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Testimony prepared for the Domestic Policy Subcommittee of the Oversight and Government Reform Committee of the U.S House of Representatives Concerning the Economic Advisability of Increasing Loan Guarantees for the Construction of Nuclear Power Plants

By

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April 20, 2010[1]

My name is Arjun Makhijani. I am President of the Institute for Energy and Environmental Research (IEER). IEER is a non-profit technical institute that provides the public and policy-makers with thoughtful, clear, and sound scientific and technical studies on a wide range of issues including energy. I mention a few items of interest in my background here. I was the principal author of the first study on the efficiency potential of the U.S. economy, published in 1971, two years before the first energy crisis. I have consulted with utilities and as well as non-government groups on energy-related issues. My record of doing studies on energy issues and more generally of doing public interest work on energy and environmental issues was recognized in 2007, when I was elected a Fellow of the American Physical Society, an honor accorded to at most one-half of one percent of its members.

Chairman Kucinich and members of the Subcommittee, I deeply appreciate the opportunity to testify before you today on some issues concerning the expansion of loan guarantees for the construction of new nuclear power plants. You asked me to address six questions, so I have prepared my testimony under six headings corresponding to those questions. But before I go down that list, Mr. Chairman, let me take this opportunity to thank you for taking the time to read my latest book, *Carbon-Free and Nuclear-Free: A Roadmap for U.S. Energy Policy*, and to promote its central conclusion that a fully renewable energy system can be achieved in the United States at reasonable cost.

A. Wall Street and Nuclear Power

[1] Correction on page 6, lines 2 to 4 made on April 30, 2010.

Your first question was:

> "Why won't Wall Street invest in nuclear power plants, and why does Moody's call them a "bet-the-farm" investment?"

In response, let me first cite Jeffrey Immelt, the CEO of General Electric, who was quoted in the *Financial Times* in November 2007 as follows:

> "If you were a utility CEO and looked at your world today, you would just do gas and wind," Mr Immelt says. "You would say [they are] easier to site, digestible today [and] **I don't have to bet my company on any of this stuff. You would never do nuclear. The economics are overwhelming.**"[2]

While General Electric sells all three types of power plants (nuclear, gas turbines, wind), Mr. Immelt was arguing for loan guarantees for nuclear because only nuclear power requires betting the whole company and sometimes more on the success of a project. Let me provide specific examples of the meaning of "betting the company" or "betting the farm."

In Florida, two utilities – Progress Energy and Florida Power and Light (FPL) – have announced nuclear projects of two reactors each. Progress Energy's market capitalization on March 10, 2010, at 3 pm was $10.85 billion.[3] The price tag for its two-reactor nuclear project is $17 billion, which is about 57 percent larger than the market value of the company. This is more than betting the company on a single project. It means that bond holders could not recover the value of their investment even if they took over all the common stock of the entire company in the event of project failure.

The FPL project, which involves the same type of reactors but a lower transmission cost estimate, is somewhat better, but even there the company, one of the largest private electric companies in the United States, has a market capitalization of about $19.41 billion,[4] not much more than the $14 billion estimated cost of the project before unforeseen delays and cost escalations, which have been common in the past.

The municipal electricity and natural gas utility of the City of San Antonio, CPS Energy, provides another illustration of the "bet-the-farm" metaphor. CPS Energy's original 50 percent share of a two-reactor project in South Texas would amount to about $9.1 billion, while the net value of all its capital assets, including its entire electrical system, its entire gas system, and all of its buildings and land was $6.4 billion at the end of its 2009 Fiscal Year (January 2009).

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[2] As quoted in Ed Crooks and Sheila McNulty, "US utilities are sceptical over nuclear energy revival," *Financial Times,* November 19 2007. Accessed February 28, 2010 via www.ft.com/cms/s/0/8975e03c-9601-11dc-b7ec-0000779fd2ac.html. Emphasis added.

[3] Progress Energy Inc. (PGN), at http://finance.yahoo.com/q?s=PgN, viewed at 3:00 pm, March 10, 2010. All market capitalization values are common stock totals.

[4] FPL Group Inc, at http://www.dailyfinance.com/quotes/fpl-group-inc/fpl/nys, viewed at 3:20 pm, March 10, 2010.

Another aspect of "betting the farm" is the long lead time for nuclear projects – six or seven years in the best case for licensing, engineering and construction; typically it takes ten years or more. That is a decade of financial outflows and interest payments before a single dollar returns as revenue. It means making a bet of the size of the company on utility forecasts, which have been notoriously unreliable. I will return to this issue in addressing your question about future electricity demand and its relation to new nuclear power plants.

Since Wall Street won't finance these projects, these three companies have turned to ratepayers to do so. The current status of ratepayer funding for these reactors is most instructive and a warning sign for what might happen to taxpayer dollars via federal loan guarantees and possibly loans via the Federal Financing Bank.

The Florida state legislature has allowed both utilities to collect money in advance from ratepayers for the projects without any promise in return that the projects will be completed or that ratepayers will get any electricity. This is like giving an advance to a builder for a house without any assurance that he will build the house and give you the keys. Florida ratepayers began their revolt almost as soon as the utilities started collecting money for these projects. This practice increases energy costs for businesses; they must either swallow these rate increases or, even tougher, pass them on to their customers in the middle of a recession. As a result, even large businesses and industries are now beginning to oppose these advance payments, according to an article in *The Washington Post*:

> The utilities' gains [advance payments] are the consumers' losses -- and businesses such as the Georgia Industrial Group and the Georgia Textile Manufacturing Association have joined consumer and environmental groups in combating the state laws and higher rates.
>
> In Florida, PCS Phosphate, which has a fertilizer plant that uses about 1 percent of Progress Energy's output, told the Public Service Commission that new rate increases "will substantially affect" the company "by directly increasing the cost of power."[5]

Ratepayer anger has resulted in the Florida Public Service Commission denying further rate increases to Progress Energy and FPL, putting both projects in jeopardy. FPL responded by suspending further investment in its nuclear project and now seems to be headed in a direction of relying on renewable electricity sources for company revenue growth.[6] FPL is also looking into loan guarantees.[7] If the Progress Energy project is abandoned, as it may be, it is unclear whether

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[5] Steven Mufson, "Nuclear Projects Face New Hurdle," *The Washington Post*, March 2, 2010, at www.washingtonpost.com/wp-dyn/content/article/2010/03/01/AR2010030103975.html?hpid=topnews, viewed on March 2, 2010 at 8:33 AM.

[6] Katarzyna Klimasinska (Bloomberg), FPL's Hay Relies on Wind as Rate Case Clouds Utility Outlook, *Business Week*, Feb. 26, 2010, at www.businessweek.com/news/2010-02-26/fpl-s-hay-relies-on-wind-as-rate-case-clouds-utility-outlook.html.

[7] Eileen O' Grady, "CERAWEEK-FPL may delay nuclear plants; seek loan guarantee: New reactors may be delayed beyond 2018," *Reuters*, http://www.reuters.com/article/idUSN1123143220100311, March 11, 2010.

ratepayers will get any of their money back – so far $196.6 million.[8] According to a Progress Energy spokesperson, "[w]ithout this legislation [allowing collection of advance payments from ratepayers], we would not be considering building new nuclear generation in Florida."[9]

In San Antonio, CPS Energy spent $370 million of ratepayer money[10] on preliminary engineering and licensing without ever getting a firm cost estimate from Toshiba, the vendor. Neither final cost estimate nor the license is due until 2012. The cost estimate of the two-reactor project has already jumped from an initially stated $5.4 billion in 2007 to $18.2 billion as of the end of 2009.[11] Such escalations were not hard to foresee. In March 2008, when the company that initiated the project, NRG Energy (NRG), put it at $6 billion to $7 billion, I estimated that the cost would be much higher – $12 billion to $17.5 billion, even in the absence of cost escalations and delays.[12] CPS Energy's original share of the project was greatly in excess of the net value of its entire electrical generation, transmission and distribution assets.

In the past three years CPS Energy not only pursued the nuclear reactors but also tried renewables and fossil fuels. The result has been a rate increase and overcapacity. This "AA+" rated (Fitch rating) utility is now in financial difficulties even before a license has been granted. The nuclear cost increases and associated controversies regarding a cover-up have caused a scandal and the resignation of the Board's Chair. CPS Energy has decided to stop spending any more money on the project and to reduce its share from 50 percent to 7.625 percent. It is far from clear that the project will be completed. It has no loan guarantees as yet. This is a case study in how nuclear investments can jeopardize even a well-rated utility.

It is worth exploring this example further because the project appears to be an early candidate for the next set of federal loan guarantees. CPS Energy filed a $32 billion lawsuit against its partners in the South Texas Project, NRG and Toshiba, which operate together for this project under a company called Nuclear Innovation North America (NINA). Among the claims that CPS Energy made in the lawsuit were that NINA made fraudulent claims to get CPS Energy into the project.[13]

As a result of the NRG v. CPS settlement, NRG and its Japanese collaborator, Toshiba, now face the prospect of owning over 92 percent of the two-reactor project. NRG, which would be the principal

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[8] Steven Mufson, "Nuclear Projects Face New Hurdle," *The Washington Post*, March 2, 2010, at www.washingtonpost.com/wp-dyn/content/article/2010/03/01/AR2010030103975.html?hpid=topnews, viewed on March 2, 2010 at 10:27 AM.

[9] As quoted in Steven Mufson, "Nuclear Projects Face New Hurdle," *The Washington Post*, March 2, 2010.

[10] "San Antonio utility settles over nuke plant expansion," *San Antonio Express-News*, Feb. 18, 2010. Accessed Mar. 2, 2010 via www.chron.com/disp/story.mpl/business/6872806.html.

[11] Tracy Idell Hamilton and Anton Caputo, "Nuclear cost estimate rises by as much as $4 billion", San Antonio Express News, October 28, 2009, at www.mysanantonio.com/news/Nuclear_cost_estimate_rises.html.

[12] Arjun Makhijani, *Assessing Nuclear Plant Capital Costs for the Two Proposed NRG Reactors at the South Texas Project Site*, Institute for Energy and Environmental Research, Takoma Park, Maryland, March 24, 2008, at http://www.ieer.org/reports/nuclearcosts.pdf.

[13] Anton Caputo, "Nuclear Lawsuit Underway," *San Antonio Express News*, January 26, 2010, on the web at http://www.mysanantonio.com/news/local_news/Nuclear_lawsuit_under_way.html.

owner of the reactors,[14] had a market capitalization of about $5.9 billion on March 17, 2010.[15] The proposed reactors are currently costed at more than three times this amount (including interest during construction).

Moreover, CPS Energy, which will put in no more money into the project to retain the 7.625 percent share, is the stronger of the two partners in terms of its bond ratings. In contrast to the high-grade rating of CPS Energy, NRG's debt is rated by all three bond-rating agencies (Moody's, S&P, and Fitch) as non-investment grade, speculative, or highly speculative.[16] This kind of debt is sometimes referred to as "junk bonds," though I should note that this term covers a wide span of ratings, with several below the ratings of NRG.

NRG would have to sell its 92-plus percent share of the power on the open electricity market unless it can get new utility partners who agree in advance to take the power. CPS Energy and NRG have been trying to secure a partner for 20 percent of the project for about two years, without success. In the meantime, the power markets for open market sales have become much more difficult since so many utilities now have surplus capacity. Average power prices at peak times in Texas were $60.98 per megawatt-hour in 2007; they rose to $86.23 in 2008 and fell by more than half to only $35.43 in 2009.[17] This is much below any estimate of the cost of power from a new nuclear reactor. While peak prices may recover, it should be noted that the average open market price of power over the whole year, which should be the gauge for a nuclear reactor owned mainly by an independent generating company, would of course generally be much lower than peak prices.

So the project that was once touted as the leading edge of the nuclear renaissance and that was one of the first in line for loan guarantees[18] and the first since 1978 to have its application for a construction and operating license accepted by the NRC is now rather a mess. Is this the kind of disorder into which taxpayers should be putting billions at risk?

These examples illustrate why Wall Street won't touch nuclear projects with a ten-foot pole. They are, after all, reminders of the sorry history of cost overruns, rate hikes, and bond defaults of the

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[14] NRG's share in the project partnership, NINA, is 88 percent; Toshiba owns the other 12 percent of NINA. See "NRG Energy, Toshiba ask CPS Energy to withdraw lawsuit," San Antonio Business Journal, December 24, 2009, at http://sanantonio.bizjournals.com/sanantonio/stories/2009/12/21/daily27.html.

[15] NRG Energy, Inc. Common Stock (NYSE: NRG), at http://finance.yahoo.com/q?s=Nrg, viewed on March 17, 2010 at 10:49 am.

[16] The ratings can be found in NRG Energy, Inc. 10-K statement of February 17, 2010 at http://www.sec.gov/Archives/edgar/data/1013871/000095012310015824/y81314e10vk.htm, p. 113. For instance, the Fitch ratings are all between B (high speculative) and BB+ (non-investment grade). The only debt type with a rating slightly above non-investment grade is Moody's rating of NRG's Term Loan Facility at Baa3. The other two rating agencies rate this same debt as non-investment grade. Hereafter NRG 10-K statement 2010.

[17] Hereafter NRG 10-K statement 2010, p. 74.

[18]NINA, *South Texas Project Selected for Department of Energy Loan Guarantee Negotiation: Project continues to be a leader in the nuclear renaissance*, New York, May 19, 2009, at http://www.nuclearinnovation.com/pdf/0519%20STP%2034%20DOE%20Loan%20Guarantees%20FINAL.pdf.

1980s that led *Forbes* to call nuclear power "the largest managerial disaster in business history."[19] That history can be summarized in two startling facts that have not been included in the present debate with any prominence. In all, more than 100 reactors have been cancelled. None of the reactors ordered after the start of the energy crisis in October 1973 was completed. Demand was overestimated; efficiency and cost were underestimated at great cost to ratepayers, bondholders, and industry, which suffered needlessly higher electricity rates as a result. As noted above, this is happening again in Florida.

Wall Street was burned once; it does not want to be burned again. So the nuclear industry now seeks to put the taxpayers' money at risk instead.

B. New Reactor Designs

The second issue you asked me about was "the extent to which there are new nuclear power plant designs with a proven track record."

There are several categories of new reactor designs. The only ones that have been certified or have applications for certifications are light-water reactor designs, often called Generation III+ designs, which are close to the designs of operating commercial reactors in the United States – that is boiling water reactors (BWRs) and pressurized water reactors (PWRs). Three of the reactors have not yet been certified – the Economically Simplified Boiling Water Reactor (ESBWR), the U.S. EPR, which is the U.S. version of the European Pressurized Water Reactor, and the U.S. APWR, a variant of the PWR. For these reactors there is no operational experience and no track record, proven or otherwise.

The European design of the EPR is being built in Finland, France, and China. However, construction is not complete even of the Finnish EPR, which was originally due to be completed in 2009. In the past two years, Finnish, British, and French regulators have raised questions about the design of the control and instrumentation systems of the EPR. In November 2009, they jointly concluded that "the issue is primarily around ensuring the adequacy of the safety systems (those used to maintain control of the plant if it goes outside normal conditions), and their independence from the control systems (those used to operate the plant under normal conditions)" and that "[i]ndependence is important because, if a safety system provides protection against the failure of a control system, then they should not fail together. The EPR design, as originally proposed by the licensees and the manufacturer, AREVA, doesn't comply with the independence principle, as there is a very high degree of complex interconnectivity between the control and safety systems."[20] In other words, there is a risk that the day-to-day and emergency systems could go down at the same time. AREVA has agreed to revise the design.

[19] Michael Grunwald, "Three Mile Island at 30: Nuclear Power's Pitfalls," *Time*, March 27, 2009, at http://www.time.com/time/nation/article/0,8599,1888119,00.html.
[20] *Joint Regulatory Position Statement on the EPR Pressurised Water Reactor*, from HSE, STUK, and ASN, [London]: UK Health and Safety Executive, November 2, 2009, at http://www.hse.gov.uk/newreactors/pressurised-water-reactor.htm.

Three reactor designs have received NRC certification. They are the Advanced Passive 600 (AP600), the Advanced Passive 1000 (AP1000), and the ABWR (Advanced Boiling Water Reactor). The first two are PWRs and the latter is a BWR.

There are no applications to build the AP600 and none has been built since the reactor was certified in 1999. The nuclear industry prefers the larger version, the AP1000, for which there are applications to the NRC for a combined Construction and Operating License for 14 reactors as of February 2010. None have been built so far in the United States, though there are AP1000s under construction in China. None are operational.

For the United States, the AP1000 certification process has been re-opened, since many design changes from the certified design have been requested by Westinghouse and NuStart, the consortium that would build the AP1000. As a result, the amended design that is sought to be built is not yet certified. There are a number of pending issues, including "a redesign of the pressurizer, a revision to the seismic analysis to allow an AP1000 reactor to be constructed on site with rock and soil conditions other than the hard rock conditions certified in the AP1000 Design Certification Rule (DCR), changes to the instrumentation and control (I&C) systems, a redesign of the fuel racks, and a revision of the reactor fuel design."[21] In addition, the NRC is requiring modifications to ensure that the reactor shield building can withstand earthquakes and other severe loads.[22] The NRC currently has no announced date by which it expects the certification process to be complete.[23]

The sixth design is the ABWR. This design was certified in by the NRC 1994. However, the South Texas Project Nuclear Operating Company, which seeks to build two of these units, has asked the NRC permission to amend the certified design:

> By letter dated June 30, 2009, South Texas Project Nuclear Operating Company (STPNOC) submitted an application to amend the ABWR DCR of the ABWR design control document (DCD). The purpose of this amendment is to demonstrate compliance to the requirements in 10 CFR 50.150, the Commission's new aircraft impact rule.[24]

The NRC anticipates completing the process for this ABWR rulemaking in August 2011.[25] In addition, the South Texas Project Nuclear Operating Company has requested 14 design

[21] Design Certification Application Review, AP1000 Amendment, at http://www.nrc.gov/reactors/new-reactors/design-cert/amended-ap1000.html, viewed on March 15, 2010, hereafter NRC AP1000 Amendment.
[22] U.S. Nuclear Regulatory Commission, Office of Public Affairs, "NRC Informs Westinghouse of Safety Issues With AP1000 Shield Building," *NRC News* No. 09-173,Washington, DC, NRC, October 15, 2009, at http://www.nrc.gov/reading-rm/doc-collections/news/2009/09-173.html; Matthew L. Wald, "U.S. Rejects Nuclear Plant Over Design of Key Piece," *New York Times*, October 16, 2009, at http://www.nytimes.com/2009/10/16/science/earth/16nuke.html?_r=1.
[23] NRC AP1000 Amendment.
[24] Design Certification Application Review – ABWR Amendment, at http://www.nrc.gov/reactors/new-reactors/design-cert/amended-abwr.html, viewed on March 15, 2010.
[25] Review Schedule for the Design Certification Application Review _ ABWR Amendment, on the web at http://www.nrc.gov/reactors/new-reactors/design-cert/amended-abwr/review-schedule.html

“departures” from the certified design, including “departures” in instrumentation and control and in “control system changes.”[26]

Four ABWR units have been built and operated in Japan, the first of which went into operation in 1996. GE-Hitachi, the consortium that owns the design, states in its fact sheet that the reactor “already has an impressive track record” in Japan but provides no data in that fact sheet.[27] In fact, two ABWRs, belonging to Tokyo Electric Power Company, had an extended shut down after the July 16, 2007, earthquake in the region, along with six other reactors at the Kashiwazaki-Kariwa Nuclear Power Station. The power station’s reactors are currently being put back into operation. IEER has been looking into some aspects of ABWR design and performance in Japan but we have not yet completed our work. The NRC’s certification for the ABWR expires in 2012, well before the completion of any U.S. project. I would recommend that the NRC take a serious look at performance and design issues in Japan in the process of its re-certification of the ABWR.

In sum, despite the NRC commitment to have completely certified reactors prior to considering construction and operating licenses for specific plants, the planned reactors for which the NRC is now considering applications for reactors that are either not certified or of reactors whose certified designs are being modified. Some issues have arisen because of an essential security rule regarding aircraft impacts; others are changes to reactor designs sought by the companies involved (vendors and/or applicants).

C. Need for new power plants

The third question you asked me to address was:

“Do we currently have such a demand for electric power that we need to rush into construction of multiple nuclear plants, or do we have time to experiment and to see what does work and what does not?”

Since October 1973, the start of the first energy crisis, forecasting electricity demand over periods longer than a few years has been perilous for utilities and their ratepayers and bondholders. As noted, none of the reactors ordered after that date was completed. A principal reason was the failure of utilities and their regulators to detect the changes that were occurring in the relationship of electricity growth to economic growth early enough. Prior to 1973, it took two percent electricity growth to produce one percent economic growth. From 1973 to 1993, it took only one percent electricity growth to generate one percent economic growth.

In 1978, the Tennessee Valley Authority was building 14 reactors. Its failure to address the problem of forecasting early on led to serious economic problems. TVA’s retrospective on these faulty forecasts is shown in the figure below.

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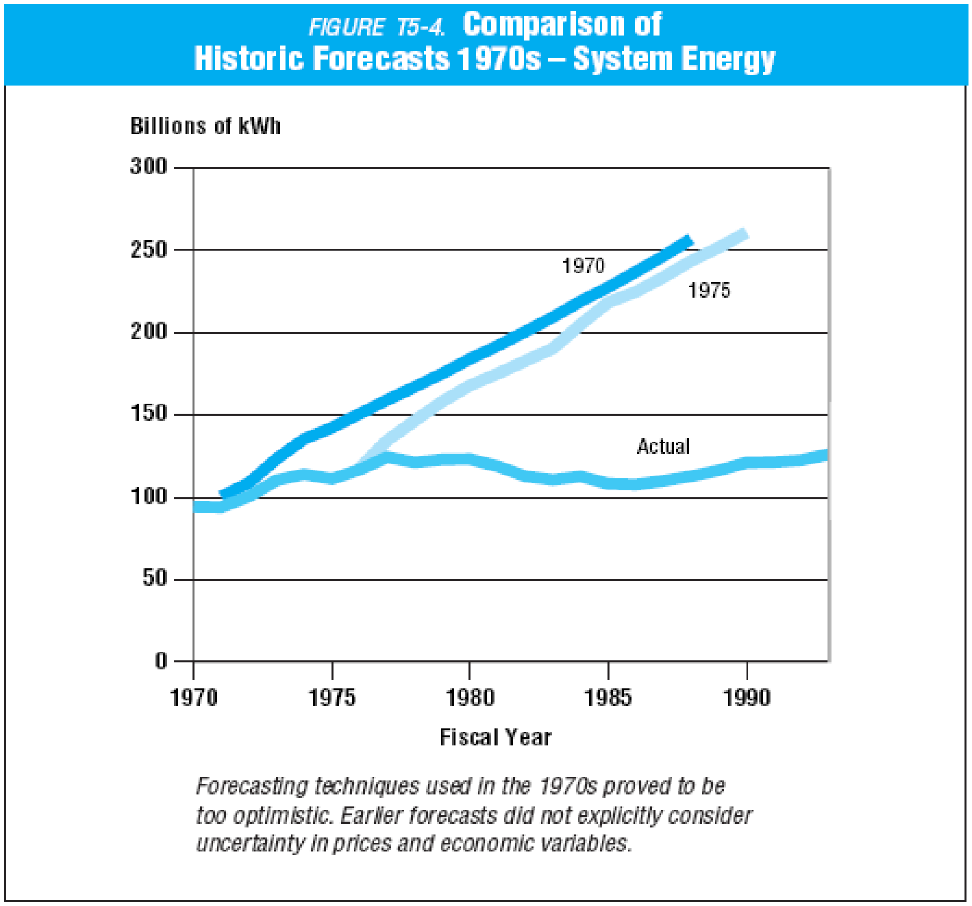
[26] Greg Gibson, COLA Revision 2, Slide 27 of a series of presentations to the NRC, NRC accession number ML0822170676, August 23, 2008.

[27] ABWR, GE Hitachi, on the web at http://www.gepower.com/prod_serv/products/nuclear_energy/en/downloads/gea14576e_abwr.pdf, viewed on March 16, 2010.



TVA 1970 and 1975 forecasts compared to actual electricity use

Source: Tennessee Valley Authority. *Energy Vision 2020: Integrated Resource Plan, Environmental Impact Statement*. [Knoxville]: TVA, December 1995. On the Web at http://www.tva.gov/environment/reports/energyvision2020/index.htm, TD5 p. T5.3

TVA is still billions of dollars in debt due to expenses on reactors it did not need (as I concluded when I consulted there in 1978) and should not have ordered.

In the last decade up to 2007 – that is, prior to the start of the recession – it took only 0.55 percent electricity growth to produce one percent economic growth. Per person electricity use in the United States has been falling even prior to the present recession. The causes are complex; they include increasing efficiency, globalization, and increasing movement of the economy into the information technology age. The trend will be intensified by increasing building and appliance efficiency standards, which are being enacted at the state level. If the building efficiency standards in the Waxman-Markey bill become law or otherwise become the norm, electricity use may stay constant or even decline with continuing economic growth. This is because the inefficiencies in existing electricity use are so large that U.S. economic growth, including use by new gadgets, can be accommodated without electricity growth.

Electric power demand has fallen about five percent since the start of the recession at the end of 2007. The efficiency initiatives that are being taken by builders and states and industries mean that the need for new power plants is far lower than before. Given the huge risks of large power plants that take a long time to build – nuclear foremost among them, but also large coal-fired power plants – investors are not rushing to put their money on such plants. To the extent that utilities are anticipating new generation requirements in view of carbon constraints or to replace existing power plants at the end of their useful lives, two major generating sources are filling the need – natural gas and wind. In the past year or so, solar thermal power plant orders and solar photovoltaic installations have grown rapidly (though from a small base). These two technologies will likely join natural gas and wind as major replacements for existing generation. The common factor in all these technologies is that lead times are short – from a few months for local megawatt-scale solar PV to about two years for wind and three years for gas. Electricity from wind and natural gas power combined cycle plants is also more economical than that from new nuclear reactors, when the comparisons are made on an unsubsidized basis and the high "betting the farm" risk of long lead times is taken into account.

New nuclear reactors are not going to contribute to new generation capacity for six years, at the very earliest. They are not going to contribute significantly to capacity for well over a decade, even if all current applications are approved. Many of the applicants have deferred or suspended work and a few have abandoned their plans already.

In sum, there is no reason to rush into building new nuclear reactors on account of anticipated electricity demand. Given the immense changes that are going on and likely to continue in the energy field, there is every reason to avoid building long-lead time power plants, like nuclear reactors. We also need to develop better forecasting techniques, specifically by coupling price to demand. I was part of a team at Lawrence Berkeley National Laboratory that developed such a model during 1975-1976.[28] The model estimated that continued overbuilding of long-lead time capital intensive plants could cause severe financial difficulties for some utilities – as actually happened. I strongly recommend that a model of this type – updated to present conditions – be used as part of due diligence to the taxpayers prior to granting of any loan guarantees for new nuclear units. The same should apply to any other long-lead time, capital intensive plant that seeks government subsidies and guarantees.

D. Loan guarantees and distribution of benefits

The fourth issue you asked me to address was:

"Do increased loan guarantees for nuclear power plants misdirect resources that could be better used for energy efficiency and renewable power projects?"

[28] Edward Kahn, Mark Davidson, Arjun Makhijani, Philip Caesar, S.M. Berman, *Investment Planning in the Energy Sector*, LBL-4474, Berkeley, CA, Lawrence Berkeley Laboratory, March 1, 1976.

The short answer to this question is an emphatic "yes, they do." It is well established that increasing energy efficiency in every sector – residential, commercial, and industrial – is more economical than any new generation, including nuclear, renewables, and natural gas. In my opinion, government loan guarantees are not a suitable way to encourage development of any energy source, especially ones that are very risky due to the combination of long-lead times and high capital costs.

Federal financial resources can be better used to make federal, state, and local building infrastructure much more efficient and to reduce the carbon footprint of the remaining energy use by procurement of renewable energy. This approach combined with building standards and appliance standards can produce much better results more economically than any other use of government funds. In addition, they will produce long-term savings in terms of reduced government expenses on fuel and electricity. I know there are many skeptics regarding standards and regulation. In my opinion, the history of refrigerator efficiency standards should put to rest the debate about whether well-designed standards are effective. Refrigerators today use just one-fourth of the electricity per cubic foot than they did before the first standards were put into place in the mid-1970s. In addition, they are less than half the price (in constant dollars).[29]

E. Loan guarantees and distribution of benefits

The fifth issue you asked me to address was

"Do increased loan guarantees for nuclear power plants misdirect United States financial resources for the benefit of other countries?"

I have not done quantitative research on the international trade aspect of this issue, so I would prefer to leave the response to this question to others who are testifying today.

F. Cost of loan guarantees to taxpayers

The sixth and last question you asked me to address was:

"Is there any way to estimate accurately how much loan guarantees for nuclear power plants are going to cost taxpayers?"

While a precise estimate of the risk of default and hence the cost of the nuclear loan guarantees to taxpayers does not appear feasible, one can approach the estimation of the cost of loan guarantees for new reactors by considering the economic and energy environment in which they

[29] Sheryl Carter, Devra Wang, and Audrey Chang, *The Rosenfeld Effect in California: The Art of Energy Efficiency*, Natural Resources Defense Council, no date, on the web at http://www.energy.ca.gov/commissioners/rosenfeld_docs/rosenfeld_effect/presentations/NRDC.pdf, p. 11 of the pdf file.

are being built and examining whether there are historical parallels that can guide us. The declining demand per capita and per unit of economic output in the United States points to a very similar situation as that in the post-1973 period when utilities overbuilt and when the impact of rising prices on demand was not taken into account adequately. Cost escalations were rife. These problems continue today. The NRC's plan to streamline procedures by pre-certifying reactors is not working. Costs have been rising rapidly since 2003, even without delays. Given that none of the nuclear reactors ordered after October 1973 was completed, the parallels with the earlier period indicate a high risk of default.

In addition, there is no indication that the long lead-time of new reactors is going to be reduced significantly. On the contrary, delays and cancellations are already occurring in a much earlier phase of nuclear reactor planning than was typical in the late 1970s and the 1980s. A delay on a two-reactor project could cost $800 million to $1.2 billion a year, according to Florida Power and Light in 2007.[30]

Finally, we can compare the situation today with the one that prevailed when the Energy Policy Act was passed in 2005. Prior to that, in 2003, the Congressional Budget Office estimated that the risk of default on nuclear loan guarantees was well over 50 percent.[31] Restraints on carbon emissions being enacted in the states and on the discussion table in Congress and the EPA would put a price on carbon and make nuclear power as well as renewables and efficiency more attractive compared to fossil fuels. But several factors are pushing the risks of investments in nuclear reactors higher.

First, the same carbon restraints would tend to increase investments in efficiency, which is cheaper than new energy sources. Hence the energy landscape will shift from supply to more efficient delivery of energy services like lighting and air-conditioning.

Second, carbon restraints will also benefit renewables. In the 1980s, renewables were generally more expensive than most nuclear power investments. This is no longer the case. Wind-generated electricity is cheaper than nuclear. Even when energy storage is added, compressed air energy storage plus wind power would be generally cheaper than unsubsidized nuclear, presuming both have to be financed on the open market. Given Wall Street's reluctance, really refusal, to finance nuclear, investments in that technology must be considered on a par with lower grade junk bonds.

Third, there are considerable uncertainties associated with the costs of spent fuel management. If the sentiment towards reprocessing – separation of plutonium and uranium from fission products – prevails, costs could increase substantially. It is worth noting here that, contrary to popular impression, reprocessing in France has significantly increased costs and only marginally decreased

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[30] Direct Testimony of Steven D. Scroggs, Florida Power & Light Company, before the Florida Public Service Commission, Docket No. 07____-EI, October 16, 2007, at http://www.psc.state.fl.us/dockets/cms/docketFilings2.aspx?docket=070650, document number 09467-07. p. 52.

[31] Congressional Budget Office, "Department of Energy's Loan Guarantees for Nuclear Power Plants," *Director's Blog,* March 4th, 2010, at http://cboblog.cbo.gov/?p=478.

uranium resource use. In fact, the French spend about two cents more for every kilowatt hour generated from plutonium fuel, which provides less than ten percent of French nuclear fuel requirements.[32]

Fourth, the costs of solar technology are coming down rapidly and energy storage technologies are also progressing fast. It is generally considered that solar-generated electricity, which is only now entering maturity and large-scale production, will be less than ten cents per kilowatt-hour in a few years. It is a reasonable prospect that nuclear-generated electricity will be economically obsolete before the first set of new nuclear reactors comes on line. In any event, such a prospect presents a major risk for nuclear power investments at the present time that cannot be disregarded. Should it come to pass, independent generators like NRG will be out of a market, and taxpayers will be out of a great deal of money.

Fifth, the much shorter lead time and modular nature of wind, solar and gas plants poses a risk to nuclear investments. If you build half a wind farm or solar PV installation, you get half the electricity. If you build half a nuclear reactor, you get nothing but the bills. Even two-reactor projects like the one in South Texas are generally phased so that the completion times of the two reactors are close together.

Finally, those who say that solar and wind are intermittent and cannot replace baseload have not caught up with the Internet age. Jon Wellinghoff, the Chairman of the Federal Energy Regulatory Commission (FERC) has noted made the following comment about baseload power. He said it is "like people saying we need more computing power, we need mainframes. We don't need mainframes, we have distributed computing."[33] Appliances like clothes washers and dishwashers can be made to turn on when the wind is blowing or the sun is shining, all with an override switch. We will need a smart grid in any case and with that approach, dispatching renewables will be in a quite different regime than the century-old approach that prevails today and is still at the center of much utility thinking.

Moreover, wind and solar can be coordinated to reduce intermittency, as a recent report by Dr. John Blackburn, former Chancellor and Professor of Economics Emeritus of Duke University has shown.[34] His study, published by IEER, of a nearly complete renewable electricity future for North Carolina provides a first template for how we should be looking at a high-tech, high-jobs, and low carbon future. We are developing a study on Minnesota's electricity system that will carry this model a couple of steps farther by including demand and renewable supply for each hour in the year as well as cost estimates.

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[32] Arjun Makhijani, *Plutonium End Game*, Institute for Energy and Environmental Research, Takoma Park, Maryland, January 2001.

[33] Noelle Straub and Peter Behr (Greenwire), "Energy Regulatory Chief Says New Coal, Nuclear Plants May Be Unnecessary," *New York Times*, April 22, 2009, http://www.nytimes.com/gwire/2009/04/22/22greenwire-no-need-to-build-new-us-coal-or-nuclear-plants-10630.html.

[34] John Blackburn, *Matching Utility Loads with Solar and Wind Power in North Carolina: Dealing with Intermittent Electricity Sources*, Takoma Park, MD, Institute for Energy and Environmental Research, March 2010, at http://www.ieer.org/reports/NC-Wind-Solar.html.

According to the Congressional Budget Office and the Government Accountability Office, the subsidy cost fee that borrowers pay the government for the guarantee will more likely be underestimated than overestimated. In fact, the Director of the CBO has noted on his official blog that charging too little for the fee is an inherent problem with loan guarantees, because setting an accurate subsidy cost could shift too much of the risk back on the borrower, which could cause the borrower to reject the loan guarantee:

> **CBO's Recent Cost Estimates Related to the Title 17 Program.** DOE's authority to guarantee loans under the title 17 program is subject to annual appropriation action. Under those appropriation laws, the subsidy cost of the guarantees must be paid by the borrower. For a number of reasons, CBO has concluded that it would be difficult to set the fee so as to entirely cover the estimated cost to the government and has therefore estimated that the fees charged to borrowers would be at least 1 percent lower than the likely cost of the guarantees. As explained in CBO's 2007 cost estimate for S. 1321, setting the fee accurately is difficult because there is a large degree of uncertainty about the cost and performance of innovative projects. In addition, requiring the borrower to pay the subsidy cost shifts most of the risk back to the project, which may limit how large the fee can be. Borrowers also may turn down a guarantee if they believe DOE's fee is too high but may go forward if they consider it too low, increasing the likelihood that DOE's portfolio will include more projects for which the subsidy fee has been underestimated than overestimated. Consequently, CBO assigned a cost of $470 million to the provision of the Omnibus Appropriations Act, 2009 (Public Law 111-8) that authorized DOE to guarantee debt totaling $47 billion under the title 17 program. [35]

In sum, I would say that a price on carbon is unlikely to be a significant benefit to nuclear since alternative low-to-zero CO_2 options are available that are modular and lower risk. Some are already cheaper; others are likely to get there before the first new set of reactors goes on line. I recommend that before the federal government makes more loan guarantees for nuclear energy,

1. The Federal Energy Regulatory Commission should create a model that couples rates and demand and takes current technical, legislative, and economic trends into account. Such a model would help reduce uncertainties in electricity forecasts and reduce the risk of defaults for any loan guarantees, should they be made.
2. The Commission should also develop a model for each transmission region of a renewable electricity system in which wind, solar, and storage can be optimized and used with existing natural gas and hydro resources to create a low carbon system.

These studies should be done transparently and with input from the public. Thank you very much for the opportunity to present this testimony to you. I will be happy to take your questions.

[35] Congressional Budget Office, "Department of Energy's Loan Guarantees for Nuclear Power Plants," *Director's Blog,* March 4th, 2010, at http://cboblog.cbo.gov/?p=478.