INFORMATION SHEET

RECORD:

VOLUME: 1 & 2

PRESIDING: Finley, Joyner, Culpepper, Beatty, Brown-Bland, Allen
PLACE: Raleigh, North Carolina
DATE: Tuesday, March 15, 2011
TIME: 9:00 a.m. to 5:03 p.m.
DOCKET NO.: E-7, Sub 819
DESCRIPTION: Duke Energy Carolinas, LLC Application for Approval of Decision to Incur Nuclear Generation Project Development Costs.

APPEARANCES

Kaylor, Shafeek-Horton, Castle, Runkle, Rankin, Green

PUBLIC STAFF:
COMMISSION STAFF:
ATTORNEY GENERAL:

APPLICANT– A COMPLAINANT-C RESPONDENT-R PROTESTANT-P INTERVENOR-I

WITNESSES

Kinnaird, Fireman, Friedman, Patrie, Kinsella, Hale, Larson, Henry, Moore, Jackson, Phillips, Taylor, Bradford, Rogers, Jamil, Hager, Maness, Ellis

EXHIBITS

Hager Direct A –D, Hager Rebuttal A-D, Maness Appendix A, Ellis Appendix B Fireman Exhibit 1, Kinsella Exhibit 1, Henry Exhibit 1, Public Advocacy Group Rogers CX 1
BRIEFS/PROPOSED ORDERS DAYS FROM THE MAILING OF TRANSCRIPT

REPORTED BY: Linda Garrett
TRANSCRIBED BY: Linda Garrett
DATE TRANSCRIBED: 3-29-2011

TRANSCRIPT PAGES: 287
PREFILED PAGES: 92

(44)

NORTH CAROLINA UTILITIES COMMISSION
APPEARANCE SLIP

DATE March 15, 2011 DOCKET NO.: E-7, Sub 819
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FIRM NAME Law Office of Robert W. Kaylor, P.A.
ADDRESS 3700 Glenwood Ave. Suite 330
CITY Raleigh NC ZIP 27612

APPEARING FOR: Duke Energy Carolinas, LLC

APPLICANT ✓ COMPLAINANT _____ INTERVENER _____
PROTESTANT _____ RESPONDENT _____ DEFENDANT _____

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Signature of Attorney

NORTH CAROLINA UTILITIES COMMISSION
APPEARANCE SLIP

DATE 3/15/2011 DOCKET NO.: E-7 Sub 819
NAME AND TITLE OF ATTORNEY Timika Shafeek-Horton, Deputy General Counsel
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CITY ~~Raleigh~~ Charlotte ZIP 28202

APPEARING FOR: Duke Energy Corp

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PROTESTANT _____ RESPONDENT _____ DEFENDANT _____

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NCWARN, NC Att'y Gen'l, Public Staff

Timika Shafeek-Horton
Signature of Attorney

NORTH CAROLINA UTILITIES COMMISSION
APPEARANCE SLIP

DATE 3/15/11 DOCKET NO.: E-7, Sub 819
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APPEARING FOR: Duke Energy Carolinas, LLC

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PROTESTANT _____ RESPONDENT _____ DEFENDANT _____

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Public Staff, NC WARN, Attorney General's office

Signature of Attorney

NORTH CAROLINA UTILITIES COMMISSION
APPEARANCE SLIP

DATE 3/15/11 DOCKET NO.: E7 Sub 819
NAME AND TITLE OF ATTORNEY John Runkle
FIRM NAME
ADDRESS PO Box 3793
CITY Chapel Hill ZIP NC 27515

APPEARING FOR: NC WARN et al (Public Advocacy Grps)

APPLICANT ____ COMPLAINANT ____ INTERVENER ✓
PROTESTANT ____ RESPONDENT ____ DEFENDANT ____

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If you would like the transcript emailed to you free of charge, please list your name, phone number and email address: John Runkle 919-942-0600 jrunkle@pricecreek.com

John T Runkle
(SIGNATURE OF PARTY OR ATTORNEY ORDERING TRANSCRIPT)

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John Runkle

John T Runkle
Signature of Attorney

NORTH CAROLINA UTILITIES COMMISSION
APPEARANCE SLIP

DATE 3-15-2011 DOCKET NO.: E-7 Sub 819
NAME AND TITLE OF ATTORNEY Len Green, Asst. AG
FIRM NAME NC Dept. of Justice v Margaret A. Force A.A.G.
ADDRESS PO Box 629
CITY Raleigh, NC ZIP 27602-0629

APPEARING FOR:

APPLICANT _____ COMPLAINANT _____ INTERVENER ✓
PROTESTANT _____ RESPONDENT _____ DEFENDANT _____

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Len Green 3/15/11
Signature of Attorney

NORTH CAROLINA UTILITIES COMMISSION
APPEARANCE SLIP

DATE 3/15/11 DOCKET NO.: E-7, Sub 819
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E-MAIL ADDRESS OF ATTORNEY gisele.rankin@psncuc.nc.gov
FIRM NAME Public Staff - North Carolina Utilities Commission
ADDRESS 4326 Mail Service Center
CITY Raleigh, NC ZIP 27699-4326

APPEARING FOR: _____

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PROTESTANT _____ RESPONDENT _____ DEFENDANT _____
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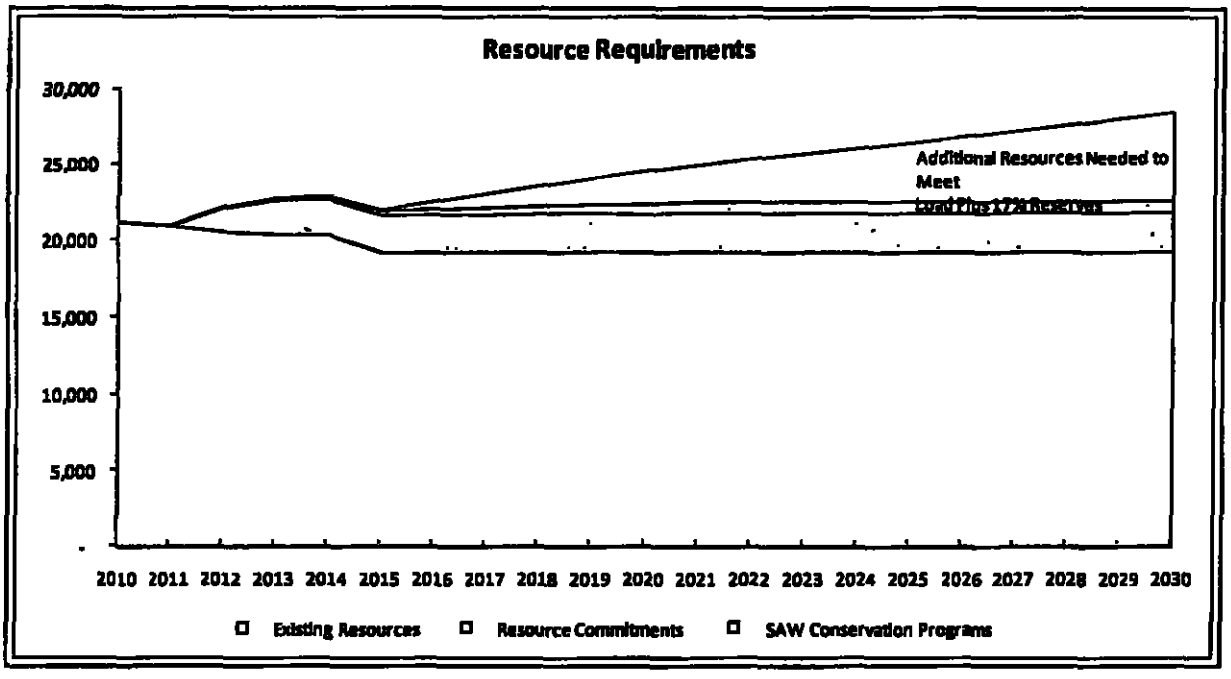
HAGER EXHIBIT A



Cumulative Resource Additions To Meet A 17 Percent Planning Reserve Margin (MWs)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Resource Need	0	0	0	0	0	90	530	940	1350	1810

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Resource Need	2220	2500	2870	3240	3620	4000	4390	4770	5170	5560	5970

Assumptions made in the development of Hager Exhibit A include: (1) Cliffside 6 is built by the summer of 2012 and therefore included in Resource Commitments; (2) Coal retirements associated with the Cliffside Unit 6 ruling and permits, Buck Units 5&6, and Lee Steam Station are included; (3) Retirement of the old fleet combustion turbines; (4) Conservation programs associated with the save-a-watt program are included; (5) DSM programs associated with the save-a-watt program are included; (6) Buck/Dan River combined cycle facilities are included in Resource Commitments; (7) Renewable capacity is built or purchased to meet the NC REPS.

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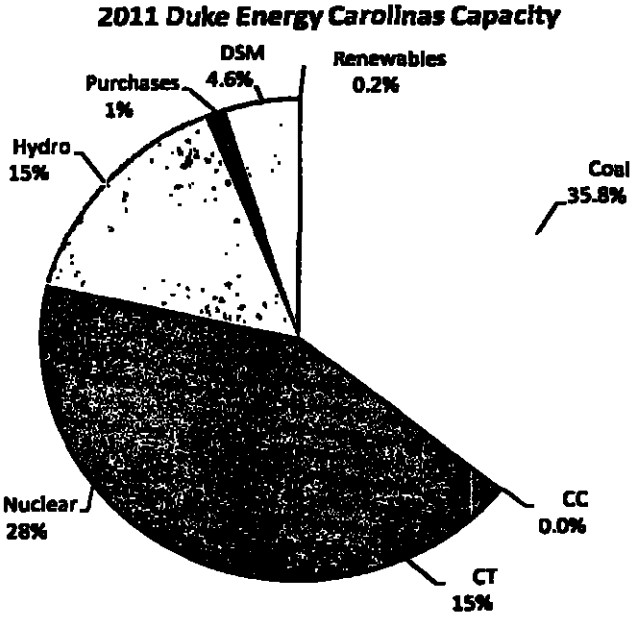
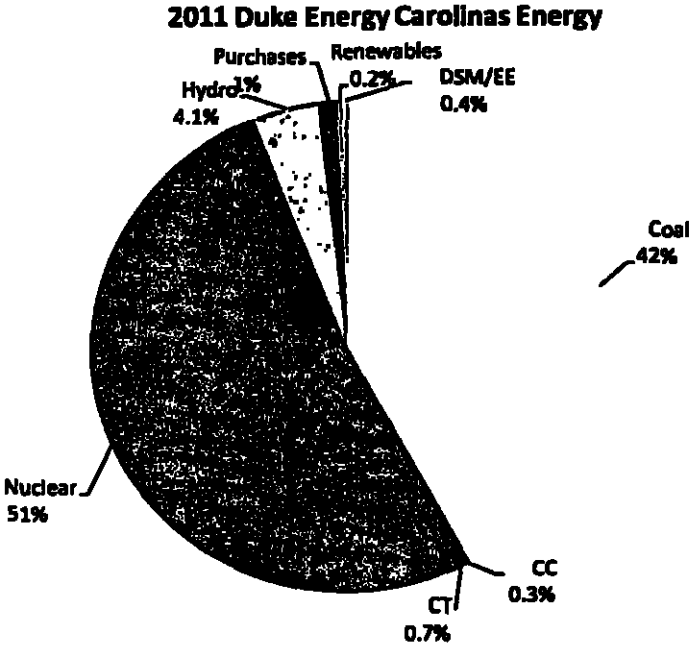
Direct

HAGER EXHIBIT B





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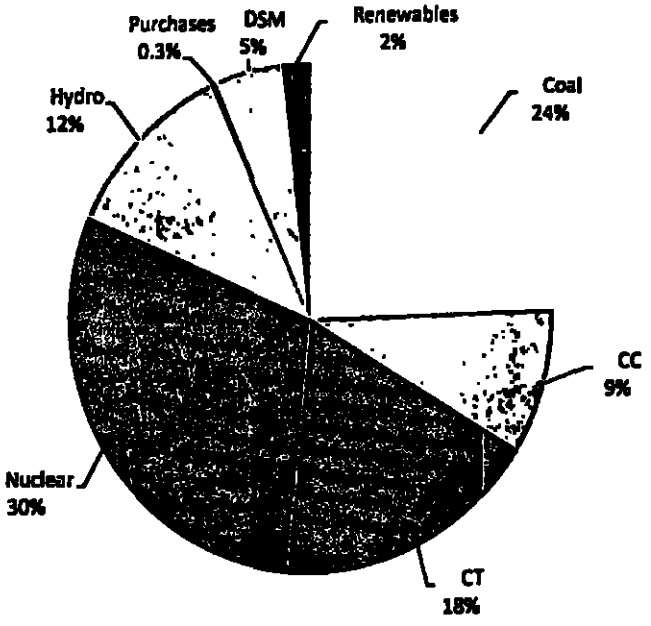
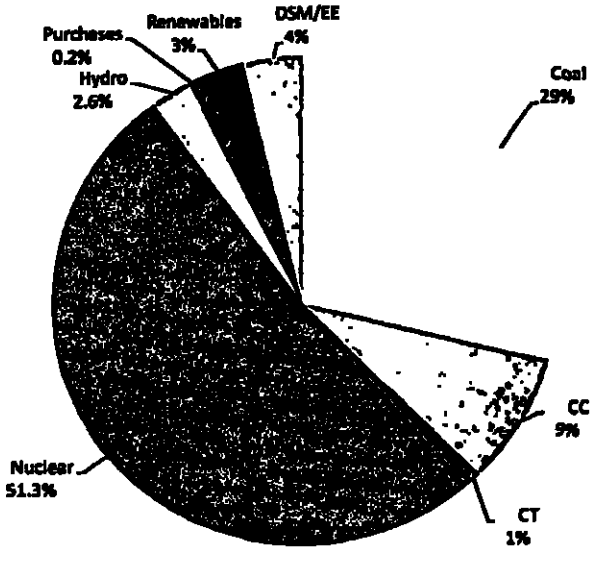
HAGER EXHIBIT C

2030 Duke Energy Carolinas Capacity



2030 Duke Energy Carolinas Energy



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HAGER EXHIBIT D

COMPARISON OF NUCLEAR PORTFOLIOS TO THE CT/CC PORTFOLIO
(COST ARE REPRESENTED IN $BILLIONS)

	Reference Case	CO2 Price Sensitivity		Fuel Sensitivity	
Portfolio		Kerry/ Lieberman	2009 Fundamental	High Fuel Cost	Low Fuel Cost
2 Nuclear Units (2021-2023)	(1.8)	(2.8)	(5.0)	(5.5)	
Natural Gas					(0.6)

	Load Sensitivity			Nuclear Capital Cost Sensitivity	
	High Load	Low Load	High DSM	20% Increase	10% Decrease
2 Nuclear Units (2021-2023)	(1.9)	(1.2)	(1.6)		(2.9)
Natural Gas				(0.5)	

Favorable Financing		Clean Energy Bill		Timing	
Portfolio	FLG & PTCs	Portfolio		Portfolio	
2 Nuclear Units (2021-2023)	(4.4)	1 Nuclear Unit (2021)	(0.7)	2 Nuclear Units (2026-2028)	(1.9)
Natural Gas		Natural Gas		Natural Gas	

E-7 Sub 819
I/A 3/15/11 TG

Hager Rebuttal

EXHIBIT A

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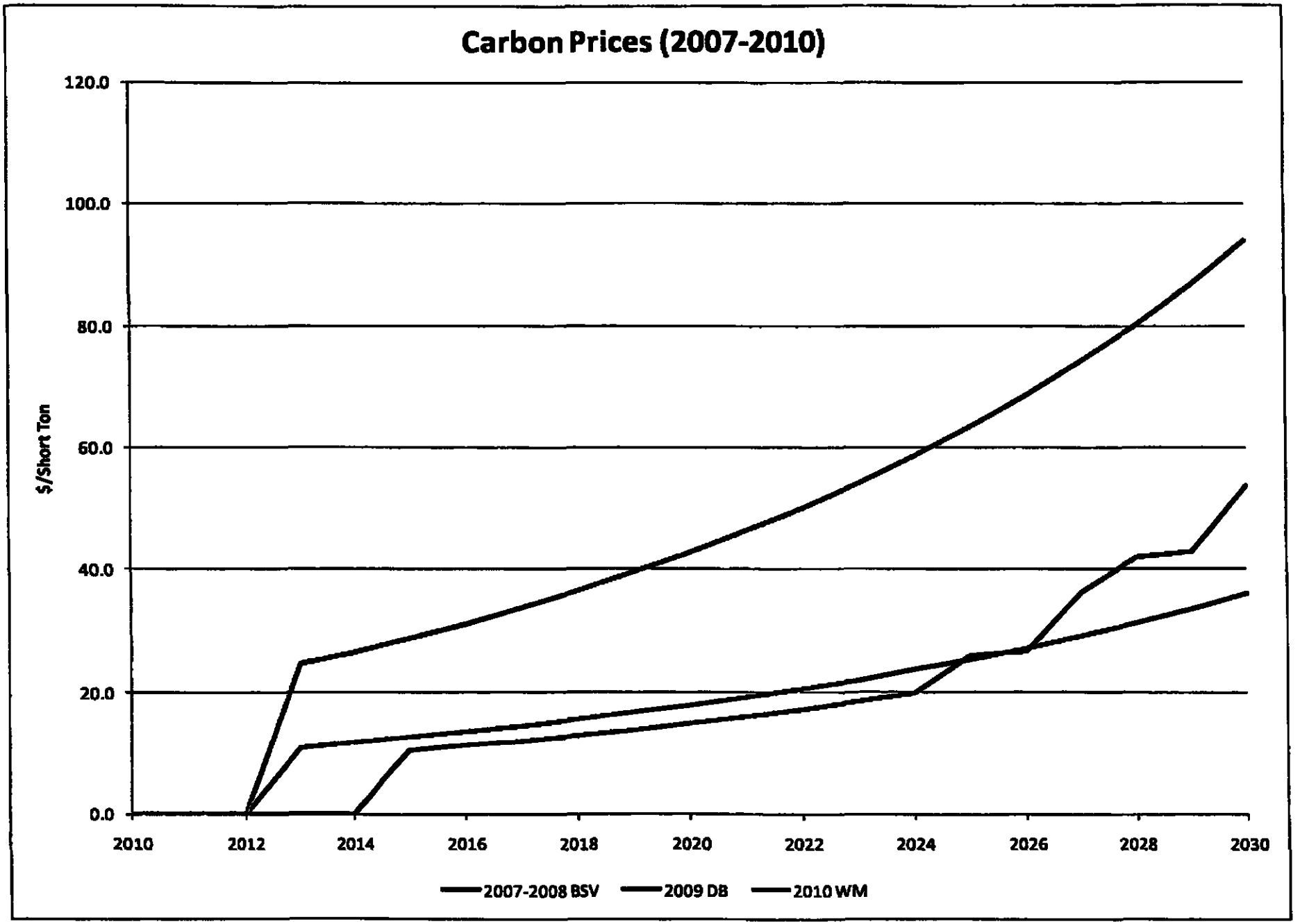
Hager Rebuttal Exhibit B



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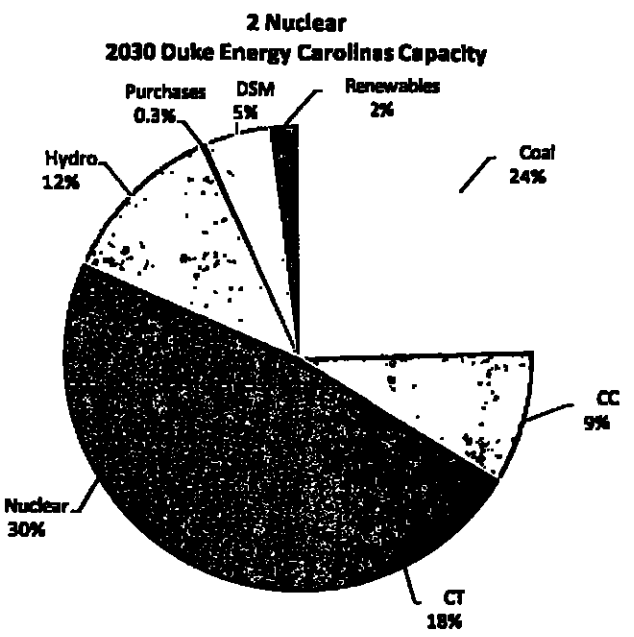
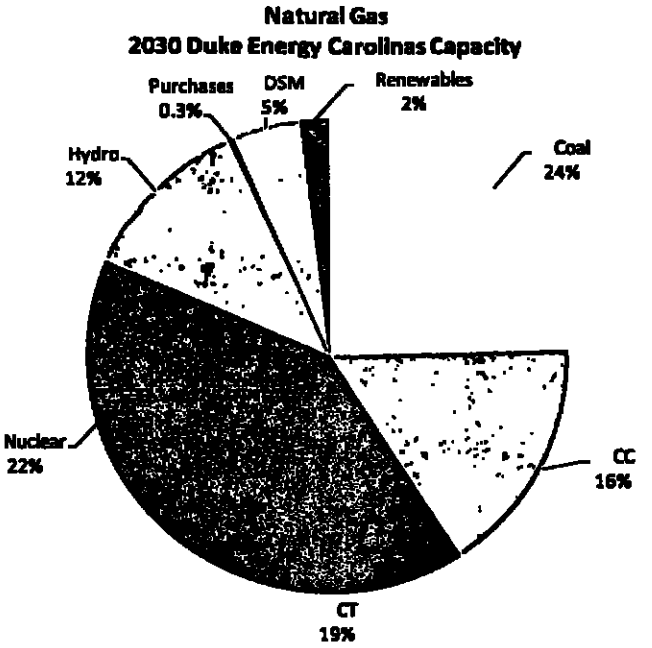
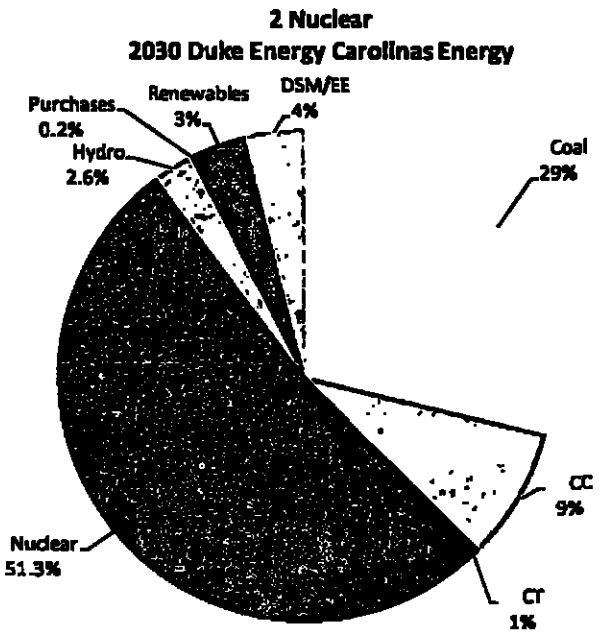
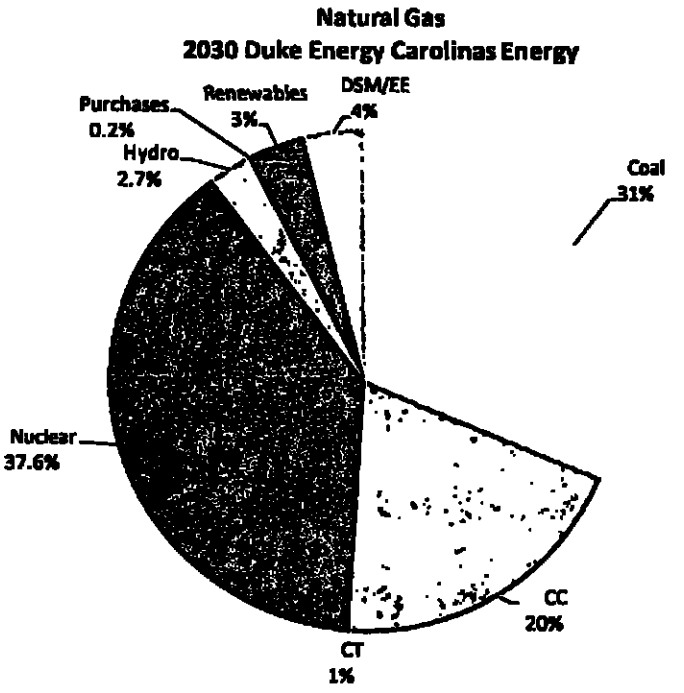
Hager Rebuttal Exhibit C









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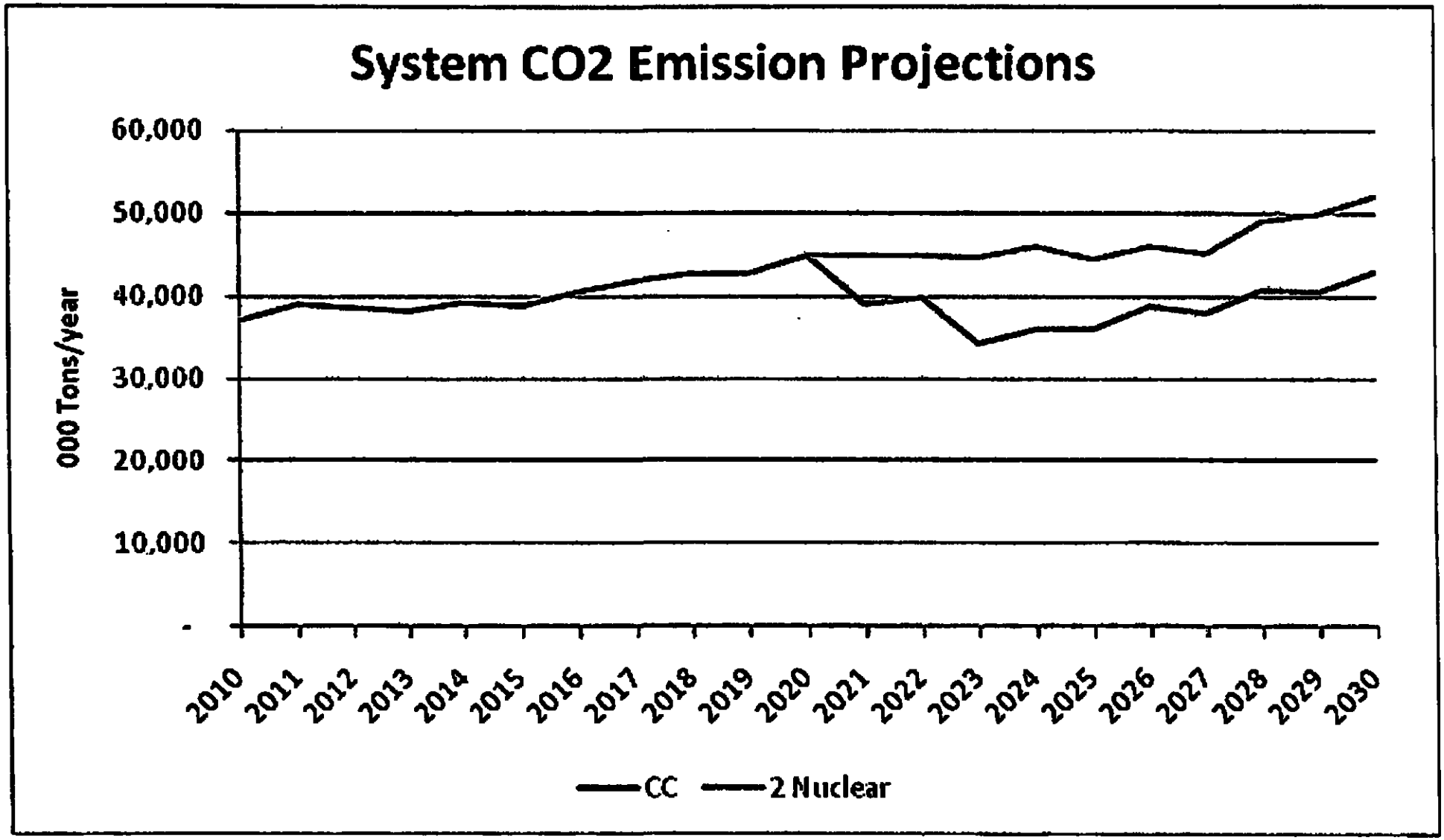
Hager Rebuttal Exhibit D



E-7 Sub 819
I/E 3/15/11 LG

APPENDIX A

MICHAEL C. MANESS

I am a graduate of the University of North Carolina at Chapel Hill with a Bachelor of Science degree in Business Administration with Accounting. I am a Certified Public Accountant and a member of both the North Carolina Association of Certified Public Accountants and the American Institute of Certified Public Accountants.

Since joining the Public Staff in July 1982, I have filed testimony or affidavits in several general and fuel rate cases of Duke Power Company, Carolina Power & Light Company, and Virginia Electric and Power Company (Dominion North Carolina Power), as well as in several water and sewer general rate cases. I have also filed testimony or affidavits in other proceedings, including applications for certificates of public convenience and necessity for the construction of generating facilities and applications for approval of self-generation deferral rates.

I have also been involved in several other matters that have come before this Commission, including the investigation undertaken by the Public Staff into the operations of the Brunswick Nuclear Plant as part of the 1993 Carolina Power & Light Company fuel rate case (Docket No. E-2, Sub 644), the Public Staff's investigation of Duke Power's relationship with its affiliates (Docket No. E-7, Sub 557), and several applications for business combinations involving electric utilities regulated by this Commission. Additionally, I was responsible for performing an examination of CP&L's accounting for the cost of Harris Unit 1 in conjunction with the prudence audit performed by the Public Staff and its consultants in 1986 and 1987.

E-7 Sub 819
I 3/15/11 LG

APPENDIX B

KENNIE D. ELLIS

I am a graduate of North Carolina State University with a Bachelor of Science Degree in Engineering with a concentration in nuclear power.

I began my employment with the Public Staff Electric Division in May of 2003. While with the Electric Division, my primary responsibilities have been customer growth analysis and validation, small power and non-utility generator Certificates of Public Convenience and Necessity, investigation of inquiries and complaints, and management of generation and co-generation tracking databases. I have also worked in the areas of rate analysis and design, revenue analysis and design, nuclear decommissioning, power plant performance, utility service rules and regulations, cost of service, analysis and review of conservation and load management programs, least-cost integrated resource planning, avoided cost, electromagnetic field, electrical safety, fuel factor computation and inventory, unbundling of service, review of wheeling and rates and depreciation analysis.

From October of 1984 until April of 2002, I was employed by Carolina Power and Light Company (now doing business as Progress Energy Carolinas) in various capacities including Regulatory Specialist, Operating Experience Coordinator, Corrective Action Program Specialist, Pressure Test Engineer, and Health Physics Technician.

From 1978 until 1984, I was employed by the United States Navy in the Naval Nuclear Power Program.

I have previously filed testimony before the Commission in new certificate applications for generating facilities, fuel proceedings, renewable portfolio standards recovery proceedings, rate cases. I also have participated in several special investigations.

Fireman Exhibit 1
E-7 Sub 819
I/A 3/15/11 LG

North Carolina Council of Churches

Resolution on Annual Utility Rate Hikes without NC Utility Commission Review
Adopted by the Governing Board on March 1, 2011

Duke Energy and Progress Energy intend to introduce legislation that would allow them to raise utility rates on customers for construction of new power plants without going through the public rate review process through the NC Utilities Commission currently required by law. The utilities are considering beginning the process of building up to four new nuclear power plants in the territory of their North Carolina customers to meet projected increase in demand. The current estimated cost of a single new nuclear power plant is over $10 billion, and projected costs have been increasing yearly. The utilities have been unable to fund these expensive nuclear projects because banks are refusing to lend them money believing that such investments are too risky, as often these projects are delayed and cancelled. This proposed legislation would bypass the only remaining consumer protection barrier to having ratepayers assume all the risk of these expensive plants while protecting the utilities and their stockholders.

The Council believes this is an issue of justice, as the health and welfare of the least among us is a deep calling from our Christian faith. The biblical prophets roundly condemned any society in which a few wallow in luxury while many others are ruined by poverty (Amos 6:4-6). The average citizen in North Carolina is struggling financially. Our economy is faltering with high unemployment and underemployment, and many breadwinners are finding it difficult if not impossible to provide basic needs for their families. Under these circumstances, it is morally unacceptable to allow utility companies without any public review process to require ordinary North Carolinians to assume the financial risk of expensive nuclear or other power projects when stockholders and bankers refuse those risks.

The elderly, others on fixed incomes, and the working poor, already spend a disproportionately large percentage of their income on heating and cooling costs. The Obama Administration has proposed federal budget plans to cut $2.6 billion from heating assistance, and state agencies and non-profits will not be able meet the demand for help that the poor require. These are the people who are most vulnerable to negative health consequences from heat waves or prolonged cold spells particularly if they are not able to afford to regulate the climate in their homes sufficiently. Preserving the current public review process is the last line of defense against uncontrolled rate hikes which would place these North Carolinians at even increased risk

Uncontrolled rate hikes would also have a harmful effect on congregations and other faith-based institutions, because they are ratepayers, too. Money that is going into ever-higher electricity bills is money that is not available for the congregation's programs and ministries. Many religious institutions are also struggling financially, reflecting the difficulties of their members and constituents

There is much controversy over the claim about how much power is needed to meet a projected increase in demand. North Carolina lags far behind many states in demand reduction and energy efficiency implementation in all customer classes—industrial, business, and residential.[1] Under current law (SB3 – Renewable Energy Portfolio Standard, adopted in 2007), the utilities are required to provide only a little over 3% of their electricity by energy efficiency by 2020.

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North Carolina Council of Churches

Many technical analyses, including one by Duke University, claim that up to 25% of energy demand reduction can occur in the same time frame (10 -15 years) required for constructing new nuclear plants if comprehensive energy efficiency measures are implemented in the state.[2] Some states have already achieved over 10% reduction in electricity use by implementing strong energy efficiency plans.[3]

Energy efficiency is the cheapest way to provide electricity, at costs about one-quarter less than conventional power generation.[4] Moreover, the benefits to society in terms of job creation, health, and safety as compared to conventional power generation are well demonstrated. A robust energy efficiency program in North Carolina would not only obviate the need for new nuclear power plants, but it would also allow Duke Energy and Progress Energy to retire their fleet of coal-fired power plants in a more timely fashion, relieving the State and its citizens of the heavy financial and public burden of paying the health and environmental "externalized" costs of coal.

The Council therefore opposes legislation that gives Duke Energy and Progress Energy automatic authority to raise rates to pay for new base-load power plants without going through proper annual public review by the NC Utilities Commission. The Council supports legislation creating a strong Energy Efficiency Standard and Plan for increasing energy efficiency in North Carolina by 25% by 2025. By investing a fraction of the money required to build new base-load nuclear power plants in a comprehensive plan to improve energy efficiency, our citizens would save substantial sums for the long term, have healthier and safer homes, and benefit from tens of thousands of new local green jobs throughout North Carolina in the manufacturing and building trades.[5]

1. American Council for an Energy-Efficient Economy: The 2010 Energy Efficiency Scorecard (http://www.aceee.org/files/pdf/ACEEE-2010-Scorecard-Executive-Summary.pdf).
The American Council for an Energy-Efficient Economy ranked N.C. 24th in its 2010 rankings, up from 29th in 2008. This increase is misleading however, as it included the projected increase in efficiency from a guarantee that Gov. Perdue made that the Building Code Council would increase efficiency in new residential construction by 30%. The Building Code Council passed a 15% improvement, which is currently being challenged in the General Assembly by allies of the Home Builders Association.

2. Energy Efficiency in the South, Appendix G, State Profiles of Energy Efficiency Opportunities in the South, North Carolina, Marilyn Brown et.al., Georgia Tech and Duke University, 2010

3. American Council for an Energy-Efficient Economy: The 2010 Energy Efficiency Scorecard (http://www.aceee.org/files/pdf/ACEEE-2010-Scorecard-Executive-Summary.pdf).
This report states that electricity savings increased by 8% in all states between 2007 and 2008. Since N.C. did not even have an energy efficiency standard at that time, and ranked 29th in 2008, it can easily be inferred that some, if not many, states have achieved over 10% improvement in energy efficiency in their electricity sector.

4. American Council for an Energy-Efficient Economy: Saving Energy Cost Effectively:: A National Review of the Cost of Energy Savings Through Utility-Sector Energy Efficiency Programs, Katherine Friedich et. Al, 2009, p.22.

5. American Council for an Energy-Efficient Economy: Strong Energy Efficiency Policies Under Consideration by Congress, Saving North Carolina Citizens Money, Creating Jobs and Reducing Emissions, 2009.

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Fireman Exhibit 1

North Carolina Interfaith Power & Light
a program of the NC Council of Churches
www.ncipl.org info@ncipl.org

27 Horne Street
Raleigh, NC 27607
(919) 828-6501

March 7, 2011

Dear Governor Perdue;

This is a very unusual letter. It is written by two M.D.'s who work for a statewide interfaith organization that is a program of the North Carolina Council of Churches. Our mission is to work with faith communities to address the causes and consequences of global climate change. We promote practical solutions through education, outreach, and public policy advocacy. We have over 4200 members, including 950 faith leaders, in well-over 400 congregations across North Carolina.

As you struggle with a huge deficit, you will be considering requests by Duke Energy and Progress Energy to use taxpayer money to help prepay for up to four new nuclear power plants. This request will amount to a substantial annual utility rate increase that bypasses public review by the North Carolina Utilities Commission. It will also be an annual rate hike with no guarantee that the power plants would ever be constructed. Moreover, the cost of each nuclear power plant is currently estimated at $10 billion (and likely to become even more costly before any would be completed). But for just a fraction of that cost, North Carolina could be well on its way to ensuring that all existing residential, commercial and industrial buildings are energy efficient, and that new renewable energy projects are fast-tracked as viable alternatives.

In these very difficult budgetary times, with a faltering economy and high unemployment, breadwinners are finding it difficult if not impossible to provide basic needs for their families. Under these circumstances, it is absolutely unfair and morally unacceptable to ask ordinary North Carolinians to assume the financial risk of expensive nuclear projects when stockholders and bankers refuse to do the same. We all know that the elderly, others on fixed incomes, and the working poor, spend too large a part of their income on heating and cooling costs. Furthermore, as businesses and municipalities struggle to operate within their budgetary constraints, the further burden of an annual rate hike seems unfair and inappropriate at best, and foolish at worst.

The solutions to our difficulties will not be solved by Republican or Democratic ideologies, as both caused the predicament that we are in. As a group of scientists said in a recent letter to the U.S. Congress, "There are no Democratic or Republican carbon dioxide molecules; they are all invisible and they all trap heat."[1] And they were all caused by a reliance on a very outdated technology that relies on boiling water to produce electricity, by burning non-renewable fossil fuels.

As medical people and people of faith, we ultimately value health and life. Hippocrates, the father of western medicine, noted nearly 2400 years ago, "Illnesses do not come out of the blue, they are developed from the small daily sins against nature. When enough sins have been accumulated, illnesses will suddenly appear." It is now crystal clear that our individual health, and the health of our society, economy and environment, are intimately tied to the small daily sins of our energy use. The sins against Creation are manifesting in an unrelenting fashion in our economy, our politics, and our environment. Industrial civilization is degrading and destroying Earth, its climatic stability, and all the geophysical and biological systems and life forms that were given to us as a gift of God's Creation.[2]

It has been our generation that has been the major cause of our predicament, and it is our responsibility to engage the difficulties as mature elders. As elders we recognize that all substantial problems are

fundamentally centered on values. For many of us, this means a return to the morality of the Biblical traditions. We need look no further than Genesis to recall that God considered all of Creation good. God valued all life, not just human life. Humanity's responsibility was to keep and protect *all* of it. Jesus called on us to love God and our neighbor as ourselves, especially the least among us. The Golden rule, do unto others as you would have them do unto you, is a moral duty common to all faith traditions. All of us are called to do no harm and to do good.

We at NC Interfaith Power & Light believe that the public wants and needs a new, clean, modern, and health-promoting energy economy, free of fossil fuels. We need an energy economy that depends on conservation, energy efficiency, and widely distributed wind, solar, solar thermal, and other renewable sources of energy. One of us heard President Clinton relate these figures at a lecture at Guilford College on November 30, 2010: For every $1 billion spent on coal energy, 800 jobs are created; for every $1B spent on solar energy, 1900 jobs are created; for every $1B spent on wind energy, 3300 jobs are created; and for every $1B spent on retrofitting buildings, **7000 jobs are created.** A recent study indicated that world energy use could be reduced by 73% by common energy efficiency and demand side management technologies.[3]

The first priority for you, our elected leaders, is to come together and find the political courage and will to build an energy efficient and renewable energy economy. Special interests need to take a back seat to the priority of promoting the general welfare of all the citizens of North Carolina. It is time to put political ideology aside. Please remember that the business of government is not protecting business, but protecting and enhancing the public good.

The gifts you give to posterity will depend on the choices you make on our energy economy and its consequences for our health and common future. We were gifted a wholesome and beautiful world. We must keep and protect it in order to leave as much of it intact for our children and those who come after. It is our moral duty, defined by our religious and spiritual traditions, to do unto future generations what we would have them do unto us. Harkening back to Hippocrates, we do not want to visit the many sins to the environment and each other we have accumulated during our period of political control on our children and their children. Please look deep into your hearts, and into your relationship with God, as you deliberate this year and make the right choices.

Respectfully,

Kathy Shea

Richard Fireman

Kathy Shea, M.D.
Director

Richard Fireman, M.D.
Public Policy Coordinator

1. *The Hill*, 2/1/11: http://thehill.com/blogs/e2-wire/677-e2-wire/141453-scientists-put-aside-politics-and-focus-on-climate-science
2. *CrossingPlanetaryBoundaries*,9/23/09:
   a. http://e360.yale.edu/feature/provocative_new_study_warns_of_crossing_planetary_boundaries/2192/
   b. http://www.stockholmresilience.org/download/18.8615c78125078c8d3380002197/ES-2009-3180.pdf
3. *Reducing Energy Demand: What Are the Practical Limits:* Jonathan M. Cullen, Julian M. Allwood, and Edward H. Borgstein,
   a. http://pubs.acs.org/doi/abs/10.1021/es102641n
   http://www.newscientist.com/article/dn20037-efficiency-could-cut-world-energy-use-over-70-per-cent.html

Fireman Exhibit 1

ENERGY EFFICIENCY IN THE SOUTH

APPENDIX G

STATE PROFILES OF ENERGY EFFICIENCY OPPORTUNITIES IN THE SOUTH: NORTH CAROLINA

Marilyn A. Brown,[1] Joy Wang,[1] Matt Cox,[1] Youngsun Baek,[1] Rodrigo Cortes,[1] Benjamin Deitchman,[1] Elizabeth Noll,[1] Yu Wang,[1] Etan Gumerman,[2] Xiaojing Sun[2]

April 13, 2010

[1]Georgia Institute of Technology
[2]Duke University

A Profile of Energy-Efficiency Opportunities in North Carolina

The economic recession, climate change concerns and rising electricity costs have motivated many states to embrace energy efficiency as a way to create new local jobs, lower energy bills and promote environmental sustainability. With this surge of interest in energy efficiency, policymakers are asking: "how much energy can be saved?" This profile addresses the opportunity for energy efficiency improvements in the residential, commercial and industrial sectors of North Carolina. It draws on the results of a study of *Energy Efficiency in the South* conducted by a team of researchers at the Georgia Institute of Technology and Duke University. The study presents primary and in-depth research of the potential for energy-efficiency improvements, using a modeling approach based on the SNUG-NEMS (National Energy Modeling System).[1]

With a population of 9.2 million people,[2] the State represents about 3.1% of the U.S. population, 2.9% of the nation's Gross Domestic Product (GDP), and 2.7% of U.S. energy consumption (Figure 1).[3] Thus, compared to the rest of the nation, North Carolina has a lower than average level of energy intensity.[i]

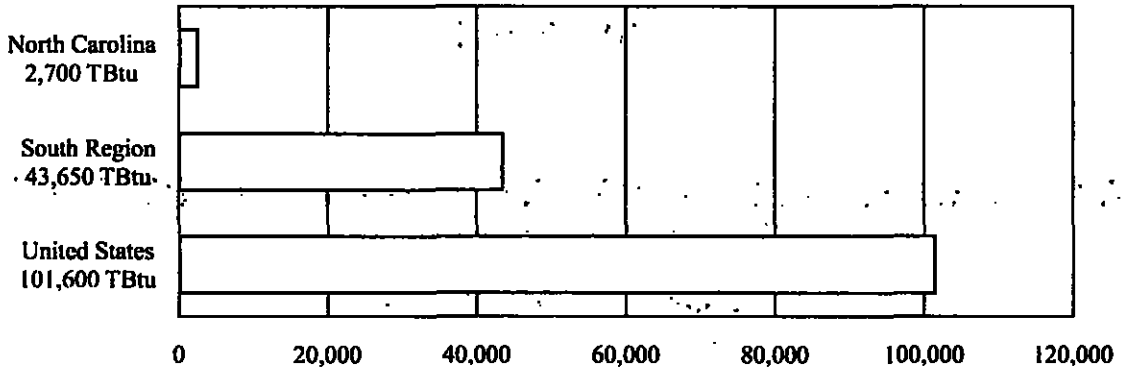

Figure 1: Energy Consumption in North Carolina, the South, and the U.S., 2007[3]

North Carolina's use of residential energy as a percentage of its overall energy consumption exceeds that of the nation and the rest of the South. Alternatively, its industrial energy consumption is lower (Figure 2). North Carolina's per capita energy consumption is ranked 39th nationally.[3]

North Carolina consumes more coal and nuclear energy than other states in the South. However, it consumes relatively less natural gas (Figure 3). The State produces its electricity largely from coal (60%), but it also is a leader in electricity produced from nuclear power. Hydroelectric power also supplies about 3% of the electricity consumed within the State.[4] North Carolina is a national leader in wind power capacity.

[i] Energy intensity is the ratio of the state's energy consumption to its Gross State Product (GSP).

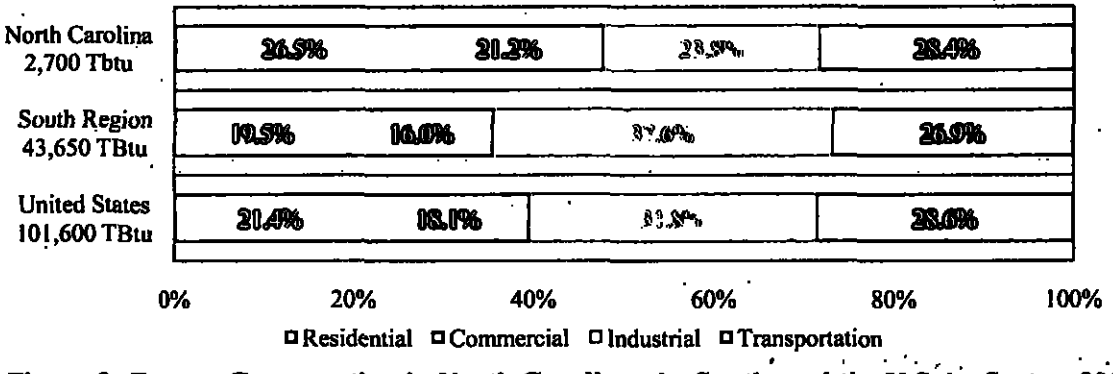

Figure 2: Energy Consumption in North Carolina, the South, and the U.S. by Sector, 2007[3]

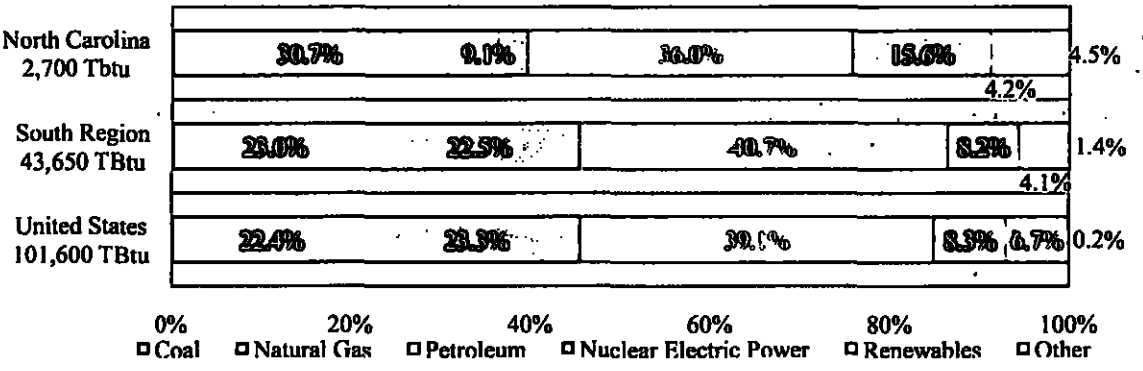

Figure 3: Energy Consumption in North Carolina, the South, and the U.S. by Fuel Type, 2007[3]

North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REPS) requires 12.5% of retail electricity in 2020 to be generated from renewables. The standard allows up to 25% of the requirement to be met through energy efficiency technologies up to 2020. Afterwards, energy efficiency may supply up to 40%.[5] Another state-wide initiative, the "Upgrade and Save" program, encourages manufactured home dealers to implement energy efficient heat pumps and pays for the measures. New homeowners can save up to $700 per year from the efficiency measure without experiencing any costs associated with the upgrade.[5] More state initiatives are described in recent Southern States Energy Board and National Association of State Energy Officials publications.[4, 6]

Nevertheless, the *2009 State Energy Efficiency Scorecard* from the American Council for an Energy Efficient Economy (and other studies of the State and region) suggests that additional policy initiatives could be implemented in the State to encourage households, businesses, and industries to utilize energy more effectively. Specifically, the ACEEE study rated North Carolina 26th of the 50 states and DC for its adoption and implementation of energy-efficiency policies. This score is based on the state's performance in six energy efficiency policy areas: utility and public benefits, transportation, building energy codes, combined heat and power, state government initiatives, and appliance efficiency standards.[7]

In the *Meta-Review of Efficiency Potential Studies and Their Implications for the South*, Chandler and Brown (2009) reviewed eight energy-efficiency studies that covered North Carolina. Estimates of "maximum achievable" electricity savings potential range from 8-27%. The total energy saved could exceed this potential. North Carolina's energy-efficiency potential would be higher than this range with the implementation of all cost-effective opportunities, but the number of studies with such estimates is limited.[8] An ACEEE study examined energy efficiency, transportation, and water savings in the State. Through the energy efficiency policies it examined, North Carolina could realize 37,830 GWh of electricity savings in 2025 or about 24% of the projected consumption.[9]

Energy Efficiency Potential by Sector

The State's total energy consumption (residential, commercial, industrial, and transportation sectors) is projected to increase 22% from 2010 to 2030. This profile describes the ability of nine energy policies to curb this growth in energy use by accelerating the adoption of cost-effective energy-efficient technologies in the residential, commercial, and industrial sectors of North Carolina. Altogether, these policies offer the potential to reduce North Carolina's energy consumption by approximately 13% of the energy consumed by the State in 2007 (360 TBtu in 2030) (Figure 4). With these policies, North Carolina's energy consumption could remain relatively stable over the next two decades. For complete policy descriptions, refer to *Energy Efficiency in the South* by Brown et al. (2010).

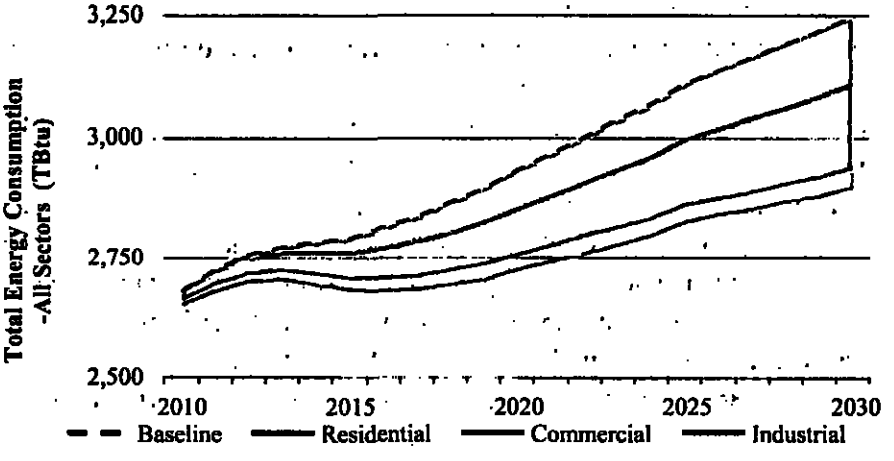

Figure 4: Energy Efficiency Potential in North Carolina

(Note: The baseline includes projected transportation sector consumption, as well as residential, commercial and industrial consumption.)

The commercial and residential sectors offer the greatest energy efficiency potential in North Carolina (Figure 5). In 2020, savings from all three sectors is about 8% (220 TBtu) of the total energy consumed by the State in 2007. Electricity savings constitute 190 TBtu of this amount. With

these policies, the electricity generated by six 500-MW power plants in 2020 and about eleven such power plants in 2030 could be avoided.[10]

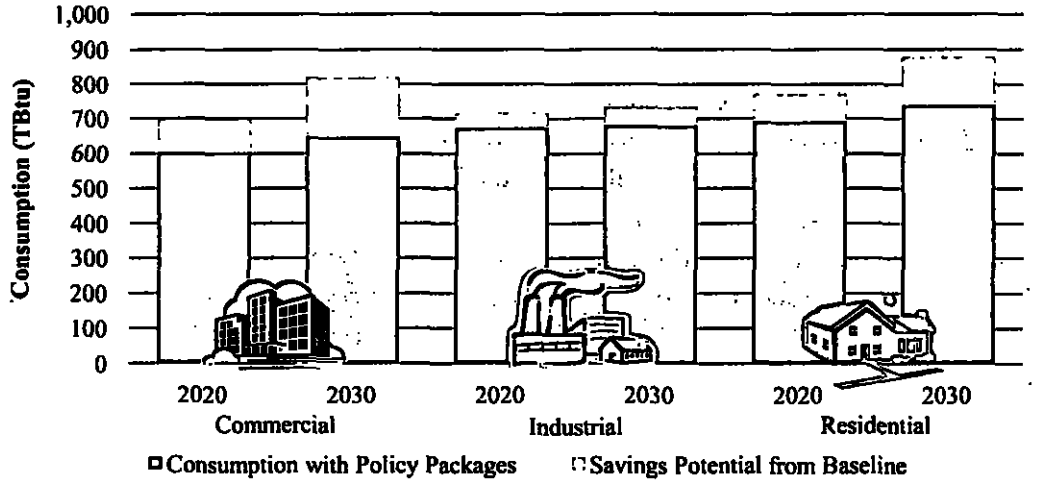

Figure 5: Energy-Efficiency Potential by Sector in North Carolina, 2020 and 2030

Residential Sector

Four residential energy efficiency policies were examined: more stringent building codes with third party verification, improved appliance standards and incentives, an expanded Weatherization Assistance Program, and retrofit incentives with increased equipment standards. Their implementation could reduce North Carolina's projected residential consumption by about 10% (79 TBtu) in 2020 and 16% (140 TBtu) in 2030 (Figure 6). In 2020, the residential energy required by about 390,000 North Carolinian households could be avoided or about $320 per household.

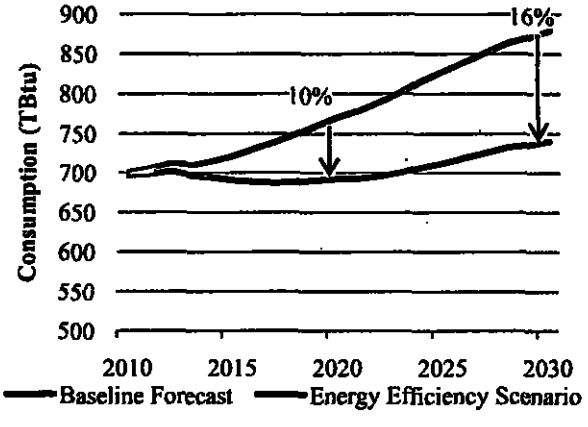

Figure 6: Residential Sector Savings

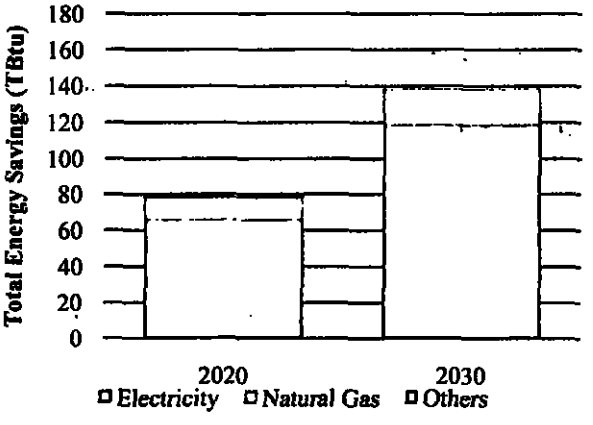

Figure 7: Residential Sector Savings by Fuel Type

The principal energy savings are from electricity, but significant natural gas savings could also occur (Figure 7). With these policies, growth in residential energy consumption could be dramatically slowed.

Commercial Sector

The implementation of appliance standards and retrofit policies in North Carolina's commercial sector could reduce projected energy consumption in 2020 by approximately 14%, and by 21% in 2030 (Figure 8). In 2020, the commercial sector could save about 95 TBtu , which is equivalent to the amount of energy that 2,700 Wal-Mart stores spend a year. Each business in North Carolina could save $65,000 on average.[11] The principal energy savings are from electricity, with natural gas and other fuels providing additional savings (Figure 9). The rapid growth of commercial energy consumption forecast for North Carolina could be constrained to only modest growth with these two energy efficiency policies.

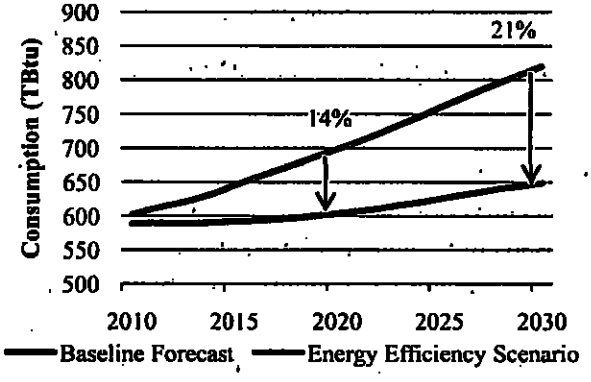

Figure 8: Commercial Sector Savings

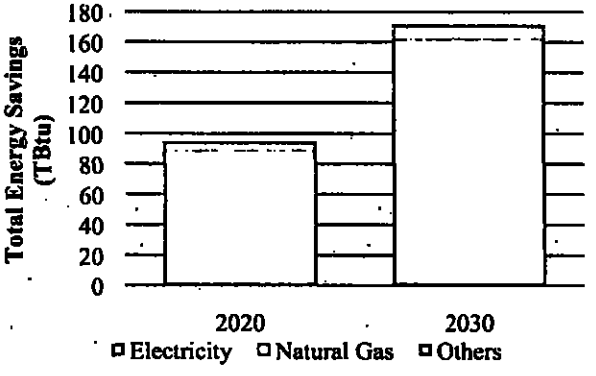

Figure 9: Commercial Sector Savings by Fuel Type

Industrial Sector

The implementation of plant utility upgrades, process improvements, and combined heat and power policies in North Carolina's industrial sector can reduce projected consumption by about 6% in 2020 (42 TBtu) and 7% in 2030 (53 TBtu) (Figure 10). The industrial energy required by about 61 average industrial facilities is avoided in 2020, or average annual bill savings of $31,000 per industrial facility. The principal energy savings are from electricity, but natural gas savings could also occur, especially in 2020 (Figure 11). These three energy efficiency policies could significantly reduce the growing consumption of industrial energy projected over the next two decades.

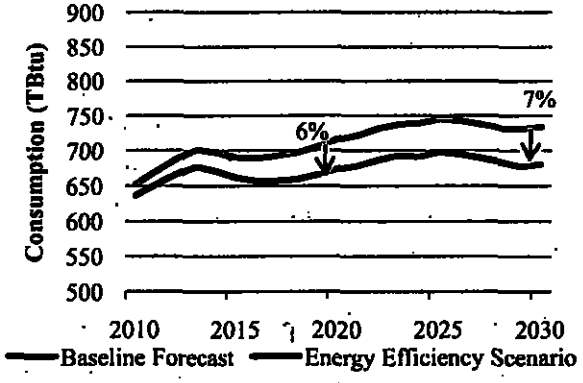

Figure 10: Industrial Sector Savings

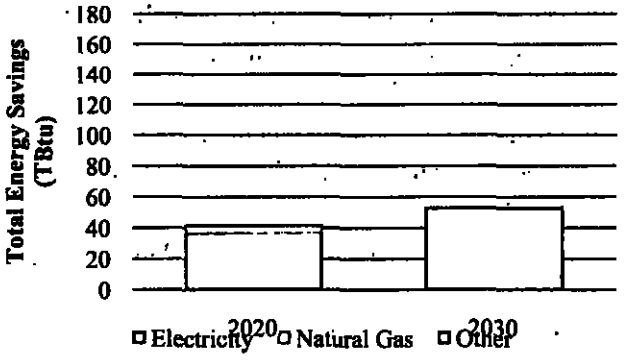

Figure 11: Industrial Sector Savings by Fuel Type

Efficient Technology Opportunities

The projected energy-efficiency potential can be realized through an array of new and existing technologies. *Energy Efficiency in the South* describes a number of these.

Emerging residential products can provide greater energy savings without sacrificing performance. For instance, currently available heat pump water heaters can cut annual energy costs for water heating up to 62%.[12]

Opportunities for commercial energy efficiency may be obtained through technologies like the geothermal heat pump (ground-source heat pump), which can reduce energy consumption by up to 44% when compared to air-source heat pumps and by up to 72% when compared to electric resistance heating with standard air-conditioning equipment. Though the installation cost is higher, the long lifetime of 20-25 years ensures energy bill saving benefits over time.[13]

Super boilers, which represent over 95 percent fuel-to-steam efficiency, can be implemented in the industrial sector. This technology is able to improve heat transfer through the use of advanced firetubes with extended surfaces that help achieve a compact design through reducing size, weight, and footprint. The advanced heat recovery system combines compact economizers, a humidifying air heater, and a patented transport membrane condenser.[14]

These technologies are illustrative. Please refer to *Energy Efficiency in the South* by Brown et al. for additional technology descriptions and examples.[1]

Economic and Financial Impacts

The nine energy efficiency policies evaluated in *Energy Efficiency in the South* could reduce energy costs for North Carolina consumers and could generate jobs in the State (Table 1). Residential, commercial and industrial consumers could benefit from total energy savings of $3.8 billion in 2020

($2 billion of which is specific to electricity), and $7.0 billion in total energy savings in 2030. In comparison, North Carolina spent $10.3 billion on electricity in 2007.[15]

Using an input-output calculation method from ACEEE – with state-specific impact coefficients and accounting for declines in employment in the electricity and natural gas sectors – we estimated that North Carolina would experience a net gain of 30,800 jobs in 2020, growing to 42,100 in 2030. In comparison, there were about 500,000 unemployed residents of North Carolina at the end of 2009.[16]

While the South's economy would grow as a result of the energy-efficiency policies, North Carolina would experience first a small increase and then a small decline in Gross State Product, with an increase of $1 million in 2020 and a decrease of $33 million in 2030. This change is a small fraction of the North Carolina's $329 billion economy; North Carolina has an average economic multiplier associated with energy-efficiency manufacturing and construction activities in North Carolina.[17]

Table 1: Economic and Employment Impacts of Energy Efficiency

Indicator	2020	2030
Public Sector Policy Financial Incentives (in million $2007)	872	1,318
Private Sector/Household Productive Investment (in million $2007)	323	382
Change in Electricity Costs (in million $2007)	-$2,006	-$3,846
Change in Natural Gas Costs (in million $2007)	-$313	-$498
Annual Increased Employment (ACEEE Calculator)	30,800	42,100
Change in Gross State Product (in million $2007)	1	-33

Conclusions

The energy-efficiency policies described in this report could set North Carolina on a course toward a more sustainable and prosperous energy future. If utilized effectively, the State's substantial energy-efficiency resources could reverse the long-term trend of ever-expanding energy consumption. With a sustained and concerted effort to use energy more wisely, North Carolina could create new job opportunities and reduce its environmental footprint.

For more information on the methodology used to derive this state profile, please see *Energy Efficiency in the South.*[1]

Acknowledgements

This study project is funded with support from the Energy Foundation (www.cf.org), the Kresge Foundation (www.kresge.org) and the Turner Foundation (www.turnerfoundation.org). The support of these three foundations is greatly appreciated.

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Congress of the United States
House of Representatives
Washington, DC 20515–2107

March 7, 2011

The Honorable Greg Jaczko
Chairman
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Dear Chairman Jaczko:

I write to urge the Commission not to finalize its pending approval of the AP1000 reactor design until serious safety concerns about its shield building have been addressed. These concerns include those raised by one of the Commission's most long-serving staff that there is a risk that an earthquake at, or aircraft impact on, the AP 1000 could result in a catastrophic core meltdown. The danger of terrorist attacks on nuclear power plants, and the importance of their structural resilience, was made very clear on February 24, 2011. A man was arrested in Texas for allegedly planning to blow up nuclear plants using explosive chemicals he purchased online.

The Commission has recently voted to approve the design of the AP 1000. As a result, the NRC's proposed rule for the AP1000 Design Certification Amendment was published in the Federal Register on February 24, 2011. The proposed rule is set to be finalized in the next few months, following a public comment period that ends May 10, 2011 and a 30 day review of public comments. However, the Commission has taken this step toward final approval despite serious safety concerns about the Westinghouse design for the reactor shield building that have been raised by Dr. John Ma. Dr. Ma has been with the NRC since it was created by Congress in 1974. He was the Commission's lead structural reviewer charged with evaluating the design of the reactor shield to determine whether it met NRC safety standards. Dr. Ma has identified potential loopholes, which, if left open, allow designs for unsafe reactors to go forward despite the risk that an earthquake or aircraft impact could result in a catastrophic core meltdown.

While I appreciate the substantive assistance and time spent by your staff in addressing my staff's questions related to the AP 1000 review process, I remain concerned about the safety of the reactor design. I therefore request that the Commission definitively resolve these potential loopholes prior to the finalization of the NRC licensing process.

As you know, the shield building for the AP1000 serves the critical safety function of preventing catastrophic damage to the reactor that could cause fuel melting and radiation releases. The shield building physically protects the highly radioactive core of the nuclear reactor (as well as critical operating equipment) against earthquakes, storms, and airplane strikes. The shield building is intended to ensure safe shutdown following such impacts. As it is designed, the

AP1000 shield building supports a water storage unit on top of it. This water is part of the vital cooling system for the reactor, which is necessary to prevent the sort of overheating that led to core melt at the Three Mile Island reactor in Pennsylvania in 1979.

NRC regulations are intended to ensure that any new reactor design will be able to withstand the dangers of earthquakes, storms, or commercial airplane strikes. The consequences of failure could be severe: According to the report of the 9/11 Commission, Al-Qaeda considered attacking a nuclear power plant as part of its September 11th plot. The Energy Policy Act of 2005 thus included my language that required the NRC to consider the "events of September 11, 2001" and the potential for "suicide attacks" and "air-based threats" in making rules for how reactors will be able to withstand a variety of scenarios related to terrorist attacks. I have long agreed with your 2006 statement that "We should be requiring they design these plants to withstand such attacks.[1]"

On June 12, 2009, NRC issued a rule, 10 CFR 50.150, requiring applicants for new reactors to include an assessment of the ability of the reactor design to withstand the impact of a large, commercial aircraft. The NRC issued its aircraft impact rule after having already issued a final rule certifying the design of the AP1000 on January 27, 2006.[2] In anticipation of the rule change on aircraft impact, Westinghouse amended its design to address aircraft impact, by submitting Revision 16 of its AP1000 design to NRC on May 26, 2007. The NRC is currently considering Revision 18 of the AP1000 design, submitted December 1, 2010[3].

When reviewing the design for the shield building, Dr. John Ma grew concerned that the structure was too brittle and could fail if struck by a natural or manmade catastrophe. He was so concerned by this and other issues that he filed a "Non-Concurrence" statement of dissent[4] on November 4, 2010. Despite the Non-Concurrence, NRC staff issued a positive Advanced Final Safety Evaluation Report (AFSER) on December 28, 2010. The Non-Concurrence accompanied the AFSER throughout a series of approval stages, allowing you and other reviewers to know that these concerns have been raised.

If the NRC approves the AP1000, then it may have widespread use throughout the United States, making questions about its safety of crucial national importance. Among the applications for the construction of 28 new reactors being considered by NRC, the AP1000 would be the design for 7 Combined License applications covering 14 reactors, to be built in Alabama, Florida, North Carolina, South Carolina, and Georgia.[5] The Department of Energy has approved

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[1] http://www.nytimes.com/2006/11/09/us/09nuke.html

[2] http://www.nrc.gov/reactors/new-reactors/design-cert/ap1000.html

[3] The current revision is a Design Certification Amendment application that would revise the AP1000 Design Control Document, which is the overall design that NRC certified in 2006.

[4] The Non-Concurrence (NRC Form 757), the response to it by other Division of Engineering staff, and Dr. Ma's rebuttal to this response are all internal NRC documents, Accession Number ML103370648 within the Agencywide Documents Access and Management System (http://www.nrc.gov/reading-rm/adams/web-based.html). The Non-Concurrence Package was published on December 3, 2010.

[5] http://www.nrc.gov/reactors/new-reactors/col.html. The proposed sites include Jackson County, Alabama (Tennessee Valley Authority's Bellefonte site); Levy County, Florida (Progress Energy Florida, Inc.'s site); Homestead, Florida (Florida Power and Light Co.'s Turkey Point site); Wake County, North Carolina (Progress Energy Carolinas, Inc.'s Harris site); Cherokee County, South Carolina (Duke Energy's William States Lee III site);

an application for a loan guarantee of $8.3 billion to Georgia Southern for two proposed AP1000 reactors, conditional on NRC approving the AP1000. Taxpayer dollars should not be spent on unsafe reactors. The Non-Concurrence identifies several potential loopholes. I am asking the Commission to reconsider its approval of the AP1000, in light of these loopholes, the most serious of which I summarize below:

1. The AP 1000 shield building failed tests because it is brittle, and could shatter "like a glass cup"

If a reactor shield is too brittle, it may fail in an earthquake or if struck by an airplane or an automobile or other missile carried by a storm. In fact, Dr. Ma warned that if the AP1000 shield was struck, it could shatter like a "glass cup." The reason for Dr. Ma's statement is that the AP1000 shield building failed, or failed to complete, physical tests designed to evaluate whether the structure has adequate toughness for these sorts of impacts.

In its new design in response to the aircraft impact rule, Westinghouse changed the composition of the shield building from reinforced concrete to a combination of steel and concrete. This "steel-concrete module" is a first-of-its-kind design for nuclear power plants. About 60 percent of the shield building would consist of a module design (module #2) that "failed miserably" in a direct physical test of its toughness. According to the NRC Design Certification Application Review of the AP1000, "test results for out-of-plane shear showed that the modules with **[redacted]** failed in a brittle manner.[6]" A second physical test, of in-plane shear, could not be completed "due to laboratory safety constraints." These shear tests are intended to determine whether the structure will be brittle or "ductile." Ductility enables an object to deform and stretch under force, rather than breaking. Both in-plane and out-of-plane shear would act on the shield building during an earthquake. As you note in comments accompanying your "Yes" vote on the AP1000, the module that would be used for 60 percent of the shield building "was unable to satisfy the experimental protocol developed by Westinghouse and agreed to by the [NRC] staff."

The potential loophole here is that the Commission has apparently accepted Westinghouse's argument that the brittle module design would only be used in regions of the building that are unlikely to encounter high loads. Thus the failing tests were ignored. Instead of relying on the results from the test intended to prove the shield building's design, Westinghouse substituted results from computer simulations that may be a poor approximation of reality.

In his Non-Concurrence, Dr. Ma asks, "How could the [NRC] staff justify using a lower standard, by accepting a brittle structural module for about **[redacted]** of the [steel-concrete] wall for AP1000 shield building, which has more safety functions and greater consequence if the wall collapses, than other types of [reinforced concrete] shield buildings that are required to design to a higher standard of ACI [American Concrete Institute] Code?" Dr. Ma also points to NRC codes stating that the standard to which a design is held must be "commensurate with the

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Fairfield County, South Carolina (South Carolina Electric & Gas' Virgil C. Summer Nuclear Station site); and Burke County, Georgia (Southern Nuclear Operating Co.'s Vogtle site).

[6] Design Certification Application Review – AP1000 Amendment. Chapter 3, page 155. http://www.nrc.gov/reactors/new-reactors/design-cert/amended-ap1000.html

importance of the safety function to be performed".[7] The AP1000 design should not be approved when the material making up 60 percent of the shield building, an essential structural component that is meant to withstand earthquakes, storms, and airplane strikes, has failed a critical physical test showing it to be brittle.

Additionally, the AP1000 shield building design has evidently failed to meet the standards of the American Concrete Institute, despite these being endorsed by NRC[8]. Westinghouse has not complied with the American Concrete Institute (ACI) "Code Requirements for Nuclear Safety-Related Concrete Structures" (ACI-349). . The design fails to meet the Code, because ACI-349 requires the structure to be ductile, would require different spacing between the steel tie-bars, and would not allow substitution of computer models in place of physical tests. Dr. Ma notes that the Safety Evaluation Report "has not provided justifications as to why its acceptance standard, which is lower than that of the ACI Code, is adequate".

To ensure the safety of the AP1000, and any future reactor designs involving steel-concrete composites, I urge you to develop a standard for this novel type of design that would apply both to the AP 1000 and other reactor designs that might seek to use it in the future. The NRC Advisory Committee on Reactor Safeguards notes that "the effort and scope of analysis and assessment required for the shield building in this case suggests that if SC [steel-concrete] composites are to be more widely used in nuclear applications, a consensus code should be developed, as has been done for other types of nuclear construction." You echoed this concern in comments accompanying your "Yes" vote for the AP1000, noting "the lack of a directly acceptable design and construction consensus standard." You write that "it would be advantageous to have such a detailed standard developed independent of any specific design approval. Therefore, I also encourage the [NRC] staff to aid in any effort ... to develop a standard." However, developing such a standard after approving the AP1000 is like planning to comply with building codes to prevent fires after the building has burned down. I ask the Commission to reverse its approval of the AP1000 until such a standard is developed, and then apply this standard to the AP1000 before reconsidering the design.

2. Weak computer simulations were used to "prove" the reactor shield is "strong enough"

Westinghouse's assertion that the brittle module is "strong enough" is based on questionable computer simulations in place of the physical tests that it should have done. The computer analysis that Westinghouse did was flawed, because it used off-the-shelf, commercially available codes to evaluate a first-of-its-kind design that could not be expected to be accurately modeled in this manner. The shield building's steel-concrete structure is novel and complex, as is the overall design of the reactor. Given the novelty and complexity of the design, Westinghouse should have developed custom code.

Additionally, Westinghouse relied on a technique known as a static "push-over" simulation. A push-over simulation imagines that an earthquake functions like a finger slowly

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[7] Codes and standards: 10 CFR 50.55a(a)(1). http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-0055a.html

[8] Regulatory Guide 1.142 - Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments). http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/rg/01-142/

pushing a cup until it falls over. Dr. Ma notes that such an analysis is not appropriate, because the shield building would experience several types of forces simultaneously during an earthquake, rather than just one simple "push." In a Technical Evaluation of Westinghouse's modeling work, scientists at Brookhaven National Laboratory agreed, stating that Westinghouse's "models may be inappropriate for static analyses intended to represent cyclic dynamic loading (i.e. earthquake); the effect of load cycling on the effective stress-strain relationship apparently is not considered [**redacted**].[9]" Westinghouse does not appear to have considered the back-and-forth forces ("cyclic dynamic loading") that occur during an actual earthquake. Instead Westinghouse appears to have fantasized that an earthquake acts like a constant force in one direction. Had Westinghouse included dynamic cyclic loading, the effective "stress-strain" curve would have had a "backbone" shape; instead, it appeared to be a monotonic curve which is consistent with Westinghouse leaving out the dynamic cyclic loading that occurs in an earthquake. The "static push-over" analysis that Westinghouse did may therefore have been inappropriate because it failed to accounts for the real back-and-forth forces in an earthquake.

Unfortunately, the Technical Evaluation document that details the software's limitations consists mostly of text redacted by NRC staff on Westinghouse's request, but the text that remains is overwhelmingly negative about Westinghouse's simulations. In addition to concerns about how Westinghouse modeled the effects of an earthquake, Westinghouse's results were presented sloppily: There is "no confidence that an appropriate level of quality assurance was implemented in the conduct of the [redacted] analyses." There were "numerous confusing, misleading, or erroneous statements." The concerns raised in this May 30, 2010 Technical Evaluation do not appear to have been addressed by Westinghouse or NRC.

I urge you to require Westinghouse, and other reactor license applicants, to complete and pass physical tests of all materials used in the design, rather than using computer models to substitute for tests that their materials have failed. There should be clear regulations indicating any exceptions where computer analyses are appropriate – and these regulations should require the use of code that is suitable to the design of the particular reactor under consideration. Where computer models are necessary, the NRC should set standards defining the quality of the models that applicants are required to use, and should conduct independent validations of those models and of the original code. Original code and data should be made available for public review, while accounting for real proprietary and security concerns. As it stands, Westinghouse may be relying on defective models that provide no meaningful assurance of whether the reactor is safe.

3. Earthquake Forces May Have Been Underestimated by Westinghouse

Westinghouse exploited an apparent loophole in how NRC defines earthquake forces. Westinghouse underestimated the earthquake forces that the reactor would be subjected to through use of a "seismic wave incoherency model to effectively reduce... ground motion"

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[9] R. Morante, M. Miranda, J. Nie. Technical Evaluation: AP1000 Shield Building Design Report, Revision 2. Dated 5/30/2010. Submitted as part of Dr. Ma's rebuttal to the staff response to the Non-Concurrence statement. Accession Number ML103370648 within the Agencywide Documents Access and Management System (http://www.nrc.gov/reading-rm/adams/web-based.html).

during an earthquake.[10] It is a "manifestation of mathematical concept that has not been verified and validated by experiments," according to a letter sent by Dr. Ma to your office and mine on November 8, 2010. Indeed, the "interim staff guidance" on incoherency appears to be based on a solitary report of the Electric Power Research Institute, rather than consensus in the peer-reviewed scientific literature. In his letter to my office and to you, Dr. Ma wrote that even assuming these reduced earthquake forces are correct, "the design margin in the shield wall is practically non-existent; the design will be grossly inadequate if the 'correct' and actual earthquake analyses were used." I ask that the Commission require that estimates of seismic forces be drawn from consensus, peer-reviewed scientific literature. Please ensure that Westinghouse re-does its analyses to demonstrate that the AP1000 can withstand real earthquake forces, without minimizing these forces using ill-founded assumptions.

I would note that, generally speaking, the NRC staff responses to the Non-Concurrence statements do not dispute the concerns raised by Dr. Ma. Instead, they appear to have acknowledged the flaws associated with Westinghouse's analysis, agreed that addressing the non-concurring staff member's concerns would improve the design, and then shrugged their collective shoulders and chose to abdicate responsibility to further investigate these matters prior to providing a positive Safety Evaluation Report on the shield building of the AP1000 reactor.

In fact, in your January 31 vote to approve the AP 1000 design, you acknowledge that "While it is clear that the use of a ductile material in all areas of the shield building would provide an additional enhancement to safety, I am not convinced that such a design requirement exists..." This is a far cry from a ringing endorsement: you could have said that you are convinced that the design is safe, but you do not go this far. All you say is that there is nothing requiring you to disapprove the design.

There appear to be many unresolved concerns about the AP1000 shield building design, concerns that may justify reversing your vote of approval. Consequently, I ask for your prompt assistance in responding to the following questions.

1. Why did you not require improvements to the AP1000 design to enable it to pass direct physical tests of ductility? Have past reactor shield designs approved by the NRC succeeded in meeting ductility tests that the AP1000 has failed (out-of-plane shear) or has not even completed (in-plane shear)? If so, why is a weaker standard being allowed for the AP1000, which is supposed to be even tougher than past reactor shield designs to meet the aircraft impact rule?

2. There are uncertainties associated with the modeling codes used by the applicant to analyze the accident responses of the highly complex shield building design. Given these uncertainties, are you able to provide me a guarantee that use of brittle modules for about 60 percent of the AP1000 shield building design will not significantly degrade the capability of the wall to resist being hit by a missile propelled by a storm or by an airplane, relative to a design that does not use a brittle module? If so, on what basis, and if not, then why did the Commission vote to approve the design?

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[10] Design Certification Application Review - AP1000 Amendment. Chapter 3, page 58. http://www.nrc.gov/reactors/new-reactors/design-cert/amended-ap1000.html

3. There are uncertainties associated with Westinghouse's use of generic computer modeling codes and sloppily presented analyses, the "seismic wave incoherency model," and the static "push-over" analyses of the accident responses of the highly complex shield building design. Given these uncertainties, are you able to provide to me a guarantee that use of brittle modules for the majority of the AP1000 shield building design will not significantly degrade the capability of the shield building to resist an earthquake, relative to a design that does not rely on a brittle module? If so, please explain the basis for such a conclusion. If not, then why did the Commission vote to approve the design?

4. Are you certain that the brittle module is strong enough to withstand the combined stress (in-plane shear, out-of-plane shear, axial force) during a "safe shutdown earthquake"? If so, on what basis did you reach this conclusion? If not, then why did the Commission vote to approve the design?

5. What is the magnitude of earthquake for which the AP1000 would be able to maintain its ability to safely shut down the reactor? Will the NRC require that the AP1000 be able to withstand earthquakes of the magnitudes experienced in all regions of the US, or otherwise limit their deployment to areas in which earthquakes beyond the threshold, "design-basis" magnitude have never been experienced? Why or why not?

6. The shield building design includes two types of steel-concrete modules. Module #2, which failed, has wider spacing of the steel ties that go through the concrete. Module #1 has narrower spacing, which makes it tougher and enabled it to pass the out-of-plane shear test. Instead of accepting Westinghouse's flawed simulations, will the Commission reverse its approval of the AP1000 and instruct Westinghouse to simply replace the brittle module # 2 with a tougher module, such as module #1? If not, why not?

7. Given that there are applications for 14 new reactors using the AP1000 design, will NRC develop a consensus design code for this type of reactor, as has been done for other types of nuclear construction? If yes, will you reverse your approval of the AP1000 design until this code is developed and applied to the AP1000? If not, why not?

8. There are many pages in the Non-Concurrence that have been entirely redacted. For each substantive redaction, please provide me with the legal basis used to justify the redaction in question. If no appropriate basis exists, please ensure that an un-redacted version of the page in question appears in the docket for the AP1000 rule. I also ask that the Non-Concurrence package itself be placed in the docket, since it does not appear to be included among the documents that support the AP1000 rule.[11] The public should be made aware of the existence of the Non-Concurrence when commenting on the proposed design approval.

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[11] The AP1000 documents are available through the Federal e-Rulemaking website at http://www.regulations.gov by searching under Docket ID NRC-2010-0131.

Thank you for your attention to this important matter. Please provide your response no later than March 28. If you have any questions, please have your staff contact Dr. Ilya Fischhoff or Dr. Michal Freedhoff of my staff at 202-225-2836.

Sincerely,

Edward J. Markey

Edward J. Markey

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Summary of *Carbon-Free and Nuclear-Free: A Roadmap for U.S. Energy Policy*
by Arjun Makhijani (RDR Press and IEER Books, 2007)
Downloadable free at http://www.ieer.org/carbonfree/CarbonFreeNuclearFree.pdf

A three-fold global energy crisis has emerged since the 1970s; it is now acute on all fronts

1. Severe climate change, caused mainly by emissions of carbon dioxide,
2. Insecurity of and violence and war associated with control of oil supplies,
3. Nuclear weapons proliferation as it is connected to the spread of nuclear energy.

There has been a great deal of activity at the state and local level as well as among some corporations and investors to address energy issues as they relate to climate. Solar photovoltaic arrays are being installed in megawatt chunks on commercial rooftops and parking lots; venture capital is pouring billions into everything from electric cars and associated battery technology to converting cellulosic biomass into liquid fuels to new solar photovoltaic and solar thermal electric generation technology. But only one work has integrated it all to show how these individual elements can be used to build an efficient energy economy based entirely on renewable energy sources. *Carbon-Free and Nuclear-Free: A Roadmap for U.S. Energy Policy* (called the *Roadmap* for short below) lays out a plan for how all fossil fuels and nuclear power can be completely phased out by 2050 in a manner that is technically and economically viable. The *Roadmap* also includes approaches to meeting fuel requirements without recourse to using food crops as feedstocks for biofuels.

A U.S. economy that is nearly free of CO_2 emissions is not only desirable; it is, practically speaking, a treaty requirement under the United Nations Framework Convention on Climate Change (UNFCCC), which calls for global greenhouse gas emissions reductions in a manner that is cognizant of current and historical inequities. A norm of equal per person CO_2 allowances is a minimal interpretation of the UNFCCC. Specifically, a global reduction of CO_2 emissions by 80 percent by 2050 coupled with an equal per capita allowance system, a demand of China, India, and other developing countries, means that the U.S. will have to reduce its emissions by about 96 percent by that date.

The nuclear industry is proposing to fill a part of the gap with dozens of new nuclear power plant proposals – but there is a catch. New nuclear power plants are costly[1] and financially risky. Even the leaders of the nuclear industry have said that they will not build new plants without 100 percent federal loan guarantees, which could run into hundreds of billions of dollars.[2] At the high end this is a scale

[1] In late 2007, Florida Power and Light estimated the capital cost at $5,000 to $8,000 per kilowatt in its filing with Florida regulators.

[2] On March 10, 2008, Gregory Jaczko, a member of the U.S. Nuclear Regulatory Commission, stated that the U.S. government would need to put up $500 billion in federal loan guarantees over the next decade if it really wanted a nuclear renaissance. Source: Selina Williams, "US Government Loan Guarantees for New Nuclear Too Small-NRC," *Dow Jones Newswires*, March 10, 2008.

comparable to the sub-prime mortgage risk capital. Such government subsidies for private nuclear investments could well foreclose the needed large-scale investments in renewable energy sources.

The *Roadmap* is based on presently available technologies, many of which are commercial today, such as wind-generated electricity and energy efficient building. Other technologies, such as plug-in hybrids and all-electric vehicles, using aquatic plants such as microalgae as power generation fuel are not yet commercial but clearly visible on the technical horizon.

Efficiency must be the foundation of a renewable energy economy that makes economic sense. For instance, the average energy use per square foot of residential buildings is about 58,000 Btu per year. But Hanover House in New Hampshire, which was built with passive solar features, such as high thermal mass and one active solar component – a solar thermal water heater with a 1,000 gallon buried tank – uses only about 8,300 Btu per square foot per year (see Figure 1). The total building cost was modest: $111 per square foot.

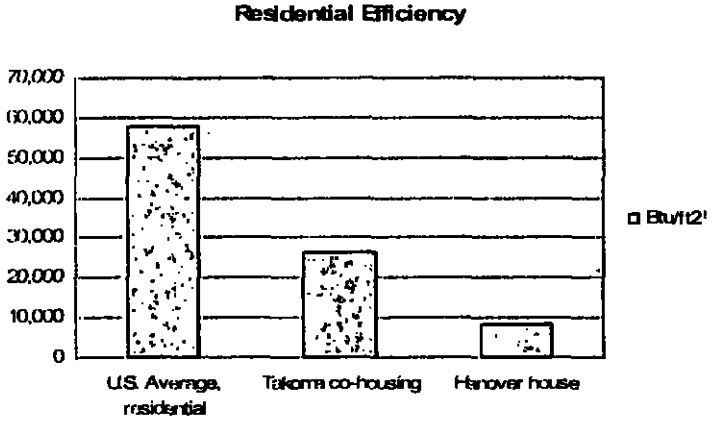

Figure 1: Average residential energy use compared with two efficient buildings: Takoma Co-housing in the Washington, D.C. area and Hanover House in New Hampshire

The United States has ample renewable energy resources to accomplish the transition. Wind energy potential, excluding cities, national parks, and other sensitive areas, amounts to about three times total U.S. electricity generation in 2005. Six states – North Dakota, Texas, Kansas, South Dakota, Montana, and Nebraska, *each* have greater wind energy potential than the total electricity generated by all 104 U.S. nuclear power plants. Solar energy is even more plentiful. In fact, the area of commercial rooftops and parking lots is large enough to supply most U.S. electricity generation. And no new transmission corridors will be needed, though distribution systems will eventually have to be strengthened.

Solar photovoltaic electricity costs, while on the high side today, are declining rapidly and can be expected to be lower than the delivered cost of nuclear electricity from new plants, especially if the solar cells are installed at intermediate scales (several hundred kilowatts to several magawatts) on commercial rooftops and parking lots. Solar thermal power plants are already approximately equivalent with new nuclear costs.

Intermittency of wind and solar energy does not become a significant issue until they assume a share of the electricity system much greater than the present one percent. Wind energy deployed with due attention to geographic diversity can supply 20 to 25 percent of electricity generation with only a few percent increase in reserve requirements. Due to the huge overbuilding of natural gas fired power plants in the last two decades, done in anticipation of continued cheap gas supplies, a significant surplus of natural gas capacity is available as standby capacity. Reserves can be complemented in many areas by

using hydropower in a manner that is coordinated with wind energy availability. Finally, by taking advantage of the diversity in solar and wind energy and building a smart grid, a solid foundation for a distributed grid can be laid in the next 15 to 20 years.

Some baseload capacity and/or energy storage will be required to go to fully renewable grid, an example of which is shown in Figure 2. Compressed air storage, vehicle-to-grid technology, stationary storage devices, such as sodium-sulfur batteries, can complement biomass-fired IGCC (integrated gasification combined cycle) power plants, geothermal plants, and solar thermal plants with heat storage for 12 hours or more. Biomass would be obtained from aquatic plants such as microalgae, water hyacinths in tropical and subtropical regions and duckweed and cattails in temperate areas. Aquatic plants and biomass that does not use agricultural land would be the sources of biofuels. The development of direct production of hydrogen from solar energy and of electrolytic hydrogen production from wind-generated electricity could accelerate the transition and reduce land requirements for biofuels.

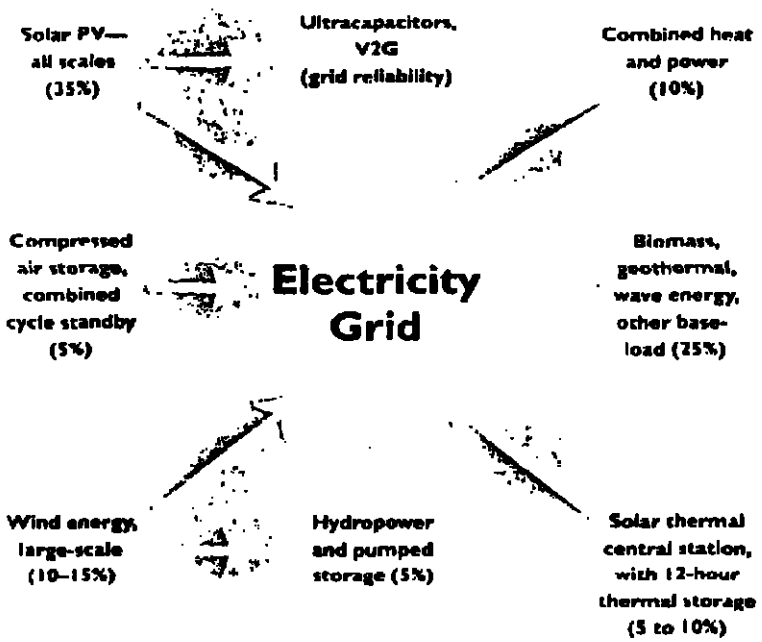

Figure 2: An example of a fully renewable energy electricity grid

Main Recommendations:

1. A single national cap on fossil fuel use should be created for all large users combined (defined as those using more than 100 billion Btu per year, which excludes small businesses and individual households). The allowances would be auctioned by the U.S. Treasury in a single national market much like its financial securities. In such a system those who have been efficient are rewarded because they have to buy fewer allowances; those who use renewable energy sources would not need any. There would be no offsets,

no generation of CO_2 credits for actual or supposed non-polluting activities, and no international trading of allowances. Holders of allowances would either use them or sell them. Verification and enforcement would be done by the EPA. This approach would cover about two-thirds of energy use (including essentially all electricity generating companies, large and medium industries, airline companies, large trucking companies, and a portion of the commercial sector). Accounting would be at the level of the (U.S.) parent corporation. It would be expected to generate $30 billion to $50 billion per year in revenues, which would provide the financial foundation for government action on energy, including revenues to be shared with state and local governments and to be used to assist worker and community transition..

2. Small energy users would be covered in so far as they use grid electricity since fossil fuel using electric companies would be covered by the national cap and by efficiency standards for appliances. Small users of fossil fuels would be covered by efficiency standards for buildings and vehicles. A Btu per square foot standard for new buildings and efficiency standards enforced at the time of sale of existing buildings would greatly increase the efficiency of the building stock over the next several decades.

3. All subsidies for fossil fuels, nuclear energy, and biofuels from food crops would be eliminated.

4. Performance-based federal purchases of buildings, energy sources, and vehicles would be oriented towards bringing the most advanced technologies that would work together for creating a renewable energy economy. For instance, governments at all levels could specify that they will only purchase carbon-neutral buildings by 2025 and that they will be make plug-in hybrids their standard vehicle purchase by 2015. The latter would be used as the basis for demonstrating large-scale vehicle-to-grid technology deployment.

5. Government contracting could give preference to companies with low carbon footprints.

6. Government research, development, and demonstration (R,D&D), including that done in public-private partnerships, as well as incentives for private R,D&D would be considerably increased.

The energy system that would result from these policies would create many more jobs in the United States. For one thing, the $250 billion spent in 2007 on imported oil would be spent on domestic energy sources and efficiency. Overall, the *Roadmap* estimates that the proportion of GDP spent on energy services would be about the same as in a business-as-usual scenario (which assumes no turbulence and no costs of climate change, and which is therefore unlikely to be realized). The unit costs of electricity and fuels would be somewhat higher, the total energy bill somewhat lower; the difference would be invested in energy efficiency.

It will take vision and political courage to enact the tough policies that will be needed to create an economy free of fossil fuels and nuclear power. But an announcement of such an economy as the U.S. goal along with those policies can put the United States in a positive global leadership role on possibly the most critical issue to face humanity. That would surely help reverse the precipitous recent decline in the regard in which it is held in the world. More than that, the United States can help lead the world to a fully renewable energy system that does not contribute to the threat of nuclear proliferation.

Center for American Progress—Nuclear Power Documents

Compiled for NC Utilities Commission by W. Kinsella, 15 March 2011

10 Reasons Not to Invest in Nuclear Energy
July 8, 2008 Nuclear power is so expensive that it requires federal subsidies to compete in the energy market. The money would be better spent elsewhere.

http://www.americanprogress.org/issues/2008/07/nuclear_energy.html

Nuclear power generates approximately 20 percent of all U.S. electricity. And because it is a low-carbon source of around-the-clock power, it has received renewed interest as concern grows over the effect of greenhouse gas emissions on our climate. Yet nuclear power's own myriad limitations will constrain its growth and make it an infeasible solution for making energy more affordable as well as more sustainable.

1. Nuclear faces prohibitively high—and escalating—capital costs.

Nuclear power plant construction costs—mainly materials, labor, and engineering—rose by 185 percent between 2000 and 2007. More recently, costs have been increasing even faster: In mid-March, Progress Energy informed state regulators that the twin 1,100 MW nuclear plants it intends to build in Florida would cost $14 billion, which "triples estimates the utility offered little more than a year ago."

Jim Harding, former direc tor of power planning and forecasting for Seattle City Light, estimates that nuclear plants constructed today would provide electricity at between 12 and 17 cents per kilowatt-hour. To put this cost into perspective, the average U.S. electricity price in 2006 was 8.9 cents per kWh, and well-placed wind turbines can produce electricity for less than 5 cents per kWh.

In August, 2007, the *Tulsa World reported* that American Electric Power Co. CEO Michael Morris was not planning to build any new nuclear power plants. He was quoted as saying, "I'm not convinced we'll see a new nuclear station before probably the 2020 timeline," citing "realistic" costs of about $4,000 per kilowatt. Since then, The prices utilities are quoting for nuclear have soared 50 percent to 100 percent.

2. Plant construction is limited by production bottlenecks.

Japan Steel is the only company in the world "capable of producing the central part of a nuclear reactor's containment vessel in a single piece, reducing the risk of a radiation leak," but it can only produce four per year. Even if Japan Steel increases its capacity, American power companies would be buying components in a global market at a time when China and India are increasing their nuclear capacity to meet growing energy needs.

Supply bottlenecks, coupled with soaring commodity prices, have resulted in enormous price increases for nuclear, which is already capital intensive, even though new reactors have only been coming online at an average rate of about four to five per year in the past decade. Increased nuclear plant construction will be constrained by these factors.

3. New nuclear plants probably won't be designed by American companies.

Because no new nuclear power plants have been built in the United States in over 30 years, foreign companies have more experience building such plants. *The New York Times reported* that, while

considering constructing a new nuclear reactor, the American utility Constellation partnered with the French-German company, Areva, to build a model plant in Finland.

The United States must produce more electricity to keep up with increasing demand, but relying on foreign companies to build nuclear plants means fewer jobs for Americans in the energy sector.

4. Unresolved problems regarding the availability and security of waste storage.

There is currently nowhere to store the radioactive nuclear waste that is a byproduct of nuclear energy generation. In the unlikely event that Yucca Mountain is opened to nuclear waste, the repository will not be large enough to store even current waste.

Proponents of nuclear power note that nuclear waste can be reprocessed, although this would not actually reduce the waste problem, and would add 1.5 to 3 cents to the cost per kilowatt-hour of electricity.

5. Nuclear faces concerns about uranium supplies and importation issues.

In 2007, the United States imported 47 million pounds, or 92 percent, of its uranium. Increased nuclear capacity would either make us more dependent on foreign uranium, or have us risk repeating the environmental debacle of the uranium boom that accompanied the buildout of the U.S. nuclear arsenal and the first wave of nuclear power plant construction.

6. Nuclear reactors require water use amid shortages.

Large areas of the United States already face water shortages, and the effects of global warming are expected to exacerbate this problem. "Electricity generation accounts for nearly half of all water withdrawals in the nation," and nuclear power stations require more water than fossil fuel use does. The only alternative to the water usage associated with nuclear energy is less efficient (and more expensive) dry cooling systems.

7. Safety concerns still plague nuclear power.

After the Three Mile Island and Chernobyl accidents, the United States stopped granting licenses for new nuclear plants. The crises demonstrated that the nuclear industry is vulnerable to public concern. While modern reactors are safer than those that failed in the past, another accident anywhere in the world could turn public opinion against nuclear power as a whole.

8. Nuclear is already a mature technology—it will not get cheaper.

The American nuclear industry has benefited from $100 billion in direct and indirect subsidies since 1948, and nuclear power provides 20 percent of electricity in the United States. The technology behind nuclear power is fully developed, so nuclear energy is unlikely to get much cheaper. Continued subsidies would be necessary to make nuclear cost-competitive with other energy sources, but will not lower the overall price of nuclear power.

9. Other clean energy technologies are cheaper, cleaner, and faster to build.

Solar power, photovoltaics, advanced biofuels, wind power, and other energy technologies promise to revolutionize how electricity is generated in the 21st century. Already, wind energy can produce

electricity for less than five cents per kWh, and concentrated solar power can produce energy for 11-12 cents per kWh—even at night—and these costs are decreasing. Alternatives do not produce nuclear waste, and they do not face the same extensive safety, regulatory, and construction costs and delays that nuclear does.

10. Nuclear subsidies take money away from more effective alternative energy subsidies.

Subsidies for nuclear reactors wouldn't subsidize nuclear technology—they would subsidize the nuclear industry. Congress should fund research of clean, alternative energy technologies that promise to rival fossil fuels in cost—without subsidies. Congress should also provide tax credits that would make such technologies cheaper by encouraging production and moving them down the experience curve.

Such support would encourage a growing American industry and create American jobs. By squandering our limited resources on subsidies for the nuclear power industry, the United States is missing an extraordinary opportunity.

Read more about why subsidizing nuclear power just doesn't make sense from our partner organization, the Center for American Progress Action Fund:

- **The Self-Limiting Future of Nuclear Power**

The High Cost of Nuclear Power
July 16, 2008 Nuclear power may look like an attractive option now, but ultimately, its own limitations will constrain its growth, by Joseph Romm

Joseph Romm | July 16, 2008

http://www.americanprogress.org/issues/2008/07/nuclear_cost.html

CAPAF's Joseph Romm testifies today to the Subcommittee on Clean Air and Nuclear Safety of the Senate Environment and Public Works Committee. Read the full testimony.

Nuclear power generates approximately 20 percent of all U.S. electricity. And because it is a low-carbon source of around-the-clock power, it has received renewed interest as concern grows over the effect of greenhouse gas emissions on our climate.

Yet nuclear power's own myriad limitations will constrain its growth, especially in the near term. These include:

- Prohibitively high, and escalating, capital costs
- Production bottlenecks in key components needed to build plants
- Very long construction times
- High electricity prices from new plants

The carbon-free power technologies that the nation and the world should focus on deploying right now at large scale are efficiency, wind power, and solar power. They are the lower-cost carbon-free strategies with minimal societal effects and the fewest production bottlenecks. They could easily meet all of U.S. demand for the next quarter -century, while substituting for some existing fossil fuel plants. In the medium- term (post-2020), other technologies, such as coal with carbon capture and storage or advanced geothermal, could be significant players, but only with a far greater development effort over the next decade.

Since nuclear power is a mature electricity generation technology with a large market share and is the beneficiary of some $100 billion in direct and indirect subsidies since 1948, it neither requires nor deserves significant subsidies in any future climate law.

Read Joseph Romm's full testimony to the Subcommittee on Clean Air and Nuclear Safety of the Senate Environment and Public Works Committee (CAPAF)

The Staggering Cost of New Nuclear Power
January 5, 2009 A new study puts generation rates for power from nuclear plants at triple current U.S. electricity rates, writes Joseph Romm. by Joseph Romm

http://www.americanprogress.org/issues/2009/01/nuclear_power.html

A new study puts the generation costs for power from new nuclear plants at 25 to 30 cents per kilowatt-hour—triple current U.S. electricity rates!

This staggering price is far higher than the cost of a variety of carbon-free renewable power sources available today—and 10 times the cost of energy efficiency (see "Is 450 ppm possible? Part 5: Old coal's out, can't wait for new nukes, so what do we do NOW?"

The new study, "Business Risks and Costs of New Nuclear Power," is one of the most detailed cost analyses publically available on the current generation of nuclear power plants being considered in this country. It is by a leading expert in power plant costs, Craig A. Severance. A practicing CPA, Severance is co-author of *The Economics of Nuclear and Coal Power* (Praeger 1976), and former assistant to the chairman and to commerce counsel, Iowa State Commerce Commission.

This important new analysis is being published by Climate Progress because it fills a critical gap in the current debate over nuclear power—transparency. Severance explains:

> All assumptions, and methods of calculation are clearly stated. The piece is a deliberate effort to demystify the entire process, so that anyone reading it (including non-technical readers) can develop a clear understanding of how total generation costs per kWh come together.

As stunning as this new, detailed cost estimate is, it should not come as a total surprise. I detailed the escalating capital costs of nuclear power in my May 2008 report, "The Self-Limiting Future of Nuclear Power." And in a story last week on nuclear power's supposed comeback, *Time* magazine notes that nuclear plants' capital costs are "out of control," concluding:

> Most efficiency improvements have been priced at 1¢ to 3¢ per kilowatt-hour, while new nuclear energy is on track to cost 15¢ to 20¢ per kilowatt-hour. And no nuclear plant has ever been completed on budget.

Time buried that in the penultimate paragraph of the story!

Yet even *Time*'s rough estimate is too low, as "Business Risks and Costs of New Nuclear Power" quantifies in detail. Here is the executive summary:

> It has been an entire generation since nuclear power was seriously considered as an energy option in the U.S. It seems to have been forgotten that the reason U.S. utilities stopped ordering nuclear power plants was their conclusion that nuclear power's business risks and costs proved excessive.
>
> With global warming concerns now taking traditional coal plants off the table, U.S. utilities are risk averse to rely solely on natural gas for new generation. Many U.S. utilities are diversifying through a combination of aggressive load reduction incentives to customers, better grid management, and a mixture of renewable energy sources supplying zero-fuel-cost kWh's, backed by the KW capacity of natural gas turbines where needed. Some U.S. utilities, primarily in the

South, often have less aggressive load reduction programs, and view their region as deficient in renewable energy resources. These utilities are now exploring new nuclear power.

Estimates for new nuclear power place these facilities among the costliest private projects ever undertaken. Utilities promoting new nuclear power assert it is their least costly option. However, independent studies have concluded new nuclear power is not economically competitive.

Given this discrepancy, nuclear's history of cost overruns, and the fact new generation designs have never been constructed any where, there is a major business risk nuclear power will be more costly than projected. Recent construction cost estimates imply capital costs/kWh (not counting operation or fuel costs) from 17-22 cents/kWh when the nuclear facilities come on-line. Another major business risk is nuclear's history of construction delays. Delays would run costs higher, risking funding shortfalls. The strain on cash flow is expected to degrade credit ratings.

Generation costs/kWh for new nuclear (including fuel & O&M but not distribution to customers) are likely to be from 25 - 30 cents/kWh. This high cost may destroy the very demand the plant was built to serve. High electric rates may seriously impact utility customers and make nuclear utilities' service areas noncompetitive with other regions of the U.S. which are developing lower-cost electricity.

I am not saying here that nuclear power will play no role in the fight to stay below 450 ppm of atmospheric CO2 concentrations and avoid catastrophic climate outcomes. Indeed, I have been including a full wedge of nuclear in my 12 to 14 wedges "solution" to global warming here. It may, however, be time to reconsider that, since it is increasingly clear achieving even one wedge of nuclear will be a very time-consuming and expensive proposition, probably costing $6 trillion to $8 trillion and sharply driving up electricity prices.

Given the myriad low-carbon, much lower-cost alternatives to nuclear power available today—such as efficiency, wind, solar thermal baseload, solar PV, geothermal, and recycled energy (see "An introduction to the core climate solutions")—the burden is on the nuclear industry to provide its own detailed, public cost estimates that it is prepared to stand behind in public utility commission hearings.

What is unique about this new analysis is its transparency: "all assumptions, and methods of calculation are clearly stated." As Severance explains:

In contrast to this transparency, many nuclear promoters have adopted a "Black Box" approach. It has unfortunately been the case over the last couple of years that some utilities have begun to claim that even rudimentary basics of their nuclear cost estimates must be hidden from the public as "trade secrets." For instance, in the South Carolina Electric & Gas proposal to build two reactors now under consideration by the South Carolina PSC, there is literally a large "box" obscuring the bulk of the calculations in the SC E&G Exhibit which presents the utility's projection of construction and financing costs for the proposed two-unit facility. In a different case, Duke Energy claimed that it does not even have to disclose its new cost estimates for a proposed nuclear facility in Cherokee County, S.C.. In the Duke case, C. Dukes Scott, South Carolina's consumer advocate, who represents the public in utility rate cases, noted, "If the cost wasn't confidential in February," Scott said, "how is it confidential in April?"

Even when no effort to conceal information is apparent, the very terminology used when projections are presented can be confusing or misleading. For instance, in 2007 when a number of new nuclear proposals began to advance, it was common for "Overnight Cost" estimates to be

quoted. For a project (such as solar or wind) whose construction period may be as short as several months, the difference between an "overnight" cost and the full cost to complete the project may not be significant. However, for a nuclear project that may typically take a decade to complete, cost escalations that occur during this long construction period, plus the financing costs during construction, may easily double the total cost of a project compared to its "overnight" cost. When the full picture is presented, some may perceive the total cost estimate has mysteriously doubled. However, it simply should have been stated clearly to begin with that major escalation and financing costs cannot be avoided when it takes a long time to complete a project. Failure to do so is tantamount to selling someone a house with "teaser" initial mortgage payments and failing to make clear that the mortgage payments will later reset to a much higher level.

Another mysterious "black box" presentation method is to fold the overall costs of the new facility into the general rate base of the utility, without ever mentioning what the generation costs per kWh of the nuclear unit will be. Instead, it is often only presented how total costs per kWh for all ratepayers will increase—which includes kWh's generated by existing generation units. (For instance, if a nuclear unit is to supply 20% of the kWh's for the utility when it comes on line, any cost increase per kWh appears to only be 1/5 as large because the additional costs are also spread over the 80% of kWh's generated by other facilities, even though those other facilities did not cause the rate increase.) While it is important to know the impact on final overall retail electric rates, it is also important to know the generation costs per kWh from the nuclear facility. If this step is "skipped" in public presentations, the nuclear units (or any new generation power source that is more expensive than existing units) can appear far cheaper than their real impact.

The Paper takes the approach that it is best to lay out in detail "how you got that number" at each step of the way. All parties can then proceed to have discussions based upon real numbers rather than mysterious "Black Box" secrets.

So feel free to criticize the analysis, but anyone offering different all-in cost estimates for power from new nuclear plants should detail their own assumptions and calculation. And simply pointing to the operating costs of existing paid-off nuclear plants doesn't count as detailed analysis—my home would be very cheap to live in if I didn't have a mortgage.

Also, it's fine to call for aggressively developing fourth generation nuclear plants (as James Hansen does)—I'm all for such R&D—but that won't help us meet 2020 climate targets, and probably won't help us significantly meet 2030 targets. In any case, it is impossible to accurately project the real world all-in costs of noncommercial technologies that are still largely sitting on the drawing board.

The full study is here.

Warning to Taxpayers, Investors: Nukes May Become Troubled Assets
January 7, 2009 The second column in a series from Joe Romm on a new report that shows the staggering cost of new nuclear power. by Joseph Romm

By Joseph Romm | January 7, 2009

Warning to Taxpayers, Investors: Nukes May Become Troubled Assets

http://www.americanprogress.org/issues/2009/01/nuclear_power_part2.html

Nuclear plants with such incredibly expensive electricity and "out of control" capital costs, as *Time* put it, obviously create large risks for utilities, their investors, and, ultimately, taxpayers. Congress extended huge loan guarantees to new nukes in 2005, and the American people will be stuck with another huge bill if those plants join the growing rank of troubled assets (see "Nuclear energy revival may cost $315 billion, with taxpayers' risking over $100B").

The risk to utilities who start down the new nuke path is also great. A June 2008 report by Moody's Investor Services Global Credit Research, "New Nuclear Generating Capacity: Potential Credit Implications for U.S. Investor Owned Utilities" (PR here), warned that "nuclear plant construction poses risks to credit metrics, ratings," concluding:

> The cost and complexity of building a new nuclear power plant could weaken the credit metrics of an electric utility and potentially pressure its credit ratings several years into the project, according to a new report from Moody's Investors Service....
>
> Moody's suggests that a utility that builds a new nuclear power plant may experience an approximately 25% to 30% deterioration in cash-flow-related credit metrics.

And this would likely result in a sharp downgrading of the utility's credit rating.

The application by Florida Power & Light (FPL) for a large nuclear plant came in at a stunning $12 to $18 billion, and the utility concedes that new reactors present "unique risks and uncertainties," with "every six-month delay adding as much as $500 million in interest costs."

The report Climate Progress published this week, "Business Risks and Costs of New Nuclear Power" by power-plant cost expert Craig Severance, has an extended discussion of the business risks to utilities and hence investors:

> In its 2003 study "The Future of Nuclear Power", MIT included a 3% risk premium in its calculations of projected Cost of Capital for nuclear projects, because of the extra business risks projected for nuclear. MIT's concerns were valid.
>
> Florida Power & Light has stated: "In general, the rating agencies (such as Moody's Investor Services) view new nuclear construction as a higher risk than other technologies. This view is primarily driven by the long approval and construction process associated with new nuclear construction as well as the size of the capital requirements in relation to the utility as compared to capital requirements for other generation technologies. Rating agencies also recall the difficulties of the 1970's and 1980's."

On June 2nd of this year, Moody's Investor Services Global Credit Research issued a public announcement entitled "Moody's: Nuclear Plant Construction Poses Risks to Credit Metrics, Ratings." Per the Announcement: "Moody's examines the effects of a new nuclear facility on the credit metrics of "NukeCo", a hypothetical electric utility. Through this illustrative model, Moody's suggests that a utility that builds a new nuclear power plant may experience an approximately 25% to 30% deterioration in cash-flow-related credit metrics. In the case of "NukeCo", cash flow from operations as a percentage of debt falls from roughly the 25% level to the mid-teens range."

The Moody's simulation begins with the fictional utility "well-positioned within the single-A ratings category before building a nuclear plant....", however " ... in years 5-10, when construction costs reach their peak and key credit metrics begin to deteriorate significantly, the fictional company would be better positioned in Baa-rating category."

In today's nervous credit climate, downgrading a corporation to a more risky Baa rating (the lowest tier of investment grade debt) may carry serious consequences. Moody's Seasoned Baa Corporate Bond Yield: Percent [www.economagic.com/em-cgi/data.exe/fedstl/baa+2], shows that in October 2008, the Baa yield climbed to 8.88 percent, compared to only 7.31 percent in September 2008, the highest relative monthly jump since the table began in 1919, indicating investors have extreme default risk concerns. The fact a Baa bond will have a higher effective interest rate is not even the biggest concern. The very ability to sell downgraded bonds in a credit market already termed "dysfunctional" may be the more critical factor.

The Moody's Announcement also notes a risk to the shareholders of the utility: "The technology is very costly and complex, and the 10- to 15-year duration of these construction projects can expose a utility to material changes in the political, regulatory, economic and commodity price environments, as well as new alternatives to nuclear generation. These potential changes in the landscape could prompt regulators to disallow certain cost recoveries from ratepayers after a plant is built, or lead to market intervention or restructuring initiatives by elected officials."

Industry commentators have also noted these financial risks. *Nuclear Engineering International* noted on 22 August 2008: "Companies that build new nuclear plants will see marked increases in their business and operating risks because of the size and complexity of these projects, the extended time they take to build, and their uncertain final cost and cost recoveries. To the extent that a company develops a financing plan that overly relies on debt financing, which has an effect of reducing the consolidated key financial credit ratios, regardless of the regulatory support associated with current cost recovery mechanisms, there is a reasonably high likelihood that credit ratings will also decline. So 'thinking caps' must now certainly go on amongst US boards of management — credit ratings are important and taking a punt on a new nuclear plant may not be the first priority of a CEO in his late 50s with a distinguished career behind him."

Severance's conclusion:

Credit ratings are very important. The prospect that undertaking a single project could have such a major impact on a utility company's balance sheet and cash flow that company credit ratings would be downgraded, should give pause to any executive, or oversight regulator, contemplating the wisdom of undertaking such a project.

The full study is here.

Taxpayer Protection and the Nuclear Loan Guarantee Program
April 20, 2010 CAP Action's Richard Caperton Testifies before the Domestic Policy Subcommittee of the Committee on Oversight and Government Reform. by Richard W. Caperton

By Richard W. Caperton | April 20, 2010

http://www.americanprogress.org/issues/2010/04/caperton_testimony.html

CAP Action's Richard Caperton testifies before the House Committee on Oversight and Government Reform. Read the testimony (CAP Action)

Nuclear power currently generates about one-fifth of American electricity. At the Center for American Progress Action Fund, we strongly believe that nuclear power will continue as a low-carbon baseload power source that will play an important role in America's clean energy future. It's vitally important that we explore all potential energy sources and encourage the development of sources that reduce our carbon emissions. At the same time, we must keep in mind that every dollar that supports one fuel source is a dollar that can't be used somewhere else. In an era of tight budgets and limited government resources, it's important that every dollar be spent in a way that cost-effectively transitions America toward a clean energy economy.

Perhaps nowhere is this challenge of balancing carbon reductions with low spending more apparent than with nuclear power. Building a nuclear reactor today will involve dealing with tremendous financial uncertainty. Cost projections for nuclear plants keep rising because of variability in material costs, complex new technology, limited suppliers for key parts, and inevitable delays in construction projects. The projected cost for two new reactors in Canada shot from $7 billion to $26 billion in just two years. A new reactor built by Areva in Finland has run into widely publicized challenges, with construction costs going up at least 50 percent since construction began three years ago. And costs for two new reactors at the South Texas Project in the United States have ballooned from $5.4 billion to an estimated $18.2 billion since 2007. Neither of these reactors has been built, so there's no way to predict what the final cost will be. But cost overruns are virtually certain in nuclear construction, which greatly increases the risk that the nuclear companies will default on their loans. Private lenders are well aware of the risks involved in building new reactors, which is why they're unwilling to finance the projects without significant government support.

The huge cost of nuclear power means that taxpayers will have to provide nuclear loan guarantees to finance new projects if the president and Congress are serious about building new reactors. The terms of these guarantees must include adequate protections for taxpayers.

CAP Action's Richard Caperton testifies before the House Committee on Oversight and Government Reform. Read the testimony (CAP Action)

Henry Exhibit 1
From a Nov. 2009 article by Mark Cooper, Senior Fellow at Vermont Law School
"All Risk, No Reward for Taxpayers and Ratepayers" E-7 Sub 819
I/A 3/15/11 LG

Table II-1: The Types of Risks Affecting New Nuclear Reactor Projects

Category	Source	Specific Risks
Technology risk	New technology risk	First-of-a-kind costs Long lead-time
	Alternative technologies	Efficiency potential identified Renewable cost declines
Policy risk	Shifting focus	Emphasis on efficiency reduces need Emphasis on renewables reduces need
	Flexible GHG reductions	Lowers carbon cost
Regulatory risk	NRC regulatory reviews	Lack of experience Change of requirements Design flaws and revisions Site-specific contentions
	Loan guarantee conditions	Taxpayer protections inhibit guarantees
	Rate review	Recovery of costs challenged
Execution risk	Construction risk	Lack of experience Counterparty risk
	Engineering, Production and Construction contract uncertainties	Cost escalation and volatility
	Size, cost and complexity	Cost overruns Delays Rework costs
Marketplace risk	Uncertain demand growth	Slowing due to recession Shifting due to debt and loss of wealth
	Uncertain fuel costs	Natural gas price decline
	Reactor costs	Long lead time Cost overruns Rate shock reduces demand
Financial risk	General conditions	Tight money New liquidity requirements High-risk premiums
	Utility finance	Increased nuclear operating exposure Existing debt and need to refinance Financial ratio deterioration Rising cost of debt Limited & declining cash & equivalents Weak balance sheets Underfunded pension plans
	Project finance	High hurdle rate for risky projects Impact of large project Debt load and service burden impact Capital structure distortion

Public Advocacy Groups E-7 Sub 89
Rogers Cross Examination I/A 3/15/11 LG
Exhibit 1

Duke Energy.

Investors

Duke Energy Indiana Proposes Cost Cap for New Power Plant

March 10, 2011

PLAINFIELD, IND. - In testimony filed with Indiana state utility regulators Thursday, Duke Energy Indiana proposed significant customer protections associated with the construction of its Edwardsport coal gasification plant near Vincennes, Ind.

The company is proposing to cap the project's construction costs to be passed along to customers at $2.72 billion, excluding financing costs on that amount. Duke Energy also is proposing rate-related adjustments that will lower the overall customer rate increase related to the project from an average of about 19 percent to about 16 percent. The average residential, homeowner impact would be about 14 percent.

The proposal is subject to Indiana Utility Regulatory Commission approval.

"The effect of these proposals would be to bring the project's near-term rate impact to approximately the same level it would have been under the currently approved, $2.35 billion cost estimate," said Duke Energy Indiana President Doug Esamann. "We believe this approach balances four important objectives: the continuing need for new power generation; modernizing Indiana's aging power system, reducing the customer rate impact; and giving shareholders a reasonable return on their investment."

Specifically, Duke is proposing:

- a hard cost cap commitment of $2.72 billion, plus financing costs on that amount;
- waiver of the deferred tax financial incentive authorized by the commission in 2007 for this project; and
- a reduction in depreciation expense charged to customers.

In addition, Indiana customers will see the benefits of "bonus depreciation." Bonus depreciation is a federal tax incentive provided for major projects such as the Edwardsport plant as part of the Tax Relief Unemployment Insurance Reauthorization and Job Creation Act of 2010.

Last April, the company announced that the Edwardsport project's scale and complexity would add approximately $530 million to the previously approved $2.35 billion estimate. That brought the total estimated cost of the plant to $2.88 billion, or $2.72 billion, not including financing costs.

The company's proposal filed today is part of Indiana Utility Regulatory Commission proceedings to review the cost increase request. Commission hearings are scheduled to begin Aug. 22.

If approved by regulators, the rate increase will not come at once; already approved costs began phasing into rates in January 2009 and will increase gradually through 2013. This "pay as you go" approach benefits customers by lowering total financing costs and spreading the rate increase over time.

Background on the Edwardsport Project

The Edwardsport coal gasification plant is under construction in southwest Indiana. The total project, factoring in aspects such as engineering, construction and purchasing, is more than 80 percent complete. Actual construction is about 70 percent done. It is scheduled to be operating in the fall of 2012.

The plant will use state-of-the-art technology to gasify coal, strip out pollutants, and then burn that cleaner gas to produce electricity. This advanced, integrated gasification combined cycle technology significantly improves plant efficiency and reduces carbon emissions per megawatt-hour by nearly half.

Regulators granted the company permission in 2007 to construct the technologically advanced clean coal power plant in Edwardsport, Ind. It is the first time a plant this size using this advanced clean coal technology has been built anywhere in the world.

The approximately 618-megawatt plant is a critical part of Duke Energy Indiana's efforts to modernize its generation fleet and an

initial step toward replacing between approximately 540 and 1,100 megawatts of older, coal-fired generation expected to be retired in the future due to pending EPA regulations. The Edwardsport plant will:

- Produce 10 times as much power as the existing plant at Edwardsport, yet with significantly less environmental impact than the much smaller plant it replaces.
- Be the first major new coal-fired power plant built in Indiana in more than two decades. The plant is a key step in modernizing the state's aging electric system.
- Generate marketable byproducts. This plant will produce sulfur and slag for agricultural and construction materials. Any revenues from marketable byproducts will go to customers.
- Use dramatically less water. The IGCC plant will need less than one-tenth the amount of water per day compared to the current plant.
- Replace the existing 160-megawatt, 60-plus-year-old power plant with state-of-the art efficiency. Because it is so efficient, Edwardsport will be one of the first plants called on when power is needed, which reduces the need to run older, less efficient units.
- One of the largest construction projects ever undertaken in Indiana. About 3,000 construction workers and other professionals are currently working on site. The plant will employ about 110-120 full-time workers. In addition, the 1.7 million to 1.9 million tons of coal the plant will use each year will support an estimated 170 mining jobs.

Duke Energy Indiana's operations provide approximately 6,800 megawatts of electricity capacity to approximately 780,000 customers, making it the state's largest electric supplier.

Duke Energy is one of the largest electric power holding companies in the United States. Its regulated utility operations serve approximately 4 million customers located in five states in the Southeast and Midwest, representing a population of approximately 11 million people. Its commercial power and international business segments own and operate diverse power generation assets in North America and Latin America, including a growing portfolio of renewable energy assets in the United States.

Headquartered in Charlotte, N.C., Duke Energy is a Fortune 500 company traded on the New York Stock Exchange under the symbol DUK. More information about the company is available on the Internet at: www.duke-energy.com (http://www.duke-energy.com). To learn more and contribute to the discussion about the energy issues of today and the possibilities of tomorrow see www.sheddingalight.org (http://www.sheddingalight.org).

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Back to News Releases (/news/default.asp)

Public Advocacy Group
Rogers Cross Examination
Exhibit 2
E-7 Sub 819
I/A 3/15/11 LG

From: Turner, Jim
To: Rogers, Jim; Executive Staff
CC: Currence, Kathy K; Toney, BT
Sent: 7/2/2010 9:20:05 AM
Subject: RE: Duke's nuclear history

[redacted]

Obviously, the "design it once, build it many times" philosophy that underpins the AP 1000 design substantially reduces the likelihood of overruns in the 340% to 450% range, but it is not unreasonable to assume and plan for costs to be as high as 40%- 50% above current estimates (see, for example, Cliffside and Edwardsport).

[redacted]

Attachment 3