEY COST DRIVERS: OVERNIGHT CAPITAL COSTS & NATURAL GAS PRICES

Projected Overnight Construction Cost: 2008 – 2012 (Cost in Nominal $)



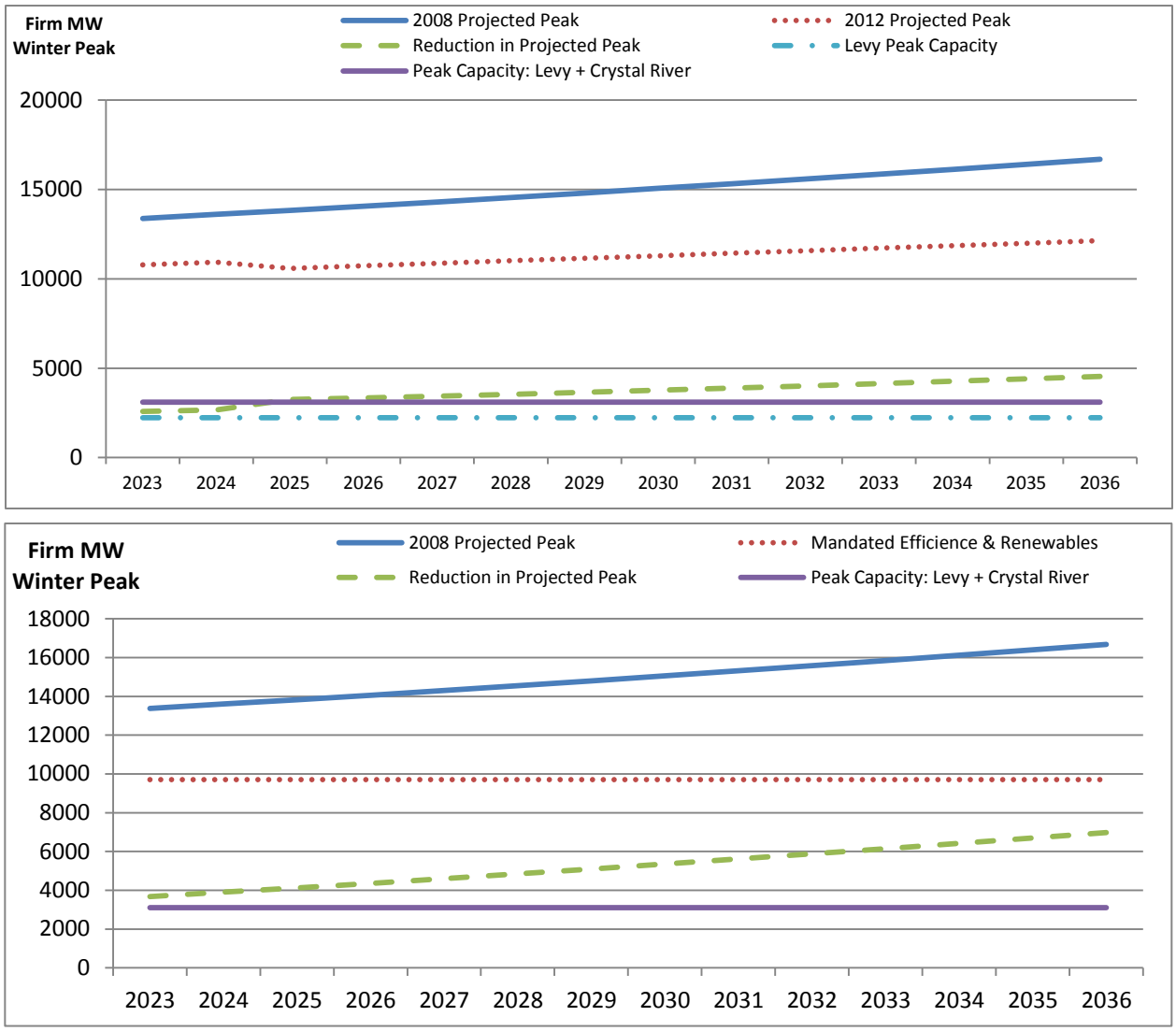
Natural gas prices



Source: Progress Energy Florida System Planning & Regulatory Performance, *Summary Brief: Progress Energy Florida, Levy Nuclear Project NCRC 2012 Feasibility Assessment, Updated Life-cycle Net Present Worth (CPVRR) Assessment,* Docket No. 120009, Exhibit No. JE-2, pp. 13 (gas costs), p. 11 (plant costs before AFUDC). Progress Energy, *Levy Nuclear Need Filing: Strategist Fuel Forecasts – Mid Reference Fuel Table,* for gas prices, *Levy Nuclear Need Filing: New Nuclear Plant Modeling Information,* for nuclear costs before AFUDC. Energy Information Administration, Annual Energy Outlook, 2008, 2012, Table A1.

the Levy project will add to the generation portfolio (as shown in the top graphs of Figure VI-2). In fact, the reduction in demand is larger than Levy plus Crystal River closed permanently. Indeed, if public policy mandates require significant amounts of efficiency and renewables, the Levy reactors would create large quantities of excess capacity that would be difficult to sell because it is so costly compared to the alternatives available (a shown in the bottom graph in Figure VI-2).

FIGURE VI-2: DECLINES IN PROJECTED PEAK DEMAND SINCE THE NEED FILING



Source: Progress Energy Florida System Planning & Regulatory Performance, Summary Brief: Progress Energy Florida, Levy Nuclear Project NCRC 2012 Feasibility Assessment, Updated Life-cycle Net Present Worth (CPVRR) Assessment, Docket No. 120009, Exhibit No. JE-2, pp. 16. Progress Energy, Levy Nuclear Need Filing: Energy Demand History and Forecasts; Direct testimony of Dr. Mark Cooper on behalf of the Southern Alliance for Clean Energy, In re: Nuclear Plant Cost Recovery Clause, before the Florida Public Service Commission Docket no. 090009-EI, July 15, 2009, pp. 20-21, introduced two levels of reduced demand, 10% and 20%. Here a 10% reduction in 2023 is assumed to grow to a 20% reduction in 2036.

The cost and availability of alternatives depicted in Figures IV-2 through IV-4, as well as the cost trends described in Figures IV-6 and IV-7, are likely to be similar in Florida to South Carolina. The efficiency potential is similar in both states, as a percentage of demand.[75] In the assessment of state policies to promote efficiency and renewable energy presented in Figure IV-5 above, Florida

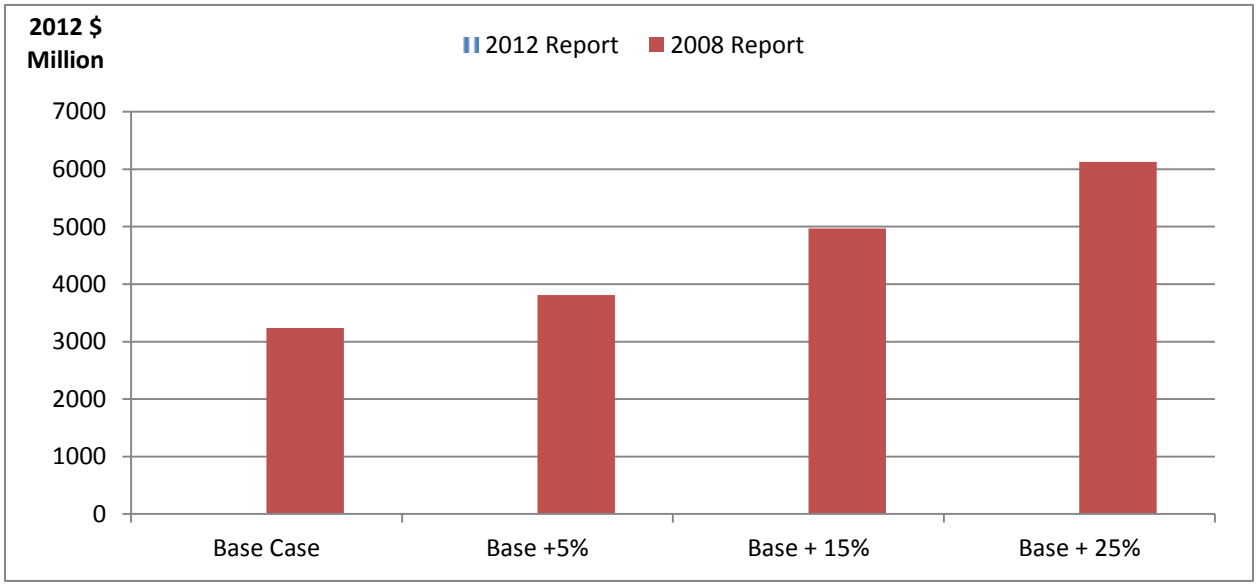
[75] American Council for and Energy Efficient Economy, *Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands,* 2007, *South Carolina's Energy Future: Minding Its Efficiency Resources,* 2009. Anthony Lopez, et al., *U.S. Renewable Energy Technical Potential: A GIS-based Analysis,"* NREL, July 2012, shows Florida with twice the potential, which is consistent with its relative size compared to South Carolina.

ranks higher than South Carolina, but there are about two dozen states that rank higher than Florida on both efficiency and renewable policy. There is much more that can be done in Florida.

C. Excessive Costs

In the base case scenario in 2008 when no carbon tax is assumed, the nuclear option was more costly than gas (see Figure VI-3). In the 2012 analysis it was much more costly that gas. In real, discounted 2012 dollars Levy is projected to cost $4 billion more than natural gas, with nuclear cost overruns, the excessive cost could be as high as $6 billion.

Figure VI-3: EXCESSIVE COST of Levy Compared to Natural Gas (Cumulative Present Value of Revenue Requirement, CPVRR)



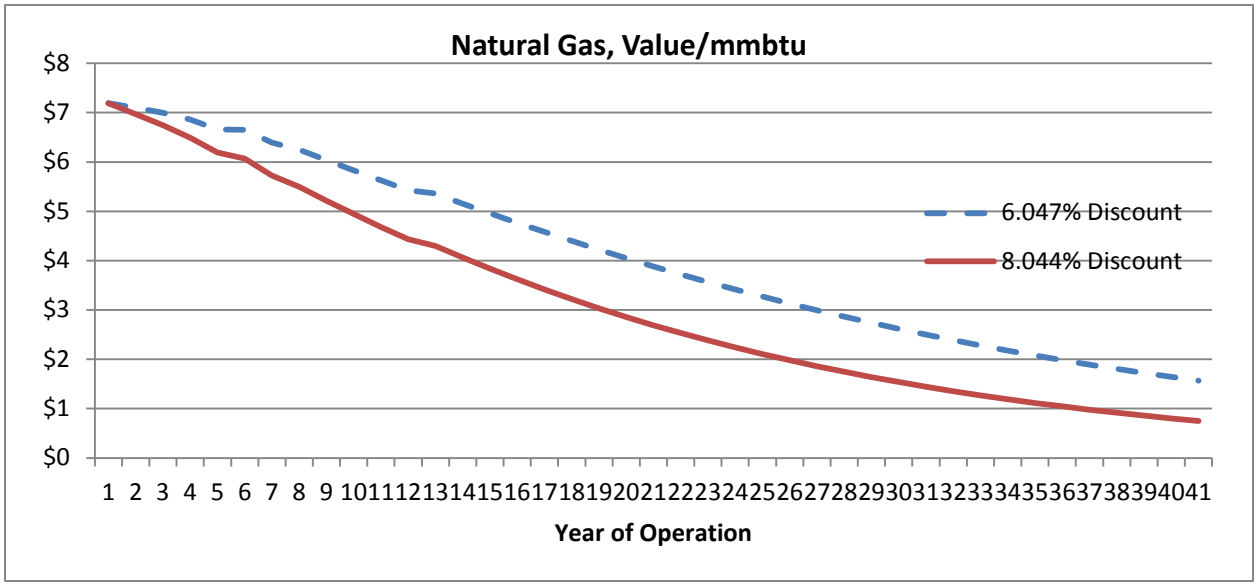
Source: Progress Energy Florida System Planning & Regulatory Performance, *Summary Brief: Progress Energy Florida, Levy Nuclear Project NCRC 2012 Feasibility Assessment, Updated Life-cycle Net Present Worth (CPVRR) Assessment,* Docket No. 120009, Exhibit No. JE-2, pp. 6-7. 2008 estimates stated in 2012 dollars by CPI inflation 2007-2012 of 12%.

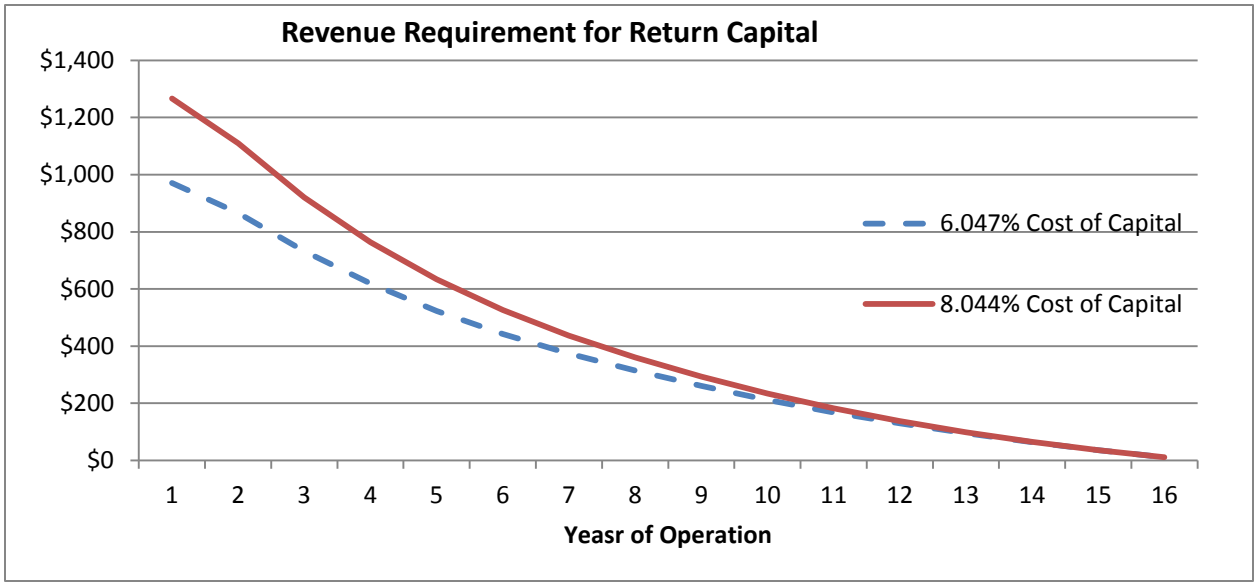
Although the bottom line findings of the Levy analysis are the same as the Summer analysis, the estimate of excessive costs in the case of Levy are not comparable to the estimates in the Summer case because the two analyses use different discount rates. The Levy analysis uses a much lower discount rate (cost of capital) of 6.47%, compared to Summer (8.44%). The low discount rate has a major impact on the economic analysis (see Figure VI-4). The cost of gas is higher with a lower discount rate (because rising future gas prices are discounted less). The capital costs of the nuclear reactor are lower (because the large nuclear capital investments earn less income).

If the Progress analysis were conducted with the higher discount rate, the present value of gas costs would be one-third lower. The present value of the difference in capital costs (nuclear minus gas) would be one-fifth higher. Progress also uses projected gas costs that are more than 10% higher than Summer. Taken together these assumptions would add at least $3 billion to the excess of nuclear costs compared to gas. One of the great dangers to ratepayers in the Levy analysis is that

having tried to make the case for nuclear with a low discount rate (cost of capital) the utility will then seek to increase the allowed cost of capital, when the reactors come online.

FIGURE VI-4: IMPACT OF A LOW DISCOUNT RATE ON THE NUCLEAR-GAS COMPARATIVE ECONOMIC ANALYSIS





Source: Natural gas prices are from Progress Energy Florida System Planning & Regulatory Performance, *Summary Brief: Progress Energy Florida, Levy Nuclear Project NCRC 2012 Feasibility Assessment, Updated Life-cycle Net Present Worth (CPVRR) Assessment,* Docket No. 120009, Exhibit No. JE-2, pp. 12. Rate of return impact is calculated based on the cost recovery schedule in Yangbo Du and John E. Parsons, *Update on the cost of Nuclear Power,* Center for Energy and MIT Environment Policy Research, Table 6a, scaled to a $15 billion overnight cost.

Even with the lower discount rate, there is no doubt that ratepayers would be better off if the project is cancelled. Since the costs sunk in the project are less than half of the cost sunk in Summer, there is more room for consumers to pay off the sunk costs and still come out ahead by switching to other alternatives.

D. CONCLUSION

The heart of prudent decision making is using all of the best and most current information and knowledge that is available to inform the choice between alternatives. The decision maker must use the most up to date knowledge available to adjust choices, whenever that is possible. In South Carolina, the process of ongoing decision-making has been rendered more difficult by the passage of the Base Load Review Act and the early commitment of SCE&G to build two units. The same happened in Florida.

- The fact that the incentives to promote nuclear power induced a premature to build commitment does not eliminate the obligation to conduct ongoing prudence review.
- The fact that recovery of sunk and termination costs place a heavy burden on the alternatives does not mean the alternatives cannot still be preferable.
- Indeed, the relative economics of nuclear reactors have deteriorated so badly, so quickly, that in all likelihood, a careful analysis shows that cancelling Summer 2 & 3 and Levy reactors are the prudent thing to do.
- A regulatory framework that allows the utility to increase its costs on a regular bases (every two years thus far), but does not allow the commission to consider whether the project continues to be prudent in the face of massive changes in material conditions is totally unbalanced and does not reflect the way markets works.

In spite of all the dramatic changes in the material conditions of the economics of building new nuclear reactors, SCE&G did not conduct a careful review of the prudence of continuing the construction project until a third party intervener challenged the prudence of the project. The company points to the fact that its request for certification of the project identified many of the risks that the construction of nuclear reactors could face and leaps to the conclusion that once those risks were identified, the utility cannot be held responsible for not including those costs in its original estimate. It argues that the SCPSC cannot conclude that the accumulation of costs associated with those risks has rendered the continuation of the project imprudent. This puts ratepayers at grave risk of excessive costs.

In Florida the utilities resisted even the more lax "economic feasibility" analysis. The utilities have refused to accept the current reality, shifting their strategy to collecting advanced cost recovery on the chance that they might (or might not) decide to build a reactor.[76] The complainants in the

[76] Direct Testimony of Dr. Mark Cooper on Behalf of Southern Alliance For Clean Energy (SACE), In Re: Nuclear Plant Cost Recovery Clause, Before The Florida Public Service Commission, Docket No. 100009-Ei, Filed: July 8, 2010, p. 3,
In a mere four years since the passage the Florida Renewable Energy Technologies and Energy Efficiency Act of 2006, which sought to promote nuclear power in the state, the "nuclear renaissance" in Florida has been reduced to the largest investor - owned utilities in the state, PEF and FPL, urging the Commission to allow them to charge ratepayers hundreds of millions of dollars to do nothing more than hold their place in a line of proposed nuclear projects at the Nuclear Regulatory Commission. The number of utilities in the line has shrunk dramatically as other proposed new

court case believe this "options" strategy violates the law. With so many less costly alternatives that could be brought online in much shorter time frames, it is clear that this is exactly the wrong option to buy. If these companies had done a better job of properly evaluating risk in the original cost projection, the commission might not have been misled into approving the project. More importantly, what we know about the cost of reactors compared to alternatives is quite different today than it was four years ago. By 2010, it was apparent that nuclear power was uneconomic. Instead of asking for cost overruns, the companies should have abandoned the project then.

The 2012 SCE&G filing is the second cost overrun in two years, suggesting that the company sees advanced cost recovery as an open spigot. In Florida, it is referred to as a blank check. Under these circumstances, time becomes essential. Because the Base Load Review Act in South Caroline and then advanced nuclear cost recovery section of the Florida statute guarantees the recovery of the sunk costs, the sooner the SCPSC reviews the prudence of the project, the more the people of South Carolina could save, if the Commission concludes the project is no longer prudent. The company has spent less than $2 billion and proposes to spend almost a billion dollars per year over the next three years on the project.

The excessive cost burden placed on consumers by construction of new nuclear reactors will run into the billions of dollars. The exact amount will vary depending on the assumptions made about the construction costs, the discount rate (cost of capital), the projected cost of gas, and the cost and availability of alternatives. The best estimate of the excess costs that will be borne by South Carolina ratepayers and the South Carolina economy is in the range of $10 billion. With future cost overruns and adjusting for the discount rate, Levy suggests a similar level of impact. Other states implementing an advanced cost recovery statute today would likely face even larger excessive costs. Moreover, these estimates are made with respect to natural gas as the alternative. When the full range of alternatives is considered, the excess costs imposed on ratepayers is likely to be even higher, since a significant amount of need can be met with efficiency, which is less costly than gas.

If time is of the essence in South Carolina, there is a sense in which it is even more important in Florida. "Only" one billion has been spent, so abandoning nuclear construction will be easier and the mistake of creating unnecessary sunk costs can be nipped in the bud. The

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nuclear projects have been cancelled around the country. For PEF and FPL, the movement of the line has slowed to a crawl, and reserving their place in the line has little if any value to the Florida ratepayers because the line is almost certainly leading nowhere any time soon.

Ironically, this sad state of affairs represents significant progress from last year. In contrast to the utilities' testimony in last year's cost recovery docket (Docket No. 090009-EI), PEF and FPL now admit that the economics of nuclear reactor construction are highly uncertain. For FPL the uncertainty is so great and the risks so high that they now say they have not determined whether they will actually build these proposed new reactors in the state.

Progress hopes that a five-year delay will resolve the uncertainty, but maintains that it is still committed to construction.

The movement in the utility positions is in the direction I pointed them in my testimony last year, but they have not moved far enough, and as a result, additional millions of ratepayer dollars have been wasted and more is proposed to be wasted over the coming years. Furthermore, while PEF and FPL promise a thorough economic review before they make the momentous decision to proceed with construction of these proposed reactors, in the interim they continue to ask that the Florida ratepayers foot the bill, without a well-grounded showing that completion of these reactors is feasible in the long-term. In my opinion, it is not reasonable or prudent to allow PEF and FPL to incur additional costs of these proposed reactors from Florida ratepayers so that the utilities can do nothing more than sit in line until they themselves determine if completion of the reactors is feasible. This is a decision that the Commission can and should make now.

construction schedule has been stretched to a decade, so there is clearly no urgent need for the new nuclear reactors. With the utility focused on building its rate base with a huge new reactor project, management has little interest in aggressively developing alternatives. The decade that will be wasted in the pursuit of excessively cost new reactors, is the most valuable decade for developing alternatives.

Thus, although the regulatory analysis inevitably focuses attention on economic cost and new reactor construction wastes a great deal of money, there may even be a more important cost imposed on ratepayers. The greatest long-term harm inflicted as a result of the incentives that advanced cost recovery gives to utilities to pursue new nuclear reactors and the most valuable asset may be time to implement and develop more consumer-friendly, low carbon alternatives.

APPENDIX A:
NUCLEAR POWER: THE RENAISSANCE THAT WASN'T

2012

November	Fukushima cleanup costs increase	Negative financial indicator
November	Vogtle cost increase lawsuit	Cost escalations
November	Calvert Cliff #3 review terminated	Cancellation
September	Loan guarantees remain in dispute	Negative financial indictor
September	Broader issues contemplated for impact assessment	Delay
August	Nuclear waste confidence ruling freezes reactor licensing	Delay
August	Vogtle acknowledges potential delay and cost increases	Increasing/Delay
August	Water problems (drought, heat) raise concerns about reactor operations	Design problem
July	Duke rating downgrade	Negative financial indicator
July	Loan guarantee disputes	Negative financial indicator
May	Progress Energy Delays Levy County Reactors Another 3 Years, Consumers Have Spent Nearly $1 Billion On Reactors That May Never Be Built	Delay
May	Progress Announces Plans To Nearly Double Monthly Consumer Fees In Electricity Bills For Proposed Levy County Reactor Projects	Cost escalations
May	SCE&G Filing Announces Another $560 Million In Cost Overruns	Cost escalations
April	NRC Cites Vogtle On Rebar That Is Inconsistent With Approved Design Standards	Construction Problems
April	TVA Announces That Watts Bar Project (Scheduled To Be Completed In 2012) Will Not Be Finished Until 2015, Cost Estimate Has Shot Up From $2.5 Billion To $4.2 Billion	Cost escalations/ Delay
March	Southern Company Requests Over 32 Amendments To Its License Including Changes In A Faulty Foundation	Construction & Design Problems
March	Vogtle Loan Guarantee Is Not Finalized In Conjunction With Issuance Of NRC License Agreement, Indications Of Disagreements Between DOE And Southern Company On Modified Financial Terms	Negative Financial Indicator
February	Shaw Power Group And Westinghouse Electric Co. Are Debating Who Will Cover Another $340 Million In Cost Overruns At Vogtle And VC Summer, Which Are The Result Of Delays With AP-1000 Design Licensing, Continued Problems At Shaw's Component Fabrication Facility, And "Unanticipated Rock Conditions" At VC Summer.	Cost escalation/ Design & Construction Problems
February	Vogtle Project Is Now 8 Months Behind Schedule	Delay
February	SCE&G Announces $155 Million Capital Cost Increase In VC Summer Cost Estimate	Cost escalations

January	Progress Energy Negotiates Agreement With Florida PSC To Cancel Its Main Construction And Development Contract For Two Reactors At Levy County Site. The Agreement Caps Spending On The Levy County License And Preconstruction Work To $350 Million Through 2017.	Construction Problems/ Negative Financial Indicator
2011		
December	Vogtle Project Is Now 5 Months Behind Schedule	Delay
November	Exelon Bans Talk Of Calvert Cliffs 3 In Context Of Constellation Merger; CEO John Rowe Calls The Project "Utterly Uneconomic" Leaving The Project Even Less Likely To Get A US Partner	Negative Financial Indicator
November	Vogtle Project Is $42 Million Over Budget	Cost escalations
September	Moody's Downgrades SCANA Over South Carolina Planned Reactors, Despite CWIP	Negative Financial Indicator
September	NRC cites southern company for quality deficiencies in Vogtle site work	Construction Problems
May	TVA Asks NRC Licensing Board To Delay Review Of Planned Bellefonte Reactors While The Company Evaluates Whether To Proceed With The Reactors In Light Of The Fukushima Crisis	Delay
May	Moody's Downgrades TEPCO Credit Rating To Near Junk Status	Negative Financial Indicator
May	S&P And Fitch Downgrade TEPCO To Junk Status	Negative Financial Indicator
April	The Nuclear Regulatory Commission Finds That The French-Owned Nuclear Utility Violates The Foreign Ownership Clause Of The Atomic Energy Act, Will Not Be Able To Build Calvert Cliffs 3 Without A US Partner Controlling More Than 50%	Negative Financial Indicator
March	A Huge Earthquake And Tsunami In Japan Leads To A Nuclear Crisis At Fukushima-Daiichi Station In Which 3 Reactors Experience Partial Core Meltdowns And A 4th Reactor Experiences A Spent Fuel Fire. The Ramifications Of This Crisis (Which Continues) May Lead To Delays In All US Reactors	Delay
March	Financial Analysts Downgrade Nearly All Companies Pursuing Nuclear Projects In The Wake Of The Japan Nuclear Crisis. NRG, The Main Investor For The South Texas Project Is Hit Particularly Hard	Negative Financial Indicator
February	Progress Energy States That Planned Reactors At Shearon Harris And Levy County Will Be Delayed "Past 2020"	Delay
February	Old Dominion Electric Cooperative Pulls Out Of North Anna 3 Project, Leaving Dominion Energy In Need Of New Partners To Sustain The Planned Reactor 3	Negative Financial Indicator
January	NRC Signals Delay In Review Of EPR Reactor Design, Citing Technical Issues, Incomplete Information From AREVA	Delay/Design Problems
January	Santee Cooper, Which Owns 45% Of Proposed Summer Reactors Plans To Drop Investment	Negative Financial Indicator
2010		
November	NRC Finds Additional Problems With AP-1000 Shield Design Stating That Westinghouse Did Not Correctly And Realistically Evaluate The Impact Of A Plane Crash, Signaling Potential Delays In AP-1000 Reactors	Design Problems

October	Constellation Rejects Conditional Loan Guarantee For Calvert Cliffs, Citing Prohibitive Market Conditions For Its Planned Merchant Plant	Negative Financial Indicator
October	South Texas Project Likewise Signals That They Will Not Take Loan Guarantees If Offered, Citing Low Natural Gas Prices As A Prohibitive Market Condition	Negative Financial Indicator
October	Constellation Drops Out Of Calvert Cliffs Project, Selling Shares To EDF, Virtually Stranding The Project Indefinitely	Negative Financial Indicator
October	Moody's Downgrades Oglethorpe Power Over Planned Vogtle Reactor Investment	Negative Financial Indicator
October	Dominion Tells Investors In Its 3rd Quarter Earnings Report That Development Will Slow On North Anna 3 Reactor	Delay
September	EDF And Constellation Engage In Emergency Talks Over Constellation's 'Put,' A Right In Which Constellation Can Dump All Of Its Nuclear Holdings On EDF, Essentially Sinking The Joint Nuclear Venture.	Negative Financial Indicator
September	Progress Energy Admits It May Never Build New Shearon Harris Reactors In North Carolina, Citing Reduced Electricity Demand	Negative Financial Indicator
September	Rate Hike For Vogtle Reactors That Goes Into Effect January 2011 Doubles From Georgia Power's Initial Estimates; Overall Price Tag Goes Up As GA PSC Guarantees Profit For Georgia Power 4	Cost escalations
August	NRG Cuts 95% Of Annual Capital Spending On South Texas Project Reactors	Negative Financial Indicator
July	NRC Warns Of Ongoing Safety Problems With The EPR Reactor Design, Signaling Potential Future Delays. This Follows A Report Issued By A Former CEO Of EDF Questioning The Credibility And Safety Of The EPR Model On A Number Of Fronts.	Design Problems
July	EDF, The Co-Owner With Constellation Energy Of The Proposed Calvert Cliffs-3 Reactor Takes A $1.4 Billion Provision Against Potential Future Losses On Its $6.5 Billion Investment In Constellation's Nuclear Program	Negative Financial Indicator
July	In Response To Slowing Federal Subsidies, Constellation Announces Plans To Cut Back On Spending For Calvert Cliffs Reactor, Signaling Future Problems And Delays	Negative Financial Indicator
July	French Flamanville EPR Reactor, The 2nd EPR Project Worldwide, Experiences $1 Billion Cost Overrun And Is Delayed By As Much As Two Years	Cost escalations/Delay
June	Finland's Olkiluoto project, the world's flagship EPR, reactor, is now 4 years behind schedule	Delay
June	Cost escalations The Current Amount Spent On The Olkiluoto Project Is Nearly Equivalent To The Cost Estimate For The Completed Project ($3 Billion)	Cost escalations
May	Cost Estimates Timeline For The Two Levy Co. Reactors Move From $17.2 Billion For The Two Reactors To $22.5 Billion	Cost escalations
May	The Timeline For The Two Levy Co. Reactors Has Been Pushed Back Again, With The First Due In 2021, The Second Some 18 Months Later. The Original Timeline Had The Reactors Set To Come Online In 2016 And 2018 Respectively.	Delay
May	Fitch Downgrades Progress Energy From A Status To BBB (Just Above Junk Bond Status)	Negative Financial Indicator

May	**TVA Announces Plans To Build A Single Conventional Reactor At Bellefonte Site Rather Than Pursue An Untested New Reactor Design 5**	**Design Problems**
April	**Moody's Downgrades FP&L Credit Rating From A2 (Low Credit Risk) To Baa1 (Moderate Credit Risk, Characteristically Unreliable)**	**Negative Financial Indicator**
April	**NRC States That Design-Review Certification Of US-APWR Will Take At Least An Additional Six Months, Shifting Deadlines Well Into 2011**	**Design Problems**
April	**Southern Company Asks For An Additional Month To Consider The Terms Of The Conditional Loan Guarantee Offered By The US Government For Two Reactors At Vogtle Determination With Any Appropriate Findngs Or Facts, Throwing The Fate Of The Project In Jeopardy**	**Delay**
March	**Florida Power & Light Announces Plans To Further Delay Of Turkey Point Reactors Beyond 2018, Signals Plans To Press For Loan Guarantees**	**Delay**
February	**Progress Energy Extends Delay On Levy Co. Reactors To At Least 36 Months**	**Delay**
February	**Toshiba/Westinghouse Indicates That Regulatory Problems Will Delay Planned Reactors In Florida**	**Delay**
January	**Santee Cooper, which owns 45% of proposed Summer reactors plans to drop investment**	**Negative Financial indicator**
November	**NRC finds additional problems with AP-1000 shield design stating Westinghouse did not correctly and realistically evaluate the impact of plane crash, signaling potential delays in AP-1000 reactors**	**Design Problems**
October	**Constellation drops out of Calvert Cliffs project, selling shares in EDF, virtually stranding the project indefinitely**	**Negative Financial Indicator**
October	**Moody's downgrades Oglethorpe Power over planned Vogtle reactor investment**	**Negative Financial Indicator**
September	**Progress Energy admits it may never build new Shearon Harris reactors in North Carolina, citing reduced electricity demand**	**Negative Financial Indicator**
September	**Rate hike for Vogtle reactors that goes into effect January 2011 doubles from Georgia Power's initial estimates; overall price tag goes up as Georgia PS guarantees profit for Georgia Power**	**Cost Escalation**
August	**NRG cuts 95% of annual capital spending on South Texas project reactors**	**Negative Financial Indicator**
July	**Constellation announces plans to cut back on spending for Calvert Cliffs 3 reactor, signaling future problems and delays**	**Negative Financial Indicator**
July	**NRC warns of ongoing safety problems with the EPR reactor design, signaling potential future delays. This follows a report by a former CEO of EDF questioning the credibility and safety of the EPR model.**	**Design Problems**
July	**EDF, co-owner of the proposed Calvert Cliffs 3 reactor takes a $1.4 billion provision against potential future losses on its $6.5 billion investment in Constellation Energy's nuclear program**	**Negative Financial Indicator**
May	**TVA announces plans to build a single conventional reactor at Bellefonte rather than pursue an untested new reactor design**	**Design Problems**
May	**The timeline for the two Levy County reactors has been pushed back again, with the first due in 2021, the second some 18 months later. The original timeline had the reactors set to come online in 2016 and 2018 respectively. Cost estimates also move from $17.2 billion for the two reactors to $22.5 billion.**	**Delay/Cost Escalation**
May	**Fitch downgrades Progress Energy from A status to BBB (just above junk bond status)**	**Negative Financial Indicator**

April	Moody's downgrades FP&L credit rating from A2 (low credit risk) to Baa1 (moderate credit risk, characteristically unreliable)	Negative Financial Indicator
April	Court finds that Georgia PSC acted illegally in violation of GA state law in certifying the need for the two Vogtle reactors by failing to support determination with any appropriate findings or facts, throwing the fate of the project in jeopardy	Scandal
April	Southern Company asks for an additional month to consider the terms of the conditional loan guarantee offered by the US government for two reactors at Vogtle	Delay
April	NRC states that design-review certification of US-APWR will take at least an additional six months, shifting deadlines well into 2011	Design Problems
March	FP&L announces delay of Turkey Point reactors past 2018, signals interest in federal loan guarantees	Delay
February	Progress Energy extends delay on Levy County reactors to at least 36 months	Delay
February	Toshiba/Westinghouse indicate that regulatory problems will delay reactors in Florida for up to 3 years	Delay
February	Obama Administration ditches Yucca Mountain, despite last-minute Bush administration waste contracts with planned reactors	Cancellation
February	State of Vermont votes to close Vt. Yankee reactor b/c of scandal involving tritium leaks, raising new concerns about safety and waste issues with nuclear power	Scandal/Cancellation
January	Progress Energy announces that they'll slow the Levy County reactors process based on the same Florida PSC decision, in which they got none of a $500 million rate hike request	Delay
January	Fitch puts FPL Group on rating watch 'Negative' after Florida PSC decision	Negative Financial Indicator
2009		
December	After discovery of $4 billion surprise price increase on South Texas Project reactors, CPS files a civil suit against NRG claiming misinformation about costs, throwing the fate of the reactors to chance	Scandal
December	Unistar asks NRC to suspend application review for Nine Mile Point reactor	Suspension
November	Areva announces plans to modify EPR reactor design at the request of safety bodies in the UK, France, and Finland	Design Problems
November	Fitch downgrades SCANA over risks posed by SCE&G's two nuclear units, VC Summer	Negative Financial Indicator
October	NRC identifies significant safety issues with AP-1000 shield design, potentially signaling delays with over half of the proposed reactors in the US	Design Problems
October	New cost estimates for South Texas Project reactors go up $4 billion, a 30% increase	Cost Escalation
September	AP-1000 design in 17th revision; NRC announces more problems that will likely delay AP-1000 designs like Shearon-Harris, Lee, and Vogtle reactors	Delay
September	Duke delays William States Lee reactors from 2016 to 2021	Delay
September	Staffers at Florida PSC are ousted over ethics scandal related to Turkey Point and Levy County rate hikes	Scandal
September	Moody's gives negative credit rating to Oglethorpe over planned investment in Vogtle reactor	Negative Financial Indicator
August	TVA delays proposed Bellefonte reactors from 2016 to 2020-2022	Delay

August	Constellation delays NRC's review of Nine Mile Point application to September 2010, a one-year delay	Delay
August	NRC delays the scheduled publication of the final environmental review for Constellation's Calvert Cliffs in Maryland to February 2011, a delay of 13 months	Delay
August	TVA cancels 3 proposed reactors at Bellefonte	Cancellation
July	Moody's and Fitch downgrade SCE&G due to proposed V.C. Summer reactors	Negative Financial Indicator
July	Ontario scraps proposed $26 billion reactor deal, cites high costs as a factor	Cancellation
May	Progress Energy in Florida announces at least a 20 month delay on planned reactors at Levy County	Delay
May	Exelon cancels two proposed Victoria County reactors	Cancellation
May	South Carolina Electric & Gas files paperwork with South Carolina PSC showing a cost escalation of more than $1 billion for two reactors at VC Summer	Cost Escalation
May	Moody's downgrades PPL to negative outlook over proposed reactor at Bell Bend	Negative Financial Indicator
May	PPL's cost estimates for one reactor at Bell Bend skyrockets from $4 billion to $13-15 billion	Cost Escalation
April	AmerenUE cancels proposed Callaway reactor	Cancellation
March	Entergy in Mississippi suspends application for reactor at Grand Gulf	Suspension
March	Entergy in Louisiana suspends application for reactor at River Bend	Suspension
2008		
December	TVA increases cost estimates for Bellefonte reactors from $6.4 billion to $10.4 billion	Cost Escalation
November	Duke Energy increases cost estimates for William States Lee reactors from $5 billion to around $11 billion	Cost Escalation
October	Progress Energy increases cost estimates for Shearon Harris reactors from $4.4 billion to $9.3 billion	Cost Escalation
August	Constellation increases cost estimates for Calvert Cliffs reactors from $2 billion to $9.6 billion	Cost Escalation
March	Progress Energy triples cost estimates for Levy County reactors to $17 billion	Cost Escalation
February	NRC suspends application for South Texas Project reactors b/c application is incomplete (NRG has since re-filed its application)	Suspension
February	Florida Power and Light revises cost estimates for Turkey Point reactors from around $8 billion to $24 billion	Cost Escalation
January	MidAmerican cancels proposed reactor in Idaho	Cancellation

Source: Update of http://www.psr.org/nuclear-bailout/resources/the-renaissance-that-wasnt.pdf

APPENDIX B:
HEARING # 12-11315, DOCKET NO. 2012-203-E:
TRANSCRIPT OF TESTIMONY VOLUME 1 and 2 OF 3

CROSS EXAMINATION OF SCE&G CEO BY MR. GUILD:

Q All right, sir. Now, you characterized what Dr. Lynch has done for your company in his presentation here, and in his duties generally, is the undertaking of – I think I wrote it down correctly -- a complex, multi-scenario analysis of generation options for the company. Is that what you understand is Dr. Lynch's role?

A Yes.

Q All right. And you fault Dr. Cooper, in your rebuttal to his initial testimony, with not having done such a multi-scenario, complex analysis, correct?

A My evaluation of his testimony was to measure the impact of the change in natural-gas prices.

Q Without considering other alternatives or variables, correct?

A Yes.

Q Now, my question for you is, does the company routinely perform such complex, multi-scenario analyses of the going-forward decision with respect to the Summer Units2 and 3 project?

A I can tell the Commission with assurance there's probably not a day that's gone by since we started construction on these new plants that I'm not thinking about these plants and how well the construction process is going, or do we have challenges, do we have issues we need to deal with. It's an ongoing monitoring process. If issues came to our attention that we believed would determine that this project would no longer be prudent to move forward, I believe it would be my obligation to bring that information to the Commission. We just haven't seen that to date. The project is going as planned. The construction is going well. We're $550 million under-budget. We fixed an additional, you know, percentage of the costs of the plants so we have almost two-thirds of the costs that are fixed. We've only got now a fourth of the project left to spend in those categories that are subject to escalation. I mean, we've had a lot of success on this project, and --

Q Yes, sir, but that's not my question. I hate to interrupt, but I really would like you to focus on my question, if you will. The specific question I asked you is, has your company routinely performed a complex, multi-scenario analysis of the decision to go forward with construction of this plant. Not whether you've monitored construction or care about it, but have you routinely performed just that multi-scenario, complex analysis of the decision to go forward?

A Well, what I was trying to say was, before I would instruct someone to go do an analysis just on a monthly, weekly, or an annual basis, I would have to have some basis for believing something had changed. I mean, if nothing has changed in the circumstances based on which we made the decision, I don't think it's necessary to go back and rerun an analysis.

Q So do I take it from that answer that the answer is, no, you have not routinely done such a multi-variable -- multi-scenario, complex analysis of the decision to go forward.

25 **A** We do -- we would update the evaluation if we considered it to be necessary to evaluate the status of the project.

Q All right.

A What I was trying to say earlier was, we don't know of anything that has risen to that level that would give me a concern, based on my years of experience in the energy industry, that would have changed the conclusion that we would have drawn in 2008, that would have required me to instruct Joe, Dr. Lynch, to go back and perform an analysis. I certainly wouldn't have him do that on a weekly or monthly basis just so he could keep his skills intact at doing that. He knows how to do that.

Q Have you done it at all? Have you done it even once, had Dr. Lynch or others in your staff conduct what you characterize as a complex, multi-scenario analysis of the decision to continue construction of Units 2 and 3?

A We have done that. It was clear, after we got the surrebuttal from Dr. Cooper, that he was not satisfied with the responses we had in our testimony and our rebuttal testimony, so I did instruct Dr. Lynch to go back and update the study that was done in 2008 that had served as the basis for making the decision to move forward with nuclear as the best alternative for our customers. He did the study. It concluded, by a wide margin, that new nuclear was --

Q Well, let's --

A -- the best option to --

Q -- let him talk about what it says, okay? I mean, we'll get to that, Mr. Marsh. That's really hearsay. But you say you, as a result of Dr. Cooper's analysis in this case, instructed Dr. Lynch to conduct an analysis – and that was the analysis that got sent to me last Thursday; is that right? 27th of September, filed with the Commission?

A You know, first of all, I don't believe Dr. Cooper did a comprehensive analysis. He made some calculations based on changes in gas prices. I don't consider that to be a multifaceted analysis like Dr. Lynch did after I instructed him to go back and update the complete analysis we did in 2008, which was the basis for the decision to --

Q Help me, now. I don't mean to cut you off, but --

A All right.

Q -- real simple question, as a matter of fact. The analysis you were just referring to is the one that was filed with the Commission and served on me last Thursday, and that's the one you asked Dr. Lynch to do as a result of reviewing Dr. Cooper's analysis, correct?

A That's correct.

Q Okay. Now, aside from that submission, that update, that review of the decision to go forward with the plant, have you communicated -- have you submitted any other such complex, multi-scenario analysis of the decision to go forward, to the Public Service Commission?

A To my knowledge, there's not a requirement under the Base Load Review Act for us to do that on a regular, consistent basis. Our commitment under the BLRA is to provide you with monthly -- I mean, quarterly reports to give you status updates on where the project is, on the issues we've got, how things are going. We are required to give the Commission an annual update, which we've done every year since the project was started. Mr. Byrne's testimony will satisfy that requirement with the Commission today. ORS is on-site on a regular basis; they look at the information and they monitor the project. So there is ongoing oversight of this project. And as I said earlier, it's not a requirement that we do that, but I feel it's my obligation, as CEO of the company, that if something rose to the level that would convince me that the project, you know, may not be prudent, then I feel like I would have an obligation to revise the evaluation, bring that to the Commission, and make the decision in conjunction with the testimony we presented before them. You know, we did that. While I don't think we were required to do that, we did that, in response to the surrebuttal from Dr. Cooper. And lo and behold, it confirmed exactly what we thought, based on our experience and evaluation of the project today.

Q Okay. The question for you is simple. Prior to that which you sent on Thursday, filed with the Commission -- and Dr. Lynch will address in his testimony -- have you ever submitted such a revised analysis of the decision to go forward with the project to this Commission or to ORS before last Thursday, ever?

A We have not, because we didn't believe it was required, and based on our experience in the industry we didn't think anything had changed to the point or would rise to the level of significance that would require us to do so.

Q All right, sir.

A The study we completed, based on Dr. Cooper's – after reading his testimony, confirmed that.

Q Well, let's test that last assertion. So you don't think enough has changed or anything material has changed since 2008 to cause you to reconsider or even reanalyze, until last Thursday, the decision to go forward.

A I do not.

Q Well, are you surprised, that the nuclear renaissance has simply failed to materialize, for one thing?

A From my years in the industry, I'm not surprised that a lot of things happen, because changes can happen and they can happen very rapidly. Our goal is to be in a position to respond to those changes. Because of the downturn in the economy, based on other companies' situations, in terms of their base-load needs or their generation mix, I wasn't surprised that people decided to put their plans on the shelf for a period of time, to watch and see what the needs were long-term.

CROSS EXAMINATION OF SCE&G VICE PRESIDENT FOR NUCLEAR FINANCE ADMINISTRATION BY MR. ELLIOTT

Q Now, do you recall testifying in the 2010-376-E proceeding that "…it wouldn't be practical to go out and canvass across all of the different areas of SCANA to try to get input into what they thought their level of support was going to be for an EPC contract at the" same "time when you were still trying to ferret out who had what responsibility for the deliverables under the EPC contract to develop those two units." Do you recall testifying to that?

A It's in black-and-white here, so I'm certain I said it.

Q Yes, ma'am. You did. And I think, at my suggestion that it might be helpful to have the costs before you applied for the Base Load Review Act, you responded here that I was trying to put the cart before the horse. Do you recall that?

A That I said that you were trying to put the cart before the horse?

Q Well, yes. I mean, if you read on, you'll see what you testified to on line six was, "But also keep in mind that, at the point in time when we were trying to negotiate the contract, it wouldn't be practical…" and I read that really long sentence. And so, in sort of concluding your remark there, you said, "So you're kind of trying to put the cart before the horse," by ascertaining your costs before you come in for your Base Load proceeding.

A And I would still be of that opinion.

Q Yes, ma'am.

A I think at that point, when they were trying to negotiate the EPC contract, one of the sticking points would be to determine who had responsibility to provide what to the project.

Q Yes, ma'am. Thank you.

A So whether we were going to be building all of the temporary structures that were going to be needed during the course of the contract, versus it being part of the EPC contract, that would drive a significant difference in what you would consider owners' costs as compared to the EPC contract costs.

Q We have page 304 of the transcript on the screen here, from the 2010-376-E. [Reference: 2010-376-E hearing transcript at Page 304/Line 16 and following]. And I asked you this question, and I would ask you if you recall the question and answer. "But, again, as I understand your testimony, it was not reasonable or prudent to ask your staff in May of 2008 what they estimated their costs would be, for the purposes of your Base Load Review application. Is that your testimony?"

And your answer was -- and I'll read part of it. You may read all of it, if you wish -- "I do not think it was reasonable for us to be able to go and do that." Do you see that testimony there?

A I do.

Q All right. And that's still your testimony, looking back on it? It would not have been reasonable to have asked the staff to ascertain your costs before you came in here for your Base Load Review application. That's still your testimony today, isn't it?

A To try to go in and do a deep dive into owners' costs?

Q Yes.

A I still think that that would be an inefficient way to operate.

Q Okay. And I think a deep dive would be -- to determine what your owners' costs were, that would be unreasonable to do.

A A deep dive, in my mind, is to go cost center by cost center, and try to articulate what we consider our resource codes -- whether it be labor, nonlabor, outside services -- what costs were to be expected by various functional groups. The core group that negotiated the contract had representation from some of the major areas licensing, construction, engineering -- but they didn't have a lot of support from the Unit 1 personnel, who ultimately are going to have the responsibility to operate Units 2 and 3 when they come on-line.

Q Okay. Thank you. I do want to ask: It was SCE&G's decision in May 2008 to apply for the Base Load order, wasn't it?

A It was.

Q I mean, it was -- there was -- you're not aware of anything in the statute that required them to file in May 2008, are you?

A I'm not, but -- I mean, I think I understand where you're going to go with this. I think you've got to understand, from a financial market position, we had executed an EPC contract that obligated our company to build two new nuclear units that were relatively high in value relative to our balance sheet, and it would be a significant risk to the company to have a binding agreement of that magnitude and not have sought regulatory support. So the two needed to be close in time, so that we could continue to have the support of the credit agencies, as well as the analysts, to be able to support SCANA.

Q I see. And as a consequence, y'all came in in that 2010 docket and asked for $145 million in owner's costs, correct?

A I'd have to go back to -- I don't think I've got that number, exactly [indicating].

Q Would you have it handy, by any chance? I'm sure the record would speak for itself, but I would appreciate being corrected. I think your -- the other SCE&G witnesses have not hesitated to correct me.

A Pardon?

Q I said I'd appreciate being corrected. I think – my note says $145 million last year, and I just would like to know.

A That's correct, 145. 144.582.

Q All right. So when you came in in May of 2008 -- well, you're asking for $131 million in owner's costs here, correct?

A That's right.

Q And you're asking for another $137 million to pay for the settlement with Westinghouse and so forth, correct?

A That's correct.

Q And so it's fair to say that your estimates in 2008 were substantially short of what costs you actually -- today, at least -- feel you need? Isn't that fair to say?

A I think that's fair to say.

APPENDIX C:

MARKET BARRIERS AND IMPERFECTIONS THAT MAKE COMPLEMENTARY POLICIES VITALLY IMPORTANT IN THE INITIAL RESPONSE TO THE CHALLENGE OF CLIMATE CHANGE

The following table catalogues the many market barriers and imperfections that have been identified as obstacles to responding to the climate change. The table provides a set of framing citations from a prominent energy/environmental research organization – Resources for the Future – the supports and expands on that framing with citations to 50 empirical articles on various aspects of climate change published in the past decade. The presence of these barriers and imperfections means that the response to carbon prices will be disappointing and impose significantly more economic harm than targeted policies to stimulate innovation smooth and accelerate the transition to a lower carbon economy. Reflecting this understanding, climate policy has begun to emphasize the complementary policies. As discussed in the text, this shift in policy shines a very harsh light on the decision to allow assumptions about hefty carbon taxes to dictate resource choices in the states.

EXHIBIT III-1: MARKET BARRIERS AND IMPERFECTION IN CLIMATE CHANGE ANALYSIS

TRADITIONAL ECONOMICS & INDUSTRIAL ORGANIZATION

EXTERNALITIES

Knowledge Externalities that are not captured by markets, e
Research and Development (20, 22, 23, 48, D), a, b
Importance of learning by searching (27, 31, 38, E), c
Deployment: Importance of learning by doing (27, 10, 31, 38, B), c
Economics of Scale/returns to scale (6, 38, 41, 47, G), d
Localization (24, 38, 45, H))

MARKET STRUCTURE:

Cost Structures: Long investment cycles, increasing returns to scale, network effects (8, 28, 33, 498 I)
Challenge of creating new markets: Undifferentiated product (20, 23, 28, 42, J)
Entry Barriers: Capital Cost, access to network (20, 41, 47 48, K)
Lack of competition hinders innovation (41, 48, L)

INERTIA:

Cost of Inertia (1, 14, 28, M)
Importance of inertia/stock of knowledge (9, 24, 37, 45, N)

NEW INSTITUTIONAL ECONOMICS

ENDEMIC

Perverse incentives: in allocation of fuel price volatility (20, 50, O), carbon tax level and permanence (21, 30, 40, 44, P) g
Asymmetric information (21, 48, Q)
Shot-term view, h, i

TRANSACTION COST

Uncertainty: as a cause of underinvestment (8, 21, 26, 43, 47, R)
Fuel price volatility, carbon tax level and permanence (fuel price volatility, carbon tax level and permanence (20, 33, S)
High risk premia on new technologies (28, T)
Information: Value of information (2, 22, U)
Sunk costs and embedded infrastructure (21, 48, V)
Incomplete markets f

POLITICAL POWER

Power of incumbents to hinder alternatives (20, 45, ZA)
Monopolistic structures and lack of competition (24, 39 41, 46, 47, ZB)
Importance of institutional support for Alternatives (22, 30, ZC)

BEHAVIORAL ECONOMICS

BEHAVIOR

Sluggish demand response (20, 23, W)
Agency (18, 8, X)
Risk Aversion (6, Y)
Calculation (17, 47, Z)

EFFECTIVE POLICY RESPONSES

Public goods (24, 49, ZC)
Institution Building (22, 30, 49, ZE)
Research and Development (5, 10, 20, 23, 25, 26, 28, 32, 35, 37, 47, ZF)
Capital subsidies Adders, premium prices (6, 41, ZG)
Obligations/Consenting (25, 28, 35, 47, M, (ZH)
Standards (8, 22, ZI)
Feed in Tariffs (28, 41, 45, 47, ZJ)
Merit order (20, 21, ZK)

EVIDENCE ON THE INEFFECTIVENESS OF PRICE/ TAX AS POLICY

Price Insufficiency (4, 11, 15, 20, 19, 25, 29, 35, 41, 47, 48 A)
Tax: Difficulty of setting and sustaining "optimal" levels (20, 19, 47, B)
Tradable permits do not increase innovation (5, 36, C)

Lower case letters (a) Raymond J. Kopp and William A Pizer, *Assessing U.S. Climate Policy Options* (Washington, D.C.: November 2007);
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50 Zorlu, Pelin, et al., Risk Managing Power Sector Decarbonization in the UK, E3G, October 2012

a) Public Goods:, Many technologies have competing or multiplicative (rather than additive) impact. The most compelling economics typically reside with the first abatement options in the analytical sequence. Pursuing energy efficiency in electric power, for example, has the potential to reduce the number of new coal-fired power plants needed (p. xx); The mismatch between near-term technology investment and long-term needs is likely to be even greater in a situation where the magnitude of desired GHG reductions can be expected to increase over time. If more stringent emissions constraint will eventually be needed, society will benefit from near-term R&D to lower the cost of achieving those reductions in the future. Similarly, rationales for public support of technology demonstration projects tend to point to the… inability of private firms to capture the rewards for rewards for designing and constructing first-of-a-kind facilities. (p. 120)
(b) R&D tends to be underprovided in a competitive markets because its benefits are often widely distributed and difficult to capture by individual firms…. economics literature on R&D points to the difficulty firms face in capturing all the benefits from their investments in innovation, which tend to spill over to other technology producers and users.. (pp. 118-120); In addition, by virtue of its critical role in the higher education system, public R&D funding will continue to be important in training researchers and engineers with the skill necessary to work in either the public or private sector to product GHG-reducing technology innovations (p. 120)… Generic public funding for research tends to receive widespread support based on significant positive spillovers that are often associated with the generation of new knowledge. (p. 136).
(c) "Another potential rationale involves spillover effects that he process of so-called "learning-by-doing" – a term that describes the tendency for production costs to fall as manufacturers gain production experience."(p. 136)
(e) Network Effects: Network effects provide a motivation for deployment policies aimed at improving coordination and planning – and where appropriate, developing compatibility standards – in situations that involve interrelated technologies, particularly within large integrated systems (for example, energy productions, transmission, and distribution networks). Setting standards in a network context may reduce excess inertia (for example, the so-called chicken-and-egg problems with alternative fuel vehicles), while simultaneously reducing search and coordination costs, but standard scan also reduce the diversity of technology options offered and may impede innovation over time. (p. 137)
(e) Similarly, rationales for public support of technology demonstration projects tend to point to the large expense; (p.120).
(f) Similarly, rationales for public support of technology demonstration projects tend to point to the large expense; high degree of technical, market and regulatory risk; and inability of private firms to capture the rewards for rewards for designing and constructing first-of-a-kind facilities. (p. 120)
(g) Finally, incomplete insurance markets may provide a rationale for liability protection or other policies for certain technology options (for example, long-term CO2 storage). (p. 137)
(h) Regulatory risk: Similarly, rationales for public support of technology demonstration projects tend to point to the… high degree of technical, market and regulatory risk. The problem of private-sector under investment in technology innovation may be exacerbated in the climate context where the energy assets involved are often very-long lives and where the incentives for bringing forward new technology rest heavily on domestic and international policies rather than natural market forces. Put another way, the development of climate-friendly technologies has little market value absent a sustained, credible government commitment to reducing GHG emissions. (p. 120)
g) The mismatch between near-term technology investment and long-term needs is likely to be even greater in situation where the magnitude of desired GHG reductions can be expected to increase over time. If more stringent emissions constraint will eventually be needed, society will benefit from near-term R&D to lower the cost of achieving those reductions in the future. (p. 120)."
h) Finally, incomplete insurance markets may provide a rationale for liability protection or other policies for certain technology options (for example, long-term CO2 storage, [.137)."
i) The problem of private-sector under investment in technology innovation may be exacerbated in the climate context where the energy assets involved are often very-long lives and where the incentives for bringing forward new technology rest heavily on domestic and international policies rather than natural market forces… "Put another way, the development of climate-friendly technologies has little market value absent a sustained, credible government commitment to reducing GHG emissions (p.12).

A Walz, Schleich and Ragwitz, 2011, p. 16, Power prices, however, are not found to drive patent activity. Hence power prices alone would likely not be sufficient to spur innovation activities in wind and arguably also other, currently less cost-efficient renewable technologies.
B The stability and long term vision of policy target setting are important policy style variables, which contribute to the legitimacy of technology and provide guidance of search…
C Calel and Dechezloprete, 2012, p. 1. "[M]ore refined estimates that combine matching methods with different-in-difference provide evidence that the EU ETS has not impacted the direction of technological change. This finding appears to be robust to a number of stability and sensitivity checks. While we cannot completely rule out the possibility that the EU ETS has impacted only large companies for which suitable unregulated comparators cannot be found, our findings suggest that the EU ETS so far has had at best a very limited impact on low-carbon technological change.

D Massetti and Nicita, 2010, p. 1The presence of market failures in the R&D sector, as emphasized by Griliches, is confirmed by the evidence, virtually found in all studies, that the social rate of return on R&D expenditure is higher than the corresponding private rate; estimates of the marginal social rate of return on R&D range between 30 and 50 percent and of private return between 7 and 15 percent… When it comes to technologies for carbon emissions reduction, the difference between private and social rate of return to R&D investment arises from a double externality; the presence of both environmental and knowledge externalities. First, without a price on carbon that equates the global and the private cost of emitting GHGs, all low emissions technologies are relatively disadvantaged and the level of investment is therefore sub-optimal. Second, the private return to investment in R&D is lower than the social return of investment due to the incomplete appropriability of knowledge creation, thus pushing further away investment for the socially optimal level.

E Massetti and Nicita, 2010, p. 17, We find that a [carbon] stabilization policy together with an R&D policy targeted at the only energy sector is significantly less costly than the stabilization policy alone. We find that energy R&D does not crowd-out non-energy R&D, and thanks to intersectoral spillovers, the policy induced increase in energy efficiency R&D spills over to the non-energy sector, contributing to knowledge accumulation and the reduction of knowledge externalities.

F Gross, et al., p.18, The phenomenon of "learning by doing", whereby costs for technologies reduces as experience is gained from deployment of the technology creates lock-in. It also creates better, cheaper technologies. The incumbent fossil and nuclear forms of generation have had many decades of technical refinement through experience which have driven their costs down to low levels relative to new, renewable technologies. In part, this was financed by considerable public subsidy… The very same effects that created lock-in to high carbon systems offer the potential to decrease the costs and improve the commercial/consumer attractiveness of new forms of low carbon energy.

G Qui and Anadon, pp. 782, The size of the wind farm is another significant factor in all specifications… indicate that a doubling in wind farm size could lead to price reductions of about 8.9%.

H Qui and Anadon, pp. 782, Localization rate is a significant factor in all specifications… indicate that a doubling of localization rate was associated with reductions in wind electricity price ranging from 10.9% to 11,4%.

I Cian and Massimo, 2011, p. 123, Uncertainty and irreversibility are two features of climate change that contribute to shape the decision making process. Technology cost uncertainty can depress the incentive to invest. The risk of underinvestment is even more severe considering that energy infrastructure has a slow turnover. Capital irreversibility and uncertainty heighten the risk of locking into existing fossil-fuel-based technologies. Additional investments are sunk costs that increase the opportunity cost of acting now… The result is reinforced when uncertain costs have a large variance, showing that investments decrease with risk. Jamasb and Nicita, (2007, p 8) R&D activity can be subject to three main types of market failure namely indivisibility, uncertainty and externalities.

J J. Kalkuhl, Edenhofer and Lessmann, 2012, p. 10, The energy sector is highly vulnerable to lock-in because electricity is an almost perfect substitute for consumers. In contrast, many innovations in the manufacturing or entertainment electronics sector provide a new product different from existing ones (e/g/ flat screens vs. CRT monitor). The low substitutability implies a high niched demand and, thus, provokes ongoing learning-by-doing although considerable spillovers exist and market prices are distorted.

K K. Gross, et al. 2012, p. 18, In the energy sector, such "network externalities" rise for example in the physical structures of large scale high voltage alternating current (AC) power grids themselves (themselves a reminders of early energy planners' desire to locate power stations close to the source of coal) which now provides a cost advantage to large scale centralized station over distributed alternatives.

L Gross, et al., 2012, p. 10, Either policymakers around the world are blind to the logic of economic theory, or there are factors that overwhelm or undermine the theoretical Pigouvian considerations. The rest of this paper discusses the considerations t

M Grimaud and Lafforgue, 2008, p. 1…20,The main results of the paper are the following: i) both a carbon tax and a green research subsidy contribute to climate change mitigation; ii) R&D subsidies have a large impact on the consumption, and then social welfare, as compared to the carbon tax alone; IV) those subsidies allow to spare the earlier generations who are, on the other hand, penalized by a carbon tax….In a second-best world, a carbon tax used alone leads to a higher social cost (with respect to first-best) than a research policy alone;

N Jamasb and Kohler, 2007, p. 9, Information technology and pharmaceuticals, for example, are both characterized by high degrees of innovation, with rapid technological change financed by private investment amounting typically to 10-20% of sector turnover. This is in dramatic contrast with power generation, where a small number of fundamentals technologies have dominated for almost a century and private sector RD&D has fallen sharply with privatization of energy industries to the point where it is under 0.4% of turnover.

O Gross, et al., 2012, p. 14, Capital intensive, zero fuel cost power stations like wind farms, need to cover their long run average costs—namely the cost of capital. They can neither actively affect/set marginal power prices nor respond to power price changes, except to curtail output, which does not save costs (as there are no fuel cost to save), but does lose revenue. However, carbon prices only affect the marginal price of fuel and power. We should therefore expect that an emissions trading scheme will encourage fuel switching from coal to gas, and efficiency first and renewable energy (or indeed nuclear) investment last. This is exactly what we have seen in reality.

P Reuter, et al., 2012, p. 253, If there is uncertainty about the future development of feed-in-tariffs, much higher levels will be needed to make renewable investment attractive for energy companies.

Q Gross, 210, p. 802, "A range of factors that relate to the amount and quality of information about technology costs and risks available to policymakers and market participants are relevant when considering incentives and investment in new technologies: Policymakers may have relatively poor information about costs for emerging technologies. 'Appraisal optimism' (where technology/project developers under estimate the cost of unproven technology/systems) is a common feature in the development of new technologies. When providing cost data to policymakers technology developers or equipment suppliers may also have incentives to up or play down costs and potential according to circumstances. Where new or unproven technologies are being utilized for the first time, information about costs may be limited for all concerned... There may be an 'option value' to potential investors in waiting (delaying investment) where there is poor information and high levels of technology and market risk. The first conclusion is that policymaking in the energy area needs new tools of analysis that can deal with the market risks associated with policy design… In particular, policymakers need to be mindful of the role of revenue risk as well as cost risk in the business case for investment.

R Fuss and Szolgayosva, 2010, p.2938, We find that the uncertainty associated with the technological progress of renewable energy technologies leads to a postponement of investment. Even the simultaneous inclusion of stochastic fossil fuel prices in the same model does not make renewable energy competitive compared to fossil-fuel-fired technology in the short run based on the data

used. This implies that policymakers have to intervene if renewable energy is supposed to get diffused more quickly. Otherwise, old fossil-fuel-fired equipment will be refurbished or replaced by fossil-fuel-fired capacity again, which enforces the lock-in of the current system into unsustainable electricity generation.

S Gross, et al., 2012, In short,, whilst carbon pricing can create conditions that make investment in wind more attractive, there are uncertainties associated with wholesale power prices, carbon permit prices, and future political decisions on carbon tax levels. These make wind investment more risky, which drives up the cost of capital investors require higher returns), and discourage investment.

T Gross, Blyth and Heponstall, 2012, p. 802.The first conclusion is that policymaking in the energy area needs new tools of analysis that can deal with the market risks associated with policy design… In particular, policymakers need to be mindful of the role of revenue risk as well as cost risk in the business case for investment.

U Horbach, 2007, p. 172, Environmental management tools help to reduce the information deficits to detect cost savings (especially material and energy savings) that are an important driving force of environmental innovation.

V Weyant, 2011, p. 677, The infrastructure for producing, distributing, and promoting the industries' current products require large investments that have already been incurred.

W Jamasb and Kohler, 2007, Thus, the 'market pull' forces reach deep into the innovation chain…This is in contrast with power generation, where a small number fundamental and private sector RD&D has fallen sharply with privatization of energy industries. technologies have dominated for almost a century and private RD&D has fallen sharply with privatization... In turn, market pull measures are devised to promote technical change by creating demand and developing the market for new technologies.

X Weyant, 2011, p. 675, The situation can develop from several different types of market failure, including poor or asymmetric information available to purchasers, limits on individual's ability to make rational decisions because of time or skill constraints, principle agent incongruities... and lack of financing opportunities.

Z Green, 2010, p. 6, The rational economic consumer considers fuel saving over the full life of a vehicle, discounting future fuel savings to present value. This requires the consumer to know how long the vehicle will remain in operation; he distances to be traveled in each future year, the reduction in the rate of fuel consumptions, and the future price of fuel…. The consumer must also estimate the fuel economy that will be achieved in real world driving based on the official estimate. Finally, the consumer must know how to make a discounted present value calculation, or must know how to obtain one… The utility-maximizing rational consumer has fixed preferences, possesses all complete and accurate information about all relevant alternatives, and has all the cognitive skills necessary to evaluate the alternatives. These are strict requirements indeed….

ZA Nicolli and Vona, p. 1, Our empirical results are consistent with predictions of political-economy models of environmental policies as lobbying, income and to a less extent, inequality have expected effects on policy. The brown lobbying power, proxied by entry barriers in the energy sector, has negative influence on the policy indicators even when taking into account endogeneity in its effect. The results are also robust to dynamic model specifications and to the exclusion of groups of countries

ZB Weyant, 2011, p. 677, Further complicating matters, existing companies in energy-related industries --- those that produce energy, those that manufacture the equipment that produces, converts and uses energy, and those that distribute energy – can have substantial incentives to delay the introduction of new technologies. This can happen if their current technologies are more profitable than the new ones that might be (or have been) invented, or if they are in explicitly (oil and gas) or implicitly (electric generation equipment producers and automakers) oligopolistic structured, or if they are imperfectly regulated (electric and gas utilities). The incentive arises partly because the infrastructure for producing, distributing, and promoting the industries' current products require large investments that have already been incurred.

ZC Horbach, 2008, p. 172, An environmentally oriented research policy has not only to regard traditional instruments like the improvement of the technological capabilities of a firm but also the coordination with soft environmental policy instruments like the introduction of environmental management systems.

ZD Johnstone and Haccic, 2010, p.25 "Since innovating in storage technologies is an important complement to innovation in all intermittent renewable generating technologies such a strategy reduces the risk of (not) picking winners. Moreover, the technologies are at a relatively early stage of development, with greater need for support.

ZE Wilson, et al., p. 781, The institutions emphasized in our analytic framework are twofold: the propensity of entrepreneurs to invest in risky innovation activities with uncertain pay-offs; and shared expectation around an innovation's future trajectory. Other important and related institutions include law, markets and public policy. Public resources are invested directly into specific innovation stages, or are used to leverage private sector resources through regulatory or market incentives structured by public policy…. New technologies successfully diffuse as a function of their relative advantage over incumbent technologies. For energy technologies, this can be measured by the difference in cost and performance of energy service provision in terms of quality, versatility, environmental impact and so on. Many of these attributes of relative advantage can be shaped by public policy as well as the other elements of the innovation system.

ZF Walz, Schleich and Ragwitz, 2011, p. 5, The specific advantage of feed-in tariffs is seen in lower transaction costs and reduced risk perception for investors and innovators, which are extremely important especially for new entrants and for financial institutions.

ZH Walz, Schleich and Ragwitz, 2011, p. 16, Our econometric analyses also imply that the existence of targets for renewables/wind and a stable policy support environment are associated with higher patent activity.

ZI de Chien and Massimon, 2012, pp. 1333…15, Against this evidence, regulation such as Emissions Performance Standards (EPS) that set a maximum threshold for the emission intensity of power generation in terms of grams of CO_2 per kilowatt hour could be justified as a way to reduce uncertainty exposure... [W]e have also pointed out that the optimal penetration of renewables is slow, even when facing a given deterministic carbon price.

ZG Rubbeike and Weiss, 2011, Including non-price-based variable increases the fit of the model… the coefficients for grants is positive and highly significant.

ZJ Gross, Blyth and Heptonstall, 2010, 802,The international evidence suggests that in most cases countries with fixed price schemes have been more successful at deploying renewables than those with trading scheme. Whilst the reasons for this are complex and varied it appears likely that investment risk plays an important role.

ZK Gross, Blyth and Heptonstall, 2010, 798,The result is that significant long-run fuel price uncertainty.. cannot usually be hedged through contractual arrangements. Long-run fuel price changes, like time of day rates, are mediated by the current market arrangements but remain fundamental to electricity prices.