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Assessing Nuclear Plant Capital Costs for the Two Proposed NRG Reactors at the South Texas Project Site

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A. Main Findings and Recommendations

NRG, a merchant electricity generating company, proposes to build two new nuclear power reactors, totaling 2,700 megawatts at the South Texas Project site near Bay City, Texas. NRG owns a part of the two units that already exist at that site. CPS Energy, San Antonio's electricity and gas municipal utility, which owns a 40 percent share of the two existing units proposes to purchase a 40 percent share of the proposed new reactors. This analysis is a preliminary report on the likely capital costs of the two reactors, as best they can be determined at the present time. It also contains some preliminary observations regarding efficiency and distributed renewable energy sources to put the CPS decision that might be made regarding investment in the NRG plant into context.

Central conclusion and recommendation

The overall finding of this report is that NRG's range of $6 billion to $7 billion is obsolete. The best available estimates indicate that capital costs would likely be about a factor of two or more higher, even without taking into account the potential for real cost escalations during construction, delays, and other risks. The risks to CPS, as a municipal utility and to its ratepayers as well as to the taxpayers of San Antonio are great. Due diligence demands that CPS participation in the project should not be pursued until an independent, detailed study with current cost estimates of the plants and alternatives to it are complete and have been publicly disclosed and discussed.

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1. Main Findings

- Careful industry analysis of new nuclear power plant costs indicates that the NRG estimate of $6 billion to $7 billion for the cost of the two new nuclear units proposed to be built at the South Texas Project site is obsolete and likely incomplete. The best currently available analyses indicate that it is a serious underestimate of the capital costs of the project.
- An analysis of new nuclear power plant costs filed by Florida Power & Light (FPL) with the Florida Public Service Commission is the most complete and rigorous analysis of new nuclear power plant capital costs publicly available to date. The FPL analysis is based on the same reactors, G.E. Advanced Boiling Water Reactors (ABWRs) as the proposed NRG project. Using this analysis, we find that the all-in total capital cost of the proposed NRG two-reactor project would be in the $12 billion to $17.5 billion range. This range is two to three times the lower NRG value of $6 billion and 1.7 to 2.5 times NRG's higher estimate of $7 billion. Moody's October 2007 estimates are within this range, as is the Progress Energy's March 2008 estimate. Even these estimates do not take into account higher imported component cost risks created by a falling dollar or possible continued real cost escalation due to rising global demand for raw materials and skilled labor.
- A 40 percent CPS' share of the project would make its likely investment in the project in the $4.8 billion to $7 billion range. Even the lower end of this range is considerably higher than the total net value of CPS's total electric plants of $3.9 billion as of the end of its 2007 fiscal year. The high end would make CPS's share equal to the high end of the total NRG cost estimate.
- As a municipal utility partnering with a merchant generator, the risks to CPS ratepayers and San Antonio taxpayers of a large, long-lead time, capital intensive project in a time of financial turbulence are considerable and need to be carefully evaluated. They should be publicly disclosed and discussed.
- CPS completed its own study of the costs of the proposed project and compared it to some alternatives in June 2007. This study has not been made public; it is being updated.
- CPS has made a commendable commitment to the concept that efficiency should be treated on a par with new investments in coal or nuclear plants. However, this commitment is only in the very initial stages of operationalization and is at very low levels of implementation relative to economic potential. The efficiency study of 2004 commissioned by CPS did not cover some technical elements and did not include combined heat and power or distributed renewable energy sources within its scope. It is also in urgent need of a financial update in light of increased costs of new coal and nuclear plants.
- An early decision to invest in the nuclear units would pre-empt and possibly even foreclose full operationalization of the concept that efficiency, distributed generation, and distributed renewables should be treated on a par with central station investments. This could result in needless rate increases and financial risk. Additional financial risk may accrue due to NRG's approach to the project. For instance, NRG filed an incomplete Combined Operating License Application with the Nuclear Regulatory Commission, a fact that has could result in delays in the licensing process.

2. Recommendations

- The CPS study of the costs of new nuclear units and alternatives should be made public. An independent review of this study would benefit the public and reduce the risks associated with an investment decision that is likely to be larger than the new value CPS's entire electricity system.
- The City Council should commission a fully independent study of the NRG's project's capital costs, including risks not quantified in this preliminary report. The study should also consider other cost elements such as fuel costs, potential consequences of a lack of federal contracts for spent fuel disposal for new reactors, opportunity costs of water that would be used by the plants, and reliability of nuclear power plants in times of extreme heat and drought that may become more common in a warming world.
- A study of efficiency, distributed generation, distributed renewables, solar thermal power plants, large scale wind, and intermediate scale (greater than 100 kW) solar PV on commercial rooftops and parking lots needs to be completed. This would provide a basis for deciding a future course of action by comparing combinations of alternative options for cost and reliability comparison with the proposed nuclear investment.
- CPS should work with Arizona Public Service, Austin Energy, regional electric cooperatives, and other utilities to develop a financial model for treating efficiency, distributed generation, and distributed renewables on a par with central station generation. This is necessary for economical operation, the health of the utility, and achieving least cost solutions within any given set of environmental and reliability constraints.
- NRG emerged from bankruptcy as recently as December 2003. It's license application was deemed to be incomplete by the NRC. Its public capital cost estimates for the project are obsolete. These facts should elicit special due diligence examination on the part of CPS, its governing board and the City Council prior to a commitment of partnership in the proposed project.
- A decision on any rate increase associated with an investment in the new nuclear units should be postponed until a sound basis for comparison as described above is developed. A decision to invest in this project should also be postponed until the studies discussed above have been completed and publicly discussed.

B. Introduction

NRG is an independent generating company that owns a part of two existing reactors at the South Texas Project. It is proposing to add two more at the site. The additions would be two of General Electric's Advanced Boiling Water Reactors, rated at 1,350 MW each, totaling 2,700 MW. San Antonio's municipally-owned electricity and gas utility, CPS Energy, is proposing to invest in this project by acquiring a 40 percent ownership share in the new reactors.

This initial report was prepared under contract to the Sustainable Energy & Economic Development (SEED) Coalition. The overall purpose of this project is to assess whether there are alternative approaches that could meet San Antonio's electricity requirements without the proposed nuclear unit investments, in light of current cost estimates of nuclear power. This

initial report focuses on current costs of nuclear power and the implications of CPS's proposal to invest in the NRG project. It also briefly presents a concept regarding the alternatives that should be considered in greater depth than they have been so far, at least in public. A more detailed report will follow this initial document.

We note that CPS had prepared its own cost assessment of the nuclear investment and alternatives to it by June 2007. This report was prepared by CPS consultants and staff. It is being updated. Neither the June 2007 report nor any information about the updates is public.

C. Background

CPS capacity, peak load, and electricity sales data are shown in Table 1.[2]

Table 1: CPS Electricity System Data	2007	2006	2005
ELECTRIC GENERATION (MWh)			
Generation	**22,266,945**	20,078,651	18,640,751
Energy purchases & other power	**1,242,451**	1,148,997	1,383,069
Native load: generation & other power	**23,509,396**	21,227,648	20,023,820
Total power available [(1)]	**23,509,396**	22,720,119	21,413,257
Capacity, MW (gas)	**2,821**	2,766	3,021
Capacity, MW (coal)	**1,365**	1,425	1,425
Capacity, MW (nuclear)	**1,054**	1,025	700
Capacity, MW (wind)	**260**	260	160
Capacity, MW (landfill gas)	**10**	10	-
Total capacity	**5,510**	5,486	5,306
ELECTRIC PEAK DEMAND (MW)	**4,407**	4,320	4,036

Source: CPS 2007. *Making the Switch: Financial Summary Fiscal Year Ended January 31, 2007*, CPS Energy FY 2007 Financial Report, CPS Energy. CPS wind generating capacity increased by July 2007 to 511 MW. See *CPS 2006-1007 Environmental Report* cited below.

CPS's proposed 40 percent share of the two proposed reactors amounts to an increase of 1,080 MW in CPS's baseload capacity. Counting CPS's coal and nuclear installed capacity of 2,419 MW as baseload, the two nuclear units would represent an increase of about 45 percent in CPS's baseload capability. About half of CPS' installed generating capacity is natural gas. Of the natural gas capacity, 2,250 MW is gas-steam power plants and 671 MW is peaking gas turbine capacity.[3] It is used for intermediate and peaking applications. The capacity factor of the gas steam capacity would be expected to be low compared to the coal and nuclear units and that of gas turbine units even lower, due to higher fuel costs. Note that of the total generation and other purchases of 23.5 million MWh, CPS sold about 2.5 million MWh to parties outside the CPS system, while purchases were about half this amount. Note that about half the growth in generation between 2006 and 2007 was due to a net increase in off-system sales.

CPS' total assets at the end of its FY 2007 were $8.6 billion, of which $3.9 billion were in its electric plants (net of accumulated depreciation).[4]

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[2] All data below in this section are for CPS fiscal years, unless otherwise stated.

[3] *CPS 2006-2007 Environmental Report*, p. 6. The values in the chart on this page appear to be gross generation capacity.

[4] CPS 2007. *Making the Switch: Financial Summary Fiscal Year Ended January 31, 2007*, CPS Energy FY 2007 Financial Report, CPS Energy, pages 15 and 17. Data regarding the CPS system in this report are from this publication, unless otherwise stated.

CPS also sells natural gas to residential, commercial and industrial customers, as well as to public authorities. The average fuel purchase cost of natural gas for distribution gas in 2007 was $7.61 per thousand cubic feet of gas sold. CPS also uses natural gas for some of its electrical generating units.

D. New Nuclear Power Plant Costs

NRG's public estimate of the capital cost of the two nuclear units totaling 2,700 MW, made in August 2007, is that it will be between $6 to $7 billion,[5] or $2,200 to $2,600 per kilowatt (rounded). CPS has not made its own evaluations of the NRG and other industry cost estimates public, claiming that it is business confidential information. As will be clear from the detailed industry and Wall Street estimates discussed below, NRG's capital cost estimates are obsolete and may be partial.

1. Florida Power and Light Estimates

A recent (October 2007) and very detailed cost estimate for a new nuclear power plant was made by Florida Power & Light (FPL) and presented to the Florida Public Service Commission by Steven Scroggs, Senior Director of Project Development for FPL.[6] This estimate, in turn was based on an earlier study by TVA. It took into account cost escalation and other factors since the completion of the TVA study. *That TVA study was for an ABWR, the same reactor type that NRG proposes to build. Hence the cost estimates made by FPL, based on this TVA study, are particularly relevant to the NRG project.* Like the proposed NRG project, the proposed FPL project is also a two-unit project of comparable size.

At present the FPL estimate is the most reliable, current, and detailed public estimate available. FPL has extensive experience in building and operating power plants and in the nuclear energy industry. As it noted in its Florida PSC filing:

> As a leader in nuclear power generation in the United States, FPL has maintained continuous involvement in a variety of industry forums and working groups. Participation through these industry outlets and direct participation in the NuStart consortium has allowed FPL to keep current with the status of new nuclear generation and to understand the issues surrounding project construction schedule and costs associated with new nuclear project designs. This involvement allows FPL to critically evaluate available information and develop an opinion as to its applicability. FPL also brings to bear a significant amount of engineering maintenance and operational knowledge that is specifically applicable to this task. FPL maintains one of the most active and current utility construction programs in the U.S., providing in-house expertise and access to industry experts in all disciplines.[7]

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[5] Bernie Woodall, NRG picks Toshiba for South Texas reactor project," Reuters, August 10, 2007. On the Internet at http://www.reuters.com/article/companyNewsAndPR/idUSN1025924820070810

[6] FPL 2007. Direct Testimony of Steven D. Scroggs, Florida Power & Light Company, before the Florida Public Service Commission, Docket No. 07____-EI, October 16, 2007. On the Internet at http://www.psc.state.fl.us/dockets/cms/docketFilings2.aspx?docket=070650, document number 09467-07.

[7] FPL 2007, op. cit., pp. 41-42.

The context of the FPL filing is somewhat similar to the NRG project in terms of project size and timing. The main difference is that FPL made a detailed and transparent capital cost estimate for a regulatory body, while NRG has made some public statements, but as a merchant generator, has not been obliged to make the basis of its cost statements public or to provide any details.

Steven Scroggs described FPL's overall cost estimation process as follows:

> The process for creating a new nuclear project cost estimate differs from fossil fuel or renewable generation projects due to a lack of a similar level of relevant market-based information and recent experience base. For example, the detailed site-specific design, firm schedule and negotiated supply contracts usually developed prior to the need filing for fossil units, will not be available for several years after the need determination process for new nuclear [units]. Because the commencement of construction is four to five years from the Need Order, the impact to final cost of market variations in materials, equipment and labor is difficult to predict. Therefore, it was necessary for FPL to survey current studies to identify a body of work that could be adapted into a cost estimating process for new nuclear in Florida. The primary source of FPL's non-binding cost estimate is an interagency study conducted by an industry consortium, led by the Tennessee Valley Authority (TVA) in coordination with the U.S. Department of Energy, and published in August of 2005….[8]

Using a careful updating and analysis of the TVA study, cost escalations since the completion of the TVA study, and other factors, FPL developed a range of capital cost estimates. These cost estimates included:

1. The "overnight cost" of the power plant, which is the cost assuming that the plant is constructed overnight and does not take into account interest during construction or any cost escalations during construction. FPL analyzed over two dozen elements of overnight cost, including cost of reactor, turbine, and electrical equipment, construction, site preparation, etc. FPL's overnight cost estimates are generally comparable to the NRG situation because they are for a site where reactors already exist. Further, FPL's reference project was the same as the NRG project – two new General Electric ABWR units built at an existing site. There would be some site-specific differences, such as the type of cooling used and the cost of transmission integration.
2. Adjustments to the TVA cost estimates for the various reactor designs considered by FPL, if different from the ABWR design that was the basis of the TVA study. These adjustments would not apply to the present case, since NRG proposes to build ABWRs.
3. An inflation escalator of 2.5 percent over the project construction and commissioning period. It is preferable in comparing cost estimates and in developing cost estimates for electrical energy to have costs in constant dollars. Therefore, the analysis in this report is in constant 2007 dollars, starting with the FPL estimates..
4. Allowance for funds used during construction (AFUDC), which is the interest cost during construction. The estimates made here also convert this cost into a constant cost in 2007 dollars.

[8] FPL 2007, op. cit., p. 40.

FPL did not make any allowance for real cost escalation during construction. FPL considered two project sizes for itself – 2,200 MW or 3,040 MW. For the latter project, the FPL cost estimates, with the above four items shown as line items, per kW of capacity range from $5,426 to $8,005 for spent year dollars – that is in dollars expended during construction. For the 2,200 MW project the range of costs per kW is about the same – from a low of $5,492 to $8,071.[9] The main difference between the two cases (2,200 MW vs. 3,040 MW) is the small cost adjustment for the type of reactor, which is not relevant to the present report. This is because the reference project used for estimating capital cost was a two-unit ABWR, the same design chosen by NRG for its proposed project.

FPL's overall cost estimate presented to the Florida Public Service Commission was in "as-spent" dollars – it combined a constant-dollar estimate of overnight costs with an inflation escalator, and a rate of 11.04 percent for allowance for funds used during construction (AFUDC), representing effective current dollar interest costs over the construction period, which is assumed to be five years. However, it is to be noted that some critical equipment. such as forgings. are presumed to be ordered ahead of that time in the FPL timeline. AFUDC represents interest costs incurred during the construction period.

We have used the FPL estimates to develop low, medium, and high case cost estimates for the proposed NRG project of two ABWRs with a rating of 1,350 MW each.[10] The three FPL estimates differ mainly in the treatment of cost escalations that have occurred since the TVA analysis, on which the FPL analysis is mainly based, was completed.

We have chosen to estimate the cost in constant 2007 dollars, rather than as spent dollars, so that the inflation adjustment has been removed and the ADFUC amounts are approximately de-escalated by an assumed inflation rate of 2.5% and a five-year construction period. In the analysis here, we assume that NRG will use the existing cooling pond and not build cooling towers. If the project as designed uses another approach to cooling, then the overall cost estimate of the NRG project would have to be appropriately increased.

We have not investigated site-specific estimates of the costs of transmission integration in this preliminary report; hence, the FPL estimates of these costs are retained in order to estimate an all-in cost estimate (see the conclusions section for further discussion). The actual cost estimates for transmission integration for the NRG project could be lower or higher. The maximum overall effect on the total cost estimate in terms of the lower bound estimate cannot be greater than the total cost of the transmission integration cost in the FPL study, which ranges from $600 million to $800 million (including constant dollar allowance for funds used during construction). In practice, the actual effect of the combined site-specific cooling system plus transmission integration costs may not be more than a few hundred million dollars either way from the total estimated costs in Table 2. In other words the error in going from the estimates below to ones that are fully site-specific is likely to be a few percent.

[9] FPL 2007, op. cit., p. 250 of the pdf file.
[10] FPL considered a rating of 1,371 MW but this does not make a material difference to the per kW costs, which are the starting point for the estimates in this section.

Table 2 shows the FPL costs for the 3,040 MW project as well as costs based on that estimate adjusted for the NRG situation. Cases A, B, and C differ mainly in how FPL modeled recent cost escalations for raw materials, labor, construction and other power plant capital cost elements.

Table 2: FPL Cost Estimates for a New Nuclear Twin Reactor Project and

FPL Cost Estimate for 3,040 MW, in as-spent dollars	**Case A**	**Case B**	**Case C**
Total overnight cost, 2007 dollars, $/kW	$3,546	$3,108	$4,540
Escalation, 2.5 percent per year (inflation rate)	$892	$764	$1,139
AFUDC @11.04%, $/kW	$1,837	$1,573	$2,345
Preconstruction cost adjustment	-$19	-$19	-$19
Total FPL cost estimate, $/kW (Note 2)	**$6,256**	**$5,426**	**$8,005**
Adjustments to FPL for ABWR and constant 2007 $			
De-escalate for inflation, $/kW	-$892	-$764	-$1,139
De-escalate AFUDC for inflation (approximate), $/kW (13.5%) Note 3	-$248	-$212	-$317
Remove preconstruction cost adjustment, $/kW	$19	$19	$19
Remove cooling tower cost, including associated AFUDC (approximate)	-$73	$0	-$80
Total estimate for NRG based on FPL, 2007 $/kW (Note 4)	**$5,062**	**$4,469**	**$6,488**
Total project cost for twin ABWR project, 2,700 MW, constant 2007 $, rounded	**$13.7 billion**	**$12.0 billion**	**$17.5 billion**

Notes:

1. Cost per kW line items are based on the gross capacity of 1,371 MW per ABWR assumed in the TVA document. FPL project costs were derived on this basis. In this report a reactor size of 1,350 MW is assumed.
2. The FPL table states the Case cost as $6,306 due to an apparent arithmetic error.
3. This approximate de-escalation by the inflation factor of 2.5 percent per year of the AFUDC is based on a five-year construction time. Pre-ordering of forgings and other components is not included in the construction time. Including an AFUDC for the pre-ordering could increase the size of this adjustment (i.e. reduce costs) by several tens of dollars per kW, which is within the range of uncertainty in these calculations.
4. Includes about $270, $250, and $290 for transmission integration in Cases A, B, and C respectively, including AFUDC in constant 2007 dollars (rounded to the nearest $10).

The estimates of all-in capital costs obtained range from $12.0 billion to $17.5 billion, in constant 2007 dollars. These costs are far above the NRG estimate of $6 to $7 billion for the capital cost of the proposed project. If CPS acquires a 40 percent share, its share of the capital cost would be in the range of $4.8 billion to $7 billion.

2. Moody's Estimates

The Wall Street credit rating firm Moody's estimated the all-in costs of new nuclear plants, including transmission integration, in October 2007, only two months after the NRG statement that project costs would be $6 billion to $7 billion. Moody's describes the context of its cost estimates as follows:

> Throughout our due diligence process, Moody's has not been able to make a finite determination of the range for the all-in cost associated with new nuclear. *As a result, we believe the ultimate costs associated with building new nuclear generation do not exist today – and that the current cost estimates represent best*

estimates, which are subject to change.

…

There are some figures available in the marketplace that claim new nuclear generation can be procured at approximately $2,500/kw - $3,500/kw, but it remains unclear as to what was included in the estimate, and more importantly, what was left out. This concept, creating an "apples-to-apples" cost comparison, could become an important determinant for various state regulatory authorities as they attempt to assess the ultimate impact on rates for end-use consumers.

…

From a credit perspective, Moody's is indifferent as to what the "overnight" cost of the actual nuclear generating plant might be – as overnight costs often exclude owner's costs and price escalation. Instead, we are concerned with the total all-in costs of the nuclear generating facility. An analogy would be the purchase price of a house (the over-night cost), which excludes the costs of appliances, furnishings, and landscaping (the all-in cost). Capitalized interest, other owner's costs (which include site preparation, administrative buildings and other administrative costs) and transmission upgrades / refurbishments could add several hundred more dollars per kw-capacity. The potential costs associated with transmission upgrades / refurbishments appears to be getting very little attention at this time – possibly due to Federal Energy Regulatory Commission (FERC) rules and regulations which make management teams leery of engaging in public discourse too early. *Moody's believes the all-in cost of a nuclear generating facility could come in at between $5,000 - $6,000/kw.*[11]

Moody's cost range is about the same as the constant dollar estimate derived above from the FPL estimate. However, Moody's is not explicit as to whether its estimate is a constant dollar estimate. The Moody's document cited here also does not provide the details of how the calculation was done. We note that the range of costs estimated above from the FPL analysis is somewhat wider – $4,500 to $6,500 per kW in constant 2007 dollars – than Moody's range of $5,000 to $6,000 per kW. All of these are much higher than NRG's range of $2,200 to $2,600 per kW.

3. Other Industry Cost Estimates

Two other recent estimates are publicly available, but they are lacking in detail. In March 2008, Progress Energy announced its intention to build a two-unit nuclear power plant at a site acquired in 2007. The units would be Westinghouse AP1000 reactors, which have a nominal capacity of 1,117 MW.[12] The total estimated cost of the project is $17 billion, of which $3 billion would be for a new 200-mile transmission line from the site. Excluding the new transmission line costs to make the estimate more comparable to that for an existing site, yields a total project cost of $14 billion, or about $6,300 per kW. No details are available as yet as to the

[11] Moody's 2007, *New Nuclear Generation in the United States: Keeping Options Open vs. Addressing an Inevitable Necessity*, Moody's Corporate Finance, October 2007, pp. 10-11, emphasis added.

[12] W.E. Cummins, M.M. Corletti, T.L. Schulz, Westinghouse AP1000 Advanced Passive Plant, *Westinghouse Electric Company, LLC* Proceedings of ICAPP '03 Cordoba, Spain, May 4-7, 2003, Paper 3235, May 4-7, 2003, Table 1.

content of this cost estimate, but it is about the same as the high end of the capital cost estimate made by FPL in constant dollar terms. However, the Progress Energy estimate may be in current dollars, which would make it comparable to the middle FPL estimate.

Austin Energy hired a consultant to evaluate the NRG project in order to assess whether it should invest in it. The consultant report is not public. However, Austin Energy noted that it stated that the NRG project could face a two-year delay and that there may be a cost overrun of $1 billion. No details of the calculation are available. However, this is unlikely to be an all-in estimate that includes AFUDC and transmission integration. The constant dollar year is also not specified. Until the report is released for public review, it is prudent to assume that the cost framework was the same as that used by NRG, which likely excludes a number of critical cost elements. Austin Energy concluded that the time available to make the decision was too short and the uncertainties too large. The Austin City Council agreed and decided not to invest in the project for the present.

E. Conclusions Regarding New Nuclear Power Plant Cost Estimates

We have compared the public statement of the capital cost of the two-reactor project made by NRG in August 2007 with more detailed cost estimates by utilities filed with state regulatory authorities and with independent estimates by the Wall Street bond rating firm, Moody's. These estimates are generally in agreement on the costs of new nuclear units and are much higher than NRG's overall cost estimate of $6 to $7 billion dollars. NRG's cost estimate does not stand up to scrutiny. It is obsolete and may be partial. It also does not appear to take adequate account of the serious cost escalation in power plant projects that have occurred in the past few years. Table 3 shows a comparison of the various all-in cost estimates discussed in this report.

Table 3: Comparison of all-in cost estimates

	Low	Medium	High	Comment
FPL project, 3040 MW case, current as-spent $	$6,256	$5,426	$8,005	Original values in FPL analysis, used as the basis for constant dollar estimates in this report
FPL Project, 3040 MW case, constant 2007 $	$5,116	$4,450	$6,549	IEER adjustments to get constant 2007 dollar estimate
NRG project, derived from FPL analysis by IEER	$5,062	$4,469	$6,488	IEER adjustments to FPL estimates, constant 2007 dollars
Progress Energy, 2,234 MW		$6,300		Dollar reference year(s) unclear. Only one estimate available.
Moody's	$5,000		$6,000	Dollar reference year(s) unclear

These estimates can be contrasted to NRG's estimate of $2,200 to $2,600 per kW made in August 2007 (inferred from the total capital cost estimate of $6 billion to $7 billion applied to 2,700 MW).. The best available industry and Wall street estimates are about two times or more higher than those of NRG. It is also disturbing to note that NRG made a rather hasty filing of its

Combined Operating License Application with the Nuclear Regulatory Commission, possibly in a rush to get in line to get the loan guarantees authorized by Congress in 2005 for early applicants. As a result, the application was incomplete in essential respects. The Nuclear Regulatory Commission (NRC) docketed the application despite the fact that their regulations require applications to be complete prior to docketing. Pursuant to a petition filed by potential interveners objecting to the intervention process being scheduled prior to the complete application being available, the NRC then withdrew the notice of hearing and indefinitely suspended the intervention timetable. The incomplete application may delay the process and the granting of the license, especially in light of the fact that NRG is asking for variations from the standard ABWR design that has been pre-approved by the NRC.

In the context of a capital intensive, long-lead time and risky project, it is also noteworthy that NRG emerged from bankruptcy as recently as December 2003. During the time it was in bankruptcy, it was able to get rid of billions of dollars of debt.[13]

Based on the above analysis, we conclude that the best available information indicates that NRG's statement that the proposed reactors would cost $6 to $7 billion is a significant underestimate. Given NRG's corporate history and its premature filing of an incomplete license application a very close look at NRG's internal cost estimates, and its contingency plans is necessary and prudent.

We cannot know the specific elements of cost or other aspects of due diligence CPS took into account in its June 2007 study or that it is considering in its current revision. The CPS study should be made public and independently reviewed. Given the magnitude of the investment and the risks, the San Antonio City Council should also seriously consider commissioning an independent study of the NRG project, of CPS's proposed role in it, and of alternatives to it.

Until an independent project-specific all-in capital cost estimate is available, it would be prudent to use a range of estimates based on the FPL filing as adjusted for the known parameters of the STP site. When converted into constant 2007 dollars the cost range is $4,500 to $6,500 per kW, for a total project cost of $12.0 billion to $17.5 billion. If CPS acquires a 40 percent share, its investment would be in the $4.8 billion to $7 billion range. These estimates are all much greater than the net depreciated value of all of CPS's generating plant, which stood at $3.9 billion at the end of its 2007 fiscal year.

These estimates do not include any real cost escalations or any costs that would be associated with delays. FPL estimates that delays would cost in the range of $800 million to $1.2 billion per year.[14] An uncertainty of a similar scale or larger may be associated with possible real cost escalations over the project construction period. Finally, it should be noted that the dollar has been declining rapidly. The Federal Reserve's policy of reducing interest rates puts further pressure in the same direction. A declining dollar would increase the costs of imported components, such as critical heavy forgings from Japan. In general, there are significant

[13] "NRG Announces Emergence From Bankruptcy," Energyonline, December 8, 2003 on the Internet at http://www.energyonline.com/Industry/News.aspx?NewsID=6609&NRG_Announces_Emergence_from_Bankruptcy

[14] FPL 2007, op. cit., p. 52.

exchange rate risks associated with any large capital project. Nuclear projects that have large elements of cost associated with imports are especially vulnerable.

The combined implications of these considerations for nuclear projects in general, and for the NRG project in particular, are difficult to assess quantitatively with confidence, especially within the limited time and budget of this preliminary study. We note however, that if NRG should run into financial difficulties in the course of the project, CPS, and hence its ratepayers as well as the taxpayers of San Antonio could be faced with significantly larger liabilities than now publicly anticipated. In this context, the possibility that CPS's share of the total project cost would likely considerably exceed the net worth of its total electric generating plant net worth of $3.9 billion is especially worrisome; it demands additional due diligence by all parties to the CPS decision.

F. Efficiency and Renewables

A future report of this project will cover efficiency and renewables in some detail. At this time some preliminary remarks will serve to provide some context for the above discussion of nuclear power plant capital costs.

According to CPS, the company has recently made a "paradigm shift" in regard to efficiency, and now considers it as equivalent to a new source of power supply. Future generation projects, including coal and nuclear, are to be compared with efficiency in terms of their potential to meet the needs of its customers.[15]

This paradigm shift holds great potential. It can enable CPS to continue to meet the needs of its customers and of the city, while at the same time moving into the new era of higher power plant capital costs, climate constraints on carbon dioxide emissions, and financial uncertainties. However, in order for the potential to be realized, this concept needs to be fully operationalized in technical and financial terms. Only that will enable CPS to use efficiency investments as a power source on a scale comparable to coal and nuclear in a way that works reliably and durably. That is also necessary to create a revenue stream that will protect the financial health of CPS and also the substantial contributions it makes to the City of San Antonio. CPS appears to be in the early stages of this operationalization both as regards the technical side. Much more needs to be done on the financial side as well, which is typical even of utilities such as Austin Energy that are farther along the road to technical integration of efficiency and renewables than CPS.

CPS commissioned an energy efficiency study, known as the KEMA study, which was published in October 2004.[16] This study concluded that there was a technical potential for load reduction of 1,935 MW, or about half the total peak load. Of this, the economic potential for peak load reduction was estimated at 1,220 MW, or about 30 percent of the peak load. However, the measures to achieve this potential that were considered were mild outreach and rebate programs and the achievable portion was judged to be only 38 to 73 megawatts. Even the maximum case was just about six percent of the economic potential and under two percent of the peak load.

[15] Personal telephone communication, Arjun Makhijani interview with Bruce Evans, 21 March 2008.
[16] KEMA 2007. *City Public Service Technical and Economic Energy Efficiency Potential Study*, prepared for City Public Service, San Antonio, Texas, KEMA Inc., Madison, Wisconsin, October 18, 2004

Since 2004 CPS has increased its target to a total of 115 MW by 2011, which would amount to 40 percent of the peak load *growth*. CPS appears set to continue the program after that. This would put in on a current course to achieve about 15 to 20 percent of the KEMA target by 2014 – better than the tiny initial goal but still far short of the economic potential.

We note here that the charter of the KEMA study did not include distributed energy sources, such as combined heat and power. Further, the KEMA study is likely economically obsolete to some extent, since costs of new power plants of all types, except solar have escalated significantly since October 2004. The technical and economic potential are now likely to be higher than before. Technology is also changing rapidly. For instance, Oak Ridge National Laboratory has spawned a combination solar/electric lighting system that uses a solar concentrator and fiber optic cables to bring sunshine to light large indoor areas. At times of reduced or no insolation, the electric component of the special luminaires increases its output automatically to maintain constant illumination.

A true integration of efficiency as a new power source also requires consideration of distributed energy sources, inter-fuel switching potential, such as gas and electric water heating to solar water heating or gas space heating to electric heating using geothermal heat pumps, along with alternative uses of the fuel. For instance, natural gas saved by using geothermal heat pumps instead of natural gas for heating could be used for electricity generation.

Integration of distributed renewables, combined heat and power and efficiency with the rest of the system also has a financial aspect. It cannot be carried very far or achieve a large fraction of its potential based on rebates and large subsidies. Such measures are needed in the initial stages in which CPS finds itself in order to kick-start the process by increasing awareness of the potential, creating an economic climate for contractors who would implement the efficiency and renewable energy programs, and so on. But a sound program that would take efficiency, combined heat and power, and distributed renewables from the present very marginal position in the system to becoming an equal element that provides the same return to consumers and the city as central station generation requires a different financial model. The public benefits of reasonable energy costs, of CPS financial health, and CPS contributions to the City of San Antonio can all be maintained under the new paradigm, but it will require that that paradigm be translated into an investment and cost recovery model appropriate to the distributed nature of the investments to be made. A hasty decision on nuclear units could foreclose options that are healthier, less financially risky, and in line with need to reduce greenhouse emissions all at the same time.

For the present we note that:

1. CPS needs to update the KEMA study in light of the realities of the costs of new central station power plants and climate considerations.
2. The update date should include current costs and benefits of geothermal heat pumps, combined heat and power, solar water heating, solar HVAC, rooftop and parking lot solar PV at scale of 100 kW and larger, energy storage (as for instance in ice), the creation of a smart grid, and other critical elements that could provide large blocks of equivalent power supply in various combinations as alternatives to nuclear and coal.

3. CPS needs to develop a financial model that enables cost recovery for CPS and the city and provides value to the customers in order to make efficiency, distributed generation, and other distributed energy sources comparable to central station power plant investments.

Until CPS has completed work on these three items, a large investment in nuclear power will:

- Pre-empt and possibly foreclose achievement of a large part of the economical potential for efficiency and renewables in the CPS service area.
- Create the risk of increased rates due to a high cost investment that could have been avoided.

Indeed, it will remain unclear as to whether a rate increase is needed for investment in new power supply, including the proposed nuclear units, until a careful evaluation of the alternatives as outlined above has been completed. CPS has stated that its study of its proposed nuclear investment considers the alternatives. This study is not public. CPS public comments and literature do not indicate that a rigorous basis for the comparison of the alternatives that considers methods to achieve the full economical potential of efficiency and distributed generation and renewables has been laid.

G. Parameters for an Independent Study

This preliminary report was limited by time and budget considerations to an assessment of the capital cost of the proposed NRG twin-reactor project at the STP site. Even that estimate did not deal with all risk factors quantitatively, as noted above. The following parameters should be considered in an independent study, should the City Council decide to commission it:

- Exchange rate risk as it may affect capital cost.
- Capital cost escalation in real terms during project planning and construction due to worldwide pressure on skilled labor and commodity costs.
- The volatility in the price of uranium and its effect on generation costs.
- Contingencies and costs in case the federal government does not sign contracts to remove spent fuel from reactor sites for new reactor projects.
- The opportunity costs of using large amounts of water for reactor cooling in a warming world with more severe extremes of weather expected.
- The reliability of nuclear power supply in long periods of extreme heat and drought, when demand for power is expected to be at its highest.

This overall approach to assessing nuclear generation costs will provide an appropriate framework for a comparison with efficiency, large-scale renewables, combined heat and power, and distributed renewables.