DIRECT TESTIMONY OF

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AND

SARA BARCZAK

ON BEHALF OF SOUTHERN ALLIANCE FOR CLEAN ENERGY

GPSC DOCKET NO. 24505-U

GEORGIA POWER'S INTEGRATED RESOURCE PLAN

MAY 4, 2007

I. Introduction

Q. PLEASE STATE YOUR NAMES, TITLES AND BUSINESS ADDRESSES.

A. (SB) My name is Sara Barczak. I am the Safe Energy Director at Southern Alliance for Clean Energy (SACE). My office address is 428 Bull Street, Suite 201, Savannah, Georgia 31401.

(AM) My name is Dr. Arjun Makhijani. I am the President of the Institute for Energy and Environmental Research (IEER). My office address is 6935 Laurel Avenue, #201, Takoma Park, Maryland 20912.

A copy of our current resumes is attached as Exhibit__ AM,SB-1.

Q. MS. BARCZAK, PLEASE SUMMARIZE YOUR EDUCATION AND PROFESSIONAL EXPERIENCE.

A. (SB) I worked for twelve years in diverse environmental fields in the private and non-profit sectors, including as an environmental consultant for Department of Defense facilities relating to hazardous waste and air quality issues and later as a citizens' advocate for two non-profit organizations focusing on environmental and public health issues. As Safe Energy Director for Southern Alliance for Clean Energy, I participate in legislative, state and federal regulatory proceedings and forums on issues concerning nuclear energy, public safety, utilities, and impacts of fossil fuel and nuclear power plants on the region's water quality. I received a B.A. degree in Biology from Lawrence University in Appleton, Wisconsin.

Q. DR. MAKHIJANI, PLEASE SUMMARIZE YOUR EDUCATION AND PROFESSIONAL EXPERIENCE.

A. (AM) I have been President and Senior Engineer at the Institute for Energy and Environmental Research (IEER) for 19 years. IEER provides policy-makers, journalists, and the public with understandable and accurate scientific and technical information on energy and environmental issues. In that capacity, I have authored and produced many studies and articles on energy and nuclear energy related issues, including nuclear waste, security, and environmental and health impacts. I have served as an expert witness in

Nuclear Regulatory Commission proceedings and in legal proceedings relating to nuclear reactor accidents, and regulations relating to emissions from nuclear facilities such as uranium processing plants. Most recently, I have nearly completed a study on the feasibility of a zero-CO_2 economy in the United States without nuclear power or fossil fuels. This study will be published in 2007. I was the principal author of the first study done (completed in 1971) on energy efficiency potential of the U.S. economy and was the principal editor of *Nuclear Wastelands* and the principal author of *Mending the Ozone Hole,* both published by MIT Press. Previous employment included serving as an Assistant and Associate Professor at Capitol College in Maryland and as a Visiting Professor at the National Institute of Bank Management, Bombay, India. I have served as an Independent Consultant for over three decades on a variety of issues, including electricity rates and investment planning, energy efficiency, technical and economic analyses of alternative energy sources, modeling of electric utility economics, analysis of energy use in agriculture, U.S. energy policy, energy policy for the Third World, and evaluations of portions of the nuclear fuel cycle. Clients in the 1975-87 period included: Tennessee Valley Authority, Lower Colorado River Authority, Federation of Rocky Mountain States, Environmental Policy Institute, and Lawrence Berkeley Laboratory, among others. I hold a Ph.D. in Engineering (specialization: controlled nuclear fusion) from the University of California, Berkeley, 1972; a M.S. in Electrical Engineering from Washington State University, Pullman, Washington, 1967; and a Bachelor of Engineering (Electrical) from the University of Bombay, Bombay, India, 1965.

II. Overview of Southern Alliance for Clean Energy's Concerns

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. (SB & AM) The purpose of our testimony is to provide background on how the conclusions in the Company's IRP regarding its desire to build new baseload nuclear power plants in Georgia potentially threatens ratepayers and the general public. Specifically, our testimony is intended to provide the Commission with information on the risks associated with the development of a new nuclear reactor or reactors in Georgia as it pertains to environmental, nuclear waste, and security concerns that have significant potential to negatively impact ratepayers and the general public.

Q. HAS THE PANEL REVIEWED THE COMPANY'S INTEGRATED RESOURCE PLAN AND ASSOCIATED PUBLIC FILINGS?

A. (SB & AM) Yes.

Q. HAVE EITHER OF THE MEMBERS OF THE PANEL SIGNED A CONFIDENTIALITY AGREEMENT ALLOWING THE SIGNATORY TO REVIEW THE UNREDACTED VERSION(S) OF THE IRP AND ASSOCIATED FILINGS?

A. (SB & AM) No. In this testimony we have relied on the redacted versions of the IRP filings and other public sources of information. A complete list of references cited is included at the end of our testimony.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS REGARDING THE GEORGIA POWER IRP.

A. (SB & AM)

1) The Georgia Power IRP claims that "[a]dding new coal or nuclear baseload generation will ensure that there remains a diversity of generation to protect customers from fuel volatility associated with natural gas prices."[1] However, our analysis shows that the construction of new nuclear of coal fired capacity in Georgia would not improve the diversity of the State's electricity sector. The state is already heavily reliant on coal and nuclear power and even if all the new demand projected for 2015 were met with natural gas (not an option that we support), Georgia would still remain dependent on coal and nuclear power. The construction of a new nuclear power plant would only further increase this dependence.

The range of options for power supply that should be considered in the IRP are broader than presented under the traditional three-sector analysis of baseload, intermediate load, and peaking power plants. Compared to the rest of the United States,

[1] Georgia IRP 2007 p. 1-6

in 2005 Georgia had a less diverse electricity sector and lagged behind in developing renewable energy resources. The development of renewable resources would, therefore, have a far more positive impact on diversifying the State's energy mix. Significantly, despite collaborating with Georgia Tech's Strategic Energy Institute to study offshore wind potential in the State, Georgia Power dropped any consideration of wind in the IRP from detailed consideration. The Company should have maintained offshore wind as a potentially viable supply option in the IRP. Further, the wind resource should be evaluated in combination with other resources such as combined cycle standby capacity, and hydropower resources given that such combinations improve the overall reliability of the system and reduces the cost of wind integration into the grid. Finally, the cost of solar PV at intermediate levels (~several hundred kW to a few MW), installed for instance in large commercial parking lots and rooftops, has declined dramatically in the past two years. Its consideration should be included in the IRP as part of the analysis of optimized supply options in combination with wind, natural gas combined cycle standby, and hydropower. It should also be included in the transmission plan.

2) The IRP claims that "[w]hile it is impossible to estimate accurately future project costs, current industry projections show nuclear energy to be the lowest cost option for generation in 2015."[2] However, from the public data that we have reviewed, it appears very unlikely that new nuclear power generation would be economically competitive with other options available. Recent studies on the economics of nuclear power conducted at the Massachusetts Institute of Technology and the University of Chicago put the likely cost of electricity from new nuclear power plants well above the cost of electricity from natural gas or pulverized coal fired plants over the time period considered in the Georgia Power IRP. Similar conclusions were reached by a review from the Congressional Budget Office based on information provided by the Nuclear Regulatory Commission, the Department of Energy, and the nuclear industry. In addition, as noted by analysts at Standard & Poor's in their 2006 assessment of nuclear power, "given that construction would entail using new designs and technology, cost overruns are highly probable."[3]

[2] Georgia IRP 2007 p. 6-5
[3] Kennedy et al. 2006

If newer coal fired technologies such as Integrated Gasification Combined Cycle (IGCC) are included in the mix of options, nuclear power is still not likely to be cost competitive. This conclusion is supported by reviews in a 2006 IEER study and a 2007 study conducted at the Massachusetts Institute of Technology. Significantly, the U.S. Energy Information Administration's 2007 *Energy Outlook* also predicts that both advanced coal fired plants and new natural gas fired plants would produce electricity cheaper than new nuclear power plants in 2015 and that new nuclear plants would still be a more expensive option in 2030. Our own evaluation of the cost of future combined cycle natural gas fired plants at $7 or $ 8 per million Btu fuel cost is that it would be about the same as nuclear power plant costs without even considering the financial uncertainties associated with waste, proliferation, and severe accident liabilities or the benefits associated with the short lead time of combined cycle plants. We are not advocating the use of new natural gas baseload plants but are presenting this as a point of comparison. In fact, we prefer energy efficiency in combination with greatly increased use of renewables.

3) Georgia Power explicitly notes that "[t]he best IRP is one that provides a high level of customer value while incorporating a broad range of potential changes."[4] Among the "additional objectives" in the IRP noted by the company are "Flexibility - Can the Plan be altered if the future is different than expected?" and "Risk - Does the Plan represent a reasonable balance between risk and cost?".[5] However, the IRP is seriously deficient in addressing the environmental, health, and security risks that would accompany any effort to build a new nuclear plant in Georgia.

Nuclear power is not a flexible choice for electricity generation. The potential for public pressure to shutdown existing plants in the wake of a serious accident or successful large scale terrorist attack on a nuclear power facility would leave open far fewer energy options (particularly in terms of reducing greenhouse emissions) if nuclear power was being expanded in Georgia. In addition, the economic vulnerability of future regulatory requirements in relation to protection of the public from terrorist attacks or as a result of new science on the hazards of radiation, such as the BEIR VII report of the

[4] Georgia IRP 2007 p. 2-4
[5] Georgia IRP 2007 p. 2-4

National Academy of Sciences or the emerging science on the health risks of tritium, being integrated into the regulatory framework, also increases with increasing reliance on nuclear power plants.

The potential for catastrophic accidents are a unique vulnerability of nuclear power. However, the likelihood of such accidents occurring is extremely difficult to predict. The uncertainties in the methodology most commonly used to make these predictions are a particular concern for new reactor designs such as the Westinghouse AP-1000, proposed for consideration by Georgia Power, since this type of reactor does not exist anywhere but on paper. While it is true that new reactor designs are more advanced than those currently in existence, information is not yet available to determine whether or to what degree these advancements were, in fact, improvements.

Many of Georgia's power plants are among the largest water users in the state. Fossil fuel and nuclear power plants require large quantities of water to operate, in marked contrast to renewable energy supplies such as bio-energy, solar, and wind. Also, the adoption of energy efficient practices and technologies reduces system-wide energy needs, thereby reducing the water requirements of the electric system as a whole. When comparing types of energy generation in relation to their water withdrawal and consumption, nuclear power has higher rates of withdrawal and consumption than coal or natural gas. To put the proposed expansion of nuclear Plant Vogtle into perspective, with average per capita daily water use in Georgia at 75 gallons from surface and ground water, more water will be lost as steam from the two existing and two proposed reactors at Plant Vogtle than is used currently by all residents (2005 census) of Atlanta (470,688), Augusta (190,782) and Savannah (128,453) combined.[6]

Further, proposed new energy supply sources, such as expanding nuclear power generation at nuclear Plant Vogtle by building up to two new reactors, could reduce water availability in the Savannah River as climate change impacts, such as reduced summer river flow, develop. Also, there are existing water quality concerns that additional nuclear reactors at Plant Vogtle along the Savannah River could exacerbate. With saltwater intrusion of the Floridan Aquifer already occurring both Beaufort and Jasper counties in South Carolina and the Savannah area will become more dependent in the

[6] Barczak 2007 pp. 2-3

future on the Savannah River for drinking water as will other areas near the Savannah River that are expanding due to population growth and development.

With regard to the high-level waste that would be generated by a new nuclear plant, it is important to consider the difficulties that have plagued the development of the nation's first high-level waste repository. Despite having already taken many decades, Yucca Mountain still faces many daunting hurdles before it could even obtain a license to begin construction. Moreover, development of a repository for existing waste should not be seen as a license for producing more waste from new power plants, since there is really no satisfactory solution to the problem of long-term waste management. Finally, proposals to reprocess spent fuel would greatly increase the vulnerabilities of a decision to build a new nuclear plant in that reprocessing schemes are expensive and create a number of serious environmental risks.

It is also important for the PSC to note that the difficulties in addressing nonproliferation would be increased if new nuclear plants were built in the United States since new uranium enrichment capacity would almost certainly have to be built. In short, as summarized by the authors of a 2003 report on the future of nuclear power conducted at the Massachusetts Institute of Technology

> The potential impact on the public from safety or waste management failure and the link to nuclear explosives technology are unique to nuclear energy among energy supply options. ***These characteristics and the fact that nuclear is more costly, make it impossible today to make a credible case for the immediate expanded use of nuclear power.***[7]

Finally, with respect to broader considerations of risk, we note that, despite being, by far, the largest single environmental concern associated with the current energy system, the public IRP filings lack any substantive discussion of climate change or the proposed impact its decisions will have on the emissions of greenhouse gases, either positively or negatively. In fact, the proposed strategy puts the ratepayers in double jeopardy with respect to climate change. The first proposal for a nuclear plant is likely to be costly and the stated back up option is a polluting CO2 emitting coal fired power plant that is likely to face stiff taxes or equivalent costs via carbon trading.

[7] MIT 2003 p. 22 (emphasis added)

III. Lack of Diversification

Q. WHAT DOES THE IRP SAY REGARDING THE NEED FOR GEORGIA TO RECEIVE ITS ELECTRICITY FROM A DIVERSE MIX OF ENERGY RESOURCES AND THE POTENTIAL ROLE OF NEW NUCLEAR POWER OR COAL IN HELPING TO IMPROVE THAT DIVERSIFICATION?

A. (AM) Regarding the current and near-term energy mix of Georgia Power, the IRP notes that

> The Company's current mix of fuel sources and generation type provides diversity of fuel source and reliability of electric supply. Fuel diversity helps to dampen fuel cost volatility as well as helps to mitigate any potential fuel availability issues that may arise in the future. The current mix of energy serving our customers by generation source is approximately 71% coal, 18% nuclear, 8% natural gas and oil, and 3% hydro power. Furthermore, for 2008, the projected mix of energy serving our customers by generation source is approximately 68% coal, 15 % natural gas and oil, 14 % nuclear, and 3% hydropower.[8]

Despite the fact that their own projections show that coal and nuclear power will be supplying more than 80 percent of the electricity generated in 2008, the IRP makes numerous references to the need to build new nuclear or coal fired plants to help increase the diversification of the Georgia energy mix. Representative examples of such claims from the IRP include:

> The Company has not added baseload nuclear or coal generation since 1989 and is now entering an era where new cost effective baseload generation is needed to serve customers. Adding new coal or nuclear baseload generation will ensure that there remains a diversity of generation to protect customers from fuel volatility associated with natural gas prices. Without new base load nuclear or coal generation additions, the Company projects that over half of its generating capacity will be

[8] Georgia IRP 2007 p. 14-7 to 14-8

> fueled by natural gas and that the amount of gas-fired energy generation will double by about the middle of the next decade.[9]
>
> Continued operation of the coal units will maintain fuel diversity and help to mitigate the risk of volatile natural gas fuel prices. Without the addition of baseload nuclear or coal, retirement of additional baseload generation would cause an unacceptable increase in the amount of gas-fired energy generated for customers in the 2015/2016 timeframe.[10]
>
> The addition of nuclear generation would further diversify Georgia's generation mix, lessening our state's dependency on natural gas and coal, while providing an additional, environmentally sound fuel alternative.[11]

Q. DO YOU AGREE WITH THE CONCLUSION THAT ADDITIONAL NUCLEAR CAPACITY IN GEORGIA IS REQUIRED BY 2015 IN ORDER TO MAINTAIN AN ACCEPTABLE MIX OF FUELS TO SERVE GEORGIA RATEPAYERS?

A. (SB & AM) No. The construction of new nuclear or coal fired capacity in Georgia would not improve the diversity of the State's electricity sector. The state is already heavily reliant on coal and nuclear power and even if all the projected new demand were met with natural gas (not an option that we support), Georgia would still remain dependent on coal and nuclear power for generating more than two-thirds of its electric power. Even compared to the rest of the United States, in 2005 Georgia lagged behind in developing renewable energy resources. As far as new supply is concerned, the development of renewable resources would have a more positive impact on diversifying the State's energy mix than increasing the State's already significant dependence on coal and nuclear power.

[9] Georgia IRP 2007 p. 1-6
[10] Georgia IRP 2007 p. 1-10
[11] Georgia IRP 2007 p. 6-5

Q. PLEASE EXPLAIN WHY YOU HAVE CONCLUDED THAT NEW NUCLEAR OR COAL FIRED CAPACITY IS NOT REQUIRED TO ENSURE AN ACCEPTABLE LEVEL OF DIVERSITY IN GEORGIA.

A. (AM) According to the U.S. Department of Energy's Energy Information Administration (EIA), the State of Georgia as a whole received 86.9% of its total electricity demand from coal (63.8%) and nuclear (23.1%) in 2005. If only the electricity generated by electric utilities is considered, then the dependence on coal and nuclear grows worse. In 2005, the electric utilities accounted for more than 92 percent of the State's electricity production and 93.2% of the utilities' generation was from nuclear and coal fired power plants.[12] However, when considering the diversity of the State's electricity sector it is important to consider all contributions to generation and not just what level of capacity Georgia Power has installed.

In the IRP, Georgia Power notes that "[t]he Company has not added baseload nuclear or coal generation since 1989 and is now entering an era where new cost effective baseload generation is needed to serve customers."[13] The EIA reports that between 1990 and 2005, the amount of total nuclear and coal fired electricity in Georgia has grown slowly at an average of 1.62% per year while the amount of natural gas fired generation has grown much more rapidly at an average of 17.9% per year. Less than half of the electricity from new natural gas fired plants was provided by the electric utilities. Despite these very different growth rates, only about one quarter of the additional generation in 2005 compared to 1990 was supplied by natural gas while the remaining three-quarters of new electricity in the State was supplied by the increased generation at coal and nuclear power plants. To put these numbers another way, the increased generation at coal and nuclear plants in Georgia between 1990 and 2005 in absolute terms was nearly three times the increase in generation from natural gas plants.

To view the mix of fuels in a more convenient way, Figure 1 compares the percent of generation by coal, nuclear, natural gas, renewables, and petroleum in the Georgia electricity sector to that in the U.S. as a whole for the year 2005.

[12] All information in this answer is from EIA 2006 [1990 - 2005 Net Generation by State by Type of Producer by Energy Source (EIA-906)] unless otherwise noted.
[13] Georgia IRP 2007 p. 1-6

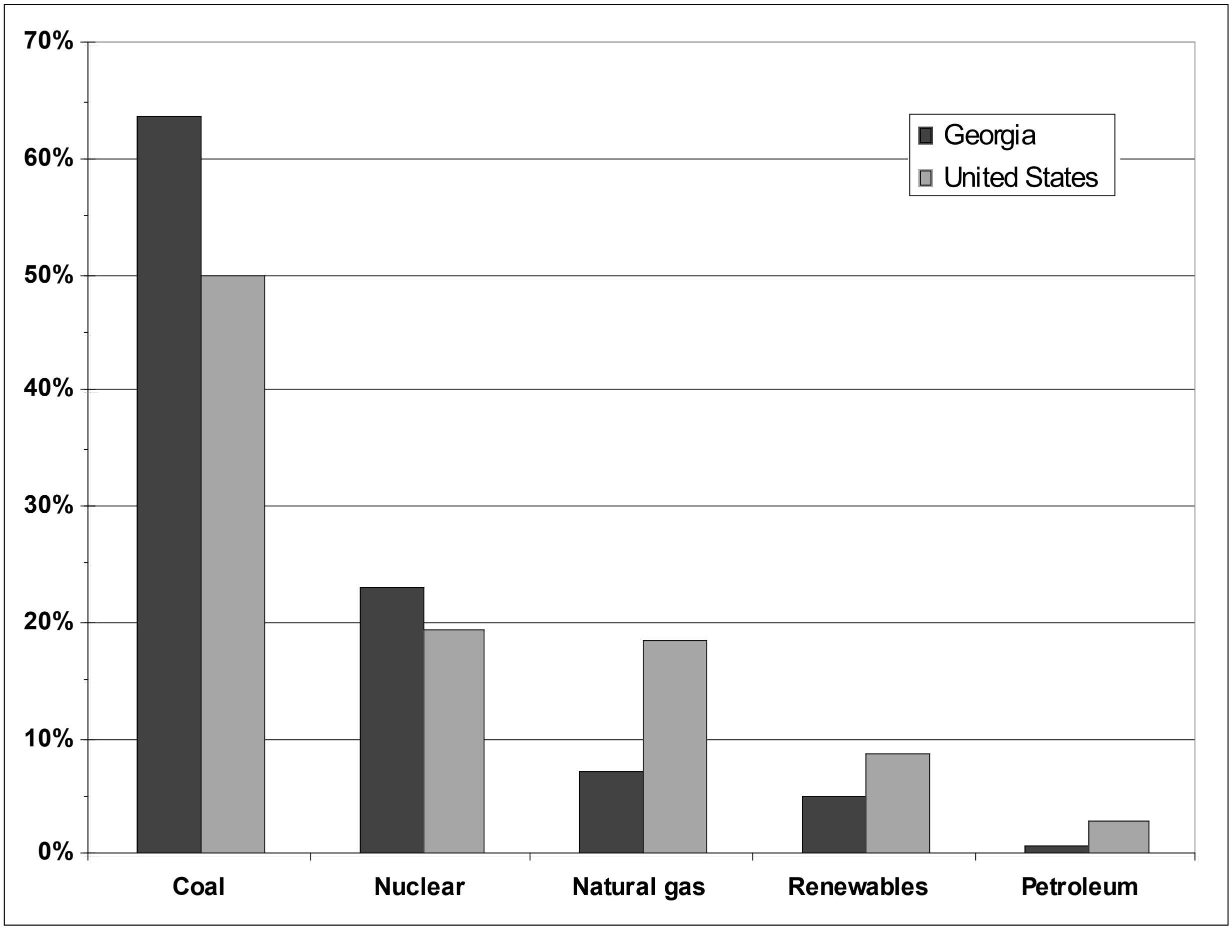

Figure 1: Fuel mix based on generation in the U.S. and Georgia electric power sectors in 2005.[14]

As expected, Figure 1 shows that Georgia is currently heavily dependent on just two fuels (coal and nuclear) for the bulk of its electricity. It also shows that Georgia has a less diverse mix of fuels than the overall United States.

To consider the claims in the IRP noted above that a new nuclear power plant is needed to "further diversify Georgia's generation mix" we constructed a set of scenarios that would tend to maximize the amount of new natural gas fired generation.[15] This is done not to support a continuation of the rapid expansion of natural gas usage that has occurred in Georgia since 1990, but to illustrate how the addition of new nuclear generating capacity might affect the diversity of the State's energy mix and to focus the discussion on the fuel mix as measured by generation and not by installed capacity. To

[14] EIA 2006 [1990 - 2005 Net Generation by State by Type of Producer by Energy Source (EIA-906)]
[15] Georgia IRP 2007 p. 6-5

accomplish this, we first projected the level of Georgia's future electricity demand assuming a continuation of its average rate of growth between 1990 and 2005 (i.e. 1.92% per year). The amount of generation from all sources was frozen at its year 2005 levels except coal and natural gas. To take into account Georgia Power's announced intention to retire the coal fired Units 1 and 2 at the Jack McDonough power plant, the amount of coal fired generation was reduced by an amount equal to 517 MW's operating with a 90 percent capacity factor.[16] Finally, the amount of natural gas fired capacity was increased to account for all of the new and replacement power needed under this scenario.

For comparison, we repeated the calculations with the addition of one new 1,000 MW nuclear power plant operating at a 90% capacity factor. The projections in the EIA's 2007 *Annual Energy Outlook* were used for the U.S. fuel mix in 2015 to compare with the projected mixes in Georgia.[17] The results are shown in Figure 2.

[16] Georgia IRP 2007 pp. 1-9. According to the EIA, the average summer and winter capacity of the two coal fired units at the Jack McDonough power plant is 517 MW. [EIA Database 860] A 90% capacity factor overestimates the likely impact of shutting down these coal plants since their largest annual average capacity factor between 2001 and 2005 was 80% and the average capacity factor over these five years was just 72%. [EIA Database 920]
[17] EIA 2007 Figure 5

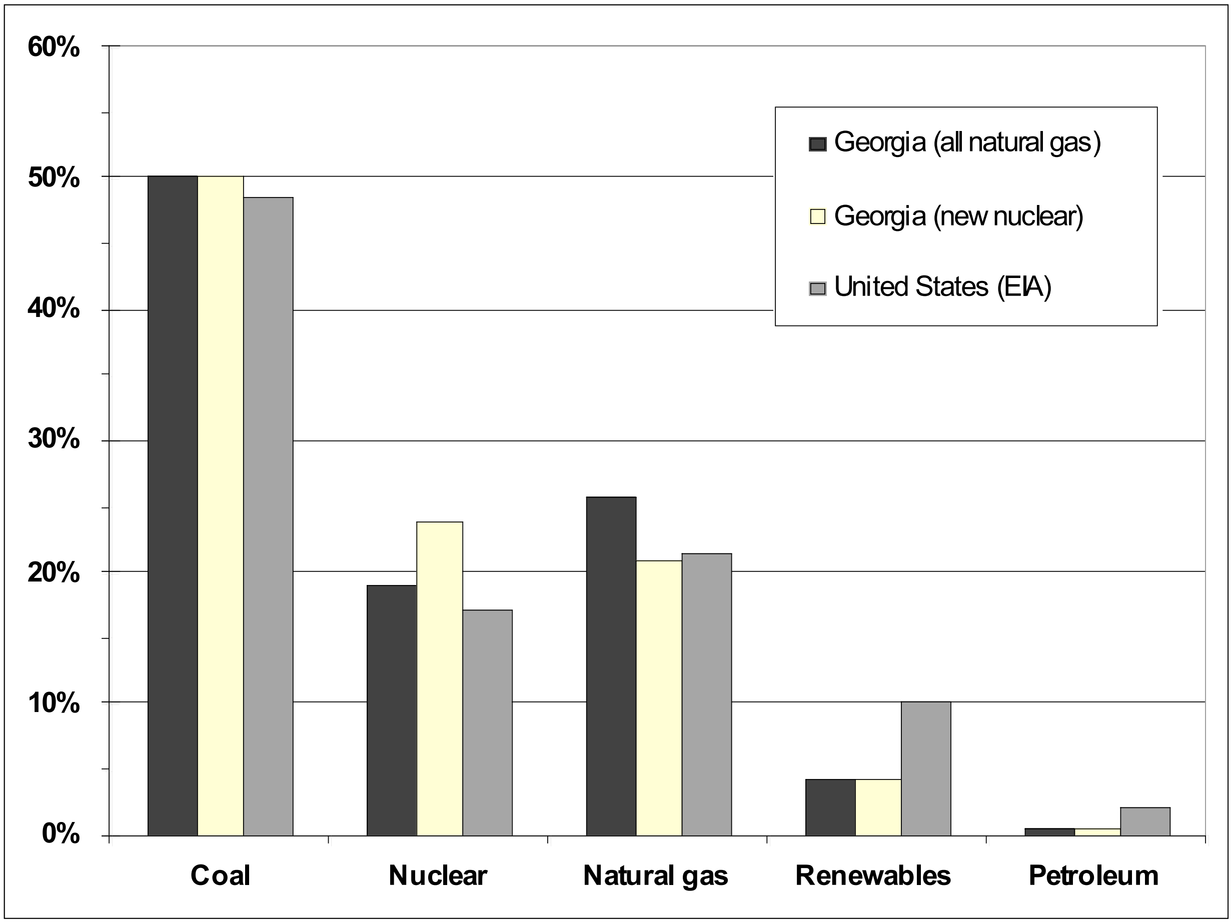

Figure 2: Projections for the fuel mix based on generation in the U.S. and Georgia in 2015. The "all natural gas" scenario assumes that all incremental increases in demand are met with be natural gas fired capacity. The "new nuclear" scenario assumes that, in addition to new natural gas fired capacity one new 1,000 MW nuclear plant would be online in 2015.[18]

The left most bar in Figure 2 is the case with only new natural gas fired capacity being added to meet future demands while the center bar corresponds to the case with one additional nuclear plant being built by 2015. The far right bar shows the EIA's projections for the overall U.S. electricity sector. In neither scenario is the fuel mix of Georgia significantly improved over what it was in 2005 or what is projected for the U.S. under a business as usual scenario by the EIA. In the case of all natural gas development, nuclear and coal would still make up nearly 70% of Georgia's electricity in 2015 while in

[18] Projections based on EIA 2006 [1990 - 2005 Net Generation by State by Type of Producer by Energy Source (EIA-906)] and EIA 2007 Figure 5

the case of a new nuclear plant being built, coal and nuclear would make up more than 74% of the State's total generation. While natural gas would grow in importance significantly in either case, it would make up, at most, about one quarter of total generation in 2015. Finally, it is important to note that the gap between Georgia and the U.S. in the use of renewables would increase under either of these scenarios; Georgia would continue to lag behind the U.S. average for the use of renewable energy

As I noted previously, these findings are not meant to support a natural gas only growth strategy for Georgia's electricity sector. This analysis is, however, meant to illustrate that the IRP's claims of a need for new nuclear or coal fired power plants in Georgia based on its ability to improve the diversification of the State's electricity sector do not appear warranted based on the information available in the public domain. Georgia is already heavily reliant on coal and nuclear power and would likely remain so through the 2015 time frame even under a high scenario for the growth of natural gas. The construction of a new nuclear power plant would only further increase dependence on coal and nuclear fuels.

Q. ARE THERE ANY PLANS DISCUSSED IN THE IRP THAT WOULD AFFECT THE CONCLUSIONS YOU HAVE DISCUSSED ABOVE?

A. (AM) Yes. In projecting the future demand and mix of energy sources in the above discussion only Georgia Power's announced intention to retire the coal fired Units 1 and 2 at the Jack McDonough power plant is factored in.[19] All other sources of generation were left fixed at their year 2005 levels. However, the IRP noted explicitly that Georgia Power plans to uprate the two nuclear reactors located at the Vogtle power plant.[20] In 1993, the NRC approved an uprate at the two Vogtle reactors amounting to 4.5 percent.[21] If uprates of this magnitude were to be done in the future at Vogtle, it would add more than 100 MW of additional nuclear capacity to the two plants. Put another way, such uprates could amount to nearly 20 percent of what is scheduled to be taken off line at McDonough. If uprates of this magnitude were to occur prior to 2015 it would further

[19] Georgia IRP 2007 p. 1-9
[20] Georgia IRP 2007 p. 6-2
[21] NRC 2004

increase the dependency of Georgia on nuclear power and would proportionately lessen the use of natural gas illustrated in the above scenarios.

In addition, the IRP notes that "[t]he number of renewable energy projects on Georgia Power's system is increasing given the higher avoided energy credits from rising fuel costs."[22] The IRP goes on to list 22 MW of renewables that are scheduled for startup in 2008 and a response from their "2010 solicitation" expressing interest in adding more than 200 MW of additional renewable capacity.[23] Adding in the generation from these new renewable resources to my analysis above would further lessen the future reliance on natural gas and would help to increase the diversity of Georgia's electricity sector. In fact, increasing the use of renewables would have the most significant benefits for increased diversification given their current under-representation in Georgia's energy mix. The planned expansion of renewables in 2008 is, however, quite modest amounting to roughly 4 percent of what is scheduled to be taken off line at McDonough.

Therefore, my analysis presented above is likely to over represent the potential future reliance of Georgia on natural gas, and to under represent the company's plans for relying more heavily on nuclear power. Thus, my conclusion is that new nuclear or coal fired capacity would not improve the diversification of the State's energy mix would be further strengthened.

Q. ARE THERE ANY ADDITIONAL ASSUMPTIONS THAT YOU HAVE USED THAT WOULD AFFECT THE CONCLUSIONS DISCUSSED ABOVE THAT YOU FEEL SHOULD BE DISCUSSED?

A. (AM) Yes. In projecting a possible electricity demand for Georgia in 2015, we used the historical rate of demand growth between 1990 and 2005 derived from EIA data (i.e. an annual increase of 1.92%). This is comparable to the national average over the same time period (an annual increase of 1.94%).[24] However, in the EIA's 2007 *Annual Energy Outlook*, they use an average growth rate of 1.46% to project future electricity demands

[22] Georgia IRP 2007 p. 10-2
[23] Georgia IRP 2007 p. 10-2
[24] EIA 2006 [1990 - 2005 Net Generation by State by Type of Producer by Energy Source (EIA-906)]

for the United States from 2005 to 2030.[25] A lower rate of future demand growth for Georgia is also to be expected. This can also be seen from the IRP, given that it notes

> Georgia Power expects to achieve approximately 1,000 MW of demand reduction by 2010 through the implementation of existing and new demand side management (DSM) programs. This load reduction represents more than 5% of the Company's current load.[26]

If the lower rate of demand growth predicted by the EIA was used in my analysis for the State of Georgia, and all other assumptions remained the same as described above, the reliance of the Georgia electric system in 2015 on coal and nuclear power would be even worse than presented above. For example, in this case, the all natural gas scenario would result in nuclear and coal making up nearly 73 percent of the State's generation while natural gas would make up just over 22 percent of total generation. These values can be compared to my extrapolation of the EIA projections for the U.S. of nearly 71 percent of generation coming from coal and nuclear and nearly 18 percent from natural gas in 2015. Adding a 1,000 MW nuclear plant to the Georgia grid would drive up the State's dependence on coal and nuclear in 2015 to nearly 78 percent of total generation. Therefore, under a lower demand growth scenario the addition of new nuclear or coal fired capacity would only increase the State's already heavy reliance on these two energy sources.

IV. Adverse Environmental Impacts

Q. WHAT ARE THE GENERAL ENVIRONMENTAL IMPACTS OF THE VARIOUS GENERATION TECHNOLOGIES PROPOSED IN THE COMPANY'S IRP?

A. (SB) The company propose new nuclear reactors at Plant Vogtle in its base case plan with pulverized coal supply technologies in an alternate plan scenario in the event the base case plan shows higher than projected costs in the future or other conditions occur. Each of the above supply types poses a range of negative environmental impacts

[25] EIA 2007 Figure 5
[26] Georgia IRP 2007 p. 1-10

involving air quality, water quality, water quantity, and land use that would have adverse impact on the state and the region. Air quality and land use concerns related to pulverized coal technologies are addressed in other SACE expert testimony while the environmental concerns related to the proposed nuclear power expansion and the general water issues of the IRP are addressed below.

Q. WHAT ARE THE ADVERSE ENVIRONMENTAL IMPACTS OF NUCLEAR POWER TECHNOLOGIES?

A. (SB) Nuclear power plants are highly water dependent and require tremendous volumes of water in order to operate. Both Plants Hatch and Vogtle return less than half of what they withdraw from surface water resources: Hatch had an average annual withdrawal in 2001 of 60 million gallons per day (mgd) and consumed 34 mgd; Vogtle respectively withdrew 64 mgd and consumed 43 mgd.[27] Water needs for a nuclear power plant are of a long-term nature, as the nuclear reactor and used or "spent" nuclear fuel requires constant cooling in order to prevent meltdown. Additionally, nuclear power plants release radioactive contaminants to the air, soil, and water along with hazardous chemicals during routine, daily operations. If a severe accident were to occur at a nuclear power plant, large land areas could be rendered uninhabitable for an extremely long period of time, not to mention the possibility of injuries and deaths that could occur in nearby communities. Nuclear power plants also produce highly radioactive used nuclear fuel that must remain shielded from humans and the environment for hundreds of thousands of years.

Q. HOW DOES THE CHOICE OF SUPPLY TECHNOLOGY THAT THE COMPANY INCLUDES IN ITS IRP AFFECT STATE OR REGIONAL WATER RESOURCES MANAGEMENT?

A. (SB) Many of Georgia's power plants are among the largest water users in the state. Fossil fuel and nuclear power plants require large quantities of water to operate, in marked contrast to renewable energy supplies such as bio-energy, solar, and wind., Also,

[27] GAEPD 2002

the adoption of energy efficient practices and technologies reduces system-wide energy needs, thereby reducing the water requirements of the electric system as a whole.[28]

According to the United States Geological Survey (USGS) 2003 report "Estimated Use of Water in the United States in 2000," nationally the largest water withdrawals were for thermoelectric power (195,000 million gallons per day, of which 30% was from saline sources) and irrigation (137,000 mgd all from fresh water sources). In Georgia, total water withdrawals in 2000 were reported at 6500 million gallons of water per day (mgd). The leading water-use categories reported for Georgia were: 1) thermoelectric power 3312 mgd (saline and fresh); 2) public supply 1250 mgd (fresh); 3) irrigation 1140 mgd (fresh); 4) industrial 652 mgd (saline & fresh); and 5) domestic use 110 mgd (USGS, 2003). [Public supply refers to water withdrawn by public and private water suppliers that furnish water to at least 25 people or have a minimum of 15 connections].[29]

With Georgia's thermoelectric power sector has the largest water withdrawals in the state, these power plants compete for water for other important needs that are vital to our state's economy and quality of life, including agriculture, industrial needs, fishing, and recreational opportunities. Less water used for the purpose of power generation translates into greater water availability for other life-dependent or life enhancing uses throughout our state. The state's first water management plan has identified the need for reducing water withdrawals as a major goal due to future constraints.

> With Georgia's abundant, yet limited, water resources, we cannot continue to use water as we have historically. We need to take steps to minimize water withdrawals and forestall adverse impacts on other water users and on the systems themselves. Without water conservation and reuse, Georgia will not be able to meet instream *and* offstream water demands of the future.[30]

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[28] Barczak 2005

[29] USGS 2003 Table 2, pp. 2-7, 13 and Barczak 2005 p. 1

[30] GAEPD 2006 p. 6

Q. WHY DO SOME POWER PLANTS CONSUME EXCESSIVE AMOUNTS OF WATER?

A. (SB) Power plants must be located next to large bodies of water or have significant water resources continuously and readily available to create steam to power the turbines. A large portion of this water is returned to the source, albeit at a higher temperature, and generally a much smaller fraction is lost or "consumed." Water withdrawals and consumption figures depend heavily on what types of cooling technologies are used. Power plants that use once-through cooling (i.e. do not have cooling towers), withdraw very large volumes of water while little water is consumed or lost because there is a negligible amount of evaporation. In contrast, power plants that use cooling towers do not need to withdraw as much water, but have a higher rate of water consumption due to the evaporation from the cooling towers.[31]

Q. WHAT ARE THE PARTICULAR CONCERNS SPECIFIC TO NUCLEAR POWER'S IMPACT ON GEORGIA'S WATER RESOURCES?

A. (SB) When comparing types of energy generation in relation to their water withdrawal and consumption, regardless of whether cooling towers are used, nuclear power has shown to have higher rates of withdrawal and consumption than coal or natural gas. Less water-intensive cooling technologies, such as dry cooling, that can be used at fossil fuel power plants are generally considered not economically achievable or viable in terms of safe operating standards for nuclear plants.

Georgia's nuclear plants use mechanical draft cooling towers, resulting in less water withdrawn (around 60 million gallons per day) but with a much greater volume of water consumed or lost (between 34 and 43 million gallons per day).[32] This ultimately results in returning less than half of the water withdrawn to the original supply source, in these cases to the Savannah and Altamaha rivers. In addition, all nuclear reactors must

[31] Barczak 2005, p. 2
[32] Barczak 2005, p. 2

have large, continuous water supplies available to cool the nuclear fuel rods in the reactor core to prevent a catastrophic meltdown accident.

Specifically, the two 2430 MW reactors, which have been operating at Plant Vogtle since 1987 and 1989, withdraw a monthly average of 68,670,000 gallons per day (Energy Information Administration 2000). Estimated consumption data from the Georgia Environmental Protection Division in 2001 showed consumption of approximately 43,000,000 gallons per day, or only about one third of what was withdrawn by Plant Vogtle from the Savannah River was being returned.[33]

According to a 2004 study for the U.S. Department of Energy, *Estimating Freshwater Needs to Meet 2025 Electrical Generating Capacity Forecasts*, nuclear plants generally have higher water withdrawal rates in gal/kWh than compared to pulverized coal plants, regardless of whether cooling technologies are used or not.[34] Once-through cooling technologies for coal and nuclear plants have equivalent consumption rates. However, when mechanical draft or recirculating cooling technologies are used, nuclear power has larger water consumption rates. Plant Vogtle currently has the largest water consumption of all power plants in Georgia.

Q. WHAT ARE THE PREDICTED WATER REQUIREMENTS FOR AND POSSIBLE WATER IMPACTS FROM THE PROPOSED NEW REACTORS?

A. (SB) The proposed two new Westinghouse AP-1000 reactors for Plant Vogtle will reportedly use approximately 53,602,560 gallons per day (gpd) from the Savannah River under normal use with a maximum withdrawal of about 83,208,960 gpd.[35] Between 50-75% will be consumptive use, that is, lost as steam. The remainder will be returned to the Savannah River at a warmer temperature resulting in thermal impacts to the river. To put this into perspective, with average per capita daily water use in Georgia at 75 gallons from surface and ground water, more water will be lost as steam from the two existing and two proposed reactors at Plant Vogtle than is used currently by all residents (2005 census) of Atlanta (470,688), Augusta (190,782) and Savannah (128,453) combined.[36]

[33] Barczak 2007, p. 2
[34] U.S. DOE 2004, p. 12
[35] SNOC 2006, p. 2.3.2-4
[36] Barczak 2007, pp. 2-3

Proposed new energy supply sources, such as expanding nuclear power generation at nuclear Plant Vogtle by building up to two new reactors, could reduce water availability in the Savannah River as climate change impacts, such as reduced summer river flow, develop.

Also, there are existing water quality concerns that additional nuclear reactors at Plant Vogtle along the Savannah River could exacerbate. With saltwater intrusion of the Floridan Aquifer already occurring both Beaufort and Jasper counties in South Carolina and the Savannah area will become more dependent in the future on the Savannah River for drinking water as will other areas near the Savannah River that are expanding due to population growth and development.

Concerns have been raised by officials in Georgia and South Carolina about the Savannah River's ability to meet assimilative capacity demand that directly impacts water quality. According to statements made by Georgia Governor Sonny Perdue's Administration, estimates show that the Savannah River may be close to approaching its maximum assimilative capacity.[37] Demands for additional assimilative capacity are expected as population and employment growth continue, which may therefore require that more aggressive steps will be needed to reduce the amount of water withdrawn and to more thoroughly treat the water being discharged back to the river.

Plant Vogtle already contributes tritium to the Savannah River.[38] The current flow of the Savannah River dilutes the radioactive tritium added to the river by Plant Vogtle, the Barnwell nuclear waste dump, and the Savannah River Site (SRS) enough to meet the EPA's maximum contaminant level for tritium. Although currently the EPA maximum contamination level for tritium is 20,000 pCi/L, in March of 2006 the California Office of Environmental Health Hazard Assessment established a Public Health Goal of 400 pCi/L for tritium in drinking water.[39] To compare this new standard for California to the situation facing the Savannah River presently, the Beaufort Jasper Water and Sewer Authority in South Carolina reported the average level of tritium for 2005 was 547

[37] Augusta Chronicle 2005

[38] SRNL 2005, Chapter 5. The total tritium transport in the Savannah River for 2005 was 4,480 Ci, compared with the previous year's 3,630 Ci. Both Plant Vogtle and SRS contributed to these release values. Accounting for Plant Vogtle's contribution, SRS's calculated releases of tritium to the river in 2005 totaled approximately 2,620 Ci.

[39] CA EPA 2006

pCi/L.[40] Additional reactors at Plant Vogtle could contribute to more tritium in the Savannah River.

Q. WHAT PROBLEMS DOES RADIOACTIVE CONTAMINATION OF WATER SUPPLIES POSE FOR GEORGIA POWER RATEPAYERS AND THE PUBLIC?

A. (SB) Historically, Georgia has been negatively impacted by radioactive contamination of its water by commercial and military activities. An example of the kind of economic damage that can occur happened over Christmas 1991. A large radioactive spill from a nuclear reactor at the Department of Energy's Savannah River Site (SRS) into the Savannah River resulted in the closure of the industrial water supply in Savannah and surrounding areas for several days. Harvesting in two local shellfish beds was suspended; the Beaufort, South Carolina water intake system was closed; and two Savannah food-processing industries shutdown, Fuji Oil and Savannah Sugar Refinery. Although Savannah is more than 90 miles downriver from SRS (and Plant Vogtle), the tritium (a radioactive form of hydrogen) levels measured in Savannah were double the maximum drinking water limits allowed by the EPA and remained above drinking water standards for days.[41] DOE failed to notify Savannah in a timely manner to prevent economic losses to local industrial water users. Prompted by the spill and decades of past releases at the site, it was decided that a tritium monitoring and advanced notification system for Savannah was needed. This system was put in place however federal and state budget allocations for the state radiation monitoring program in Georgia are continually in peril.

Savannah and other downstream communities deserve a guaranteed, safe water supply. There are already threats to safe water supplies exist now, as releases of tritium and other radioactive contaminants already occur from existing plants, and they would only intensify under nuclear expansion scenarios in the Savannah River area either instate or in neighboring South Carolina. If the state monitoring and notification program is lost or further reduced or eroded, then residents and businesses are at higher potential risk, jeopardizing the health and prosperity of Georgians.

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[40] BJWSA 2005

[41] The drinking water standard is set as an annual average. Local authorities and others use this as an action level when it was exceeded.

Q. ARE THERE OTHER PROCEEDINGS/DELIBERATIONS THAT THE COMMISSION SHOULD BE AWARE OF THAT INCREASES THE UNCERTAINTY OF THE LICENSING OF THE ADDITIONAL VOGTLE REACTORS?

A. (SB) Yes. The possible expansion of Vogtle is currently under initial review by the U.S. Nuclear Regulatory Commission (NRC) as it studies Southern Nuclear Operating Company's early site permit application submitted in August 2006. Of the initial three other permits filed with the NRC, only one, the Clinton site in Illinois, has been issued a permit and it took 3 ½ years. The other two have been under review since fall of 2003.[42] For Vogtle's permitting process, the NRC has issued additional Requests for Additional Information (RAI) and stated there would be additional schedule impacts.[43]

Additionally, several citizen groups including Southern Alliance for Clean Energy filed a petition in December 2006 to intervene on behalf of their members with the NRC. The Atomic Safety and Licensing Board, an appointed, three-judge panel, concluded on March 12, 2007 that threats to the Savannah River and surrounding environment need to be further examined by Southern Company.[44]

Also, a combined construction and operating license (COL), is required from the NRC before construction of new reactors can begin. Southern Company has stated it intends to file a COL in Spring 2008. Currently, no utility has filed a COL and given that this is a new licensing procedure, there is no regulatory experience with this process, indicating uncertainty about the schedule to bring new reactors online at Plant Vogtle.

Lastly, NRC commissioners recently testified before Congress that the NRC is experiencing severe staff shortages at a moment where an unprecedented number of new reactor applications may be filed in the near term. The NRC commissioners also testified that the manufacturing capacity globally for nuclear plant parts is limited. This adds to the uncertainty of the regulatory approval process happening in a timely manner along with the ability to actually build the facilities. These delays could impact the cost effectiveness of new nuclear generation.[45]

[42] NRC 2007
[43] NRC 2007b
[44] ASLB 2007
[45] MarketWatch 2007

Q. WHAT OTHER WATER CONCERNS SHOULD BE CONSIDERED IN LONG RANGE POWER PLANNING?

A. (SB) Limited water availability in times of drought should be considered with current and future energy production. Most power production in Georgia relies on continuously and readily available water supplies. If that trend continues, and coincides with drought conditions, Georgians and Georgia Power ratepayers could be vulnerable.

Climate change models generally indicate either no to moderate increase in precipitation during winter months. They also indicate that seasonal shifts in rainfall coupled with higher temperatures may result in significantly drier months from late spring through early fall. Thus, modeling predictions for summer and early fall months may constitute what we would currently classify as drought conditions. Recent work that utilizes models (GFDL CM2.1) developed by Princeton's Geophysical Fluid Dynamics Laboratory pose the future possibility of long-term mega-droughts that could embrace the southwestern U.S. and the subtropics including Georgia). While the severity, duration, and frequency of future droughts are uncertain, the possibilities should not be ignored when planning for long-term water allocation.[46]

Consumptive water use exacerbates the severity of droughts and further reduces the assimilative capacity of the Savannah River. Lakes Hartwell, Thurman, and Russell, upriver from Augusta were created, in part, to mitigate drought years by releasing stored water to maintain minimal flow levels. The Savannah River Drought Contingency Plan Update calls for maintaining a minimum flow rate of 3600 cubic feet per second (cfs) during level 3 drought years. Therefore the average total daily use of water by the four reactors (two existing and two proposed) at Plant Vogtle will be approximately 4% of the Savannah River during a level 3 drought with a maximum daily use withdrawal of about 10%. Consumptive losses represent as much as 3 to 7.5% of the Savannah River below Lake Thurmond during a level 3 drought.[47] Increasing consumptive use of water in the Savannah River Basin during low flow periods could contribute to other environmental risks. Here, we call attention to salt water moving upriver as river flows decrease. One risk is that salt water may enter the Savannah Wildlife Refuge and impact the

[46] Barczak 2007, p. 3
[47] Barczak 2007, p. 3

productivity and wildlife value of this important refuge. An additional risk is how the salt water wedge moving upriver will impact the productivity of the Savannah River estuary.

Q. WHAT OTHER EFFECTS COULD DROUGHT AND HEAT WAVE HAVE ON NUCLEAR PLANT OPERATIONS?

A. (SB) Additionally, the predicted effects of global warming on this region, such as summer heat waves or droughts, could negatively impact the ability for the existing or proposed reactors at Vogtle to generate electricity under those conditions. This deficiency was demonstrated by the 2006 summer heat wave, when nuclear power plants in France, Germany, and across Europe, and in the U.S. at the Cook nuclear plant in Michigan, had to shut down because the water temperatures were too high to allow for safe operation. Some companies in Europe also had to secure exemptions from regulations in order to discharge overheated water into the environment and others were forced to buy electricity on the spot market.[48]

Q. WITH RESPECT TO WIND POWER IN PARTICULAR, WHAT CONCERNS DO YOU HAVE REGARDING THE IRP'S TREATMENT OF THIS POTENTIAL RESOURCE?

A. (AM) The IRP "[t]echnology screening" dropped any consideration of wind power in Georgia from detailed consideration because they claim "[a]vailable wind resources in the southeastern U.S. are not adequate to support significant utility scale use of this technology."[49] However, elsewhere in the IRP, Georgia Power notes that

> Southern Company and Georgia Tech's Strategic Energy Institute are collaborating on a study of the feasibility of locating wind turbines off the coast of Savannah, Georgia. The goal of the project is to determine if offshore wind power is an efficient and cost-effective renewable energy option for power generation. Design and conceptual engineering for the project will be performed using technical expertise from both Georgia Tech and Southern Company. The study will evaluate various technology

[48] Christian Science Monitor 2006 and Bloomberg News 2006 and Lochbaum 2006
[49] Georgia IRP 2007 p. 15-15

> options for wind turbines, platforms/foundations, submarine cabling, and grid interconnection. Detailed analyses of a site location and environmental regulations and jurisdictions, including permitting requirements, will also be determined. A final report will be available in early 2007.[50]

Given that this effort will have its final report completed within this year, the Company should have maintained offshore wind as a potentially viable supply option in the IRP for analysis in the event that the Company's own study shows that it is, in fact, "an efficient and cost-effective renewable energy option for power generation." In my evaluation wind power in many areas, including many offshore areas, is more economical today than nuclear power.

Further, the wind resource should be evaluated in combination with other resources. For instance, at prices of natural gas over about $6.50 per million Btu, it is economical to use combined cycle power plants as back up for wind power. This improves the overall reliability of the system and reduces the cost of wind integration into the grid. Similarly, coordination of wind, natural gas combined cycle, and hydro resources could have multiple beneficial economic impacts on Georgia Power ratepayers and on the environment. The IRP makes no mention of considering renewable resources (wind and hydro) together and optimizing the two by combining power planning with using some combined cycle power plants in a standby mode. This would reduce demand pressure on natural gas and exert a downward influence on natural gas prices, if it is made part of an overall electricity sector development strategy. Such a trend would have beneficial impacts on other sectors of the economy. As noted above, the addition of renewable resources would have a very positive effect on the fuel diversity of Georgia's electric power sector and would also help to lower the State's exposure to fuel price uncertainty as well as the serious risks associated with building a new nuclear power plant (see below).

[50] Georgia IRP 2007 p. 10-8

Q. ARE THERE OTHER CONCERNS RELATED TO GEORGIA POWER RELYING ON AN INCREASINGLY HIGH DEPENDENCE ON NUCLEAR POWER IN THE FUTURE AS PROPOSED IN THE IRP?

A. (AM) An additional concern for relying heavily on nuclear power is raised by the potential for accidents at current or future reactors. As the partial meltdown at Three Mile Island in 1979 and the explosion at Chernobyl in 1986 demonstrated, an accident in any country can affect the acceptance of nuclear plants around the world. These two accidents served to heighten the public awareness of the risks inherent in nuclear power and forced the U.S. Nuclear Regulatory Commission to, at least temporarily, tighten its regulations and oversight. Already Austria, Belgium, Demark, Germany, Italy, the Netherlands, New Zealand, and Sweden have all made official commitments to prohibit or phase out nuclear power.[51]

Despite the growing concerns over global warming, the opposition to nuclear power continues. In October 2005, the International Atomic Energy Agency, a body explicitly charged with promoting the spread of civilian nuclear technologies, released a report on public opinion in 18 countries. In their survey, the IAEA found that, overall, nearly three out of every five people interviewed opposed the construction of new nuclear plants. In only one country, South Korea, was a majority in favor of building new reactors.[52]

The economic vulnerability of future regulatory requirements in relation to protection of the public from terrorist attacks also increases with increasing reliance on nuclear power plants. Finally, the fact that there may be new tritium requirements for drinking water in the future in light of the California's public health goal of 400 pCi/liter and the widespread concern about tritium releases from nuclear power plants that has been evident in the past two years, the addition of nuclear power plants may significantly increase Georgia ratepayers' liabilities for remediation of alternative water supplies. Further, even the controversy over increasing contamination with tritiated water, which crosses the placenta, could further reduce public acceptance of nuclear power. The added

[51] IEA 2001b p. 155, 228, and 246 and MIT 2003 p. 21

[52] The countries included in the survey were: Argentina, Australia, Cameroon, Canada, France, Germany, Hungary, India, Indonesia, Japan, Jordan, Mexico, Morocco, Russia, Saudi Arabia, South Korea, United Kingdom, and the United States. [IAEA 2005f p. 18-20]

costs of reducing tritium discharges to near zero and eliminating the risk of leaks need to be factored into Georgia Power's analysis of nuclear power.

Q. HAS THERE BEEN ANY CONCERN RAISED ABOUT GEORGIA POWER'S PROPOSED EXPANSION OF PLANT VOGTLE?

A. (SB) Yes. Exhibit__ AM,SB-2 lists various non-governmental organizations that are calling for a stop to nuclear expansion in Georgia.

Q. HOW IS THE HISTORIC OPPOSITION TO NUCLEAR POWER RELEVANT TO THE GEORGIA PSC IN THIS DOCKET?

A. (AM) The history of opposition to nuclear power in the U.S. and abroad is important to consider because, even if new plants can be built without significant disruption, it is unlikely that public opposition could be avoided in the wake of a serious accident or successful large scale terrorist attack on a nuclear power facility as noted above. If nuclear power in Georgia is in the process of being expanded and accounts for a significant amount of the Company's capacity in terms of either absolute generation or a percentage of overall electricity usage (as it would under the proposed actions in the IRP), then future public pressure to shutdown existing plants would leave open far fewer energy options (particularly in terms of reducing greenhouse emissions). The options that would be available to achieve a rapid phase-out of nuclear power under those circumstances would likely come at a higher price for ratepayers considering both the sunken capital in the completed nuclear plants as well as the cost of ad hoc measures that would be needed to rapidly replace the off-lined baseload nuclear capacity. On the other hand, however, if Georgia Power was already pursuing plans to diversify its fuel mix with a focus on indigenous and renewable resources when a future accident or terrorist attack occurred, there would likely be far more options available and those options could be accelerated with significantly less serious disruptions to Georgia's economy.

Georgia Power explicitly notes that "[t]he best IRP is one that provides a high level of customer value while incorporating a broad range of potential changes."[53] Among the "additional objectives" in the IRP noted by the company are "Flexibility -

[53] Georgia IRP 2007 p. 2-4

Can the Plan be altered if the future is different than expected?" and "Risk - Does the Plan represent a reasonable balance between risk and cost?". [54] The public pressures that are possible in the wake of a serious accident or successful terrorist attack anywhere make the option of pursing a new 1000 MW nuclear reactor, let alone two 1000 MW reactors, a very inflexible and risky option for Georgia ratepayers.

Q. IS IT YOUR TESTIMONY THAT IF GEORGIA POWER WERE TO UNDERTAKE THE CONSTRUCTION OF A NEW NUCLEAR POWER REACTOR AND A MAJOR ACCIDENT AT A NUCLEAR POWER REACTOR OCCURRED SOMEWHERE AROUND THE GLOBE, THEN THIS COULD HARM GEORGIA POWER RATEPAYERS?

A. (AM) Yes, this is a possibility. We recognize that predicting the public's reaction to a major nuclear accident is in no way certain. However, taking the history of public opinion as a guide, the risks of serious disruption to an energy system that would be as heavily reliant on nuclear power as Georgia's is following a major accident or successful terrorist attack should not be ignored. As summarized by Dr. Russell Peterson, one of the commissioners appointed by President Carter to investigate the accident at Three Mile Island, in 1979

> As a final comment, I wish to emphasize my conviction, strongly reinforced by this investigation, that the complexity of a nuclear power plant -- coupled with the normal shortcomings of human beings so well illustrated in the TMI accident -- will lead to a much more serious accident somewhere, sometime. The unprecedented worldwide fear and concern caused by the TMI-2 "near-miss" foretell the probable reaction to an accident where a major release of radioactivity occurs over a wide area. It appears essential to provide humanity with alternate choices of energy supply.[55]

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[54] Georgia IRP 2007 p. 2-4
[55] Kemeny Commission 1979 p. 87

Q. DO YOU AGREE WITH THE IRP'S CONCLUSIONS REGARDING THE ECONOMIC COMPETITIVENESS OF NUCLEAR POWER COMPARED TO OTHER SOURCES OF NEW BASELOAD GENERATION?

A. (AM) No. The IRP claims that "[w]hile it is impossible to estimate accurately future project costs, current industry projections show nuclear energy to be the lowest cost option for generation in 2015."[56] It also notes that "[t]he 2007 IRP Mix Study selected nuclear as the most cost effective resource in the 2015 and 2016 timeframe."[57]

However, from the public data that I have reviewed, it appears very unlikely that new nuclear power generation would be economically competitive with other baseload options available. Two of the most important recent studies on the economics of nuclear power in the U.S. are a 2003 study from the Massachusetts Institute of Technology and a 2004 study conducted at the University of Chicago. These studies put the likely cost of electricity from new nuclear power plants well above the cost of electricity from natural gas or pulverized coal fired plants over the time period considered in the Georgia Power IRP (see Tables 1 and 2).

Table 1: Levelized cost of electricity from new nuclear power, pulverized coal, and natural gas fired power plants as estimated by the MIT and University of Chicago studies.[58]

Generation Type	MIT Report (2003)	University of Chicago Report (2004)
Pulverized Coal[(a)]	4.2 cents per kWh	3.3 to 4.1 cents per kWh
Natural Gas (CCGT)[(b)]	3.8 to 5.6 cents per kWh	3.5 to 4.5 cents per kWh
Nuclear Power[(c)]	6.7 cents per kWh	6.2 cents per kWh

(a) Levelized cost of coal in the MIT study is $1.30 per MMBtu while the average price of coal over the lifetime of the plants in the U Chicago study is $1.02 to $1.23 per MMBtu.
(b) Levelized cost of natural gas in the MIT study is $3.77 to $6.72 per MMBtu. The average price of natural gas over the lifetime of the plants in the U Chicago study is $3.39 to $4.46 per MMBtu. The spot market price for natural gas has, at times, been well above the "high" fuel price used in these studies. However, long-term gas prices can be expected to remain within the range assumed by the MIT study. For example, the 2007 EIA *Annual Energy Outlook* projects an average fuel costs to electricity suppliers between 2005 and 2030 of $6.13 per MMBtu for natural gas (in 2005 dollars).

[56] Georgia IRP 2007 p. 6-5
[57] Georgia IRP 2007 p. 1-8
[58] MIT 2003 p. 40 and 42-43 and U Chicago 2004 p. 5-24 to 5-25 and 9-5 to 9-6

(c) Overnight capital cost of a nuclear plant in the MIT study is $2,000 per kW. While the U Chicago analysis considered a range of capital costs from $1,200 to $1,800 per kW, the lower end of this range was so far out of what could be reasonably expected from experience in the U.S. and around the world that we did not consider it to be a credible basis for analysis. The middle of the U Chicago range, $1,500 per kW, was used as the basis for our economic analysis.

Table 2: Comparison of the assumptions for overnight capital cost, lead time for construction, and effective interest rate used in the MIT and University of Chicago studies.[59]

Generation Type	MIT Study (2003)			University of Chicago Study (2004)		
	Overnight Capital Cost ($ per kW)	Lead Time (years)	Effective Interest Rate	Overnight Capital Cost ($ per kW)	Lead Time (years)	Effective Interest Rate
Natural Gas	500	2	9.6%	500 to 700	3	9.5%
Coal	1,300	4	9.6%	1,182 to 1,430	4	9.5%
Nuclear	2,000	5	11.5%	1,200 to 1,800	7	12.5%

From our analysis of the likely overnight capital cost, lead time for construction, and interest rate premium charged by financial institutions due to the higher risk of nuclear construction, we have concluded that it is likely that the cost of electricity from future nuclear power plants will fall within the range of six to seven cents per kWh; there is a significant chance that it may be higher than that (see below), even apart from issues such as waste management and disposal.

As summarized by the authors of the 2003 MIT report,

> *Unfavorable economics.* Most operating nuclear plants are economical to operate when costs going forward are considered, i.e. when sunk capital and construction costs are ignored. However, new plants appear to be more expensive than alternate sources of base load generation, notably coal and natural gas fired electricity generation, when both capital and operating costs are taken into account.[60]

This conclusion was echoed by the authors of the University of Chicago study,

> In summary, with the expectation of a 7-year construction period, no individual financial policy can be counted on unambiguously to bring the

[59] MIT 2003 p. 43, 132, and 135 and U Chicago 2004 p. 3-16, 5-17, 5-21, 5-23 to 5-24, and 9-5 to 9-6
[60] MIT 2003 p. 21

> LCOE [levelized cost of electricity] of first new nuclear plants within the range of LCOE competitive with fossil generation.[61]

Moreover, the range of options for power supply are broader than presented under the traditional three-sector analysis of baseload, intermediate load, and peaking power plants. As noted above, intermittent renewable sources like wind should be planned in conjunction with combined cycle standby capacity, and hydropower resources. When combined with targeted efficiency measures that change the shape of the load curve to suit the supply mix, the proportion of traditional baseload power plants needed in the mix of generation can be reduced. This is particularly the case if intermediate scale solar PV in large parking lots and large commercial rooftops (~several hundred kW to a few MW) is combined with the mix of wind, hydro, combined cycle natural gas standby. The picture for baseload plant requirements would further change if advanced battery storage is considered in conjunction with the above. Finally, intermediate scale solar PV also reduces transmission cost. Indeed, this option should be fully integrated into transmission and distribution planning.

Q. IS THERE FURTHER EVIDENCE TO SUPPORT THE ECONOMIC FINDINGS IN THE MIT AND UNIVERSITY OF CHICAGO STUDIES?

A. (AM) Yes. As further support for the conclusions reached by these studies, a 2003 Congressional Budget Office report, using information provided by the Nuclear Regulatory Commission, the Department of Energy, and "industry sources," assumed that a new nuclear plant with a capacity of 1,100 MW could be built starting in 2011 at a cost of approximately $1,900 to $2,700 per kW, with a best estimate of $2,300 per kW.[62] This is about 13 percent above the overnight capital cost estimated by the MIT study and more than 53 percent above the middle of the range assumed by the U Chicago study, thus making their estimates potentially optimistic regarding the expense of electricity from new nuclear reactors. Significantly, the Congressional Budget Office concluded that

[61] U Chicago 2004 p. 9-10
[62] CBO 2003 p. 11

> [b]ecause the cost of power from the first of the next generation of new nuclear power plants would likely be significantly above prevailing market rates, we would expect that the plant operators would default on the borrowing that financed its capital costs.[63]

Thus, the decision by Georgia Power to pursue new nuclear construction exposes the ratepayers of Georgia to the significant financial risks associated with their utility potentially having to default on its financing due to electricity costs "significantly above prevailing market rates" as the CBO put it.

Q. HOW WOULD CONSIDERATION OF OTHER TYPES OF COAL FIRED POWER PLANTS AFFECT YOUR CONCLUSIONS REGARDING THE ECONOMICS OF NUCLEAR POWER?

A. (AM) If newer coal fired technologies such as Integrated Gasification Combined Cycle (IGCC) are included in the mix of options to consider, nuclear power is still not likely to be cost competitive (see Table 3).

Table 3: Levelized cost of electricity from new pulverized coal and integrated gasification combined cycle plants.[64]

Generation Type	Studies Reviewed by IEER (2006)	Studies Reviewed by MIT (2007)
Pulverized Coal	3.2 to 4.3 cents per kWh	4.2 to 5.2 cents per kWh
Integrated Gasification Combined Cycle (IGCC)	3.2 to 4.8 cents per kWh	4.1 to 5.0 cents per kWh

These cost ranges for electricity from IGCC plants are comparable to what the 2007 EIA *Annual Energy Outlook* predicts for 2015.[65] In addition, it is important to note that the EIA itself predicts that both advanced coal fired plants and new natural gas fired plants would produce electricity cheaper than new nuclear power plants in 2015 and that new nuclear plants would still be a more expensive option in 2030.[66]

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[63] CBO 2003 p. 12
[64] MIT 2007 p. 127-129 and Smith 2006 p. 89
[65] EIA 2007 Figure 56
[66] EIA 2007 Figure 56

Finally, it is important to note that even if carbon capture and storage (i.e. carbon sequestration) was added to the coal gasification plants in order to reduce their emissions of greenhouse gases, the cost of electricity would still likely remain competitive with new nuclear power. For example, the 2007 review by researchers at MIT found an estimated range of 5.4 to 6.6 cents per kWh for IGCC plants with carbon capture and storage. This compares well with the six to seven cents per kWh that new nuclear power is likely to cost.

Thus, even at the high range for new IGCC plants without sequestration or the high end of the range of likely long-term natural gas prices (about 6 dollars per million Btu), nuclear power is likely to be about 0.5 to 1.0 cent per kWh more expensive than fossil fuel fired capacity, and perhaps more if pulverized coal was the alternative. To appreciate the scale of this added cost, I note that, for one 1,000 MW reactor operating at a capacity factor of 85 percent, the higher cost of electricity from this plant would add an estimated $37.2 to $74.5 million to the electricity bill of Georgia ratepayers.

Q. ARE THERE ANY REASONS TO CONCLUDE THAT ESTIMATES FOR THE CAPITAL COST OF NUCLEAR REACTORS SUPPLIED BY THE INDUSTRY SHOULD POTENTIALLY BE VIEWED WITH SOME DEGREE OF SKEPTICISM?

A. (AM) The history of cost overruns at nuclear plants in the United States is well known, including those at the Vogtle nuclear power plant in Georgia.[67] Significantly, in a review of historical experience with nuclear plant construction, the DOE's Energy Information Administration noted explicitly that

> … although the utilities did increase their lead-time and cost estimates as work on the plants proceeded, they still tended to underestimate real overnight costs (i.e., quantities of land, labor, material, and equipment) and lead-times ***even when the plants were 90 percent complete***.[68]

[67] See for example Forbes 1985, EIA 1986, and NAS/NRC 1992
[68] EIA 1986 p. xv (emphasis added)

In this review, the EIA found that, for those plants that began construction between 1966 and 1969, the utilities were underestimating the final cost of the nuclear plants by an average of 63 percent prior to construction beginning and were still underestimating their final cost by 22 percent when the plants were three-quarters complete. Surprisingly, for those plants that began construction between 1974 and 1977, the nuclear industry actually grew slightly worse at estimating the final plant cost despite its increase in experience. Specifically, the utilities underestimated the costs of these plants by 72 percent prior to construction and, even when past plants were three-fourths complete, they were still underestimating the final construction cost by roughly 23 percent.[69]

A particular concern in the current case is that the IRP Mix Study uses Westinghouse's AP-1000 as the base case option for new nuclear capacity.[70] An AP-1000 has never been built anywhere in the world, not to mention anywhere in the United States, so no real world experience is available from which to draw a direct comparison. This adds to the uncertainty in cost estimates. As noted by analysts at Standard & Poor's in their 2006 assessment of nuclear power generally, "given that construction would entail using new designs and technology, cost overruns are highly probable."[71]

In recent regulatory actions in North Carolina, where Duke Power has proposed to build new coal plants at the existing Cliffside power plant, the doubts about nuclear power's cost-effectiveness and viability were voiced. Jim Rogers, CEO of Duke Power, which has expressed serious interest in pursuing nuclear power stated in his testimony:

> Here's my judgment. We put 1800 [dollars] in because it's what Westinghouse has told us the number is. We are in negotiations with Westinghouse. My personal – and we modeled – what if it was 2200 and under 2200 Cliffside and Gas would be the least cost alternative in every scenario almost. And the reality is, my personal belief about nuclear, I don't think it comes on in 2016. I'm not a true believer. And secondly, I don't believe – I believe it comes closer to 2500 or 2600. And if you look

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[69] EIA 1986 page xvi
[70] Georgia IRP 2007 p. 1-15
[71] Kennedy et al. 2006

> at the testimony of Judah Rose, it's pretty close to 2500. So my personal judgment is, is that nuclear comes in at a much higher price, and it comes – and we are actually able to build it, it's going to be delayed beyond 2016. That would be my bet if I had to make the bet today.[72]

Q. DOES THE IRP ADEQUATELY ADDRESS THE RISKS ASSOCIATED WITH GLOBAL CLIMATE CHANGE?

A. (AM, SB) No. Climate change is, by far, the largest single environmental risk associated with the current energy system. Despite the importance and high profile of this issue, the public IRP filings lacks substantive discussion of climate change or the proposed impact its decisions will have on the emissions of greenhouse gases, either positively or negatively. This lack of discussion is particularly troubling given that the "additional objectives" of the IRP include "Environmental - Does the Plan consider environmental impacts?"[73]

Beyond the main IRP documents, the environmental compliance document contains only a single explicit reference to climate change, and does not provide any substantive discussion of what regulations may be put in place by 2015 regarding greenhouse gas emissions that could potentially affect the decision as to whether or not to consider building new coal fired plants with carbon sequestration as an alternative to new nuclear power.[74]

Finally, despite having higher greenhouse gas emissions per unit of generation than any other source, the IRP notes without discussion that

> If the Company finds that baseload nuclear is not cost-effective as it is preparing its updated Mix Study in anticipation of a nuclear Certification filing, then the Company will develop a baseload coal proposal along with the Mix Study.[75]

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[72] NCUC 2007
[73] Georgia IRP 2007 p. 2-4
[74] Georgia EC 2007 p. 5
[75] Georgia IRP 2007 p. 1-8

This strategy puts the ratepayers in double jeopardy. The first proposal is for a nuclear plant that is likely to be costly. And the back up is a polluting CO_2 emitting plant that is likely to face stiff taxes or equivalent costs via carbon trading.

Q. WHAT CONCLUSIONS HAVE YOU DRAWN REGARDING NUCLEAR POWER'S POTENTIAL ROLE IN ADDRESSING CLIMATE CHANGE?

A. (AM) While it is true that, compared to the other major energy sources utilized to generate base load electricity such as coal, oil, and natural gas, nuclear power plants emit far lower levels of greenhouse gases even when mining, enrichment, and fuel fabrication are taken into consideration, nuclear energy is not a viable solution to global warming. New nuclear power plants are expected to be very expensive, requiring billions of dollars in U.S. taxpayer subsidies such as those specified in the Energy Policy Act of 2005. If they are even built, they are not expected to be online before 2013-2014 at the very earliest as nuclear power plants require much longer lead times than other technologies, resulting in a marked delay in contributing to reducing greenhouse gas emissions compared to other available options. Next-generation reactors are even further from becoming a reality. In order to make a significant contribution to the reduction of carbon dioxide emissions globally, between one and three thousand nuclear power plants would need to be built around the world by 2050.[76] This would impose an unrealistic timeframe for construction with a new plant having to come online between every five days to two weeks through mid-century. The large number of plants required would greatly exacerbate the concerns over nuclear weapons proliferation and reactor safety, and accelerate the generation of waste. Even at the low end of the range, 1000 reactors online by 2050, the global uranium enrichment capacity would have to increase by roughly two and a half times, a new repository the size of Yucca Mountain would be needed somewhere in the world every six years between now and mid-century, and there would be an unacceptably high risk of at least one Three Mile Island level accident occurring over the lifetime of the plants. As such the expense and unique vulnerabilities associated with nuclear power make it a very risky, unsustainable, and highly uncertain option for reducing greenhouse gas emissions. In short, as summarized by the authors of a 2003

[76] Smith 2006 p. 26-28

report on the future of nuclear power conducted at the Massachusetts Institute of Technology.

> The potential impact on the public from safety or waste management failure and the link to nuclear explosives technology are unique to nuclear energy among energy supply options. ***These characteristics and the fact that nuclear is more costly, make it impossible today to make a credible case for the immediate expanded use of nuclear power.***[77]

While the conditions are somewhat different today than when the MIT study was published, the underlying reasoning of the study is sound. Its high natural gas price assumption is considerably higher than typical historical LNG costs and a reasonable one for long-term upper limit costs. Moreover, wind power is more economical than nuclear. And, while natural gas prices have gone up, other technologies, including intermediate scale solar PV, have become more economical. None of these carry the financial, safety, security or waste management risks of nuclear power. Finally, IGCC with sequestration is also closer to realization today than it was when the MIT study was written.

Q. WHAT PROBLEMS DOES HIGH LEVEL NUCLEAR WASTE POSE FOR GEORGIA POWER RATEPAYERS AND THE PUBLIC?

A. (SB & AM) Yucca Mountain is being presented by the U.S. Department of Energy as a solution to the problem of high-level nuclear waste. However, the Nuclear Waste Policy Act limits the waste destined for Yucca Mountain to a maximum of 70,000 metric tons of heavy metal (MTHM). The bulk of this allotment, about 63,000 MTHM, would be for spent fuel assemblies from commercial nuclear power plants, with the remaining space used for military high-level wastes from nuclear weapons production. The development of the nation's first high-level nuclear waste repository has already taken many decades and still faces many daunting hurdles before it could even obtain a license to begin construction. An April 2006 report from the Government Accountability Office (GAO) reaffirms the mounting challenges facing the Yucca Mountain project and reiterates the long history of quality assurance problems at the site that have led to repeated delays and increases in cost. These revelations included the release of emails that revealed the lack

[77] MIT 2003 p. 22 (emphasis added)

of confidence project managers and contractors had on the geological stability of the Yucca Mountain site and that the release of information on how reports Department of Energy reports on the safety and security of Yucca Mountain were falsified.[78]

Adding to the uncertainty about the repository's future is the fact that a key element of the regulations governing the Yucca Mountain site was struck down by a federal court and was re-issued by the Environmental Protection Agency in draft form in August 2005.[79] As of this date, no final standard has yet been adopted by the EPA.

As acknowledged in January 2006 by Dr. Ernest Moniz and Dr. John Deutch, both MIT professors, both former Undersecretaries in the Department of Energy, and both co-chairs of the 2003 MIT study on the future of nuclear power, "it is unclear whether Yucca Mountain will ever receive a license from the Nuclear Regulatory Commission."[80] No other country currently plans to have a repository in operation before 2020 at the very earliest, and all of these programs have encountered some level of difficulty.[81]

Q. BEYOND DELAYS AND POOR MANAGEMENT, WHAT OTHER PROBLEMS DOES THE U.S. HIGH LEVEL WASTE REPOSITORY PROGRAM FACE?

A. (AM) Even if delays and poor management had not plagued the U.S. repository program, a number of serious concerns would remain. First, the land upon which the Nevada Test Site and Yucca Mountain are located is claimed by the Western Shoshone Nation that opposes the placement of the repository. The lack of informed consent from those with a deep cultural and historical connection to the land should alone be sufficient to prevent any further consideration of the site. Second, Yucca Mountain is a highly complex site that is geologically unique in many important ways from any other locations being considered around the world. Yucca Mountain is the only site proposed for construction in an oxidizing environment, which significantly increases the rate of waste corrosion and contaminant transport compared to sites with a reducing environment. Third, the DOE itself projects that Yucca Mountain would not be able to meet the most basic requirement

[78] GAO 2006
[79] For a further discussion of the proposed EPA Yucca Mountain standard see [Makhijani and Smith 2005b].
[80] Washington Post 2006c
[81] MIT 2003 p. 158 and Holt 2005 p. CRS-1

of a repository; namely that it should maintain the peak dose to an acceptably low level. While IEER has long shared the scientific consensus that mined repository disposal is the least worst option available for the existing spent fuel and high-level waste, it is our conclusion that Yucca Mountain cannot be regarded as an appropriate site for the development of such a repository. Moreover, development of a repository for existing waste and that from existing nuclear power plants should not be seen as a license for producing more waste from new power plants, since there is really no satisfactory solution to the problem of long-term waste management and since other options for meeting society's requirements for the services that energy provides are available.

Q. HOW DO THE CONTINUING UNCERTAINTIES OF HIGH-LEVEL WASTE DISPOSAL FURTHER IMPACT GEORGIA RATEPAYERS?

A. (SB & AM) Despite the ongoing problems encountered by the Yucca Mountain project, from 1983 to 2004, Georgia's electricity consumers have paid approximately $873 million into the federal Nuclear Waste Fund to finance nuclear waste management. This continuing uncertainty could impact the ratepayer in terms of unknown or unpredictable costs in dealing with nuclear waste management in the future. Furthermore, even if the Yucca Mountain project was to eventually open and begin accepting commercial high-level radioactive waste from nuclear power plants, it is not large enough to handle the waste from existing plants let alone new nuclear power plants. Table A-7, in the final Department of Energy Environmental Impact Statement on the Yucca Mountain Project, shows that by 2011 all currently operating nuclear power plants will have generated a total waste amount of 63,000 (MTHM).[82] Thus, the current fleet of nuclear reactors will have generated as much commercial nuclear waste as Yucca Mountain is allowed by law to hold before the new nuclear plant proposed by Georgia Power could be brought online. Southern Company had been involved in a consortium, Private Fuel Storage, L.L.C. (PFS), to develop an offsite storage facility to handle commercial high-level nuclear waste on the Skull Valley Goshute Native American reservation in Utah 45 miles SW of Salt Lake City. However, in a December 7, 2005 letter to U.S. Senator Orrin Hatch of

[82] DOE 2002

Utah, Southern Company stated that it would no longer support PFS and that "Southern Company is committed to Yucca Mountain as the nation's spent fuel repository."[83]

Q. WHAT ADDITIONAL CONCERNS EXIST WITH THE COMPANY'S PROPOSAL REGARDING HIGH-LEVEL RADIOACTIVE WASTE?

A. (SB) The projection of only 10 years of available wet storage for highly radioactive spent fuel for the AP-1000 design is problematic even if a design change can be made to add an additional 7 years of wet storage for a total of 17 years of wet storage. Plant Vogtle's Unit 1& 2 have operated since 1987 and 1989 respectively and according to the Georgia Environmental Protection Division (EPD) are expected to be able to provide wet storage for the full 40-year length of its operating license. The Company's filed testimony did not mention how they intend to store spent fuel onsite upon reaching capacity of the spent fuel pools. This uncertainty could impact ratepayers in terms of unknown or unpredictable costs in dealing with nuclear waste management (e.g. costs associated with onsite dry cask storage in a manner that would be safe from terrorist attacks).

Q. WHAT PROBLEMS ARE LIKELY TO ARISE UNDER AN INITIATIVE TO REPROCESS SPENT FUEL AS AN ALTERNATIVE TO A MINED REPOSITORY?

A. (AM) Alternatives to disposal in a mined repository are unlikely to overcome the challenges posed by nuclear waste. Proposals to reprocess spent fuel that have recently been put forward, most notably in President Bush's Global Nuclear Energy Partnership initiative, would not solve the waste problem and instead would greatly increase the vulnerabilities of a decision to build a new nuclear plant in that reprocessing schemes are expensive and create a number of serious environmental risks.

First we note that the 2003 interdisciplinary MIT study on the future of nuclear power estimated that reprocessing the spent fuel and using the separated plutonium in mixed-oxide fuel (MOX) would be more than four times as expensive as making fresh fuel from uranium and disposing of it directly in a geologic repository. A previous estimate from the National Research Council of the U.S. National Academy of Sciences

[83] Southern Company 2005

found that, even if the plutonium was assumed to be provided to the utilities free of charge (such as would be the case for plutonium turned over from the surplus military stockpile), then MOX fuel would still be more than one and a half times as expensive as fuel from fresh uranium.[84] The MIT study estimates a fuel cost of $2,040 per kgIHM of fresh LEU fuel compared to a cost of $8,890 per kgIHM of MOX fuel.

Other than the high cost of reprocessing itself, the excess cost of plutonium fuel is due to the fact that fuel fabrication costs are much higher for MOX than low-enriched uranium fuel. This higher cost is due to the stricter health and safety requirements as well as the cost of adding better materials accounting systems to safeguard the weapons usable plutonium. IEER estimates that reprocessing and the use of MOX fuel in light water reactors in France has imposed an additional cost of about 2 cents for every kWh generated from that fuel. As evidence of the lack of suitability of reprocessing technology, over 200 metric tons of separated plutonium has piled up around the world, without any real prospect of being used as a fuel. This adds to costs and security vulnerabilities. New reprocessing technologies will present new challenges as to technology, cost, and proliferation control.

Second, routine discharges and accidents at existing commercial and military reprocessing facilities have caused environmental damage by contaminating large areas in the United States, Russia, the English Channel, and the Irish sea. The 1957 explosion of a waste tank at the Chelyabinsk-65 military reprocessing plant in the Soviet Union contaminated an area the size of the state of Connecticut and led to the evacuation of more than 10,000 people.[85] A similar explosion at the French reprocessing plant at La Hague and the British reprocessing plant at Sellafield is possible, though some of the technical details of the process are different. The high-level waste tanks at the Savannah River Site, located in South Carolina across from Augusta, Georgia and along the Savannah River, already has the most radioactivity in waste of any DOE site.[86] Westinghouse, the contractor currently operating SRS, filed an expression of interest with the DOE to potentially pursue the development of new reprocessing technologies and as a result any future reprocessing of commercial fuel that may occur at the Savannah River

[84] MIT 2003 p. 146 and 148 and NAS 1995 p. 302
[85] Hu, Makhijani, & Yih 1992 p. 80-94
[86] DOE 1997b p. 2-23

Site would potentially bring additional risks to the people of Georgia who live along the Savannah River and who rely on it for drinking water or as a source of fish.[87]

Third, reprocessing generates a large amount of radioactive waste that still requires geologic disposal in a mined repository. Vitrified high-level waste and spent MOX fuel both require a repository similar to that required for unreprocessed spent fuel. The unfissioned uranium separated by reprocessing would eventually have to be disposed of in a repository similar to the Waste Isolation Pilot Plant in New Mexico due both to its own radiological and chemical properties and its contamination with plutonium and other transuranic elements. In addition, the amounts of plutonium bearing wastes generated during the decommissioning of the reprocessing plants is also expected to be quite large, and to add significantly to the volume of waste destined for repository disposal.[88] Finally, current commercial reprocessing technology, PUREX, generates a large amount of liquid radioactive waste. Discharges from La Hague and Sellafield into the English Channel and Irish Sea (respectively) have polluted the seas and the ocean off Western Europe, drawing a demand from most members of the Oslo-Paris accords (OSPAR) to demand a permanent stop to the discharges. That demand has yet to be fulfilled. Large volumes of intermediate level waste contaminated with plutonium are also generated.

Fourth, and most importantly, reprocessing results in the separation of plutonium that can be used to make nuclear weapons. As noted above, over 200 metric tons of surplus separated, weapons-usable plutonium already sits unused at various commercial reprocessing plants. Future reprocessing technologies like UREX+ or pyroprocessing, if successfully developed and eventually commercialized, still pose proliferation risks, though they are advertised as being proliferation resistant. For instance, the impure plutonium that comes from pyroprocessing could still be useful to in making crude nuclear weapons.[89] Moreover, in being more compact and less easily detectable than PUREX plants, pyroprocessing plants would aggravate proliferation risks by making detection of illegal plants more difficult.

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[87] GNEP 2006

[88] Bunn et al. 2003 p. 3, 39-40, and 62, MIT 2003 p. 59, Zerriffi and Makhijani 2000 p. 103-105, 144-145, and 170-174, Makhijani and Smith 2004, and Makhijani and Smith 2005,

[89] Kang and von Hippel 2005 p. 171-174 and 177 and CISAC and PSGS 2005 p. 55-56

Q. WHAT PROBLEMS DOES LOW-LEVEL NUCLEAR WASTE POSE FOR GEORGIA POWER RATEPAYERS AND THE PUBLIC?

A. (SB) Plant Vogtle historically has sent low-level nuclear waste (LLW) to Barnwell, South Carolina. However, according to the U.S. NRC, disposal at Barnwell will be limited to members of the Atlantic Interstate Low-Level Radioactive Waste Compact after 2008, which consists of only three states: SC, NJ, and CT. Since the Company's testimony did not state their plans on where they will send their nuclear waste after 2008 or the projected costs associated with the change in disposal locations, the Commission should gather more background on this issue. It is possible that the Company is now shipping some Class A LLW to EnergySolutions (formerly Envirocare) in Utah. It is unclear on what Plant Vogtle will do with its Class B and C LLW waste besides storing it on site. According to the Georgia Environmental Protection Division (EPD), EPD does not regulate LLW storage at "production facilities licensed by the NRC" and apparently there are no requirements for the Company to report to the State on their disposal activities. Georgia falls within the Southeast Compact Commission for Low-Level Radioactive Waste, which includes VA, TN, MS, AL, GA, and FL. According to the Southeast Compact Commission:

> The majority of the Class A waste in the Southeast Compact region, by curies and by volume, will be accepted for disposal at Envirocare of Utah. After July 1, 2008, disposal will not be available for certain Class A wastes, including Class A sealed sources and medical wastes, and all Class B and Class C wastes from the Southeast Compact region. Generators of low-level radioactive waste in the Southeast Compact region will likely need to store Class B, Class C, and certain Class A waste for an uncertain period of time.[90]

This uncertainty could impact ratepayers in terms of unknown or unpredictable costs in dealing with nuclear waste management. According to the Tennessee Valley Authority's (TVA) 2001 Annual Report, disposal costs for low-level radioactive waste that results

[90] SE Compact

from the normal operation of nuclear plants have increased in recent years.[91]

Further, the EPA will soon begin to consider the impact of the BEIR VII report of the National Academy of Sciences on radiation protection standards. This report increased prior estimates of the cancer risk of radiation notably to women and also published risks of incidence by age and sex. These increased risks may well be reflected in tighter radiation protection standards for low-level waste disposal and increase the reluctance of communities to accept such waste. Both of these factors will tend to increase low level waste disposal cost; neither has been taken into account by Georgia Power.

Q. WHAT CONSIDERATIONS NEED TO BE MADE FOR PLANT DECOMISSIONING?

A. (SB) The dangers and liabilities associated with nuclear power do not end once a plant is shut down. Decommissioning poses a major economic and environmental hurdle and the nuclear industry has little experience overall with the process. Of the 125 nuclear power plants licensed to operate since 1959, only three have been completely decommissioned. The 1997 NRC minimum decommissioning funding requirements are $1.3 billion for Vogtle. An October 2003 analysis by the U.S. Government Accounting Office (GAO) reported serious deficiencies in the accumulation of adequate decommissioning funds by 33 owners at 42 nuclear power plants across the United States along with an ineffective effort by the NRC to ensure proper funding. Oglethorpe Power, which owns approximately 30% of Plant Vogtle Units 1 & 2, was found to be 51-100% below the benchmark of sufficiency for trust fund balances and/or contribution rates for decommissioning.[92] The Company's assertion that the decommission cost estimate is subject to trade secret is unwarranted because this is a public concern that warrants full tracking and scrutiny by ratepayers, policy makers beyond the PSC, and the affected public.

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[91] TVA 2001
[92] GAO 2003

Q. WHAT UNIQUE SAFETY AND SECURITY PROBLEMS DO NUCLEAR PLANTS POSE FOR GEORGIA POWER RATEPAYERS AND THE PUBLIC?

A. (AM) As noted, among the "additional objectives" in the IRP noted explicitly by Georgia Power are "Environmental - Does the Plan consider environmental impacts?" and "Risk - Does the Plan represent a reasonable balance between risk and cost?"[93] However, the IRP is seriously deficient in addressing the environmental, health, and security risks that would accompany any effort to build a new nuclear plant in Georgia. In addressing the issue of whether the IRP represents "a reasonable balance between reduced risk and cost," Georgia Power replies

> Yes. There is a risk that the load growth will be more or less than expected, and that the demand-side programs may not be well received or provide the projected load reductions. There also is risk that there will be more interest in DSM than currently experienced, decreasing the need for new capacity acquisitions. The Financial Information section in Technical Appendix Volume 1A provides additional information regarding the business and financial risks associated with the IRP.[94]

However, "business and financial risks" are not the only risks associated with the IRP's proposal to build a new light-water nuclear reactor in Georgia. Specifically, this overly narrow definition of risk ignores the potential risks for a catastrophic accident or a well coordinated terrorist attack such as those of September 11, 2001, to result in the release of a large amount of radiation and to contaminate a vast area of the State. Perhaps the only other type of accident within the energy system that could begin to approach the immediate environmental impacts of a serious accident at a nuclear plant are the failure of a large hydroelectric dam or the rupture of a supertanker carrying oil through a fragile ecosystem such as what happened with the Exxon Valdez in March 1989. However, the impacts on human health and the environment, the difficulty and cost involved in cleanup and decontamination efforts, and the very long time scales over which the impacts of the contamination will persist all make the large-scale release of radiation from a nuclear

[93] Georgia IRP 2007 p. 2-4
[94] Georgia IRP 2007 p. 8-5

plant a truly unique concern. These risks should be addressed explicitly by any proposal to construct a new nuclear power plant and the PSC needs to be aware of these risks as such an accident or successful terrorist attack would have significant negative implications for ratepayers and the public.

Q. WHAT ARE SOME OF THE POTENTIAL IMPACTS FROM AN ACCIDENT OR SUCCESSFUL LARGE-SCALE TERRORIST ATTACK AT AN OPERATING NUCLEAR POWER PLANT?

A. (AM) The last study published by the U.S government, entitled Calculation of Reactor Accident Consequences for U.S. Nuclear Power Plants (CRAC-2) conducted at Sandia National Laboratories, found that a worst case accident at many power plants could cause tens of thousands of deaths from prompt radiation effects and long-term fatal cancers and cause hundred of billions of dollars in damage. While an accident under typical weather conditions would have much lower consequences, the damage at some plants could still exceed the Price-Anderson Act's current liability limit of $10.9 billion.[95] In addition, it is important to keep in mind the lesson learned from the release of toxic methyl isocyanate gas at the Union Carbide plant in Bhopal, India, which killed nearly 4,000 people and injured 200,000; namely that sometimes a worst case accident can, in fact, occur.[96]

Even if a reactor's secondary containment was not breached, however, and there were not dangerously large offsite releases of radiation, a serious accident would still cost a utility a great deal due both to the loss of the reactor and the need to buy replacement power until new generating capacity could be built. As summarized by Peter Bradford, a former commissioner of the Nuclear Regulatory Commission,

> The abiding lesson that Three Mile Island taught Wall Street was that a group of N.R.C.-licensed reactor operators, as good as any others, could turn a $2 billion asset into a $1 billion cleanup job in about 90 minutes.[97]

This is a significant financial risk associated with nuclear power that is not currently addressed by the IRP.

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[95] U.S. Congress 2005 p. 186-189
[96] Perrow 1999 p. 355-360
[97] New York Times 2005d

To date, the worst reactor accident of any kind was the April 26, 1986 steam explosion at the graphite moderated, water-cooled Chernobyl nuclear power plant. An estimated 220,000 people were forced to relocate following the accident and large areas of agricultural land had to be abandoned. While the estimates are mired in controversy, thousands of people across Europe and the former Soviet Union are ultimately expected to die as a result of this disaster. So far, the most serious accident to have occurred at a commercial light-water reactor was the March 1979 partial meltdown at Three Mile Island. While this accident is not officially believed to have resulted in the release of large quantities of non-noble gas radionuclides to the environment, as Richard Feynman famously noted in relation to the O-ring failures that led to the destruction of the Space Shuttle Challenger, "[w]hen playing Russian roulette, the fact that the first shot got off safely is of little comfort for the next."[98] This cautionary remark must be taken to heart especially in a context where a large number of new reactors would be built for addressing global warming concerns.

Q. WHAT GENERAL ISSUES MUST BE CONSIDERED REGARDING THE RISK OF AN ACCIDENT OCCURRING AT A NUCLEAR POWER PLANT WITH RESPECT TO THE AGE OF THE FACILITY?

A. (AM) Risk involves considering both the consequences of an event as well as the likelihood of that event occurring. Therefore, examining the probability of accidents occurring is a vital step in evaluating the risk posed by Georgia Power's proposed plan to build a new reactor.

Overall, the rate of accidents at nuclear plants can be expected to follow what David Lochbaum, nuclear safety engineer with the Union of Concerned Scientists, has called the "bathtub curve."[99] Specifically, the accident rate is expected to be higher during the initial shakedown phase when the plant is new. As the equipment is broken in and the operators gain experience, the failure rate is expected to fall until it reaches a relatively steady rate where it remains for a majority of the plant's operation. Eventually the equipment in the plant begins to age and wear out while the operator's accumulation

[98] Feynman 1988 p. 223
[99] Lochbaum 2000

of experience has the potential to lead to over confidence. During this wear out stage, the accident rate will begin to rise and grow over time until the plant is finally shut down. The average failure rate over the whole lifetime of the plant is the parameter of most interest in determining the risk, and will not be accurately reflected by ignoring the higher values during either the initial shakedown or eventual wear-out phases.

All seven of the nuclear accidents that have so far occurred at civilian and military research and power reactors have happened within one to seven years of the reactors first achieving criticality. Overall, the average length of time that these reactors had been operating before suffering their respective accidents was less than three and a half years.[100] As the current fleet of reactors has aged, the number of incidents caused by equipment wearing out has grown. So far, the most important example of the degradation of safety due to aging has been the corrosion of the reactor vessel head at the Davis-Besse plant near Toledo, Ohio. During inspections in March 2002, the operator of the plant discovered that boric acid leaking from inside the core had corroded the carbon steel top of the reactor vessel and created a pit the size of a pineapple. As a result, the only material left to contain the superheated cooling water, exerting more than 2,180 pounds per square inch of pressure, was a stainless steel liner just 0.125 inches thick. If this lining had ruptured, it could have damaged the nearby control rod and would have led to a potentially serious loss of coolant accident.[101]

Both the NRC's "Lessons Learned" Task Force and the U.S. Government Accountability Office concluded that the corrosion of the vessel head could have been prevented if the NRC and the reactor operators had acted properly. At least twice, the operators of the Davis-Besse plant put off careful examination of the vessel despite identification of possible boric acid leaks. Following these revelations, NRC Chairman Richard Meserve concluded that "[i]n short, the inspections at Davis-Besse have revealed that the head corrosion problem was a direct result of a degraded safety culture" and that

[100] Makhijani and Saleska 1999 p. 152-153, Fuller 1975 p. 103-115, 128, and 194-206, Kemeny Commission 1979 p. 110-161, Jedicke 1989, Medvedev 1990 p. 12-36, Wise 1999 p. 4-5, Makhijani, Hu, and Yih 2000 p. 417-419, Stacy 2000 p. 138-149, EIA 2002, and IEER 2005

[101] NRC 2002, UCS 2003, GAO 2004, and OIG 2002

"a recurrent theme over the past decade is the need for improvement of safety culture at plants that are encountering serious difficulties."[102]

Q. WHAT GENERAL CONCLUSIONS HAVE YOU DRAWN REGARDING PREDICTIONS FOR THE SAFETY OF NUCLEAR POWER PLANTS?

A. (AM) That the impacts from a major accident at a commercial light-water reactor could be very severe is not in debate – this has been officially acknowledged since the 1950s. However, the likelihood that such accidents might occur remains more uncertain. Estimates for the likelihood of an accident occurring have significant uncertainties that greatly complicate projections about the safety of an expanded use of nuclear power. Specifically, the probabilistic risk assessments (PRA) used to model the likelihood of accidents have numerous methodological weaknesses that make them an uncertain basis upon which to make decisions that could have such wide-ranging and long-lasting impacts.

Q. WHAT SPECIFIC AREAS OF UNCERTAINTY MUST BE CONSIDERED IN ANALYZING THE RESULTS OF PROBABILISTIC RISK ASSESSMENTS FOR NUCLEAR POWER PLANTS?

A. (AM) First, the questions of completeness and how to incorporate design defects are particularly difficult to handle within the PRA methodology in that they essentially require the analyst to know what they don't know about what could go wrong. If important accident scenarios could be foreseen they would already be included in the analysis, and if design defects were identified they could be addressed. The omission of design defects is particularly important because, in the PRA methodology, all accident scenarios are assumed to flow linearly from one failure to the next. In other words, it is assumed that the system as designed and built functions properly, and that it is only when equipment breaks or an operator makes a mistake that an accident can occur. However, in a real system, equipment may function as designed, but simply not be appropriate to the task, such as a pump that activated as planned, but was of insufficient power to force water to where it was needed.

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[102] Meserve 2002

As summarized by Edward Hagen, a development specialist at Oak Ridge National Laboratory and editor of the Control and Instrumentation section of the journal *Nuclear Safety*,

> Mistakes made in the past are not likely to be repeated, but in each new design other mistakes will creep in. The need for vigilance is eternal.
>
> …
>
> No reactor system has ever failed because of a deficiency that could be seen on a designer's flow sheet or an analyst's model. Such deficiencies have been revealed only via operating experiences.[103]

Q. ARE THERE OTHER AREAS OF UNCERTAINTY THAT MUST BE CONSIDERED IN ANALYZING THE RESULTS OF PROBABILISTIC RISK ASSESSMENTS FOR NUCLEAR POWER PLANTS?

A. (AM) Yes. Additional concerns arise due to the fact that nuclear power demands an extremely high level of competence at all times from all levels of the organization -- from the regulators and managers all the way through to the operators and maintenance crews. If the human element of the system falters, then there is the possibility for a severe accident to occur. As summarized by Edward Hagen,

> There is not now and never will be a "typical" or "average" human being whose performance and reactions to any operating condition, let alone an abnormal operating condition, can be catalogued, qualitatively defined, or quantitatively determined. There are no human robots.[104]

This difficulty in integrating human error into PRAs is particularly important given the contribution of these mistakes to the overall failure rate of many systems. There are a number of factors that can unpredictably affect human performance which add to the uncertainty in PRAs. The stress of accident situations when the consequences are potentially so high is certainly one such factor as is the potential impacts of drug or alcohol abuse. However, even simple fatigue can have a dramatic impact on human

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[103] Hagen 1980 p. 189-191
[104] Hagen 1980 p. 191

reliability. As summarized by the Presidential Commission appointed to investigate the Three Mile Island accident

> We are convinced that if the only problems were equipment problems, this Presidential Commission would never have been created. The equipment was sufficiently good that, except for human failures, the major accident at Three Mile Island would have been a minor incident. But, wherever we looked, we found problems with the human beings who operate the plant, with the management that runs the key organization, and with the agency that is charged with assuring the safety of nuclear power plants.[105]

Q. WHAT OTHER AREAS OF UNCERTAINTY CAN AFFECT THE RESULTS OF PROBABILISTIC RISK ASSESSMENTS?

A. (AM) The increased use of computers and digital systems in new reactor designs create important safety tradeoffs with improvements possible during normal operation, but the potential for unexpected problems to arise during accidents. The National Research Council has noted that there remains an ongoing "controversy within the software engineering community as to whether an accurate failure probability can be assessed for software or even whether software fails randomly."[106] In addition, the National Research Council concluded that

> At this time, there does not seem to be an agreed-upon, effective methodology for designers, owner-operators, maintainers, and regulators to assess the overall impact of computer-based, human-machine interfaces on human performance in nuclear power plants.[107]

Finally, the increased reliance on software can have an important impact on the completeness of PRAs as well. As summarized by the National Research Council, "[a]nalog systems are believed to fail in more predictable and obvious ways than do the

[105] Kemeny Commission 1979 p. 8
[106] NAS/NRC 1997 p. 7
[107] NAS/NRC 1997 p. 7

more hidden and insidious failure mechanisms in software."[108] The possibility for such hidden failure modes is increased in some plants by the much greater complexity of the software systems that have been developed.

Reactor operators have already reported a number of problems with digital systems.[109] A particularly striking example occurred recently in France. On March 3, 2006, an operator at the Civaux nuclear plant placed a notebook on his keyboard accidentally causing a group of control rods to move out of the reactor. As a result, the reactor exceeded its maximum rated power for approximately one minute and twenty seconds before the operator recognized the problem and reinserted the control rods.[110]

Q. OVERALL WHAT IMPACT DO THE UNCERTAINTIES HAVE ON THE USEFULNESS OF PROBABILISTIC RISK ASSESSMENTS AS A MEANS OF PROJECTING THE SAFETY OF FUTURE NUCLEAR POWER PLANTS?

A. (AM) In light of the uncertainties inherent in the PRA methodology and the influence that may be exerted by the choices made in conducting the analysis, William Ruckelshaus, the head of the U.S. Environmental Protection Agency under both Presidents Nixon and Reagan, cautioned that

> We should remember that risk assessment data can be like the captured spy: if you torture it long enough, it will tell you anything you want to know.[111]

The uncertainties in the PRA methodology are a particular concern for estimates of the safety of new reactor designs such as the Westinghouse AP-1000 proposed for consideration by Georgia Power since this type of reactor does not exist anywhere but on paper. Many important and unforeseen accident scenarios and design flaws have been discovered during the nearly 3,000 reactor years of operating experience that has been gained at current reactors. While it is true that new reactor designs are more advanced than those currently in existence, information is not yet available to determine whether or to what degree these advancements were, in fact, improvements. These uncertainties

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[108] NAS/NRC 1997 p. 44
[109] NAS/NRC 1997 p. 40-41
[110] Le Monde 2006
[111] Ruckelshaus 1984 p. 157-158

expose the people of Georgia to economic risks as well as potentially serious health and environmental risks in the event of an accident or successful terrorist attack. Placing too much faith in theoretical estimates for the safety of new designs without a suitable consideration of the uncertainties involved could be a potentially catastrophic mistake.

Q. WHAT ADDITIONAL CONCERNS REGARDING NUCLEAR PLANT SAFETY ARISE AS A RESULT OF POTENTIAL TERRORIST ACTIONS?

A. (SB & AM) In addition to accidents, a successful terrorist attack on the scale of those carried out on September 11, 2001, could also lead to a major release of radiation from a nuclear plant. While the likelihood of this kind of attack occurring is likely to be small, more reactors mean more targets, and we should not forget that the probability of the World Trade Center towers collapsing due to the impact of civilian aircraft was also considered to be small before they fell. Significantly, FBI director Robert S. Mueller testified before the Select Committee on Intelligence in the U.S. Senate in February 2005 that

> Another area we consider vulnerable and target rich is the energy sector, particularly nuclear power plants. Al-Qa'ida planner Khalid Sheikh Mohammed had nuclear power plants as part of his target set and we have no reason to believe that al-Qa'ida has reconsidered.[112]

Already at least once since September 11, 2001 the Federal Aviation Administration has issued an order temporarily banning all general aviation flying within 10 nautical miles (11.5 miles) of 86 nuclear power and nuclear weapons production sites due to the threat of terrorist actions and the GAO has continued to raise concerns regarding the process for revising the NRC's design basis threat for nuclear plants.[113]

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[112] Mueller 2005
[113] FAA 2001, GAO 2006b, and GAO 2006c

Q. WHAT ARE THE CONNECTIONS BETWEEN NUCLEAR POWER AND NUCLEAR WEAPONS PROLIFERATION THAT SHOULD BE CONSIDERED BY THE COMMISSION?

A. (AM) As summarized nearly sixty years ago by the U.S. Committee on Atomic Energy, "[t]he development of atomic energy for peaceful purposes and the development of atomic energy for bombs are in much of their course interchangeable and interdependent."[114] This overlap between the nuclear fuel cycle and the infrastructure required to produce nuclear weapons makes nuclear power uniquely dangerous among all sources of electricity.

Q. HOW WOULD A DECISION BY GEORGIA POWER TO PURSUE NEW NUCLEAR POWER PLANTS IMPACT THE ISSUE OF NUCLEAR WEAPONS PROLIFERATION AND HOW COULD THAT IMPACT THE GEORGIA RATEPAYERS?

A. (AM) The difficulties in addressing nonproliferation would be increased if new nuclear plants were built in the United States since new uranium enrichment capacity would almost certainly have to be built. The only enrichment plant in current operation in the U.S. is the highly energy inefficient gas diffusion plant in Paducah, Kentucky. This facility is already more than 50 years old. If new nuclear power plants were to be built anywhere in the U.S., this enrichment facility would very likely be replaced by smaller more energy efficient gas centrifuge plants. There are currently two new enrichment plants proposed for construction in the United States. One, the American Centrifuge Plant in Piketon, Ohio, is still seeking a license from the Nuclear Regulatory Commission, while the other, the National Enrichment Facility in Hobbs, New Mexico, received a license from the NRC in June 2006. The license for the National Enrichment Facility is currently being challenged by interveners in federal court. I have served as one of the experts before the NRC's Atomic Safety and Licensing Board in the National Enrichment Facility case. Both enrichment plants combined, however, would replace

[114] The Committee on Atomic Energy was commissioned in 1946 by then Under-Secretary of State Dean Acheson. The committee was chaired by David Lilienthal, then the Chairman of the Tennessee Valley Authority and later the first Chairman of the Atomic Energy Commission. The committee also included the presidents of the New Jersey Bell Telephone Company, Monsanto, and General Electric, as well as Robert Oppenheimer who had headed the bomb design work at Los Alamos Laboratory during the Manhattan Project. [Acheson and Lilienthal 1946 p. 4]

less than 60 percent of the Paducah plant's capacity. The continued development of new enrichment plants in the U.S undermines efforts to prevent other countries, such as Iran or North Korea, from developing these same capabilities.

The instability and global security concerns created by the potential proliferation of nuclear weapons (particularly when the countries involved are in resource rich areas) can have a significant impact on the world economy, as the war on Iraq and ongoing confrontation with Iran have demonstrated. Finally, in addition to the tragic human consequences, the global economic consequences that would follow a nuclear attack on a city like New York, Atlanta, or Tokyo are very difficult to predict, but would almost certainly be catastrophic. For example, the U.N. High-level Panel on Threats, Challenges and Change concluded that the total economic impact following the detonation of even a simple nuclear weapon in a major city would be "at least one trillion dollars."[115]

Q. ARE THERE PROPOSALS FOR MANAGING THE RISKS OF NUCLEAR WEAPONS PROLIFERATION THAT ARE LIKELY TO BE ABLE TO ADEQUATELY ADDRESS THESE CONCERNS?

A. (AM) The proposals that have been put forward to try and reduce the proliferation risks posed by a revival of nuclear power are unlikely to be sustainable over the long term in light of the continued refusal of the nuclear weapons states to disarm and their continued focus on nuclear weapons as a corner stone of their national security posture.[116] In effect, the current nonproliferation efforts seek to permanently institutionalize a discriminatory system of nuclear weapons "haves" and "have-nots." Even efforts to enhance the power of inspections by the International Atomic Energy Agency (IAEA) have been undermined by the preferential treatment given to the acknowledged nuclear weapons states. For example, despite the favorable conditions in the agreements, neither Russia nor the United States have ratified their Additional Protocols with the IAEA further undermining efforts to achieve universal adherence.[117]

[115] High-level Panel 2004 p. 40
[116] DOD 2001, NATO 2001 p. 160, Smith 2003, Deller, Makhijani, and Burroughs 2003, Makhijani and Deller 2003. NTI 2004, New York Times 2004, and Chirac 2006
[117] IAEA 2005b p. 13-14 and IAEA 2005c

Despite the clear language of the Nuclear Nonproliferation Treaty giving any member the "inalienable" right to possess uranium enrichment and reprocessing facilities as part of a civilian nuclear power program, proposals from the Bush Administration and the International Atomic Energy Agency now seek to restrict access to these fuel cycle technologies. The proposals to limit the spread of enrichment and reprocessing are motivated by the inability of all but the most highly intrusive, expensive, and time consuming inspection regimes to prevent proliferation in the event of a state determined to develop nuclear weapons, as well as the possibility that states could pull out of safeguards in the future and use formerly civilian infrastructure for weapons production.

Proposals to create national or international monopolies on the nuclear fuel cycle, however, are very unlikely to be acceptable. The implication of these proposals is that certain countries can be trusted with the fuel cycle while no one else can. This is clearly a highly discriminatory policy, and not one likely to gain significant support. The deadlock at the 2005 NPT Review Conference in New York and the continued refusal of Iran to abandon its development of an indigenous enrichment capability despite U.N. Security Council sanctions, are clear examples of the difficulties faced by attempts to prevent countries from controlling the production of their own nuclear fuel. It is significant that while the United States and Russia seek to develop a discriminatory regime in commercial nuclear technology, many countries who do not now have it, including several in the Persian Gulf region, are intensifying their interest in it.

III. Recommendations

Q. WHAT SHOULD THE COMMISSION DO TO ADDRESS THE RATEPAYER AND SOCIETAL RISKS POSED BY GEORGIA POWER'S NUCLEAR POWER EXPANSION PLAN IN ITS IRP?

A. (SB)

- The Commission should require a cost analysis of current and projected security measures that can be anticipated as national security measures are adopted such as the recent post-Sept. 11 security proposal by the NRC that "would require each applicant for a new reactor design to assess how the design, to the extent practicable, can have greater built-in protections to avoid or mitigate the effects of a large commercial aircraft impact, making them even more resistant to an attack."[118]

- The Commission should examine the limitations present in the Price Anderson Act that currently limit the liability assessed to nuclear power utilities in cases of major accidents and ultimately places the financial burden on tax payers and rate payers.
- The Commission should examine the potential water impacts that will result from the choices and location of new energy supply technologies in the state, including energy efficiency measures.
- The Commission should order the companies to discontinue their pursuit of new nuclear plants due to their inherent threat to the public.
- The Commission should order the companies to explicitly consider how a mix of wind, solar PV on an intermediate scale, standby of existing combined cycle plants, and existing hydropower power plants could be operated so as to provide reliable electricity supply at modest cost. Explicit optimization strategies should be considered for the mix.
- Lastly, the Commission should order the companies to coordinate different stages of IRP development so that a diverse range of public and ratepayer interests, including intervening parties and state agencies such as the Georgia Environmental Facilities Authority and the Environmental Protection Division, that have important input into the IRP process can help ensure that the IRPs filed with the Commission more closely reflect public and ratepayer preferences, needs and concerns.

Q. PLEASE PROVIDE THE FULL REFERENCES FOR FOOTNOTES FROM YOUR TESTIMONY.

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Q. DOES THIS COMPLETE YOUR TESTIMONY?

A. (SB & AM) Yes.