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THE CURRENT "NUCLEAR RENAISSANCE" IN THE UNITED STATES, ITS UNDERLYING REASONS, AND ITS POTENTIAL PITFALLS

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Synopsis: The nuclear renaissance is indeed a reality within the United States today. This is apparent from the number of nuclear plant construction applications and new uranium mining applications filed with or expected by the Nuclear Regulatory Commission, as well as the major merger-and-acquisitions activity within the nuclear industry. This renaissance stems from such factors as concern over global warming, nuclear energy's advantages over competitor fuels, a significant increase in public and governmental support, major scientific and technological developments, and the financial community's increasing interest in nuclear energy. But, a number of factors could still undermine the success of nuclear energy – such as workforce and component manufacturing constraints, the recent "Wall Street meltdown," a catastrophe at a nuclear power facility anywhere in the world, a terrorist attack using nuclear material, blocked transportation of radioactive material, regulatory and adjudicatory delays, self-inflicted wounds by the industry, and concerns about proliferation and spent fuel management. The industry's success in the coming years will turn largely on money, attention to detail, and an ability to earn and retain the trust of all its stakeholders.

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SUMMARY

The catch phrase "nuclear renaissance" appears in most articles and speeches these days about nuclear energy. Indeed, nuclear energy is increasingly in the news and is being portrayed there in an increasingly positive light. Unfortunately, few writers or speakers have looked objectively, critically, and in depth at the questions: (i) whether the nuclear renaissance is a reality; (ii) if so, why; and (iii) what could derail it. I seek to do so here.

In the first section of this article, I conclude that the nuclear renaissance is indeed a reality. I base this conclusion on factors such as the wave of nuclear plant construction applications filed with or expected by the Nuclear Regulatory Commission, the resurgence of interest in uranium mining, the major merger-and-acquisitions activity within the nuclear industry, and the increasing interest in nuclear energy elsewhere in the world.

In the second section, I examine the reasons for this renaissance. Specifically, I discuss concern over global warming and the environment, nuclear energy's environmental and economic advantages over competitor fuels, the significant increase in public support, significant scientific and technological developments that enhance its attractiveness, nuclear energy's strong governmental support at the federal, state and local levels, and the financial community's increasing interest in and support of nuclear energy.

And in the final section, I examine nine potential developments that could derail the nuclear renaissance – non-scientific problems with managing spent fuel, workforce constraints, component manufacturing constraints, a catastrophe at a nuclear power facility anywhere in the world, a terrorist attack using nuclear material, blocked transportation of radioactive material, regulatory and adjudicatory delays, increased difficulties in obtaining construction financing, and self-inflicted wounds by the industry.

With money, dedication to detail, and an unwavering effort to earn and retain the trust of all the industry's stakeholders, the nuclear industry can take full advantage of the factors contributing to the current renaissance, and minimize the chances of its derailment. But, if that trust is lost, the renaissance will likely lose momentum and die aborning.

INTRODUCTION

The "nuclear renaissance is here," proclaims the Nuclear Regulatory Commission (NRC or Commission) Chairman Dale E. Klein.[1] At a House of Representatives hearing in September 2007, Representative David Hobson (R-Ohio) observes that "[n]uclear energy seems to be poised on the verge of a significant rebirth in this country and around the world."[2] Even more effusive,

1. Elaine Hiruo, *"Nuclear Renaissance is Here," Klein Says After TVA Submits COL Application*, NUCLEONICS WEEK, Nov. 1, 2007, at 1.

2. Keay Davidson, *Fresno a Player in Debate Over Nuclear Power: Proposal for Plant in City faces Obstacles, but Technology is on Cusp of National Rebirth*, S.F. CHRON., Apr. 8, 2007, at A15, http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/04/08/MNGSOP4A4T1.DTL&feed=rss.news.

Senator Chuck Hagel (R-Neb.) describes the nuclear industry's immediate future as an "almost golden time of possibilities."[3]

But others – particularly within the environmentalist community – continue to portray nuclear energy as, at best, the black sheep of the energy community and, at worst, utter anathema. For instance, Paul Gunter of the organization Beyond Nuclear labels nuclear energy as a "failed technology,"[4] and Cyrus Reed, conservation director of the Lone Star chapter of the Sierra Club, claims that nuclear energy is "destroying our planet."[5] More colorfully, Jim Riccio of Greenpeace describes nuclear plants as "pre-positioned weapons of mass destruction."[6] Yet, even the opponents of nuclear energy now concede that it has "risen up from the dead."[7]

Unfortunately, few writers or speakers have looked objectively, critically and in depth at the questions: (i) whether the nuclear renaissance is a reality; (ii) if so, why; and (iii) what could derail it.[8] This article seeks to do so. But two caveats. First, the discussions of "why the renaissance" (in section II) and "what could derail it" (in section III) should not be viewed, respectively, as arguments for or against nuclear energy itself – a broader issue on which neither this article nor this author takes a position. Second, given the fast-changing nature of many subjects addressed in this article, some of the information presented here is bound to be out-of-date (and some of the citations' hyperlinks disconnected) by the time you read this article.

I. IS THERE A NUCLEAR RENAISSANCE IN THE UNITED STATES?

The nuclear renaissance and global warming have two things in common: (i) each has been the subject of an enormous amount of misinformation and hype; and (ii) after a period of disbelief by opponents, the existence of each has become undeniable to all but a few outliers. Perhaps the most immediate and concrete indication of the nuclear renaissance in the United States is that, in 2006, a consortium of energy companies began construction of a uranium

3. Jenny Weil & Elaine Hiruo, *Political, Public Support Said Never Stronger for Nuclear Power*, NUCLEONICS WEEK, Nov. 17, 2005, at 1, 10.

4. Dan Morse, *Officials Support 3rd Nuclear Reactor*, WASH. POST, Aug. 15, 2007, at B02.

5. Asher Price, *As Austin Turns From Ownership in Nuclear Power, Broader Questions About Future of Industry*, AUSTIN AMERICAN-STATESMAN, Feb. 14, 2008, at 18, http://www.statesman.com/news/content/news/stories/local/02/14/0214nuke.html.

6. Thor Valdmanis, *Nuclear Power Slides Back Onto the Agenda*, USA TODAY, Sept. 27, 2004, at 1B, http://www.usatoday.com/money/industries/energy/2004-09-26-nuclear-cover_x.htm.

7. Dave Flessner, *Ex-TVA Head Blasts Plans for Nuke Plants*, CHATTANOOGA TIMES FREE PRESS, June 13, 2008, at C1, http://timesfreepress.com/news/2008/jun/13/chattanooga-ex-tva-head-blasts-plans-nuke-plants/.

8. A notable exception is the Keystone Center's excellent report, NUCLEAR POWER JOINT FACT-FINDING (2007). http://www.keystone.org/spp/documents/FinalReport_NJFF6_12_2007(1).pdf

enrichment facility - the country's first new nuclear facility in thirty years.[9] And as many as three more enrichment plants may be on the way.[10]

Similarly, as of May 2008, the NRC had received six uranium mining license applications, and notices of intent to file twenty-four more.[11] The first application since 1988 arrived in October 2007 for a new in situ leach uranium mine.[12] Moreover, the NRC expects that three existing licensees who ceased operations will seek permission to restart their mining activities, and that others will request authority to expand their existing operations.[13] As another indication, "claims" to mine uranium in the United States jumped ten-fold from 2004 (4,333) to 2007 (43,153).[14]

Equally telling is the high level of interest in the construction of new nuclear power plants – an interest virtually non-existent as recently as five years ago. Two United States utilities have recently signed engineering, procurement, and construction contracts for four nuclear plants – the first such orders since 1978. The NRC expects to receive twenty-three combined operating license (COL) applications (authorizing both the construction and operation of one or more nuclear power reactors) by the end of 2010 for licenses to construct and operate thirty-four new reactor units.[15] And in 2007, then-Commissioner Jeffrey Merrifield went even further, predicting that "in the next 20 years, assuming continued safe operation, we could at least double the number of nuclear power plants we have in this country."[16]

Although most of the anticipated COL applicants are expected seek approval to construct and operate new reactor units in the Southeastern swath of the United States (between Maryland and Texas), companies elsewhere in the

9. Mike Stuckey, *New nuclear power "wave" -- or just a ripple? How millions for lobbying, campaigns helped fuel U.S. industry's big plans*, MSNBC.COM, Jan. 23, 2007, http://www.msnbc.msn.com/id/16272910/; *Opinion: Nuclear Twilight*, Colorado Springs Gazette, Sept. 05, 2006, http://www.gazette.com/display.php?id=1321210&secid=13.

10. Pascal Program, *Areva plans nuclear enrichment plant for US*, Financial Times, July 3, 2007, http://www.ft.com/cms/s/574478ec-28fd-11dc-af78-000b5df10621.html (referring to possible construction of enrichment facilities by USEC in Ohio, URENCO in New Mexico, and Areva in an undisclosed location). *See also* Daniel Horner, *DOE says its U inventory can supply 10% of US need, plus new cores*, Nuclear Fuel, Mar. 24, 2008, at 1, 5 (referring to possible applications from Areva and GE-Hitachi in 2008).

11. *Correction: Uranium-Mining Story*, Montana's News Station, May 14, 2008, http://www.montanasnewsstation.com/global/story.asp?s=8321621.

12. Michael Knapik, Tom Harrison, & David Stellfox, *Spot price drops to $75/lb; some see fast rebound*, Nuclear Fuel, Oct. 8, 2007, at 1.

13. *NRC sees three applications for new uranium recovery operations*, Platts.com, Mar. 13, 2008, http://www.platts.com/Nuclear/News/8588094.xml?src=Nuclearrssheadlines1. *See also* Katherine McIntire Peters, *NRC reviewing application for new uranium recovery facility*, Government Executive, Oct. 10, 2007, http://www.govexec.com/story_page.cfm?articleid=38255&dcn=todaysnews.

14. Judy Pasternak, *A Grand Canyon Rush for Uranium*, L.A. Times, May 4, 2008, http://articles.latimes.com/2008/may/04/nation/na-uranium4.

15. The numbers in the above text are current as of September 25, 2008. *See* http://www.nrc.gov/reactors/new-reactors/new-licensing-files/expected-new-rx-applications.pdf. And the NRC's list of expected applications is available at http://www.nrc.gov/reactors/new-reactors/col.html. As of October 3, 2008, the Commission had already received 15 applications for 24 new reactors. *Id.*; Jenny Weil, Tom Harrison, & Steven Dolley, *Three more filings bring total to 15 reviews*, Inside NRC, Sept. 29, 2008, at 1.

16. Jeffrey S. Merrifield, Comm'r, U.S. Nuclear Regulatory Comm'n, *You Ain't Seen Nothin' Yet*, S-07-008, at 3 (Mar. 13, 2007), a*vailable at* http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2007/s-07-008.html.

United States have also expressed interest. For instance, two companies in the Midwest recently announced their intent to apply for COLs.[17] On the West Coast, Pacific Gas and Electric Company is considering construction of a nuclear power facility outside its home state of California,[18] and the more-ambitious Fresno Nuclear Energy Group is seeking (so far, unsuccessfully) to overturn California's moratorium on in-state nuclear plant construction and to build a plant in central California.[19] Elsewhere in the West, one company in Idaho,[20] two in Colorado,[21] and one in Utah,[22] have expressed varying levels of interest in constructing nuclear power plants. Even in the Northeast (the sector of the country least enamored of nuclear energy), some companies are beginning to express interest.[23]

17. Bob Watson, *Planning for possible second nuclear unit to be explained tonight*, Fulton Sun, Mar. 13, 2008, http://www.fultonsun.com/articles/2008/03/13/news/293news00callaway.txt; Jeffrey Tomich, *Ameren says Callaway the site if it builds 2nd nuclear plant*, St. Louis Post-Dispatch, July 21, 2007, http://www.stltoday.com/stltoday/business/stories.nsf/0/0B4FA7688B93C73F8625731F000A959C?OpenDocument; Jenny Weil, *Environmental groups reassess nuclear regarding climate change*, Nucleonics Week, May 17, 2007, at 11, 12; Eric Morath, *DTE plans for nuclear plant*, Detroit News, Feb. 13, 2007, http://www.detnews.com/apps/pbcs.dll/article?AID=/20070213/BIZ/702130338/1001.

18. David R. Baker, *Calpine Target of Takeover by NRG Energy*, S.F. CHRON., May 23, 2008, at C1, http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/05/22/BULB10R7LB.DTL&feed=rss.business.

19. *Nuclear Power Tries Comeback in California*, CENTRAL VALLEY BUSINESS TIMES, July 10, 2007, http://www.centralvalleybusinesstimes.com/stories/001/?ID=5643; Keay Davidson, *Fresno a Player in Debate Over Nuclear Power: Proposal for Plant in City faces Obstacles, but Technology is on Cusp of National Rebirth*, S.F. CHRON., Apr. 8, 2007, at A15, http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2007/04/08/MNGSOP4A4T1.DTL&feed=rss.news.

20. Idaho Power Company advised the Idaho Public Utilities Commission in November 2006 that it is considering construction of a nuclear plant, and Alternative Energy Holdings (together with an Idaho-based farmers cooperative) has expressed a similar interest. Jenny Weil, *Several proposals surfacing to expand nuclear in western US*, NUCLEONICS WEEK, Apr. 10, 2008, at 4; Lee Vander Boegh, "Nuclear plant files application," IDAHO PRESS-TRIBUNE, July 18, 2007, http://idahopress.com/articles/2007/07/18/news/news5.txt; *Proposed nuclear plant clears hurdle*, IDAHO PRESS-TRIBUNE, June 27, 2007, http://www.idahopress.com/articles/2007/06/27/news/news3.txt; Ken Dey, *Proposed Idaho nuclear plant secures $3.5 billion funding commitment*, IDAHO STATESMAN, June 26, 2007, http://www.idahostatesman.com/business/story/90908.html.

21. Tri-State Generation and Transmission is considering construction of a nuclear plant, and Xcel Energy (Colorado's largest energy producer) has stated that nuclear will be "on the table" as the company considers its future energy sources for that state. Editorial, *Nuclear Power*, Pueblo Chieftain, Apr. 16, 2008, http://www.chieftain.com/editorial/1208347201/1; Todd Hartmandand and Gargi Chakrabarty, *Nuke Interest Surges in State*, Rocky Mt. News, June 7, 2008, http://www.rockymountainnews.com/news/2008/jun/07/nuke-interest-resurges-in-state/?partner=yahoo_headlines.

22. In early 2008, Transition Power Development announced its intention to seek, by April 2010, a COL, or an early site permit (ESP, approving the location for a possible power reactor, but not authorizing its construction or operation), or both, for two reactors in east-central Utah by April 2010. Jenny Weil, *Several proposals surfacing to expand nuclear in western US*, Nucleonics Week, Apr. 10, 2008, at 4.

23. For instance:

- Public Service Enterprise Group expressed such interest as early as November 2006, when it announced that it might add more nuclear capacity to its Salem and Hope Creek nuclear power facilities in New Jersey. Trish G. Graber, *Fourth nuclear reactor?* Bridgeton [NJ] News, July 23, 2007, http://www.nj.com/news/bridgeton/local/index.ssf?/base/news-10/118516385698200.xml&coll=10; Daniel Horner, *Operating Salem, Hope Creek seen as key factor in PSEG's future*, Nucleonics Week, Jan. 18, 2007, at 3. *See also* Tom Johnson, *PSEG's energy challenge: Company considers constructing another nuclear power plant*, [Newark NJ] Star-Ledger, Apr. 18, 2007,

In addition to this interest in building *new* nuclear plants, there is also the high likelihood that all *existing* nuclear power plant licensees will seek 20-year extensions of their plants' operating licenses. The NRC has already granted 20-year license renewals for 49 of the nation's 104 operating nuclear reactor units, renewal applications for another 18 units are under review, and the NRC has received letters of intent regarding additional renewal applications for 27 more reactor units.[24] Plus the industry, the United States Department of Energy (DOE) and NRC are already discussing a possible second 20-year extension period.[25] One expert predicts that this second round of renewal applications could begin to arrive at the NRC as early as 2009.[26] And according to Joe Sheppard (President and CEO of STP Nuclear Operating Company), "[t]he 'vast majority' of industry executives believe that life extension beyond 60 years is 'likely,' and 'more than half' believe it is 'very likely.'"[27] And, in February 2008, the NRC began researching whether existing "plants could continue to operate safely... for 80 or even 100 years."[28]

Another indication of the nuclear industry's revival, is the numerous recent purchases and sales of nuclear plants[29] and growing specializations among the

http://www.nj.com/printer/printer.ssf?/base/business-6/1176876202213720.xml&coll=1&thispage=2.

- PPL Corporation (a nuclear skeptic only a year earlier) declared in June 2007 that it may construct a third nuclear unit at Bell Bend near its existing Susquehanna plant in Pennsylvania. Paul Adams, *Economics of Nuclear Power are Rethought*, Baltimore Sun, Sept. 4, 2007, http://www.baltimoresun.com/business/bal-te.bz.nuclear04sep04,0,2384711.story; Tom Harrison, *PPL considering building new Susquehanna unit*, Nucleonics Week, June 21, 2007, at 1; Jim Polson, *PPL May Construct Third Pennsylvania Nuclear Reactor (Update1)*, Bloomberg, June 14, 2007, http://www.bloomberg.com/apps/news?pid=20601207&sid=aShQKYXxhk8Y&refer=energy. And by the end of March 2008, PPL Corp was discussing the estimated cost of constructing the third unit. Op-Ed, *The Power of Forethought has Eluded Electricity Users*, WILKES-BARRE TIMES LEADER, Mar. 27, 2008.
- Constellation stated in 2007 that it was considering the construction of new units at its Nine Mile Point and Ginna facilities in upstate New York. *Constellation in joint venture with EDF*, Yahoo.com, July 20, 2007, http://biz.yahoo.com/ap/070720/constellation_joint_venture.html?.v=1; Tom Harrison, *PPL considering building new Susquehanna unit*, Nucleonics Week, June 21, 2007, at 1; *Constellation in joint venture with EDF*, Yahoo.com, July 20, 2007, http://biz.yahoo.com/ap/070720/constellation_joint_venture.html?.v=1. And in late September 2008, Constellation filed a COL application for a new reactor at Nine Mile Point.

24. For a current list of license renewal applications granted, under consideration, and anticipated, see U.S. Nuclear Regulatory Commission, *Status of License Renewal Applications and Industry Activities*, *available at* http://www.nrc.gov/reactors/operating/licensing/renewal/applications.html (information current as of Sept. 4, 2008).

25. Daniel Horner, *Jaczko Stresses Policy Elements of decisions on "Life Beyond 60,"* INSIDE NRC, June 9, 2008, at 5.

26. William E. Burchill, *A Nuclear Power Renaissance*, ENERGY TRIB., July 14, 2008, http://www.energyTRIB..com/articles.cfm?aid=942.

27. Steven Dolley, *NRC, DOE, Industry to Investigate LWR Life Extension Beyond 60 years*, NUCLEONICS WEEK, Feb. 21, 2008, at 2, 3.

28. Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, *Moving Toward a 100-Year Plant*, NUCLEAR POWER INT'L, Mar. 2008, www.qmags.com/download/default.aspx?pub=NPI&upid=13441&fl=others/NPI/NPI_20080301_Mar_2008.pdf.

29. For instance, Consumers Power sold its Palisades plant to Entergy. *Entergy finalizes nuclear deal*, Nuclear Engineering International Magazine, Aug. 3, 2006; *Entergy to Buy Palisades Nuclear Energy Plant*

companies that own, operate, or manufacture them. Indeed, a handful of companies have developed such an expertise to become the premier operators of nuclear plants, namely: Exelon, PSEG Entergy Holdings, FPL Group, Dominion Resources, Entergy, and Constellation Energy Group (which, contingent upon various regulatory approvals, will presumably become a part of Midamerican Energy Holdings Company[30]). Such commercial activity simply would not be occurring in a moribund industry. Nor would the recent creation of a uranium "futures market" on the New York Mercantile Exchange.[31]

A further sign of the nuclear renaissance is the fact that dormant or partially-constructed plants are now being resurrected. The Tennessee Valley Authority (TVA) restarted its Browns Ferry-1 reactor unit (dormant since 1985) in 2007, intends to complete construction of (and seek an operating license for) its Watts Bar-2 reactor unit by 2012, and currently seeks to renew construction permits for two unfinished reactor units at its Bellefonte site.

Nor is the nuclear renaissance confined to the United States. Countries that have never considered nuclear energy before are now contemplating its use, other nations that have foresworn the use of nuclear plants are now reconsidering their earlier decisions, and countries with operating nuclear plants are considering, or are in actually the process of, augmenting their fleets.[32] The

From Consumers Energy, Yahoo!Finance (Press Release July 12, 2006), http://biz.yahoo.com/prnews/060712/clw022.html?.v=56. And FPL Energy purchased the Point Beach nuclear facility. Daniel Horner, *Sale manager: Point Beach garnered top price*, Nucleonics Week, Jan. 4, 2007, at 1. *See also* Daniel Horner, *Wepco, FPL Energy agree on final terms of Point Beach sale*, Nucleonics Week, Oct. 4, 2007, at 1.

30. Warren Buffett's Midamerican Energy Holdings Company announced in mid-September 2008 that it will buy Constellation Energy Group (contingent upon its receiving the necessary regulatory approvals). Rebecca Smith, *Buffett Could Reshape Nuclear Power Industry*, Wall St. J., Sept. 26, 2008, at B1, B7. But at press time for my article, Mr. Buffett's success was still uncertain – for the French utility Électricité de France (EDF) was seeking to convince Constellation's Board to rescind the agreement with Midamerican and accept instead EDF's higher bid. Rebecca Smith, *Midamerican to Push Ahead on CEG Bid*, Wall St. J., Oct. 4-5, 2008, at B6; Peggy Hollinger & Julie MacIntosh, *EDF looks to trump Buffett on Constellation*, Financial Times (Oct. 1 2008), http://www.ft.com/cms/s/0/0e7e23aa-8feb-11dd-9890-0000779fd18c.html?nclick_check=1. As for other corporate mergers and acquisitions, here is small sample:

*PECO Energy and UniCom merged to form Exelon;

*GE and Hitachi merged their nuclear units;

*Toshiba purchased Westinghouse;

*Shaw Group in turn purchased 20% of Westinghouse from Toshiba; and

*Kohlberg Kravis Roberts & Co. (along with other investors) purchased TXU now named Energy Future Holdings) and created the company now known as Luminant.

31. David Stellfox, *Industry Working Group Pursues Uranium Contract Trading Platform*, NUCLEONICS WEEK, May 8, 2008, at 4, 5; Nicky Smith, *Boom Time for Uranium*, FIN. MAIL, June 22, 2007, http://free.financialmail.co.za/07/0622/cover/coverstory.htm. Michael Knapik, Tom Harrison & Daniel Horner, *Two Uranium Auctions Expected to Push U Price Up*, NUCLEAR FUEL, May 21, 2007, at 1, 2. *See also* URANIUM FUTURES, http://www.nymex.com/UX_spec.aspx.

32. Joby Warrick, *Spread of Nuclear Capability is Feared*, WASH. POST, May 12, 2008, at A01. A survey of press articles in recent years reveals seventy-seven such countries: Argentina, Algeria, Armenia, Australia, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Brazil, Bulgaria, Burma, Cameroon, Canada, Chile, China (up to forty reactors by 2023), the Czech Republic, Egypt, Estonia, Finland, France, Ghana, Guinea, Georgia, Germany, Hungary, India (twenty to thirty-two new nuclear plants by 2020), Indonesia, Iran, Israel, Italy, Japan (eleven new plants by 2010), Jordan, Kazakhstan, Kenya, Kuwait, Latvia, Libya, Lithuania, Malaysia, Mexico, Morocco, Namibia, the Netherlands, Nigeria, North Korea, Oman, Pakistan, Poland, Portugal, Qatar, Romania, Russia (twenty-six to fifty-eight new plants by 2030), Saudi Arabia, Senegal,

International Energy Agency (IEA) recently took the unprecedented step of urging governments to help accelerate the construction of new nuclear power plants. And, as of July 2008, 445 nuclear power reactors were currently operating around the world and 35 were under construction.[33] Indeed, according to various reports, the number of nuclear power plants worldwide is expected to increase by 107 (or about 25%) by 2020,[34] 40% by 2031,[35] and 100% by 2070.[36]

Offering country-specific examples, the French consulting firm Eurostaf even two years ago saw "China multiplying its existing capacity seven-fold, to 49 GW, with Japan adding the same amount of capacity during that period, equivalent to about 73% of its current nuclear power fleet."[37] And in 2007, Russia's then-President, Vladimir Putin, approved the construction of 26 new nuclear power facilities – nearly doubling the current total of 31.[38] Indeed, "[i]n early 2007, the number of announcements [worldwide] concerning new nuclear capacity buil[t], life extensions or at least new milestones in planned projects (signed deals, tenders, regulatory applications or government statements of intent) outnumbered those of announcements concerning plant closures for the first time since 1990."[39]

In light of the facts set forth above, the question *whether* the nuclear renaissance is real has been laid to rest. The more interesting questions are *why*, and *what could scuttle it*. As explained in the next section, the answer to the "why" question is that the nuclear renaissance is attributable - at least in significant part - to the following factors: growing public concern about global warming and the environment, nuclear energy's environmental and economic

Slovakia, Slovenia, South Korea, Spain, Sudan, Sweden, Switzerland, Syria, Taiwan, Tanzania, Thailand, Tunisia, Turkey, Uganda, the Union of South Africa, the United Arab Emirates, the United Kingdom, Ukraine, the United States, Venezuela, Vietnam, and Yemen.

33. *At 50, NEA prepares to publish first "Nuclear Energy Outlook*," Nucleonics Week, Sept. 4, 2008, at 8. Unavailable at my article's press deadline, the "Nuclear Energy Outlook" promises to contain a wealth of information relevant to the nuclear renaissance: "nuclear power's current status and projected trends, environmental impacts, uranium resources and security of supply, costs, safety and regulation, radioactive waste management and decommissioning, nonproliferation and security, legal frameworks, infrastructure, stakeholder engagement, advanced reactors, and advanced fuel cycles." *Id.*

34. Lars Paulsson & Paul Dobson, *Nuclear Power Expansion Threatened by Staff Shortages (Update 2)*, Bloomberg, Nov. 14, 2007, http://www.bloomberg.com/apps/news?pid=20601207&sid=aa4W5lwzAtSg&refer=energy (citing World Nuclear Association data).

35. Richard Karn, *Nuclear Tide*, RESOURCE INVESTOR, Aug. 1, 2006, *available at* http://www.resourceinvestor.com/pebble.asp?relid=22187#_ftn1, *citing* World Nuclear Association, *The New Economics of Nuclear Power*, at 6 (2005).

36. Global New Wire, *Energy Industry Gears up for "Nuclear Renaissance,"* July 24, 2007, *available at* http://news.yahoo.com/s/afp/20070724/wl_canada_afp/canadafrancenuclearenergyuranium_070724073817.

37. Ann MacLachlan, *Westinghouse "Best Positioned" to Win New Orders, Study Says*, NUCLEONICS WEEK, Oct. 5, 2006, at 5. To place the numbers in context, a GW (gigawatt, or 1 billion watts) of power is enough electricity to power a city of 500,000. Brice Smith & Arjun Makhijani, *Nuclear is Not the Way*, THE WILSON QUARTERLY, Autumn 2006, at 64.

38. Fred Weir, *Russia Plans Big Nuclear Expansion*, CHRISTIAN SCI. MONITOR, July 17, 2007, at 1 http://www.csmonitor.com/2007/0717/p01s04-woeu.html?page=1. *See also* MacLachlan, *supra* note 37, at 5 (Eurostaf projects Russia will add about 78% to its current nuclear fleet, reaching about 36 GW in 2030).

39. *Nuclear Power Generation Could be Returning to Favor*, ENERGY BUS. REV., Nov. 15, 2007, http://www.energy-business-review.com/article_feature.asp?guid=2D85957A-8AD7-422E-A131-9D142A662622.

advantages over fossil fuel (coal, oil and, natural gas), significant scientific developments, strong governmental and increasing public support for the industry, and budding financial support from the financial community.

II. WHY THE NUCLEAR RENAISSANCE?

A. Global Warming and New-Found Sensitivity to the Environment

Pictures of rapidly melting ice in places such as Alaska, Greenland, and the Arctic have served to emphasize the need to control emissions of greenhouse gases from fossil fuels. This need has been further highlighted by former Vice President Al Gore's receiving an Academy Award and the Nobel Peace Prize for his documentary *An Inconvenient Truth*[40] – a movie that brought to the forefront of public consciousness the current and potential impact of man-made climate change on the Earth's environment. When addressing that problem before a House of Representatives committee last year, Mr. Gore stated that "I'm not an absolutist in being opposed to nuclear. I think it's likely to play some role."[41] And on another occasion, Mr. Gore said he saw nuclear energy as playing at least a "small part" in the strategy to address global warming.[42]

The Supreme Court has weighed in too (albeit indirectly), in *Massachusetts v. EPA*.[43] There the High Court explicitly acknowledged the problem of global warming and held that Environmental Protection Agency (EPA) had the statutory authority to regulate one of the principal greenhouse gases – carbon dioxide (CO_2) – as a pollutant under the Clean Air Act. Max Schulz of the Manhattan Institute believes the Supreme Court's ruling in *Massachusetts v. EPA* could help "spur the revival of nuclear power."[44]

Climate change has likewise captured the attention of Congress. For instance, the recently proposed Warner-Lieberman Climate Security Act, Senate Bill 2191, would have established a cap-and-trade system covering 87% of United States' emissions, with the goal of cutting them nearly 70% by 2050.[45] Although this legislation did not pass the Senate (failing in June 2008 to garner the necessary sixty votes to override a filibuster), it did advance further than previous similar bills. It was also the first bill with bipartisan support to address global warming and to set carbon reduction targets.

Global warming, and the need to control greenhouse gases, loomed large in the presidential campaign this year and will continue to do so in any new Administration. The two presidential nominees, John McCain (R-N.M.) and

40. Release date Aug. 31, 2006. *See* http://www.imdb.com/title/tt0497116/.

41. David Whitford, *Going Nuclear*, FORTUNE, Aug. 6, 2007.

42. Richard Simon, *Nuclear Power Enters Global Warming Debate*, L.A. TIMES, Apr. 9, 2007.

43. 127 S. Ct. 1438 (2007).

44. Richard Simon, *Pelosi, Clinton, Obama Favor More Nuclear Plants*, L.A. TIMES, Apr. 9, 2007.

45. *See generally*, http://web2.westlaw.com/search/default.wl?tf=-1&method=ConcordTemplate&fn=_top&mt=Westlaw&rltdb=CLID_DB63554813310&db=CONG-BILLTXT&query=CI(2191)&sv=Split&action=Search&dups=false&vr=2.0&rs=WLW8.09&qttab=QT_CONG_BILLTXT&tc=1003&rp=%2fsearch%2fdefault.wl&qtrcc=QueryTemplate&tempinfo=CONG-BILLTXT%7cTEMPLATE%7cNumber%3aInTxt%3d2191%7cChamber%3dAchoice1%3a%7cType%3dBchoice1%3a%7cVersion%3dCchoice1%3a%7cCongSess%3dDchoice1%3a%7cCDate7%3d_cdstd1%3a%5e_cdOpstd%3a%7cQueryTemplate0.

Barack Obama (D-Ill.), have "supported legislation that would cap greenhouse gas emissions and provide incentives to power companies to build more nuclear plants."[46]

On the Presidential campaign trail, Senator Obama declared himself willing to consider nuclear energy as one way to address global warming, but only after issues such as plant safety, spent fuel disposal, and security of nuclear materials have been resolved.[47]

Senator McCain has not been so tentative. In his presidential campaign, he called directly for the increased use of nuclear energy[48] (specifically, "45 new nuclear plants by 2030"[49]) as well as the reprocessing (recycling) of spent nuclear fuel[50] - and he has referred explicitly to his advocacy for nuclear power.[51] Throughout this decade (2003, 2005, and 2007), he has repeatedly cosponsored (with Senator Lieberman) a bill "to reduce greenhouse gas emissions by 2050 to a third of 2000 levels, [and to] provide federal loans or guarantees to subsidize as many as three advanced reactor projects."[52] Had it been enacted and signed into law, the bill would have also provided subsidies for nuclear power.

Other prominent public officials, formerly skeptics, have accepted the fact of climate change and the need to do something about it. For instance, Senator Pete Domenici (R-N.M.) (a longstanding advocate of nuclear energy) was one of the first senior Republican senators to say global warming is a serious problem.[53] He has since organized the Senate Energy Committee Climate Conference to examine possible solutions (e.g., limits on carbon emissions) to the global warming problem.[54] (There still remain a few in Congress, like Senator James Inhofe (R-Okla.), who refuse to acknowledge that global warming is real).

46. Kevin Landrigan, *Senator's Forum Focuses on Green*, NASHUA TEL., July 25, 2007 (referring to the Climate Stewardship and Innovation Act). *See also* Stephen Power, *In Energy Policy, McCain Obama Differ on Role of Government*, WALL ST. J., June 9, 2008, at A2.

47. Mary Ann Giordano & Larry Rohter, *McCain at Nuclear Plant Highlights Energy Issue*, N.Y. TIMES, Aug. 5, 2008; Editorial, *State Visit Could Give McCain an Edge on Energy*, DETROIT NEWS, Aug. 4, 2008.

48. Tom LoBianco, *Maryland on Track for Nuke Reactor*, WASH. TIMES, Apr. 19, 2008; Gerald Karey & Jenny Weil, *McCain Differs from Clinton and Obama on Nuclear Power*, NUCLEONICS WEEK, Feb. 28, 2008, at 12-13; *McCain Presses for Energy Independence*, UPI, Dec. 10, 2007, http://www.upi.com/Top_News/2007/12/10/McCain_presses_for_energy_independence/UPI-70261197332521/.

49. Noam N. Levey, *McCain's Energy Record is On/Off*, L.A. TIMES, July 1, 2008.

50. Karey & Weil, *supra* note 48, at 1, 12-13; Meg Kinnard, *McCain Focuses on Oil*, THE STATE (S.C.), Dec. 11, 2007. *See also* LoBianco, *supra* note 48.

51. Kate Sheppard, *Subsidize My Love*, Gristmill, May 15, 2008, *available at* http://gristmill.grist.org/story/2008/5/15/131812/464.

52. Richard Simon, *Nuclear Power Enters Global Warming Debate*, N.Y. TIMES, Apr. 9, 2007. Just as repeatedly, the bill has failed to pass the Senate. Rebecca Smith, *Climate Change on Agenda of Candidates*, WALL ST. J., Jan. 31, 2008, at A8. For examples and discussions of other similar bills, *see* Rebecca Smith, *Carbon Caps may Give Nuclear Power a Lift*, WALL ST. J., May 19, 2008, at A4 (describing the Warner-Lieberman Climate Security Act of 2008); Congressional Research Service, *Nuclear Power: Outlook for New U.S. Reactors*, Mar. 9, 2007, at CRS-19 to CRS-21.

53. Editorial, *Climate Shock*, N.Y. TIMES, June 27, 2005.

54. Press Release, Senator Dianne Feinstein, Senator Feinstein Outlines New Legislation to Curb Global Warming, Keep Economy Strong (Mar. 20, 2006).

Support for limits on carbon emission is also coming from the states. For instance, in December 2005, the seven governors of Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont signed a memorandum of understanding on such limits,[55] and by the summer of 2007, that number had increased to ten.[56] In early 2007, "the governors of California, Oregon, New Mexico, Arizona and Washington state jointly announced plans to reduce 'greenhouse gases' through a 'cap-and-trade' program that would allocate emissions credits to companies, which could use or trade them."[57] About the same time, Minnesota, South Carolina, and Florida were working on their own plans to reduce greenhouse gas emissions. In November 2007, twelve Midwestern states entered into a compact that included cap-and-trade provisions.[58] And, as of June 2008, the governors of Minnesota and Wisconsin were leading an effort to create a "cap-and-trade" program to limit carbon emissions.[59]

As a result of the growing attention to global warming, support for nuclear energy is increasingly coming from a surprising place – the environmental community. At least *some* leading environmental activists now take the position that nuclear energy is both safe and reliable, and that it cannot realistically be phased out and replaced with renewable energy sources, such as intermittent wind, climatologically-limited solar, and conservation. For instance, Patrick Moore (co-founder of Greenpeace) is now a consultant to both the United States's and Canada's nuclear trade associations. Sir James Lovelock, the famed British environmentalist who created the Earth-is-a-living-organism "Gaia hypothesis," has stated that "[w]e have no time to experiment with visionary energy sources; civilization is in imminent danger and has to use nuclear – the one safe, available energy source."[60] Other environmentalists expressing varying degrees of support for nuclear energy include Stewart Brand (founder of the "Whole Earth Catalog" who now describes himself as "mildly pro-nuclear"[61]), the late British Bishop Hugh Montefiore (founder and director of Friends of the Earth, who was forced to resign as trustee after publishing a pro-nuclear article),[62] and Greg Bourne (head of WWF-Australia, formerly World Wildlife Fund).[63]

55. *Embracing Reggie*, ECONOMIST, Nov. 17, 2007, at 36; John J. Fialka, *Carbon Curbs Gain Backers: Energy Groups Shift Stance, Possibly Giving Campaign New Fuel*, WALL ST. J., Feb. 27, 2007, at A8; Matthew Garrahan, *Emissions Cuts by California put the Heat on Washington*, FINANCIAL TIMES, Jan. 23, 2007, at 11.

56. Nicole Genilas, *An Inconvenient Solution*, N.Y. CITY J., Summer 2007.

57. Fialka, *supra* note 55, at A8; Garrahan, *supra* note 55, at 11; Jeffrey Ball & Jim Carlton, *California Pact Would Place Cap on Emission*, WALL ST. J., Aug. 31, 2006, at A1, A7.

58. Editorial, *Don't Nuke Nuclear Energy*, WIS. STATE J., Nov. 17, 2007.

59. Ron Way, *Given Carbon-Reduction Goals, Minnesota Begins to Reconsider Role, Risks of Nuclear Power*, MINN. POST, June 11, 2008.

60. Max Wilkinson, *Embrace Nuclear Power and Stop Titling at Windmills*, FINANCIAL TIMES, Apr. 5, 2006, at 13.

61. Janis Mara, *Nuclear War in California*, CONTRA COSTA TIMES (Cal.), Mar. 26, 2008.

62. Dave Robinson, *You Can't Steer Looking Backwards: Nuclear is the North*, Northern Ontario Business (May 17, 2006), http://www.nob.on.ca/columns/Robinson/05-06-backwards.asp.

63. Jenny Weil, *US industry optimism growing that new plant construction possible*, Nucleonics Week, May 25, 2006, at 1, 11.

Other environmentalists do not go quite so far, but still express a willingness at least to consider nuclear energy as an option under the right circumstances – a position rare or unheard-of in the environmental community as recently as ten years ago. For instance, Fred Krupp (president of Environmental Defense) has opined that "[w]e should all keep an open mind about nuclear power."[64] Both Environmental Defense and the Natural Resources Defense Council now state that nuclear energy is worth another look[65] and that "nuclear power would be acceptable if solutions are found for the risks that have impeded its development for years: disposal of toxic waste, security against terrorist attack and misuse of radioactive material for weapons."[66] Likewise, the Wildlife Habitat Council is urging legislators not to discount nuclear energy. [67]

Similarly, according to a recent report by the Union of Concerned Scientists, "[t]he risks posed by climate change may turn out to be so grave that the United States and the world cannot afford to rule out nuclear power as a major contributor to addressing global warming."[68] And, while Earthjustice opposes nuclear subsidies and does not actively advocate the development of nuclear energy, the organization does not rigidly oppose nuclear energy itself. [69] And, as a more general example, TXU (a Texas utility) recently garnered the support of local and state environmentalists by dropping its plans to construct a fleet of coal-fired power plants and agreeing instead to build as many as five large nuclear plants. [70]

Last year, then-Commissioner Jeffrey S. Merrifield captured the current sea change amongst environmentalists this way:

> [T]he views of the environmental community have changed. Now I would not be so bold as to say that the environmental community is embracing nuclear power. However, the opposition to nuclear power within the environmental community is more tempered and less shrill than it was when I first came to Washington in 1986. Rather than utilize a sky-is-falling mentality, the environmental community is focusing on the cost of nuclear power plants and the ongoing debate on Yucca Mountain as the principle avenues of debate.[71]

Still, the bulk of the environmental community either remains staunchly opposed to nuclear energy or sits decisively on the sidelines – at least for now.

64. Jim Motavalli, *A Nuclear Phoenix?* FAYETTEVILLE FREE WEEKLY, July 19, 2007.

65. Erika Lovley, *Nuclear Industry Wants Green Light,* POLITICO, Jan. 29, 2007 ("Environmental Defense said it is willing to carefully consider nuclear as one of several options to global warming"); Rebecca Smith, *TXU Sheds Coal Plan, Charts Nuclear Path*, WALL ST. J., Apr 10, 2007, at A2 (referring to Environmental Defense's willingness to "take another look" at nuclear energy).

66. Michael Janofsky, *Texas Going Nuclear with Greenpeace Founder's backing (Update 1)*, Bloomberg, Dec. 17, 2007, http://www.bloomberg.com/apps/news?pid=20601103&sid=a980jwliyVpA&refer=us.

67. Erika Lovley, *Environmentalists See Fission on Nuclear Power*, POLITICO, Jan. 31, 2008.

68. Frank Nelson, *Nuclear's on the Road Again, But It's Uphill*, MILLER-MCCUNE, Mar. 6, 2008. But the Union of Concerned Scientists also adds the following caveat: "it may also turn out that nuclear power cannot be deployed worldwide on the scale needed to make a significant dent in emissions without resulting in unacceptably high safety and security risks." *Id.*

69. Lovley, *supra* note 67.

70. David Whitford, *Going Nuclear*, FORTUNE, Aug. 6, 2007.

71. Jeffrey S. Merrifield, Comm'r, U.S. Nuclear Regulatory Comm'n, *Newton's First Law of Physics*, S-07-025, at 2 (June 13, 2007), available at http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2007/s-07-025.html.

The Nuclear Information and Resource Service announced in late 2007 that "more than 500 organizations - including Greenpeace, Friends of the Earth International, and the Sierra Club - have signed a statement rejecting nuclear power as a means of addressing climate change."[72]

Although the clout of these anti-nuclear forces does not lend itself to statistical analysis, anecdotal evidence suggests that their influence appears to have diminished significantly from the environmental movement's heyday in the 1970s. Compared with the large turnouts for anti-nuclear rallies of that era, a rally against the proposed third nuclear unit at Calvert Cliffs in the Spring of 2008 drew only about a dozen protesters.[73] Cindy Schwartz, the director of the Maryland League of Conservation Voters, acknowledges that "there's not going to be a huge outcry" against the proposed third unit at Calvert Cliffs.[74] She explains that "[t]he technology has changed, and the political and environmental landscape has changed.... If you're concerned about climate change, where's the power coming from? That's why you're not hearing the same opposition you heard 20 years ago."[75]

And there has indeed been no huge outcry regarding Calvert Cliffs. At a Maryland Public Service Commission meeting in early August 2008, supporters of the third reactor outnumbered opponents four to one.[76] Similarly, a public meeting in July 2008 regarding a possible new reactor at the Callaway facility in Missouri drew only "a handful" of protestors, and "a majority of the comments were in support of the proposal."[77] Only forty of the more than 400 attendees at an NRC-sponsored meeting regarding a possible new plant in Victoria County, Texas, rose in opposition to the plant.[78] And Xcel's plan to store spent fuel in dry casks at its Monticello nuclear power plant is drawing no protests at all – in sharp contrast to the outcry when a similar plan was proposed for the Prairie Island plant in the 1990s.[79]

72. Jenny Weil & Jean Chemnick, *DOE gets Congressional Approval for Nuclear Energy Loan Guarantees*, NUCLEONICS WEEK, Dec. 20, 2007, at 1.

73. Len Lazarick, *Demonstrators Protest Maryland's New Nuclear Plant*, BALTIMORE EXAMINER, May 3, 2008.

74. Lisa Rein & Christy Goodman, *Little Outcry on Nuclear Reactor Proposal*, WASH. POST, Aug. 4, 2008, at B01.

75. *Id.*

76. Megan Greenwell, Jenna Johnson, & Christy Goodman, *La Plata Mayor Calls it Quits*, WASH. POST, Aug. 8, 2008, at SM02; Erica Mitrano, *Speakers Mostly Support Reactor*, CALVERT COUNTY REPORTER, Aug. 6, 2008.

77. Janet Saidi, *Nuclear Regulatory Commission Goes to Public on AmerenUE and a Second Nuclear Reactor*, KBIA, July 10, 2008, http://publicbroadcasting.net/kbia/news.newsmain?action=article&ARTICLE_ID=1315782&sectionID=1.

78. Tara Bozick, *A Lot of Questions*, VICTORIA ADVOCATE (Tex.), Aug. 7, 2008.

79. Heron Marquez Estrada, *No Protests as Xcel Ramps up Nuclear Plans*, MINNEAPOLIS STAR TRIB., July 28, 2008.

B. Nuclear Energy's Economic and Environmental Plusses

1. Public Benefits

The first of these public benefits is the new plants' ability to boost energy supplies "without cramping lifestyles or creating discomfort."[80] So much has been written in recent years about our nation's ravenous and increasing thirst for energy and our refusal to conserve that I will merely note this first reason and move on to the rest.

These are more concrete and measurable—the additional jobs and tax revenue that would accrue to the communities where new nuclear power plants would be built, the indirect benefits for local economies, and the significant environmental advantages.

a. Jobs

Let's start with jobs. First, the view from 30,000 feet. On September 22, 2008, the American Council on Global Nuclear Competitiveness issued a report predicting that new U.S. reactor construction could create 350,000 jobs in the next twenty years.[81] The report assumes that construction will begin on 33 reactors by 2021, and another 20 by 2025, and also assumes the construction of four uranium enrichment plants and a reprocessing plant.[82]

Next, the micro view—examining jobs at individual facilities. General estimates indicate that a new nuclear plant would generate 1,400 - 1,800 construction jobs and that its operation and maintenance would require about 400 permanent employees.[83] But plant-specific estimates vary widely. Prognostications as to the number of temporary jobs that would be generated by the construction of particular new nuclear plants range from 1,000 to 5,000 per new reactor.[84] And it is not just *new reactors* that bring construction jobs to

80. Paul Alongi, *Oconee Nuke Plant Could be Biggest in Nation*, GREENVILLE NEWS (S.C.), May 22, 2006; Stephen Koff, *Nuclear Industry Sets up Coalition to be Advocate*, CLEVELAND PLAIN DEALER, Apr. 23, 2006.

81. "Economic, Employment and Environmental Benefits of Renewed U.S. Investment in Nuclear Energy: National and State Analysis" (2008), http://www.nuclearcompetitiveness.org/images/Oxford_State_Benefits_2008.pdf; Steven Dolley, *Report: US reactor construction could create 350,000 jobs by 2028*, Nucleonics Week, Sept. 25, 2008, at 7.

82. See authority cited *supra* note 81.

83. Jim Snyder, *Nuclear advocates try to clear obstacles*, THE HILL Nov. 8, 2007, http://thehill.com/business--lobby/nuclear-advocates-try-to-clear-obstacles-2007-11-08.html.

communities. For instance, the recent work to reopen Browns Ferry-1 involved 2,400 construction workers, and the construction of a uranium enrichment plant by Areva would create an estimated 700-1,000 construction jobs.[85]

Likewise, a new nuclear reactor would generally bring between 400 and 700 new *permanent jobs* to the host community, according to both former Energy Secretary Spencer Abraham and former EPA Administrator Christine Todd Whitman.[86] Plant-specific estimates indicate that a new operating plant would add anywhere from 200 to a whopping (and seemingly unrealistic) 1,000 new permanent jobs to the host community.[87] And Areva's uranium enrichment plant would create 500 permanent jobs.[88]

84. Here is a sample of those wide-ranging estimates:
1,000-4,000 at Nine Mile Point plant, New York State
1,000 at a possible plant in South Dakota
1,000-3,000 at the proposed new plant in Levy County, Florida
1,200-1,500 for a new Gulf States plant in Louisiana
1,500-2,000 for each of two possible new plants at the V.C. Summer facility in South Carolina
1,500-3,000 for a possible plant in Victoria County, Texas
1,800 for a hypothetical new plant in Michigan
1,800-2,000 for a possible plant in Matagorda County, Texas
2,000 at Plant Vogtle in Georgia
2,000-3,000 for a new unit at the Callaway plant in Missouri
2,000 for Bellefonte in Alabama
1,000 or 2,000-3,000 for the Lee Plant in South Carolina
2,000 - 4,000 at Calvert Cliffs in Maryland
2,000-3,500 at Grand Gulf in Mississippi
2,300 for completion of 60%-finished Watts Bar-2 in Tennessee
3,000 for two new units at Turkey Point in Florida
up to 3,000 at Fermi in Michigan
4,000 for the proposed new reactor at Nine Mile Point in New York
up to 5,000 for a proposed plant in Bruneau, Idaho
3,000-6,000 for two adjoining plants at the South Texas facility in Bay City, Texas

85. TENNESSEE VALLEY AUTHORITY, BROWNS FERRY UNIT 1 FACT SHEET (2007) http://www.tva.gov/power/nuclear/brownsferry_unit1_facts.htm; Ruth Campbell, *New on Thursday . . . Andrews, Lea counties in line for new uranium enrichment facility*, MyWestTexas.com, Mar. 6, 2008.

86. Jenny Weil, *US Nuclear Construction Could Create Thousands of New Jobs, Group Says*, NUCLEONICS WEEK, June 19, 2008, at 1; Jessica Coomes, *Ex-Gov Touts Nuke Jobs*, TODAY'S SUNBEAM (N.J.), June 18, 2008.

Moreover, these permanent jobs would be high-paying. For instance, the permanent employees at the possible plant in Victoria County, Texas, are expected to earn an average of $70,000 annually,[89] and Exelon's employees at Byron Generating Station currently earn an average of $79,466 annually.[90] The Salem/Hope Creek nuclear facilities in New Jersey employ 318 New Castle County residents full-time at an average annual salary of $81,400 – "well above the county's $45,600 annual average, according to a study published last year by the Nuclear Energy Institute (NEI)."[91]

b. Collateral Benefits to Local Economy

Then there is the beneficial ripple effect on the local economy. According to both the office of Michigan Congressman Fred Upton (ranking minority member of the U.S. House of Representatives' Subcommittee on Energy and Air Quality) and Christine Todd Whitman, "[e]ach of today's 104 reactors generates an estimated $430 million a year in total output for the local community and nearly $40 million per year in total labor income."[92] Here are a few specific examples. A new plant would indirectly generate 1,000-2,000 off-site

87. For instance:
200-400 at Grand Gulf in Mississippi
200-600 at Callaway in Missouri
250 at Watts Bar-2 in Tennessee
300-1,100 for the proposed Lee Plant in South Carolina
360 at Calvert Cliffs in Maryland
300-500 at Nine Mile Point in New York State
400-500 for each of two possible new plants at the V.C. Summer facility in South Carolina
400-500 for Bellefonte in Alabama
400-600 at the potential Bell Bend reactor, near the Susquehanna plant in Pennsylvania
450-700 or 800 or 938 (an oddly precise number) or 1,200 for Matagorda County Texas
500 for the Alternative Energy Holdings' proposed plant in Idaho
500-800 for the proposed new plant in Levy County, Florida
600 for Gulf States in Louisiana
696 for Byron Generating Station in Illinois
750 for North Anna in Virginia
700-900 for Victoria County, Texas
up to 800 at Fermi in Michigan
about 800 for Plant Vogtle in Georgia
700-1,000 for each of two new adjoining plants at an undisclosed location in Texas
2,000 for River Bend, Louisiana (although this figure may have been for two reactors)

88. Eddie Kovsky, *Idaho Senate committee approves Areva bills*, THE IDAHO BUS. REV., Mar. 17, 2008., http://www.redorbit.com/news/business/1298709/idaho_senate_committee_approves_areva_bills/index.html#; Bryan Gentry, *Areva expansion will bring 500 jobs to Lynchburg*, Lynchburg News & Advance, June 6, 2008, http://www.newsadvance.com/lna/news/local/article/areva_expansion_will_bring_500_jobs_to_lynchburg/5534/.

89. Allison Miles, *Average worker could make $70,000*, VICTORIA ADVOCATE, Dec. 18, 2007, http://www.victoriaadvocate.com/exelon/story/169716.html.

90. *Id*.

91. Jeff Montgomery, *Nuclear Revival*, THE NEWS J. (Wilmington, Del.), Dec. 23, 2007, at 1A.

92. Jessica Sieff, *Upton announces nuclear energy initiatives*, NILES DAILY STAR ONLINE ED., July 1, 2008, http://www.nilesstar.com/articles/2008/07/01/news/ndnews2.txt; Jenny Weil, *US Nuclear Construction Could Create Thousands of New Jobs, Group Says*, NUCLEONICS WEEK, June 19, 2008, at 1.

manufacturing jobs to support the plant operations,[93] and "[e]very dollar spent by a plant generates about $1.13 in the local economy."[94] The Salem/Hope Creek facilities in New Jersey "made more than $14 million in purchases in New Castle County [NJ] in 2006, mostly for supplies and architectural and engineering services."[95] The Braidwood nuclear plant brings in nearly $60 million in spending annually to Illinois' Will County.[96] Exelon's nuclear plant in Clinton, Illinois, pays out about $30 million in salaries and spends another $33 million in the community.[97] And more indirectly, the "railways, trucking and barge lines in the region are likely to benefit from a broad pickup in traffic" attributable to the construction of new nuclear power plants.[98]

New plants would also enrich the coffers of the local charities. To offer just five examples from existing plants: the LaSalle "plant and its workers contributed more than $200,000 to local charities;"[99] the TMI plant contributed close to $250,000 to "the United Way, fire and ambulance companies, educational, health and youth organizations" in 2007;[100] the Catawba plant's employees "donated $130,000 to the United Way;"[101] Duke Energy "contributed $31,000 to the county arts program;"[102] and Duke Energy's employees have "provided Christmas for 50 needy children, donated 450 pints of blood a year and for 17 years... picked up trash along the roadside to improve the county's appearance."[103]

93. Editorial, *Nuke plants may be best answers to energy needs*, SOUTH MARION ONLINE, July 30, 2008, http://www.smcitizen.com/cgi-bin/storyviewnew.cgi?076+OpinionEditorial.2008730-1939-076-076009.Lead+ (1,000-2,000 jobs); Richard Conn, *Nuclear plant could double Levy tax base*, OCALA STAR-BANNER, Dec. 28, 2006,
http://www.ocala.com/apps/pbcs.dll/article?AID=/20061228/NEWS/212280380&SearchID=73267566920316 (more than 1,000 jobs); Tara Bozick, *Landowners want answers*, VICTORIA ADVOCATE, July 24, 2008, http://www.victoriaadvocate.com/exelon/story/285530.html ("The Victoria Economic Development Corp. studied job count increases, which could benefit the area two to three times over in a multiplier effect," according to the Corporation's vice president of marketing Adrian Cannady).

94. John Engler, *America needs more nuclear energy to confront crisis*, DETROIT NEWS, May 31, 2006, http://www.detnews.com/apps/pbcs.dll/article?AID=/20060531/OPINION01/605310309/1008.

95. *Id.*

96. Miles, *supra* note 89.

97. Editorial, *Nuclear power plant would be boon to the region*, VICTORIA ADVOCATE, Mar. 27, 2008, http://www.victoriaadvocate.com/opinion/editorials/story/218151.html#.

98. Marchall Loeb, *The coming rebound of nuclear power*, MARKET WATCH, Aug. 19, 2006, http://www.marketwatch.com/News/Story/Story.aspx?dist=newsfinder&siteid=google&guid=%7BB6CA24D7-E9F2-47E4-9EBF-75F656367537%7D&k.

99. JONATHAN BILYK, EXELON LIKELY TO SEEK 20 MORE YEARS: PLANT COULD KEEP FUELING ECONOMY BEYOND 2042 (2006) *available at* http://mywebtimes.com/archives/ottawa/display.php?id=276757.

100. Russel West, *Guest Column: TMI License Extension Will Allow Decades of Production*, MIDDLETOWN PRESS & J., Jan. 18, 2008, http://www.pressandjournal.com/viewPointsDetail.aspx?ID=140.

101. Janet S. Spencer, *Pros, Cons of Nuclear Plant Debate-Duke Energy Plan: Public Weighs in on Economic, Safety, Ecological Impact*, SPARTANBURG HERALD-JOURNAL, May 2, 2008, at A1, http://www.goupstate.com/article/20080502/NEWS/805020359/1051/NEWS01.

102. *Id*.

103. *Id*.

Local and state governments benefit from a large (sometimes overwhelming) increase in tax revenue.[104] The President of Calvert County's Board of Commissioners recently stated that the existing Calvert Cliffs nuclear power plant has "enabled us to have the lowest property taxes in the region."[105] And Danita Boonchaisri, a spokeswoman for the same county's Department of Economic Development has stated that, "[b]ack in the early '70s, Calvert County was one of the poorest counties in the state, but it became one of the richest" as a result of Calvert Cliffs.[106] Finally, according to Mike Cleary, spokesman for AmerenEU, a new reactor unit at Missouri's Callaway facility would generate more than $115 million in property taxes during the construction period, and then another $90 million thereafter.[107]

c. Environmental Advantages

Nuclear fuel's environmental advantages over competitor fuels constitute another reason why society would benefit from the current and expected high level of activity in nuclear energy development. Many experts have concluded that nuclear power plants emit negligible greenhouse gases or mercury when generating electricity (*e.g.*, 2%-6% of the CO_2 emitted per kilowatt-hour (kWh) from natural gas power plants,[108]) and is thus (as noted above) one of the energy sources strongly favored by those environmentalists who consider global warming to be the principal environmental threat to our planet. This environmental advantage would, if true, be quite significant, given that the

104. Here are a few examples:
- $16 million in current local payroll, property and miscellaneous taxes from Perry in Ohio
- $6 million in current annual local and state tax revenue, plus additional economic activity generated by the plants results in a total state and local tax impact of $19 million from Exelon's reactors in Pennsylvania
- More than $15 million to the Berwick Area School District, Luzerne County, and Salem Township Pennsylvania, between 2000 and 2004
- $199 million in predicted sales taxes over twelve years from the proposed plant in Levy County Florida
- $20 million for the local school system, $3.6 million for the Fire and Rescue Service, and 80% of the county's entire property tax basis from Plant Vogtle in Georgia
- $13 million in property taxes to La Salle County and other taxing bodies from the LaSalle facility in Illinois
- $4 billion increase in Victoria County's existing $4 billion tax base in Texas
- $8.5 million in local and state revenue from the proposed Lee plant in South Carolina
- $53 million in local taxes and $74 million in state taxes from a potential facility in Elmore County, Idaho
- $20 million in estimated annual revenue from a new Calvert Cliffs reactor in Maryland, even with a 50- percent property tax credit for the first fifteen years

105. Ovetta Wiggins, *Unistar Nuclear Chooses Lusby For Possible Plant*, WASH. POST, May 1, 2007, at B02.

106. Ben Meyerson, *Nuclear renaissance moving forward at Calvert Cliffs*, DELMARVA DAILY TIMES, Apr. 24, 2008, http://www.delmarvanow.com/apps/pbcs.dll/article?AID=/20080424/NEWS01/80424050/1002.

107. Chris Waller, *Proposed nuclear plant draws support, criticism*, Fulton [MO] Sun, Aug. 17, 2008, http://www.fultonsun.com/articles/2008/08/17/news/136news01nuclear.txt.

108. Bryan Walsh, *Is Nuclear Power Viable?*, TIME, June 6, 2008 (referring to a 2007 British government report). *See also* text associated with note 120, *infra*.

generation of electricity is the single largest contributor of CO_2 emissions in the United States. [109] As a point of reference, the replacement of 103 of the country's operating nuclear power plants with coal-fired power plants would increase the United States' annual CO_2 emissions by 700 million metric tons, sulfur dioxide (SO_2) by three million tons and nitrogen oxide by one million tons.[110]

But candor requires two "asides" regarding greenhouse gases. First, even if all of the predicted long-term construction of nuclear power plants are implemented fully within the next thirty years and then extended for an additional twenty years, the total nuclear-generated capacity of these new plants would still be slightly less than the amount needed to replace the retiring nuclear capacity during that same fifty-year time span.[111]

Second, although the operation of nuclear plants does not itself result in the emission of significant amounts of carbon dioxide, methane, or other greenhouse gases, scientists hotly debate the extent to which the same can be said for other phases of the fuel cycle (*e.g.*, the mining, milling, and enrichment of uranium) or for the construction and dismantling of the plants themselves, or for the transportation of new and used nuclear fuel, or for the ultimate disposal of spent fuel. Unfortunately, as Dr. Helen Caldicott pointed out last year, "[v]ery few studies are yet available that analyze the total life cycle of nuclear power...."[112]

On the anti-nuclear side of the debate are Jan Willem Storm van Leeuwen and Philip Smith, two nuclear scientists at the University of Groningen in the Netherlands, who claim that:

> The use of nuclear power causes, at the end of the road and under the most favorable conditions, approximately one-third as much carbon dioxide (CO_2) emission as gas (from) electricity production. The rich uranium ores required to achieve this reduction are, however, so limited that if the entire present world electricity demand were to be provided by nuclear power, these ores would be exhausted within nine years. Use of the remaining poorer ores in nuclear reactors would produce more CO_2 emission than burning fossil fuels directly.[113]

109. Matthew L. Wald, *Slow Start for Revival of Reactors*, New York Times, Aug. 22, 2006, at C1, C4 ("The utility sector emits about a third of the carbon dioxide produced in this country, nearly all of that from coal"); Spencer Jakab, *Utilities Consider Coal Technology to Limit Greenhouse Gases*, Wall St. J., May 15, 2006, at C8. Also, coal is one of the main culprits in creating acid rain.

110. Eric McErlain, *Nuclear energy debate fraught with myths on danger, high costs*, SAN JOSE CA MERCURY NEWS, May 8, 2006, http://www.mercurynews.com/mld/mercurynews/news/opinion/14527506.htm; Max Schulz, *Nuclear Power Is the Future*, Wilson Qtly., Autumn 2006, at 59, 63 (700 million metric tons of CO_2 each year); Paul Vieira, *The nuclear renaissance: Is it true love or PR blitz?* FINANCIAL POST, Sept. 27, 2007, http://www.canada.com/nationalpost/financialpost/story.html?id=31c547b4-ddcc-403a-8b69-affee586eeeb&k=87931 ("it is estimated a 1,000-megawatt nuclear power plant cuts carbon output on an annual basis by up to seven million tonnes compared with a similar-sized coal plant").

111. *Keystone Report*, *supra* note 8, at 25.

112. Helen Caldicott, *Outside View: Nuclear CO2 Warming Costs*, POST CHRONICLE, May 22, 2007, http://www.postchronicle.com/news/security/article_21282090.shtml. In a recent interview, however, Caldicott stated that the entire nuclear fuel cycle currently "produces about one-third the amount of CO_2 as a similar-sized gas-fired plant." Helen Caldicott, *Truth is Stanger than Fission*, [Edmonton] VUE Weekly, Oct. 2, 2008, http://www.vueweekly.com/article.php?id=9732.

113. Caldicott, *Outside View*, *supra* note 112 (quoting the University of Groningen study's conclusion). *See also* Helen Caldicott, *Truth is Stanger than Fission*, *supra* note 112. Jon Rutter, *Cooling Solution?*

Their conclusions find at least general support from other studies. For instance, a 1998 Oko Institute study which also found that "the nuclear fuel cycle emits up to four or five times as much CO_2 as renewables, such as wind or solar."[114] Likewise, a report by the Nuclear Information and Resource Service (a group generally considered opposed to nuclear energy) concluded that "[a] strict accounting of carbon emissions from the nuclear fuel chain shows that nuclear power causes carbon releases that are comparable to the carbon released by burning natural gas in power plants."[115] According to Dr. Caldicott, this is because "[m]ost of the energy used to create nuclear energy—to mine uranium ore for fuel, to crush and mill the ore, to enrich the uranium, to create the concrete and steel for the reactor and to store the thermally and radioactively hot nuclear waste—comes from the consumption of fossil fuels...."[116]

On the pro-nuclear side of this argument is the IEA, which concluded in 2001 "that the entire nuclear energy life cycle resulted in the second-lowes[t] emissions of greenhouse gases next to wind, which is not a baseload electricity source."[117] Along the same lines, the International Atomic Energy Agency's (IAEA) Deputy Director General Yuri Sokolov stated that "[n]uclear power, including the fuel cycle chain from mining through [spent fuel] disposal and decommissioning, has one of the lowest greenhouse gas emission levels of all power generation options... about the same as wind and solar power and well below coal, oil and natural gas."[118]

According to Constellation Energy's Vice Chairman Michael Wallace, nuclear energy results in the emission of about the same amount of CO_2 (14 tons/Gigawatt-Hour) as hydroelectric (18 tons), geothermal (15 tons), and wind energy (14 tons) – and far less than is produced by either coal (1,041 tons) or natural gas (622 tons).[119] Mr. Wallace's conclusion is consistent with a United

INTELLIGENCER J., July 10, 2006, http://www.redorbit.com/news/science/565618/cooling_solution/index.html?source=r_science.

114. Jon Rutter, *supra* note 113.

115. Dr. Lewis E. Patrie, *Best way to make America more secure is to head off the nuclear menace*, ASHEVILLE CITIZEN-TIMES, Feb. 22, 2006, at 7A, http://www.citizen-times.com/apps/pbcs.dll/article?AID=200660221022.

116. Caldicott, *Outside view*, *supra* note 112.

117. Wayne Barber, *Group says nuclear power no solution to global warming*, SNLI, Oct. 25, 2006, http://www.snl.com/interactivex/article.aspx?CdId=A-4851702-11623.

118. *Global Nuclear Expansion Based on Plentiful Uranium Supply*, Environmental News Service, June 6, 2006, http://www.ens-newswire.com/ens/jun2006/2006-06-06-03.asp. Likewise, the NEI argues that "nuclear power is cleaner than gas and coal-fired plants and says studies show that over a nuclear plant's life-cycle - including construction and the mining of uranium ore - its greenhouse gas emissions are comparable to those of wind and hydro power." Laura Smith-Spark, *US eyes boom in nuclear reactors*, BBC NEWS, Oct. 11, 2007, *available at* http://news.bbc.co.uk/2/hi/americas/7027147.stm. *See also* Michael Totty, *Nuclear's the Answer*, WALL ST. J., June 30, 2008 (CO_2 discharges from the entire nuclear fuel cycle are on a par with the full life-cycle emissions from wind and hydropower, and less than solar).

119. Presentation of Michael Wallace at Platts' "Nuclear Energy" Conference (Feb. 5, 2008), slide: "Comparison of Life Cycle Emissions." *See also* Forrest J. Remick (former NRC Commissioner), *Nuclear Power: Myth and Reality*, THE TIMES OF TRENTON, June 28, 2008, at A09, http://www.nj.com/opinion/times/editorials/index.ssf/?//base/news0/1214625980218960.xml&coll=5.
("[D]uring the entire life cycle of nuclear plants, on a per kilowatt-hour basis the carbon dioxide emissions are roughly comparable to hydro, geothermal and wind plants. They produce less than half the life-cycle carbon emissions of solar photovoltaic plants, 61 times less than coal-fired power plants, and 36 times less than power

Kingdom government's 2007 white paper, which "factored in everything from uranium mining to plant decommissioning and determined that nuclear power emits 2%-6% of the carbon per kilowatt-hour as natural gas, the cleanest of the fossil fuels."[120]

Even some opponents of nuclear energy concede this point. For instance, Brice Smith in his book *Insurmountable Risks: The Danger of Using Nuclear Power to Combat Global Climate Change* (IEER Press 2006) acknowledges that, "when compared to fossil fuels, nuclear power emits far lower levels of greenhouse gases, even when mining, enrichment and fuel fabrication are taken into account."[121] Likewise, Tyson Slocum, director of energy policy for Public Citizen, concedes that the nuclear fuel cycle "produce less greenhouse gas emissions than coal or gas."[122]

So it all depends on whose experts you believe.

But greenhouse gases are not the only environmental issue here. According to the EPA, "coal-fired plants in the United States annually cause 24,000 early deaths – including 2,800 from lung cancer.... [E]missions of fine particle pollution (or soot) resulted in an average loss of 14 years of life for the victims, along with 38,200 non-fatal heart attacks and 534,000 asthma attacks each year."[123]

Another point of reference—and a quite ironic one—is that, according to scientists from both Los Alamos and Oak Ridge National Laboratories, "a 1,000 megawatt-electric (MWe[124]) *coal*-fired power plant releases about 100 times as much radioactivity into the environment as a comparable nuclear power plant."[125] One of those scientists, Alex Gabbard,[126] also reaches the following, equally relevant, conclusions:

> Americans living near coal-fired plants are exposed to higher radiation doses than those living near nuclear power plants that meet government regulations.[127]

plants that burn natural gas"); Matthew Giovanelli, *Arguments Against Nuclear Power Don't Stand Up to Close Scrutiny*, MILWAULKEE J. SENTINEL, Feb. 23, 2008, http://www.jsonline/story/index.aspx?id=721151 ("The complete nuclear power train, from mining to waste disposal, including reactor construction, emits only 6 grams of carbon per kilowatt-hour, two orders of magnitude below coal and oil").

120. Spencer Reiss, *Face It. Nukes Are the Most Climate-Friendly Industrial-Scale Form of Energy*, WIRED, May 19, 2008, http://www.wired.com/science/planetearth/magazine/16-06/ff_heresies_08nuclear.

121. Jim Motavalli, *A Nuclear Phoenix?*, FAYETTEVILLE FREE WEEKLY, July 19, 2007, http://www.freeweekly.com/2007/07/19/a-nuclear-phoenix/ (paraphrasing Mr. Smith's conclusion).

122. Smith-Spark, *supra* note 118.

123. Ed Hiserodt, *Another Look at Nuclear Energy*, JOHN BIRCH SOCIETY, Apr. 30, 2007, http://www.iterfan.org/index.php?option=com_content&task=view&id=290&Itemid=2.

124. Throughout this article, all references to "MW" indicate megawatts of electricity (MWe) rather than thermal megawatts.

125. Elie A. Shneour, *Nuclear Power's Promising Future*, VOICE OF SAN DIEGO, Aug. 10, 2006, http://www.voiceofsandiego.org/articles/2006/08/10/opinion/02shneournuke.tx, *citing* Richard Rhodes & Denis Beller, *The Need for Nuclear Power*, FOREIGN AFFAIRS, Vol. 75, pp. 30-44 (Jan.-Feb. 2000). *See also* Mara Hvistendahl, *Coal Ash Is More Radioactive than Nuclear Waste*, SCIENTIFIC AM., Dec. 13, 2007; Alex Gabbard, *Coal Combustion: Nuclear Resource or Danger*, OAK RIDGE NAT'L LAB. REV., Vol. 26, Nos. 3 & 4 (Summer/Fall 1993).

126. Mr. Gabbard was the leader of the High Temperature Fuel Behavior Group in the Nuclear Fuel Materials Section of Oak Ridge National Laboratory's Metals and Ceramics Division and a principal investigator for the Laboratory's Nuclear Energy Program.

127. Gabbard, *supra* note 125.

> According to 1982 figures, 111 American nuclear plants consumed about 540 tons of nuclear fuel.... During the same year, about 810 tons of uranium alone were released from American coal plants. Add 1971 tons of thorium, and the release of nuclear components from coal combustion far exceeds the entire U.S. consumption of nuclear fuels.[128]

> [B]ecause of regulatory differences, coal-fired power plants are allowed to release quantities of radioactive material that would provoke enormous public outcry if such amounts were released from nuclear facilities. Nuclear waste products from coal combustion are allowed to be dispersed throughout the biosphere in an unregulated manner. Collected nuclear wastes that accumulate on [coal-fired] electric utility sites are not protected from weather, thus exposing people to increasing quantities of radioactive isotopes through air and water movement and the food chain.[129]

> If coal-fired power plants were regulated in a similar manner [to nuclear power plants], the added cost of handling nuclear waste from coal combustion would be significant and would, perhaps, make it difficult for coal-burning plants to compete economically with nuclear power.[130]

Another (though longer-term) environmental advantage of nuclear energy is that, if the United States is to develop a hydrogen-based economy, the country will need vast amounts of fresh water and electricity to develop the hydrogen supply. Nuclear power facilities (and particularly the anticipated duel-use, very-high-temperature "Next Generation Nuclear Plants") provide the most likely – and perhaps the only – realistic option for producing sufficiently high-temperature steam to separate out high-purity hydrogen from water and, separately, to run desalination plants. (As of two years ago, Canadian utility Bruce Power was looking seriously into the commercial viability of producing hydrogen during its nuclear plants' off-peak hours.[131]) Hydrogen could eventually replace fossil fuels in many contexts—the most obvious being transportation fuel (*e.g.*, gasoline, diesel fuel, and aviation fuel). But nuclear energy's assistance in the replacement of the fossil fuel is not awaiting the advent of the hydrogen-based economy. Nuclear power plants already provide much of the electricity used to charge the batteries of today's electric and hybrid vehicles – cars, trucks, and sports utility vehicles that are far more environmentally friendly than their purely fossil-fuel equivalents.

2. Private Benefits

a. Caveats

Before launching into this topic, I must in candor acknowledge eight difficulties in comparing the cost of producing electricity via nuclear, coal, gas, and other energy sources. First, those generating or publicizing the nuclear cost figures are, as a general rule, "interested parties" – often the nuclear industry or

128. *Id*.

129. *Id*.

130. *Id*.

131. Tyler Hamilton, *Bruce Power CEO Urges Hydrogen Options*, TORONTO STAR, July 20, 2006.

the anti-nuclear activists – who have their own axes to grind. Consequently, the nuclear-power cost figures are suspect. To offer but one example:

> Some critics say nuclear plants take too long for a payback on the money spent to build them. With a price tag of $2.5 billion to $4 billion each for a nuclear reactor, it would take a utility 25 to 40 years to recover its investment, according to an estimate from the Natural Resources Defense Council, an environmental advocacy group.[132]

> Utilities and others in the nuclear industry believe they can get their money back much more quickly. TVA officials have said they believe they can get their $1.8 billion investment in Browns Ferry Unit 1 back in five years through the electricity it will sell.[133]

Second, the recorded expenses of current nuclear power generation can ignore significant government subsidies (see discussions in section II.D, below, regarding federal, state, and local governmental support for nuclear energy). And third, many older nuclear plants' construction costs (the main cost of producing nuclear power) have been fully depreciated or otherwise written off:

> With most American nuclear reactors now well into their peak operational phases, the low cost of nuclear-generated electricity is regularly being trotted out as proof positive of how competitive the industry is. This is misleading to say the least. By far the largest cost associated with a nuclear power plant is its construction and financing, which is generally assumed to account for between half and two-thirds of total costs, but this cost is not reflected in the price of nuclear electricity today because those costs have long been written off. So what the nuclear energy industry is submitting as electrical generation costs bears no more resemblance to the truth than a hacker bragging about his golf score—if you but disregard the times he shot over par.[134]

These second and third difficulties make accurate cost comparisons difficult at best.

The fourth difficulty is that the carbon-fueled plants have not been held to account financially for the economic and health costs associated with their emission of SO_2, CO_2 and other pollutants. This cost has been estimated to be as high as $250 per ton.[135]

The fifth, sixth, and seventh difficulties are, essentially, the mirror images of the first, second, and third. Fifth, the coal, gas and oil industries, and their various opponents, are just as adept as nuclear proponents and opponents at skewing figures, so the numbers coming from those sources (comparing fossil and nuclear energy expenses) must likewise be viewed with a jaundiced eye. Sixth, the non-nuclear sectors of the energy industry receive government subsidies – just as the nuclear industry does. For instance, "green" technologies such as wind and solar receive federal loan guarantees, and wind power receives

132. Kent Faulk, Katherine Bouma, & Russell Hubbard, *Federal Incentives Start to Bring New Nuke Power Online*, NEWHOUSE NEWS SERV., Apr. 18, 2007.

133. *Id*.

134. Richard Karn, *Nuclear Tide*, RESOURCE INVESTOR, Aug. 1, 2006, http://www.resourceinvestor.com/pebble.asp?relid=22187#_ftn1, *citing Climate change: The nuclear answer?* THE ECONOMIST, July 7, 2005.

135. *Id*., *citing* J.W. Anderson, *Coal: Dirty Cheap Energy*, RESOURCES FOR THE FUTURE, at 33 (Winter 2005).

production tax credits.[136] According to the EIA, "solar energy is subsidized to the tune of $24.34 per megawatt hour, wind $23.37[,]... 'clean coal' $29.81[,]... normal coal... 44 cents, natural gas a mere quarter, hydroelectric about 67 cents and nuclear energy $1.59."[137] And *Time Magazine* reports, that "the booming global solar industry wouldn't be anywhere near as hot without a generous German tariff."[138] Seventh, these same sectors have depreciated or otherwise written off the construction costs of their power plants – just as the nuclear sector has. So, as with the public opinion polls discussed in section II.E below, the numbers—and therefore their comparisons—are subject to manipulation.

As close as I have found to an objective comparison is the "adjusted" construction cost comparison chart presented in a paper by Mr. Richard Karn—though, as a reflection of the difficulty of such an exercise, *even he* questions the chart's reliability):

Plant Type (1000 mWe capacity)	COST (Billion dollars)
Scrubbed Coal	2.081
Integrated Coal-Gasification Combined Cycle (IGCC)	2.623
IGCC with Carbon Sequestration	5.431
Converted Gas/Oil Combined Cycle (CCGT)	2.336
Advanced CCGT	1.438
Advanced CCGT with Carbon Sequestration	2.867
Advanced Nuclear	2.014
Conventional Hydropower	2.904[139]

Finally, the eighth difficulty is yet another kind of accounting ambiguity: different people calculate differently the construction cost per kilowatt for a new nuclear power plant. As Ed Cummins (vice president of regulatory affairs and standardization for Westinghouse) has observed, "there have been a wide range of plant cost estimates published by different studies and potential customers, and each uses a different definition of cost... [s]o it's difficult to have an intelligent conversation about costs."[140]

For instance, in April 2007, Constellation Energy estimated the construction cost of a new Calvert Cliffs nuclear unit at $2,400/kW – substantially more than

136. Judith Lewis, *The Nuclear Option*, MOTHER JONES (2008), http://www.motherjones.com/news/feature/2008/05/the-nuclear-option.html; Sue Morse, *Nuclear debate rises in primary campaign*, PORTMOUTH NEWS HERALD, Jan 9, 2008, http://www.seacoastonline.com/apps/pbcs.dll/article?AID=/20080108/NEWS/801080366/-1/NEWS ("Congress recently approved $21 billion in production tax credits for solar and wind power initiatives").

137. Letter to the Editor, Review & Outlook: *Wind ($23.37) v. Gas (25 Cents)*, WALL ST. J, May 12, 2008, at A14.

138. Walsh, *supra* note 108.

139. Karn, *supra* note 134 (construction costs for a 1,000-MW plant fueled by: natural gas $1 billion; coal $1.0-$1.5 billion; nuclear $2.5 + billion). *See also* Faulk, *supra* note 132.

140. Jenny Weil, *Reactor vendors say cost estimates to vary*, NUCLEONICS WEEK, July 3, 2008, at 1, 2.

vendor Areva's June 2006 estimate of $1,800-$2,000/kW for that same unit.[141] According to UniStar President George Vanderheyden, the difference between those two estimates was that the higher one "is an 'all-in' figure that includes items such as owner's costs, detailed design, transmission upgrades, and contingency costs."[142] Mr. Vanderheyden explained that "[v]ender cost estimates to date have been 'a little like liar's poker'.... You never know until you dig into the details what is in that number and what is excluded from that number."[143]

As another example, some estimates refer to "overnight costs" (the cost of a plant if built overnight), while others will include the interest paid over the life of the construction. The difference can be substantial: a $3,000/kW overnight cost equates to a $3,600-$4,000/kW cost including interest.[144] And a final example: the cost estimates for Progress Energy's two possible new nuclear plants have variously been reported at both $14 billion and $17 billion – with the difference being attributable to offsite transmission line construction.[145]

b. Discussion

The DOE estimates that, from 2005 to 2030, "commercial electricity demand [in the United States] is projected to increase 75 percent... and residential demand is expected to rise by 47 percent."[146] Similarly, for the period 2005 - 2025, overall sales of electricity in the United States are expected to increase 1.9% annually.[147] During this same period, United States utilities expect to retire generating facilities that currently produce 43 GW of electricity.[148] This combination of increased demand and decreased generating capacity yields a need for a whopping 281 GW of new capacity.[149] Moreover, the plants that come online to meet this need must be able to operate efficiently, at a high capacity factor.[150] That is, they must be able to produce the maximum allowable electricity during a high percentage of their available generating time.

141. Daniel Horner & Jenny Weil, *UniStar officially chooses site, sets target date for COL filing*, NUCLEONICS WEEK, May 3, 2007, at 2, 3.

142. *Id*.

143. *Id*.

144. *Hearing Before the Subcomm. on Clean Air and Nuclear Safety*, 110th Cong. *3 (2008) (statement of Dr. Joseph Romm, senior fellow, ctr. for Am. Progress Action Fund), *available at* http://epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=33efb28f-fa40-4e15-b24e-f477c0f9fea2. (In this article's citations, unnumbered pages are preceded by an asterisk.)

145. *Id*. at *4.

146. Jon Talton, *Complex comeback: A new atomic age faces hurdles in America*, ARIZ. REPUBLIC, July 6, 2006, http://www.azcentral.com/arizonarepublic/business/articles/0706biz-talton0706.html. In the South (where most of the proposed new nuclear plants would be located), this increase is driven largely by a major migration. For instance, 1,000 people move to Florida each day. Andy Opsahi, *Nuclear Revival*, GOV'T TECH., Sept. 1, 2007, http://www.govtech.com/gt/133808?topic=117673.

147. Stephen L. Teichler & Charles W. Whitney, *Nuclear Power Is Coming Back to Life*, LEGAL TIMES, June 12, 2006, at 28.

148. *Id*.

149. *Id*.

150. NRC, 2007-2008 INFORMATION DIGEST 22 ("Capacity factor is the ratio of electricity generated to the amount of [electricity] that could have been generated").

This is where nuclear energy comes into its own. Even taking into account the caveats in the previous section, it is safe to conclude that nuclear energy still has significant economic advantages over its competition in meeting the country's need for increasing electric power. These advantages stem from a variety of factors: plant efficiency (*i.e.*, capacity factor), electricity generation costs, possible carbon taxes or emission trading programs, and fuel costs (the last three of which are intertwined, both in the real world and in the remainder of this discussion). And they must be balanced against one very significant disadvantage: rapidly escalating plant construction costs (also discussed below).

Nuclear energy's capacity factor has consistently improved over the last three decades. In 2007, United States nuclear power reactors operated collectively at a 91.8-percent capacity factor,[151] compared with 89.7% in 2005,[152] 71% in 1997,[153] 66% in 1990,[154] and 56% in 1980.[155] More important, their capacity factor compares quite favorably with the current 72% capacity factors for coal, 43% for natural gas combined cycle, 30% for solar, 20% for wind, and 16% for natural gas steam turbine.[156]

Almost all estimates indicate that the cost of producing a kilowatt-hour of electricity (measured in ¢/kWh) from a nuclear generating plant is less than the equivalent cost from either a gas-fueled or coal-fired plant. According to former NRC Commissioner Forrest J. Remmick, the electricity production cost at nuclear power plants in 2007 was 1.7¢/kWh, compared to coal at 2.4¢/kWh, natural gas at 6.8¢/kWh and oil at 10.2¢/kWh.[157] Similarly, Exelon claimed in 2007 that its nuclear-produced electricity cost only 1.3¢/kWh but its coal-produced electricity ran 2.2¢/kWh. And, using a different basis of comparison, Jeremy Sussman (an analyst at Natixis Bleichroeder in New York) concludes that "[United States] nuclear plants generated electricity in the fourth quarter [of 2007] for as little as $18 per megawatt-hour [1.8¢/kWh], 71 percent less than the average cost for the most efficient plants fueled by natural gas."[158]

151. NEI News Release, *U.S. Nuclear Power Plants Set Record Highs For Electric Production, Efficiency in 2007*, NEI, Feb. 6, 2008, *available at* http://www.nei.org/newsandevents/newsreleases/setrecordhighs/.

152. NEI News Release, *Nuclear Energy Industry Poised for Growth Based on Excellent Performance of Today's Plants*, NEI, Feb. 2, 2006, *available at* http://www.nei.org/newsandevents/industrypoisedforgrowth/.

153. Dave Flessner & Pam Sohn, *Nuclear Revival*, CHATTANOOGA TIMES, Jan. 28, 2007.

154. Energy Information Admin., *Nuclear Power: 12 percent of America's Generating Capacity, 20 percent of the Electricity*, *available at* http://www.eia.doe.gov/cneaf/nuclear/page/analysis/nuclearpower.html.

155. *Id.*

156. Howard Shaffer, *For Cheaper, More Reliable Energy, Go Nuclear*, Union Leader, July 29, 2008, http://www.unionleader.com/article.aspx?headline=Howard+Shaffer%3A+For+cheaper%2c+more+reliable+energy%2c+go+nuclear&articleId=7987fd6c-6320-4694-ab5d-fbb6e5121781; Nolan E. Hertel, *Has The Time Come For Nuclear Power? Yes: It's Safe, Clean, Cost-effective*, Atlanta Journal-Constitution, July 27, 2008.

157. FORREST J. REMICK, NUCLEAR POWER (June 28, 2008), http://www.nj.com/opinion/times/editorials/index.ssf?/base/news-0/1214625980218960.xml&coll=5. *See also* SCOTT PETERSON, NUCLEAR POWER VITAL TO CAROLINAS (Nov. 10, 2007), http://blueridgenow.com/article/20071110/NEWS/711100317/1015/OPINION02/NEWS/Nuclear_power_vital_to_Carolinas. (quotes similar cost figures for 2006).

158. Edward Klump, *FPL Group profit tumbles 16%*, MIAMI HERALD, Jan. 28, 2008, http://www.miamiherald.com/breaking_business/story/396395.html.

One major reason for this difference in generation cost is the comparative fuel prices. The price of coal – nuclear energy's primary competitor – is on the rise,[159] and could double if proposed CO_2 restrictions are imposed. Moreover, the energy generation industry has concerns about "the reliability and capacity of rail transportation infrastructure... related to coal."[160]

The price of natural gas has also been highly unstable, has risen substantially, and is expected to continue its upward path[161] – while domestic gas production has grown at a minuscule rate. At the same time, natural gas supplies have "plummeted far below the 'proven reserve' estimates made during the '90s."[162] Some assert that domestic gas supplies will probably be "insufficient to support long-term expansions in gas-fired generation, even if domestic gas production increases."[163] Natural gas prices will also be pressed upwards by the anticipated dwindling in the number of available drilling rigs in the Gulf of Mexico.[164] The rise in the price of natural gas in 2005 (and also the price of oil, though oil is only a minor competitor in the United States' bulk power market) was due in significant part to the effects of Hurricanes Katrina and Rita on the nation's gas and oil supplies and refining capacity[165] – effects which have led energy and economic experts to urge greater reliance upon nuclear energy. [166]

But the increase in nuclear energy's competitiveness actually predates these two natural disasters. A December 2005 report by a nuclear industry trade group, the World Nuclear Association (WNA), using data assembled before the two hurricanes and the more-recent surges in fossil fuel prices, found that the total energy costs for nuclear power plant construction and operation were already substantially lower than those for coal and natural gas power plants:

> Total electricity costs for power plant construction and operation were calculated at two interest rates. At 10%, mid-range generating costs per kilowatt-hour are nuclear at 4.0 cents, coal at 4.7 cents, and natural gas at 5.1 cents. At a 5% interest rate, mid-range costs per kWh fall to nuclear at 2.6 cents, coal at 3.7 cents, and

159. For instance, the price of coal gas rose 128% from January through July 2008. Anne Paine, *Electric bills are going up*, Tennesseean, Aug. 7, 2008, http://www.tennessean.com/apps/pbcs.dll/article?AID=/20080807/NEWS02/808070396/1006/NEWS01. *See also* Andy Opsahi, *supra* note 146,

160. *Nuclear Power is Heating up again*, BUS. WEEK, June 27, 2006, http://www.businessweek.com/investor/content/jun2006/pi20060627_680870.htm.

161. For instance, the price of natural gas rose 66% from January through July 2008. Anne Paine & Duncan Mansfield, *Electric bills are going up*, Tennesseean, Aug. 7, 2008, http://www.tennessean.com/apps/pbcs.dll/article?AID=/20080807/NEWS02/808070396/1006/NEWS01.

162. Opsahi, *supra* note 146.

163. Hiserodt, *supra* note 123, at 12.

164. Mike Spector, *Oil Rigs Stage Exodus From Gulf of Mexico*, Wall St. J., July 5, 2006, at C1.

165. For instance, these two hurricanes sank 108 oil and natural gas rigs in the Gulf of Mexico. *What's News*, Wall St. J., Oct. 5, 2005, at A1.

166. *See, e.g.*, Brian S. Wesbury (Chief Investment Strategist with Claymore Advisors LLC), *Resilient Economy*, Wall St. J., Sept. 8, 2005, at A18 ("More nuclear power . . . would . . . reduce the impact of future storms in the Gulf"); Letter to the Editor from Dr. Charles Ebinger (senior advisor at the International Resources Group and a specialist on global energy issues), *Katrina Exposes a Need For Global Energy Security*, Wall St. J., Sept. 7, 2005, at A17 (noting "the promise of next-generation nuclear technology" in the context of Katrina's damage to the U.S.'s energy infrastructure).

> natural gas at 4.3 cents. Increased fossil fuel prices tilt this balance still further toward nuclear power.[167]

The WNA concluded (not surprisingly) that, when viewed in purely economic terms, nuclear energy then stood as "the world's least expensive way to generate electricity"[168] – a conclusion which, if still correct, would be particularly significant to the United States, given its anticipated 20-percent increase in electricity demand by the year 2015.[169] The WNA report attributes this increased competitiveness to:

> cost reductions in all aspects of nuclear economics: construction, financing, operations, and waste management and decommissioning. Among the cost-lowering factors are the evolution to standardized reactor designs, shorter construction periods, new financing techniques, more efficient generating technologies, higher rates of reactor utilization (i.e., increased capacity factors), and longer plant lifetimes.[170]

For instance, the average cost of operating and maintaining a nuclear unit (including fuel but excluding capital costs) had declined from 3.5¢/kWh in 1987 to 1.7¢/kWh in 2005.[171]

As noted earlier, predicted construction cost for nuclear plants is also a factor in the industry's competitiveness – but, contrary to WNA's conclusion above, it is now a negative factor. And it is to that factor that I now turn.

According to 2007 data from the EIA, the estimated construction cost for a nuclear plant exceeds by 41% that for a conventional coal plant.[172] Although this negative factor is partly counterbalanced by the fact that nuclear fuel is far less expensive than coal or gas when measured per unit of energy produced, the predicted construction expenses are still mammoth – and, as explained below, are becoming more so.

Predicting construction costs for nuclear power reactors is difficult at best. According to Cambridge Energy Research Associates (CERA), "nuclear power plants were suffering the highest run-up in costs, nearly tripling since 2000, and most sharply since 2005 [—] higher than coal or natural gas)."[173] And a spokesman for NEI indicated in December 2007 that he knows of no company

167. WNA, THE NEW ECONOMICS OF NUCLEAR POWER, 4 (Dec. 2005), www.world-nuclear.org./economics.pdf. The WNA report is a distillation of post-2002 independent economic studies by such bodies as the IAEA, Massachusetts Institute of Technology, the United Kingdom's Royal Academy of Engineering, and the Nuclear Energy Agency. Thus, despite the WNA's presumed bias in favor of nuclear energy, the neutral sources distilled in its report give the document credibility.

168. *Nuclear Plant Now the Lowest-Cost Electricity-Generating Technology, New World Nuclear Association Analysis Shows*, BUS. WIRE, Dec. 1, 2005, *available at* http://findarticles.com/p/articles/mi_m0EIN/is_2005_Dec_1/ai_n15892152. (quoting John Rich, Director General of the WNA).

169. Rebecca Smith, *U.S. Electricity Demand is Outpacing New Resources*, WALL ST. J., Oct. 16, 2006, at A2.

170. *Lowest-Cost Electricity*, *supra* note 168.

171. Order Code RL33442, *Nuclear Power: Outlook for U.S. Reactors*, CRS REPORT FOR CONGRESS, Mar. 9, 2007, at p. CRS-5 (citing *U.S. Utility Operating Costs, 2005*, NUCLEONICS WEEK, Sept. 14, 2006, at 7).

172. Elliot Blair Smith, "Nuclear Utilities Redefine One Word to Bulldoze for New Plants," Bloomberg (Sept. 25, 2007), http://www.bloomberg.com/apps/news?pid=20601109&sid=ag_TpOMlk0Xw&refer=home.

173. Rob Linke, *Rising costs take glow off nuclear plants*, TEL.-J., June 30, 2008, *available at* http://telegraphjournal.canadaeast.com/search/article/340525.

that has released *firm* cost estimates for new nuclear units, a fact he attributed to those companies' continuing negotiations with suppliers[174] (though five months later, South Carolina Electric & Gas signed a $9.8 billion engineering, procurement, and construction contract with Westinghouse and Stone and Webster for two new units at its existing Summer nuclear plant[175]). "It will be between six and 18 months before we have any real clarity," said NEI's Mitch Singer.[176] According to George Bilicic, who heads the Global Power & Utilities Group of Lazard, this uncertainly is largely due to the potential for hyper-inflated costs of labor and components in the nuclear energy arena.[177]

Consider, for instance, the recent rise in the price of materials needed to construct nuclear power plants. According to a September 2007 report commissioned by the Edison Electric Institute, "steel prices have risen 60 percent since 2003[, c]opper prices nearly quadrupled between 2003 and 2006[,] and cement prices rose 30 percent during the same period."[178] In just the twelve months from April 2007 through March 2008, the relevant commodity prices for nuclear construction increased 10%, according to NRG Energy's executive vice president Steve Winn.[179] These escalating prices for raw materials are attributable not only to their increasing demand in the economic market as a whole, but more particularly to the cost-supply dynamics that stem directly from growing worldwide interest in constructing nuclear plants.

Also consider the potential (at least in the near term) for monopoly pricing by Japan Steel Works – currently the world's *sole* supplier of ultra-large forgings needed for reactor vessels.[180] Some predict that this kind of supply squeeze could double[181]—or even triple[182]—construction expenses.

174. Pam Radtke Russell, *Georgia Power gets extra time to firm up new Vogtle units' cost*, NUCLEONICS WEEK, Dec. 20, 2007, at 5.

175. *Fitch lowers Scana ratings outlook, citing plans for new reactors*, NUCLEONICS WEEK, Aug. 7, 2008, at 3.

176. Pam Radtke Russell, *Georgia Power gets extra time to firm up new Vogtle units' cost*, NUCLEONICS WEEK, Dec. 20, 2007, at 5.

177. Sheila McNulty, *A sea change in attitudes*, FIN. TIMES, Nov. 9, 2007, http://search.ft.com/ftArticle?queryText=Gwyneth+Cravens+&y=10&aje=false&x=8&id=071109000255&ct=0.

178. Russell Ray, *Nuclear Costs Explode*, TAMPA TRIB., Jan. 15, 2008, http://www2.tbo.com/content/2008/jan/15/bz-nuclear-costs-explode/. In his February 5, 2008 speech at the Platts "Nuclear Energy" Conference in Rockville, MD, Michael Wallace (then-President and CEO of Constellation Energy Nuclear Group, and now Vice-Chairman of Constellation) indicated that steel prices had risen about 250% since 2000. *See* Slide 13 of Mr. Wallace's presentation, on file with author.

179. Jenny Weil, *NRG, Toshiba Form Partnership to Build ABWRs*, NUCLEONICS WEEK, Mar. 27, 2008, at 1, 2.

180. Todd Crowell, *One Steel Mill Holds Key to the Nuclear Revival*, ASIA SENTINEL, July 1, 2008, *available at* http://asiasentinel.com/index.php?option=com_content&task=view&id=1296&Itemid=32 (also listing Britain's Sheffield Forgemasters, Ltd., South Korea's Dooson Heavy Industries and Construction Company as potential future competitors, and observing that Russia's OMZ Special Steels can currently produce such forgings, but *solely* for the Russian-designed VVER reactors); David Stellfox, *Sheffield to make all casings for AP1000 reactor coolant pumps*, Nucleonics Week, Sept. 4, 2008, at 8 (referring to "Sheffield Forgemasters's plans to buy a 15,000-mt press for ultra-large forgings [which] would put it in competition with Japan Steel Works, the monopoly supplier of such parts," but stating that Sheffield has not yet decided on the financial arrangements for the purchase); Michael Totty, *No To Nuclear*, WALL ST. J., June 30, 2008, at R1, R3 (China plans to begin making the ultra-large forgings); Ann MacLachlan, *Areva investing to increase component-making capacity*, NUCLEONICS WEEK, July 10, 2008, at 4-5 (Areva's Creusot facility will be

And finally, consider the effect of the falling value of the dollar against the Japanese yen. From April 2007 to March 2008, the United States dollar fell 30% against the yen[183] – a particularly relevant fact, given Japan Steel Works' current monopoly in ultra-large forgings and considering further that companies like NRG anticipate importing 30% of reactor parts from Japan.[184] No wonder firm estimates of construction costs are so hard to come by.[185] As shown next, the *non-firm* estimates vary widely – from $1,000 to $10,000 per installed kilowatt of capacity ($/kW).

The lowest estimate I have seen is that of Transition Power Development, a private equity company in Utah, which proposed in 2007 to build a 3,000-MW nuclear power facility (the Blue Castle Generation Project) for only $3 billion – or a mere $1,000/kW.[186] This number is (at least to me) suspect because it is at the lowest end of the spectrum of estimates and comes from a company that has never built a nuclear power plant. Even as far back as 2003, NEI was predicting that the first new nuclear plant would cost 40% more than that—$1400/kW[187]—with the subsequent ones running about $1200/kW, or 20% more than Transition Power Development's estimates.[188]

Per Peterson (a nuclear engineer at the University of California at Berkeley) noted as recently as mid-2007 that "[v]endors have said consistently they will come in under $1,500 per kilowatt."[189] Other optimists concluded in 2006 that the cost of constructing a nuclear power plant would be roughly the same as Dr. Peterson's estimate. One example is James Asselstine, the then-managing director of Lehman Brothers Inc., and a former NRC Commissioner, who testified before the Senate Energy and Natural Resources Committee in May 2006, that:

> most of the industry is thinking it will cost between $1,500 and $2,000 per installed kilowatt [to construct] new nuclear plants. Taking into account the production tax

capable of manufacturing ultra-large forgings in "a few years"). *But see* John Carey, *Nuclear's Tangled Economics*, BUS. WEEK, June 26, 2008, http://www.businessweek.com/magazine/content/08_27/b4091024354027.htm (listing France's Creusot Forge as a facility *already* capable of producing ultra-large castings).

181. Joshua Boak, *New energy in nuclear power supply battle: Firms jostle to be 1st in line for scarce reactor components*, CHICAGO TRIB., Jan. 6, 2008.

182. Russell Ray, *Nuclear Costs Explode*, TAMPA TRIB., Jan. 15, 2008, http://www2.tbo.com/content/2008/jan/15/bz-nuclear-costs-explode/.

183. *Toshiba Form Partnership*, *supra* note 179.

184. Elizabeth Souder, *NRG's estimate for Texas nuclear reactors still climbing*, DALLAS MORNING NEWS, Mar. 27, 2008, http://www.dallasnews.com/sharedcontent/dws/bus/industries/energy/stories/DN-nrgcost_27bus.ART.State.Edition1.15de092.html.

185. For more discussion of these cost increases, see Section III.B.2, *infra*.

186. JIM POLSON, NRG'S APPLICATION TO EXPAND NUCLEAR PLANT ACCEPTED (Dec. 3, 2007), http://deseretnews.com/dn/view/0,5143,695232235,00.html.

187. Matthew L. Wald, *Cost of reopening U.S. nuclear reactor shows how difficult it will be to build new facilities*, INT'L HERALD TRIB., May 9, 2007, http://www.iht.com/articles/2007/05/09/sports/nuke.php. *See also* Jenny Weil & Elaine Hiruo, *MidAmerican cancels project as others reassess nuclear option*, NUCLEONICS WEEK, Jan. 31, 2008, at 1, 14.

188. Matthew L. Wald, *Cost of reopening U.S. nuclear reactor shows how difficult it will be to build new facilities*, INT'L HERALD TRIB., May 9, 2007, http://www.iht.com/articles/2007/05/09/sports/nuke.php.

189. William McCall, *New nuclear plant designs are streamlined? theoretically safer*, KGW.com, July 15, 2006, http://www.kgw.com/sharedcontent/APStories/stories/D8ISJN003.html.

> credit and the loan guarantees,... the installed cost could be brought down to around $1,200 per installed kilowatt, which is competitive with the cost of a new coal plant.[190]

Similarly, Standard and Poor's 2006 estimate was $1,500/kW.[191]

Generally consistent with this $1,500-$2,000 range, many independent power producers, utilities and others have, from 2003 through 2007, offered the following construction cost estimates per kilowatt (with the approximate dates being based primarily on the publication dates of the press articles from which the numbers were drawn):

$1,528	(3/07)[192]
$1,500-$2,000	(6/06)[193]
$1,600-$2,000	(6/06)[194]
$1,667	(10/06)[195]
$1,790	(12/07)[196]
$1,900	(8/07)[197]
$1,913	(3/07 & 5/06) (in 2004 dollars)[198]
$1,915	(6/06)[199]
$1,926	(6/07)[200]

190. KATHLEEN HART, NRC CHAIRMAN TELLS SENATE 25 NEW NUCLEAR PLANTS ARE UNDER CONSIDERATION, (May 22, 2006), http://www.snl.com/interactivex/article.aspx?CdId=A-4224568-11364. The amount of any one plant's loan guarantee is a complete unknown, given that, currently, 17 electric power companies are asking collectively for $122 billion in loan guarantees – far above the $18.5 billion authorized by Congress. Jenny Weil and Tom Harrison, *Areva Only Applicant Besides USEC to Seek Front-End Loan Guarantees*, Nuclear Fuel, Oct. 6, 2008, at 9. *Cf. DOE Reviews Nuclear loan Guarantee Requests*, Power Engineering, Oct. 3, 2008, http://pepei.pennnet.com/Articles/Article_Display.cfm?Section=ONART&PUBLICATION_ID=6&ARTICLE_ID=341570&C=PRODJ&dcmp=rss (offering different figures: $188 billion for 21 new reactors at 14 sites).

191. Jim Motavalli, *A Nuclear Phoenix*? FAYETTEVILLE FREE WEEKLY, July 19, 2007, http://www.freeweekly.com/2007/07/19/a-nuclear-phoenix/.

192. Congressional Research Service, *Nuclear Power: Outlook for New U.S. Reactors*, Mar. 9, 2007, at CRS-15.

193. Adam Aston, *Nuclear Power's Missing Fuel*, BUS. WEEK, June 29, 2006, http://www.businessweek.com/technology/content/jun2006/tc20060628_463853.htm?chan=technology_technology+index+page_more+of+today.

194. Dan Zehr & Robert Elder, *Company plans to double the size of Texas nuclear plant: Firm to spend $6.8 billion in Texas, might add reactors to Austin nuke*, AUSTIN AM.-STATESMAN, June 22, 2006, http://www.statesman.com/news/content/news/stories/local/06/22power.html ($5.2 billion for two 1350-MW nuclear units at the South Texas Project near Bay City, Texas).

195. Laura Youngs, *Plant Vogtle's expansion is moving ahead, manager says*, AUGUSTA CHRONICLE, Oct. 18, 2006, http://chronicle.augusta.com/stories/101806/bus_100922.shtml ("The 2,400-megawatt, two-unit facility is seeking to double its size in a project expected to cost $4 billion" - yielding a construction cost per kilowatt of $1,667).

196. This figure represents the low end of estimates for the William States Lee III Nuclear Station in South Carolina. LYNNE P. SHACKLEFORD, DUKE NUCLEAR PLANS FOR CHEROKEE TO COST $230M (Dec. 13, 2007), http://www.goupstate.com/article/20071213/NEWS/712130359/1051/NEWS01 ($4-$6 billion for two 1,117-MW plants).

197. TINA SEELEY, TVA MAY FINISH REACTOR, 35 YEARS AFTER STARTING (UPDATE 3) (Aug. 2, 2007), http://www.bloomberg.com/apps/news?pid=20601207&sid=amCxWIJC5vdY&refer=energy#.

198. Congressional Research Service, *Nuclear Power: Outlook for New U.S. Reactors*, at CRS-14, Table 2, Mar. 9, 2007; *id.* at 12, Table 2, May 31, 2006, Order No. RL33442, on file with author.

199. Jenny Weil & Michael Knapik, *NRG may build ABWRs at South Texas; commercial-grade parts to cut costs*, INSIDE NRC, June 26, 2006, at 1.

$2,000 (2003 & 2/07)[201]

By mid-2006, vendors of nuclear power plants were offering estimates of $1,500-$2,000/kW, similar to those cited above:

1,390-MW "economic simplified boiling water reactor" (ESBWR)	$1,600/kW,
General Electric's Advanced Boiling Water Reactor (ABWR)	$1,850/kW,
Westinghouse's 1,100-MW AP1000 advance pressurized[202] water reactor (AP1000)	$1,500 - $1,800/kW, and
Areva's 1,600-MW U.S. Evolutionary Power Reactor (US EPR)	$1,800 - $2,000/kW.[203]

And TVA's decision to complete the construction of its 1,000-MW Browns Ferry-1 reactor unit for $1.8 billion[204] suggests than, at least in 2007, TVA viewed the renovation as less expensive that building a new plant from scratch – which would in turn mean that TVA believed a new plant would cost more than the completion's $1,800/kW price tag.[205]

200. *Toshiba eyes big US nuclear deal*, Yahoo! Finance, June 27, 2007, http://sg.biz.yahoo.com/070627/1/49hd4.html ($5.2 billion for two 1.35-GW reactors).

201. Eric Morath, *DTE Plans for Nuclear Plant,* Detroit News, Feb. 13, 2007, http://www.detnews.com/apps/pbcs.dll/article?AID=/20070213/BIZ/702130338/1001; *DTE Plans New Reactor at Fermi Nuclear Power Plant*, LCG Consulting - Energy Online, Feb. 14, 2007, http://www.energyonline.com/Industry/News.aspx?NewsID=7129&DTE_Plans_New_Reactor_at_Fermi_Nuclear_Power_Plant; Steve Dolley, *Duke CEO a 'Skeptical optimist' on Future of US Nuclear Power,* NUCLEONICS WEEK, June 21, 2007, at 2, 3, *citing* 2003 Massachusetts Institute of Technology study, http://www.detnews.com/apps/pbcs.dll/article?AID=/20070213/BIZ/702130338/1001.

202. Westinghouse has also referred to the "AP" as meaning "advance passive." Progress Energy Florida's Petition for Determination of Need for Levy Units 1 and 2 Nuclear Power Plants, Docket No. 080148-EI, at 13 (Mar. 11, 2008), http://www.floridapsc.com/library/filings/08/01792-08/01792-08.pdf; Ken Bonner, *First steps taken on COL for Bellefonte*, SCOTTSBORO DAILY SENTINEL (AL), Sept. 13, 2007, http://www.thedailysentinel.com/story.lasso?ewcd=a91e64209be28b05&page=all.

203. Jenny Weil & Elaine Hiruo, *MidAmerican Cancels Project as Others Reassess Nuclear Option*, NUCLEONICS WEEK, Jan. 31, 2008, at 1, 15; Ann MacLachlan, *Estimates Increase for Costs of New Nuclear Plants in US*, NUCLEONICS WEEK, July 6, 2006, at 1, 13-14. *See also* Jenny Weil & Tom Harrison, *Farmer's Co-op Wants Reactor Built in Idaho*, NUCLEONICS WEEK, Dec, 7, 2006, at 1, 3 (earlier in 2006, executives at Westinghouse, Areva and General Electric estimated construction costs at $1,600-$2,000/kW); Ann MacLachlan, *Nuclear "Renaissance" Could Falter if Costs Rise, Icapp Meeting Told*, NUCLEONICS WEEK, May 24, 2007, at 2 ($2,000/kW for an Areva EPR).

204. Tom Harrison, *Browns Ferry – 1 Achieves Critically After 22-Year Shutdown*, NUCLEONICS WEEK, May 24, 2007, at 1, 11; Tom Harrison, *NRC Approves Browns Ferry – 1 Restart*, NUCLEONICS WEEK, May 17, 2007, at 1, 2; Allison Gorman, *The Nuclear Option*, BUSINESS TN, May 2, 2007, http://www.businesstn.com/pub/4_5/cover/8104-1.html.

205. Scott Henry, *Georgia Power Takes a Fresh Look at Nuclear Power,* CREATIVE LOAFING ATLANTA, Aug. 22, 2007, http://atlanta.creativeloafing.com/gyrobase/Content?oid=291119. Conversely, however, TVA expected earlier this year that construction of the remaining 40% of the 1167-MWe Watts Bar-2 unit will cost $2.49 billion – or $5,334/kW. Presentation of Ashok Bhatnagar (TVA's Senior Vice President of Nuclear Generation Development and Construction) at Platts' "Nuclear Energy" Conference (Feb. 5, 2008), Slide 11, on file with author. *See also* Dave Flessner & Herman Wang, *Tennessee Valley Authority Changed Region, Providing Access to Power, Economic Growth*, CHATTANOOGA TIMES FREE PRESS, May 18, 2008,

One conclusion is inescapable from these numbers: even on this low end of the estimate spectrum, there is nowhere near a consensus on the cost of constructing a nuclear power plant. The numbers cited above (at least when viewed in isolation) do not even lend themselves to the common-sense conclusion that estimates rise over time (a conclusion which, however, will be borne out by the later data discussed below).

Other prognosticators are less optimistic than those cited above. Here is a representative sample, all reported in 2007. David Schlissel of Synapse Energy Economics (a Massachusetts-based consulting firm) considers the industry's estimate of $1,200-$2,000/kW "very likely optimistic, considering construction costs are rising and new designs have not been proven at full scale."[206] The EIA estimates a 1,000-MW plant would cost $2.1 billion, or $2,100 per installed kilowatt.[207] John Krenicki, President and CEO of GE Energy, expects the construction of both nuclear and coal plants to cost about $2,000-$3,000/kW, depending upon whether the site is greenfield or brownfield.[208] And offering essentially those same numbers, Dominion Virginia Power estimated its anticipated costs for a new 1,520-MW reactor at between $1,974/kW and $3,026/kW .[209]

A bit more pessimistically, Constellation Energy's Vice Chairman Michael Wallace has, at various times during the last two years, estimated the cost at between $2,500/kW and $3,500/kW[210] or (most recently) only "slightly" above $3,000/kW for the first reactor and $2,400/kW for a fleet of four reactors.[211] Similarly, NuStart is predicting for the new Bellefonte plant a construction cost of $2,500-$3,500/kW[212] (although others place that cost as high as $5,000/kW[213]). And international nuclear vendors contemporaneously predicted (as reported in early 2008) that they could construct a plant for $2,500/kW or less;[214] but by mid-2008, vendors GE and Westinghouse were each estimating the cost for their ABWR and AP1000, respectively, at $3,000/kW.[215] Between September 2006 and April 2008, many others in the

http://timesfreepress.com/news/2008/may/18/tennessee-valley-authority-changed-region-providin/ ($2.5 million).

206. Judy Fahys, *Lawmakers Balk on Nuclear Proposal for Now*, THE SALT LAKE TRIB., Sept. 19, 2007, http://www.sltrib.com/ci_6942084?source=rss.

207. John Wilen, *Utilities Press For New3 Nuclear Future*, BUS. WEEK, Sept. 18, 2007, http://www.businessweek.com/ap/financialnews/D8RO03VG0.htm.

208. Jenny Weil, *GE, Hitachi Say Alliance Strengthens Standing*, NUCLEONICS WEEK, July 12, 2007, at 1, 2.

209. Greg Edwards, *Bids for Nuclear Power Soar*, RICHMOND TIMES-DISPATCH, Dec. 10, 2007, at A-1.

210. Ann MacLachlan, *US Utility Experts Differ on New Plant Cost*, NUCLEONICS WEEK, Sept. 27, 2007, at 1.

211. Daniel Horner, *Constellation Keeping up Pace on Reactor Construction Effort*, NUCLEONICS WEEK, Feb. 7, 2008, at 6.

212. Ken Bonner, *First Steps Taken on COL for Bellefonte*, SCOTTSBORO DAILY SENTINEL, Sept. 13, 2007.

213. Kent Faulk, *NRC to Review Bid on Two New Reactors: Decisions on Bellefonte Nuclear Site License Could take 3 to 4 Years*, BIRMINGHAM NEWS, Sept. 12, 2007, at 5C.

214. Jenny Weil & Elaine Hiruo, *MidAmerican Cancels Project as Others Reassess Nuclear Options*, NUCLEONICS WEEK, Jan. 31, 2008, at 1, 15.

215. Jenny Weil, *Reactor Vendors Say Cost Estimates to Vary*, NUCLEONICS WEEK, July 3, 2008, at 1.

industry likewise placed the construction cost in this same general ($2,000-$3,000/kW) range:

$2,000-$2,500	(9/07)[216]
$2,100	(9/06)[217]
$2,188	(7/07)[218]
$2,200	(10/07)[219]
$2,222	(2/08)[220]
$2,234-2,685	(12/07)[221]
$2,273-$3,182	(10/07 & 12/07)[222]
$2,400	(12/07)[223]
$2,500	(2006, 12/06, 7/07, 8/07, 1/08 & 3/08)[224]

216. Rebecca Smith, *Nuclear Energy's Second Act?*, WALL ST. J., Sept. 25, 2007, at B1 ($2,000-$2,250); Tina Seeley & Greg Chang, *NRG Files First Full Application for U.S. Reactor (Update 3)*, BLOOMBERG, Sept. 24, 2007, http://www.bloomberg.com/apps/news?pid=20601087&sid=a_Kp1BDPL6ZE&refer=home *quoting* NRG Energy Chief Executive Officer David Crane, who estimates the construction cost for two new units at the South Texas site at $5.4-$6.75 billion, which for 2,700 MWs equates to $2,000-$2,500/kW. Others, however, estimate the cost slightly higher at between $6 billion and $7 billion, or $2,222-$2,592/kW. *See also* Vicki Vaughn, *CPS Stake in Nuke Plant Could Grow*, SAN ANTONIO EXPRESS-NEWS, Feb. 11, 2008 ($7 billion); Matthew L. Wald, *Approval is Sought to Build Two Reactors in Texas*, N.Y. TIMES, Sept. 25, 2007 ($6-$7 billion).

217. Elizabeth Souder, *3 Nuclear Plants in TXU's Future: Plan Addresses Coal Pollution Worries, Raises Waste-removal Concerns*, DALLAS MORNING NEWS, Aug. 31, 2006.

218. Lee Vander Boegh, *Nuclear Plant Files Application*, IDAHO PRESS-TRIB., July 18, 2007 ($3.5 billion for a proposed 1,500- to 1,600-MW reactor in Idaho); *Group Says it has Financial Backing for $3.5B Nuclear Power Plant*, KVTB.com, June 26, 2007, http://www.ktvb.com/news/business/stories/ktvbn-jun2607-nuclear_power_plant.182afdb9.html ($3.5 billion for a proposed 1,500 to 1,600-MW reactor in Idaho). However, from June to December 2007, the estimated cost of constructing a nuclear plant in Idaho jumped from $3.5 billion to $4.5 billion. Ken Dey, *SLC Firm to Invest in Proposed Nuke Plant*, IDAHO STATESMAN, Dec. 7, 2007.

219. Vaughn Scully, *A U.S. Nuclear Power Renaissance*, BUS. WK., Oct. 3, 2007.

220. Pam Radtke Russell, *STP's Biggest Owners to Pursue Expansion as City of Austin Opts Out*, NUCLEONICS WEEK, Feb. 21, 2008, at 5 (two 1,350-MW plants for $6 billion).

221. *Duke Submits Application for S.C. Nuclear Station*, CHARLOTTE BUS. J., Dec. 13, 2007.

222. Dave Flessner & Herman Wang, *TVA Applies for New Alabama Nuclear Plant*, CHATTANOOGA TIMES FREE PRESS, Oct. 31, 2007 ("Although no final cost estimate has been prepared for the AP1000 reactors, TVA Vice President Jack Bailey said preliminary estimates indicate each of the AP1000 reactors [each rated at 1,100-MW] at Bellefonte would cost $2.5 billion to $3.5 billion to build"); Nathan Crabbe & Karen Voyles, *Utility Eyes Levy Site for Nuclear Plant*, GAINESVILLE SUN, Dec. 13, 2006 (Progress Energy estimates that its proposed new 1,100-MW reactor in Levy County, Florida, would cost between $2.5 billion and $3.5 billion).

223. Margaret Newkirk, *Nuke Plants may be Pricier than Expected*, ATLANTA JOURNAL-CONST., Dec. 15, 2007, at 1C.

224. Christie Goodman, *Careful Studies of 3rd Nuclear Reactor Urged*, WASH. POST, Mar. 23, 2008, at 6 (referring to an estimated $4-billion price tag for Areva's 1,600-MW reactor); Paul Adams, *CEG Might put N.Y. Ahead on Reactor: Irked Constellation Unit Threatens to Delay Calvert Cliffs Expansion*, BALTIMORE SUN, Jan. 30, 2008, at 1D (again, referring to an estimated $4-billion price tag for Areva's 1,600-MW reactor); Dan Morse, *Officials Support 3rd Nuclear Reactor: Agency Describes Process to License Calvert Cliffs Plant*, WASH. POST, at B02 (Constellation estimates the cost of its proposed 1,600-MW reactor at Calvert Cliffs at $4 billion – or $2,500/kW); Jenny Mandel, *Nuclear Power: Industry's 'Renaissance' Means Race for Resources*, GREENWIRE, Aug. 6, 2007 ("Vendor estimates last year set totals around $2,500 per kilowatt, but prices will not be locked in until contracts are signed"); David Gauthier-Villars, *EDF Teams Up with Constellation*, WALL ST. J., July 23, 2007 (referring to an estimated $4-billion price tag for Areva's 1,600-MW reactor); Jeff St.

$2,500-$3,125	(12/07)[225]
$2,500-$3,500	(4/08)[226]
$2,631	(11/07)[227]
$2,272-$2,727	(7/07)[228]
$2,727	(6/07)[229]
$2,812	(2/08)[230]
$2,900	(3/08)[231]
$3,000	(7/07, 8/07 & 7/08)[232]

Despite the scattershot nature of this pool of numbers, the data and dates I cite above lend themselves to at least one clear conclusion: almost all estimates between $2,000 and $3,000 came in 2007 or 2008 rather than 2006. Compared with the dates for the $1,000-$2,000 estimates (2003-2007) described above, this conclusion does at least *suggest* an upward trend in estimated construction costs.

Within the $1,000-$3,000 range, perhaps the starkest example of this apparent trend is that of NRG. When the company announced its intent in June 2006 to construct two new nuclear units at the South Texas Project, it estimated $1,915 per gross kilowatt installed for a 1,350-MW ABWR.[233] But in April 2007, NRG's estimated cost for two such reactors was $3.5 billion each – or $2,593/kW[234] – more than one-third more than NRG's estimate just ten months

John, *Nuclear Plant Idea Takes Hold: Group Says it will Seek Power Facility for Fresno*, FRESNO BEE, Dec. 14, 2006 (a group of California businessmen and investors are considering construction for a $4-billion, 1,600-MW nuclear reactor in Central California – or $2,500/kW).

225. *PPL Closer to Adding Reactor*, STANDARD SPEAKER (Hazelton, PA), Dec. 20, 2007.

226. *Georgia. Power Reaches Deal for Construction of Two Nuclear Reactors*, COLUMBUS LEDGER-ENQUIRER, Apr. 8, 2008.

227. Greg Edwards, *Virginia Power Files to Build Reactor*, RICHMOND TIMES-DISPATCH, Nov. 29, 2007.

228. Progress Energy pegs the cost for its anticipated Levy County, FL, reactor at $2.5–$3.0 billion. Russell Ray, *Progress Energy Plans Nuclear Plant with Safer Design*, TAMPA TRIB., July 11, 2007.

229. Steven Dolley, *Duke CEO a 'Skeptical Optimism' on Future of US Nuclear Power*, NUCLEONICS WEEK, June 21, 2007, at 2-3 (the construction cost for two proposed 1,100 MW Westinghouse AP1000 units in South Carolina would be "about $6 billion," or $2,727/kW).

230. Ken Dey, *Nuclear Plant Developer Settles Fee Dispute*, IDAHO STATESMAN, Feb. 19, 2008, http://www.idahostatesman.com/business/story/299465.html, ("Alternate Energy Holdings . . . is proposing a $4.5 billion, 1,600-MW nuclear power plant").

231. Jenny Weil & Tom Tiernan, *NRG, IEER Differ on the Cost of New ABWRs*, NUCLEONICS WEEK, May 8, 2008, at 1, 2.

232. Ann MacLachlan, *Big cost hikes make vendors wary of releasing reactor cost estimates*, Nucleonics Week, Sept. 11, 2008, at 2-3 (citing July 2008 overnight-cost projections by GE-Hitachi and Westinghouse); Rebecca Smith, *Nuclear Energy's Second Act?*, WALL ST. J., Sept. 25, 2007, at B1; Jenny Mandel, *Nuclear Power: Industry's 'Renaissance' Means Race for Resources*, GREENWIRE, Aug. 6, 2007, *citing* Jone-Lin Wang, a senior director with CERA and co-author of a paper on the nuclear renaissance. Ms. Wang has also offered a more general prediction of between $2,200/kW and $5,000/kW. Vicki Vaughn, *CPS Energy May Make History with New Nuclear Reactors*, SAN ANTONIO EXPRESS-NEWS, Oct. 20, 2007.

233. Jenny Weil, *NRG First Merchant Company to Look at Nuclear*, NUCLEONICS WEEK, June 29, 2006, at 1-2; Jenny Weil & Michael Knapik, *NRG may build ABWRs at South Texas: Commercial-grade Parts to Cut Cost*, INSIDE NRC, June 26, 2006, at 1.

234. Rebecca Smith, *TXU Sheds Coal Plan, Charts Nuclear Path*, WALL ST. J., Apr. 10, 2007, at A2.

earlier. And in March 2008, NRG's CEO raised the estimated amount yet again, this time to $8 billion in construction costs for the two units[235] – or $2,963/kW.

This general range ($2,000-$3,000/kW) finds further support in some estimates from other countries between 2004-2008. Take, for instance, Japan's experience in constructing nuclear power plants: a 2004 study by the University of Chicago indicated that construction costs of Japanese plants then ranged from $1,796/kW to $2,827/kW.[236] Likewise, Energy Alberta Corporation announced in September of 2007 that it intended to build a C$6.2-billion dollar, 2,200-megawatt CANDU twin reactor near Peace River, Alberta – which translates to $2,818/kW (in both Canadian and United States currency).[237] In March 2008, Bruce Power, LP (which had just purchased Energy Alberta) filed an application to prepare a potential 4,000-MW nuclear power plant site in northwestern Alberta, the actual construction cost of which would be C$8-C$10 billion, or C$2,000–C$2,500/kW.[238] (This latter project replaced the one that Energy Alberta had announced in September 2007.)

But even the $2,000-$3,000/kW range now appears too optimistic. Some of the most recent (2007-2008) estimates have come in a *great* deal higher (in roughly ascending order of cost):

- Booz Allen Hamilton's Tom Flaherty (senior Vice President for Energy and Commercial Utility Practice) estimated at a February 2008 conference that the overnight cost of constructing a nuclear plant is $3,000-$4,000/kW in 2007 dollars.[239]
- At the same conference, Morgan Stanley's Jeffrey Holzschuh (Vice Chairman, Institutional Securities and Chairman Environmental Committee) estimated the capital cost at $3,000-$3,325/kW.[240]
- Also in early 2008, Amarillo and UniStar estimated that the former's proposed 1,600-MW plant near Amarillo, Texas, would cost about $5 billion,[241] or $3,125/kW.

235. Elizabeth Souder, *NRG's Estimate for Texas Nuclear Reactors Still Climbing*, DALLAS MORNING NEWS, Mar. 27, 2008; Jenny Weil, *NRG, Toshiba Form Partnership to Build ABWRs*, NUCLEONICS WEEK, Mar. 27, 2008, at 1, 2 ($2,900/kW); Matthew L. Wald, *NRG Energy Sets Up an Entity to Build Nuclear Plants*, N.Y. TIMES, Mar. 26, 2008.

236. FRIENDS OF THE EARTH, WHY A FUTURE FOR THE NUCLEAR INDUSTRY IS RISKY (2007), http://www.cleanenergy.org/resources/reports/WhyNewNukesAreRiskyFACTSHEET.pdf, at 2, *citing* University of Chicago for the DOE, The Economic Future of Nuclear Power, Aug. 2004, at 2-14; *see also Keystone Report*, *supra* note 8 ($1,800–$2,818).

237. Sonja Franklin & Ian McKinnon, *Bruce Power Applies to Prepare Site for Nuclear Plant (Update 2)*, BLOOMBERG, Mar. 13, 2008, http://www.bloomberg.com/apps/news?sid=az9Fsu7cDHMo&pid=20601082; *Energy Alberta Says no Deal in Place for Power from Proposed Nuclear Plant*, CANADIAN PRESS, Sept. 11, 2007; Gordon Jaremko, *Energy Power Buyer not for Real*, EDMONTON JOURNAL, Sept. 10, 2007. At the time of the announcement, the United States and Canadian dollar were practically identical in value. *Canadian Dollar Equals US Dollar*, ECONOMIC TIMES, Sept. 21, 2007, http://economictimes.indiatimes.com/International_Business/Canadian_dollar_equals_US_dollar/articleshow/2390831.cms.

238. Sonja Franklin & Ian McKinnon, *Bruce Power Applies to Prepare Site for Nuclear Plant (Update 2)*, BLOOMBERG, Mar. 13, 2008, http://www.bloomberg.com/apps/news?sid=az9Fsu7cDHMo&pid=20601082.

239. Tom Flaherty, Presentation at Platts Nuclear Energy Conference, (Feb. 5, 2008), Slide 3 ("Comparative Capital Costs"), on file with author.

240. Jeffrey Holzschuh, Presentation at Platts Nuclear Energy Conference (Feb. 6, 2008), slides 12 & 13 ("Capital Costs" & "Projected Nuclear Build for Next 15 Years"), on file with author.

● About the same time, Toshiba was quoted as estimating the construction price for its 1,100-MW AP1000 at $3.5 billion, or $3,182/kW.[242]

● Last year and this, Exelon estimated that construction of a new 1,100-MW plant in Texas will run about $4 billion, or $3,636/kW[243] and that a 3,000-MW plant would run $10 billion,[244] or $3,333/kW.

● CERA predicted in February 2008 a construction cost of $3,500/kW (up from $2,000/kW three years earlier).[245]

● In September 2008, construction costs for two new 1,700-MW reactor units was estimated at between $3,529/kW and $5,000/kW.[246]

● In early 2008, Atomic Energy of Canada Ltd. indicated that it was considering construction of a 1,085-MW nuclear plant in Saint John Province for about C$4 billion, or C$3,687/kW.[247]

● In 2007, Moray Dewhurst (Chief Financial Officer of FPL) estimated "[t]he overnight costs of building the first new nuclear unit at a greenfield site [at] between $2,400 and $3,500 per kilowatt in 2006 dollars," but predicted that escalation costs and interest could drive these figures upwards to between $4,000 and $5,500 in 2020 dollars.[248]

● Jonathan Baliff (Managing Director of Credit Suisse's Global Energy Group) stated in a February 2008 conference that "conventional wisdom" on Wall Street placed construction costs at $4.0-$5.5 billion/plant[249] – which (assuming a 1,117-MW AP1000 plant) equates to $3,851-$4,924/kW.

● A 2007 analysis of nuclear energy by the Keystone Center "calculated a capital cost for new US nuclear power in the range of $3,600 to $4,000/kW."[250]

● AmerenUE announced in June 2008 that the potential new plant at its Callaway facility in Missouri would cost $3,750-$5,625/kW,[251] depending on

241. Karen Smith Welch, *Navigating the Nuclear Greenfield: Developer Pushes Ahead with Amarillo Site Plan*, AMARILLO GLOBE NEWS, Mar. 16, 2008 (1,600-MW); Jim McBride, *Greenfields Face Long Process*, AMARILLO GLOBE NEWS, Mar. 16, 2008 (at least $5 billion).

242. Chris Oliver, *Toshiba Seeks Orders for 4 U.S. Nuclear Plants*, MARKETWATCH, Apr. 2, 2008, http://www.marketwatch.com/news/story/toshiba-seeks-14b-order-us/story.aspx?guid=%7bB2420B15-76C4-456A-BC31-4598AD42EBD2%7d&dist=msr_1&print=true&dist=printTop.

243. Fannie S. Chirinos, *Nuclear Power Plant Proposed*, CORPUS-CHRISTI CALLER-TIMES, June 29, 2007.

244. Steven Dolley, *Nuclear Power Key to Exelon's Low-Carbon Plan*, NUCLEONICS WEEK, Feb. 14, 2008, at 1-2.

245. Tom Fowler, *Snags Seen for Nuclear Power*, HOUSTON CHRONICLE, Feb. 15, 2008.

246. Randy Lee Loftis, *Dallas-based Luminant seeks to expand Comanche Peak nuclear power plant*, Dallas Morning News, Sept. 22, 2008, http://www.dallasnews.com/sharedcontent/dws/bus/stories/DN-comanche_20bus.ART.State.Edition1.15134ef.html.

247. Peter Moreira, *Saint John Gets its Swagger Back: With an LNG Terminal, Pipeline, Nuclear Power, and Possibly Another Refinery, the City is on a Roll*, TORONTO GLOBE AND MAIL, Jan. 2, 2008, at B1. At the time of the announcement, the U.S. and Canadian dollar were practically identical in value.

248. Jenny Weil, *Costs for New Plant Still High, Says FPL's Top Financial Officer*, NUCLEONICS WEEK, Feb. 15, 2007, at 2-3.

249. Jonathan Baliff, Presentation at Platts Nuclear Energy Conference (Feb. 5, 2008), Slide 5, on file with author.

250. *Keystone Report*, *supra* note 8.

251. Jordan Raubold, *Nuclear Plans on Track: New Callaway Plant would Cost $6 billion*, COLUMBIA TRIB. (Columbia, MO), June 9, 2008 ($6 billion to $9 billion for a 1,600-MW plant). *See also Agency to Hold Forum on AmerenUE Plans*, COLUMBIA TRIB. (Columbia, MO), July 8, 2008 ($6 billion).

whether the state changes a law prohibiting AmerenUE from charging its customers for the plant's construction costs before the plant begins to produce electricity.[252]

● American Electric Power Company's CEO Michael Morris in 2007 predicted "realistic" costs of about $4,000/KW.[253]

● In a February 2008 conference, Paul Dabbar (J.P. Morgan's Managing Director of Global Mergers and Acquisitions) set the range at $2,000-$5,000/kW.[254]

● In early September 2008, Areva estimated the price of its 1,600-MW EPR reactor under construction in Finland at $6.5 billion, or $4,063/kW, though it also pointed out that each EPR will have different features and therefore a different price tag.[255] (Moreover, foreign reactors will presumably also incur different regulatory expenses from those in the United States.)

● In late 2007, Exelon estimated that its two proposed units in Victoria County, Texas, would cost $4,276/kW.[256]

● In August 2008, Scana Corporation and Santee Cooper confirmed that the estimated cost for two new 1,117-kW reactor units in South Carolina would be $9.6 billion, or $4,297/kW.[257]

● About the same time, Duke Energy predicted that a new 1,117-MW plant in South Carolina would cost $4,476-$5,372/kW.[258]

● In March 2008, NEI was reported as predicting that a 1,000-MW plant will cost as much as $5,300/kW.[259]

● As of August 2008, DTE Energy's most recent cost estimate for a new 1,500-MW reactor at its Fermi plant in Michigan was $8.5 billion, or $5,667/kW.[260]

● In July 2008, Entergy Nuclear spokesman Mike Bowling estimated the cost of a new 1,100-MW reactor unit at the Grand Gulf site in Mississippi at between $4.9-$6.1 billion, or $4,454-$5,545/kW.[261]

252. AmerenUE spokesman indicated that the company would not build the plant without a favorable change in the law. Jeffrey Tomich, *AmerenUE Ponders State Law as it Looks to Add a Nuke Plant*, ST. LOUIS POST-DISPATCH, June 9, 2008.

253. Tina Seeley, *AEP Sees no New U.S. Nuclear Plants Before 2020 (Update 1)*, BLOOMBERG, Aug. 28, 2007, http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aYyA4oyc6ehw.

254. Paul Dabbar, Presentation at Platts Nuclear Energy Conference, unnumbered slide entitled "Although some cautionary points continue to impact the industry," (Feb. 6, 2008), on file with author.

255. John P. McDermott, *Designer, builder of 2 plants would bet $6.4 billion*, Charleston [SC] Post and Courier, Aug. 29, 2008), http://www.charleston.net/news/2008/aug/29/designer_builder_plants_would_get_b52368/.

256. *Exelon Offers a Great Future for Victoria*, VICTORIA ADVOCATE (Victoria, TX), Dec. 19, 2007 ($13 billion for two units); Allison Miles, *Victoria Top Site for Proposed Nuclear Plant*, VICTORIA ADVOCATE (Victoria, TX), Dec. 18, 2007 (1,520-MW per unit).

257. John P. McDermott, *Designer, builder of 2 plants would bet $6.4 billion*, Charleston [SC] Post and Courier, Aug. 29, 2008, http://www.charleston.net/news/2008/aug/29/designer_builder_plants_would_get_b52368/.

258. John Downey, *Duke Plans to Spend $160M Next Year on Nuke Plant*, CHARLOTTE BUS. J., Dec. 11, 2007.

259. *Nuclear Plant Costs Rising*, PITTSBURGH TRIB.-REV., Mar. 7, 2008.

260. Tom Henry, *Nuclear power reconsidered*, Toledo Blade, Aug. 24, 2008, http://www.toledoblade.com/apps/pbcs.dll/article?AID=/20080824/COLUMNIST42/106231991.

● In August 2008, Constellation estimated the construction cost for a new reactor at its Calvert Cliffs facility at between $4,500/kW and $6,000/kW[262] - a range the industry as a whole has recently been using for overnight construction costs.[263]

● In October 2007, Moody's Investors Service estimated construction costs for nuclear plants generally to be between $5,000/kW and $6,000/kW[264] and, the following year, in excess of $7,000/kW.[265]

● In May 2008, Georgia Power announced an estimated $6,300/kW construction cost for its two anticipated new 1,100-MW units.[266]

● And in 2008, Puget Sound Energy quoted the highest estimate yet—$10,000/kW.[267]

Likewise, the following estimates from Florida Power & Light during 2007-2008 suggest a rise in estimated construction costs to a level *far* higher than the more-optimistic pre-2007 estimates of $3,000 or less per kilowatt:

● In the Autumn of 2007, Lewis Hay III, the CEO of FPL, has predicted $4,000-$5,000/kW[268] – a figure echoed only a bit less pessimistically by his company's official prediction of between $3,108/kW and $4,540/kW for two Westinghouse AP1000s and $2,444-$3,582/kW for two GE ABWRs.[269]

● But, just a few months later, FPL announced the results of a detailed study, with the bottom-line estimate of total costs (including interest) at $5,780-8,071/kW.[270]

261. Gary Perilloux, *Going Nuclear*, BATON ROUGE ADVOCATE, July 20, 2008.

262. Aaron Cahall, *Majority Favors New Calvert Cliffs Reactor*, BALTIMORE EXAMINER, Aug. 5, 2008. The same article also cites Paul Gunter, director of reactor oversight for anti-nuclear organization Beyond Nuclear, as estimating the cost at $7,000/kW.

263. Daniel Horner, *Loan Guarantee Sough for Calvert Cliffs-3*, NUCLEONICS WEEK, Aug. 7, 2008, at 1, 2.

264. Pam Radtke Russell, *FPL Says Cost of New Reactors at Turkey Point Could Top $24 Billion*, NUCLEONICS WEEK, Feb. 21, 2008, at 3, 4; Russell Ray, *Nuclear Costs Explode*, TAMPA TRIB., Jan. 15, 2008; Margaret Newkirk, *Nuke Plants May be Pricier than Expected*, ATLANTA J.-CONST., Dec. 15, 2007, at 1C.

265. Jeffrey Tomich, *AmerenUE Ponders State Law as it Looks to Add a Nuke Plant*, ST. LOUIS POST-DISPATCH, June 9, 2008.

266. Kristi E. Swartz, *Georgia Power to Pay $6.4 Billion for New Nuclear Reactors*, ATLANTA J.-CONST., May 7, 2008; *Georgia Nuclear Plant Could Cost $6,300/kW*, POWER ENG'G, May 8, 2008.

267. *Hearing*, *supra* note 144.

268. Edward Klump, *FPL Chief Sees Costs, Critics Slowing Nuclear Revival (Update 1)*, BLOOMBERG, Sept. 27, 2007, http://www.bloomberg.com/apps/news?pid=20601207&sid=aTwIyfF8hlII&refer=energy (estimating cost for 3,000 MW of nuclear generating capacity at $12-$15 billion).

269. Ann MacLachlan, *Big cost hikes make vendors wary of releasing reactor cost estimates*, Nucleonics Week, Sept. 11, 2008, at 2, 3; Jenny Weil & Housley Carr, *FPL Seeks Regulatory Approval for Expansion at Turkey Point*, NUCLEONICS WEEK, Oct. 18, 2007, at 7, 8.

270. Pam Radtke Russell, *FPL Says Cost of New Reactors at Turkey Point Could Top $24 billion*, NUCLEONICS WEEK, Feb. 21, 2008, at 3, 4. These numbers comport with Florida Power and Light's slightly earlier estimate of its overnight cost for constructing two 1,100-MW Westinghouse AP1000s at between $12.1 billion and $17.8 billion – or $5,500-$8,090/kW – and the cost of two 1,520-MW ESBWRs at between $16.5 billion and $24.3 billion – or $5,428-$7,994/kW. Steven Dolley, *Florida PSC Give FPL Go-ahead to Pursue New Turkey Point Reactors*, NUCLEONICS WEEK, Mar. 20, 2008, at 12.

● However, within another few months, FPL reduced the high end of that estimate to $7,273/kW.[271]

Others are following the same tack, quoting estimates between $6,300/kW and $7,300/kW:

● Progress Energy (FPL's nuclear competitor in Florida) announced in March 2008, that construction of two 1,100-MW units in Levy County would cost $14 billion,[272] or $6,363/kW. The company also offered lower figures of $5,144/kW for the first unit and $3,376/kW for the second, based on exclusion of both escalation of expenses and an estimated $3.245 billion dollars for Allowance for Funds Used During Construction[273] - another example of the difficulty of "comparing apples to apples" when dealing with nuclear plant construction costs.[274]

● As of the end of March 2008, PPL Corp was predicting that construction of a third (1,600-MW) plant at its Susquehanna facility could cost $10 billion – or $6,250/kW.[275]

It seems likely that almost all these cost figures can be reduced through mass production ("modularization") and "lessons learned." Consider the following remarkable optimistic prediction from 2006: "TXU aims to cut capital costs for the plants by 30%-40% from the average industry estimate of $2,100 per kilowatt."[276] This would equate to only $1260-$1470/kW. Remarkably, TXU appears to be generally on track. In April 2007, it announced its intention to seek a COL for at least one Mitsubishi 1,700-MW reactor that, Mitsubishi predicted, can be built for only $1,500/kW[277] – a figure that Mitsubishi

271. John Dorschner, *FPL to Hike Rates Next Year*, MIAMI HERALD, May 6, 2008 ($16 billion to construct two 1,100-MW units).

272. PROGRESS ENERGY FLORIDA FILES PLAN TO BUILD TWO NUCLEAR UNITS, http://www.nucwatch.com/platts/2008/platts080314.txt; *Progress Energy Files Plans for Florida Nuclear Plant*, WALL ST. J. ONLINE, Mar. 11, 2008, http://online.wsj.com/article/SB120526030092327771.html?mod=googlenews_wsj. *See also* Dave Flessner, *New Nuclear Plants Get More Expensive*, CHATTANOOGA TIMES FREE PRESS, June 11, 2008.

273. Petition for Determination of Need for Levy Units 1 and 2 Nuclear Power Plants, at 15-16, Progress Energy Florida, No. 080148-EI (Fla. Pub. Serv. Comm'n Mar. 11, 2008). *See also* Pam Radtke Russell, *Progress Energy Says New Reactors in Levy County to Cost $14 Billion*, NUCLEONICS WEEK, Mar. 13, 2008, at 3.

274. Any yet another example, also from Progress Energy: Jeff Lyash (Progress Energy Florida's President and CEO) insists that his company's March 2008 cost estimate of $14 billion for two nuclear units should not be compared with its December 2006 estimate of $2.5-$3.5 billion per unit, because the latter did not include all infrastructure and construction costs. Rick Cundiff, *Nuclear Plant Takes Step Forward*, OCALA STAR-BANNER, Mar. 12, 2008.

275. Op-Ed, *The Power of Forethought has Eluded Electricity Users*, WILKES-BARRE TIMES LEADER, Mar. 27, 2008.

276. Tom Harrison, *TXU Plans COL Submittals in 2008 for up to Six New Reactors*, INSIDE NRC, Sept. 4, 2006, at 1; Sudeep Reddy, *Power Providers Banking on Getting a Hand from Uncle Sam*, DALLAS MORNING NEWS, Jan. 16, 2007; *UPDATE:TXU Plans To Build, Operate New Nuclear Generators*, WALL ST. J. ONLINE, Aug. 31, 2006. *See also* Press Release, TXU Corp., *TXU Corp. Announces Plan for Additional Nuclear Power* (Aug. 31, 2006).

277. Rebecca Smith, *TXU Sheds Coal Plan, Charts Nuclear Path*, WALL ST. J., Apr. 10, 2007, at A2.

confirmed in January 2008.[278] Along the same general lines, Westinghouse has forecast that the construction cost after it had completed its first four AP1000 plants would be only 66% of the cost of those first four.[279]

Given that the construction cost of a nuclear power plant is highly conjectural, it would be equally difficult to determine whether electricity generation costs for a nuclear plant would be competitive as against electricity generation costs for a coal or gas-fired plant. But here is some information from 2006 that offers at least a rough basis for comparison.

For a $2,000/kW nuclear plant, the cost of producing power would be $60 per megawatt-hour (mWh). But with the Energy Policy Act's 80-percent loan guarantee and production tax credits of $18/mWh, the same plant could produce power for only $30/mWh. This would make such a plant competitive with new gas-fired plants or pulverized coal plants[280] (although construction costs for such plants are rising rapidly as well, and for much the same reasons[281]). Assuming fuel prices of $6/MMBTU and coal prices of $33/ton, the costs of generation for those two types of power plants would be $57 and $49/mWh, respectively—considerably higher than the anticipated generation cost from a $2,000/kW nuclear plant after taking into account loan guarantees and production tax credits.[282] Viewed from a different (and, for the nuclear industry, a less optimistic) angle, the annualized cost of an advanced nuclear power plant would

278. Jenny Weil, *Mitsubishi Heavy Industries files application to certify US-APWR*, NUCLEONICS WEEK, Jan. 10, 2008, at 4.

279. Glenn R. George, *Financing New Nuclear Capacity: Will the "Nuclear Renaissance" Be a Self-Sustaining Reaction*?, ELECTRICITY J., 12 (Apr. 2007), http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VSS-4NBR3XM-2&_user=5250395&_coverDate=04%2F30%2F2007&_rdoc=1&_fmt=&_orig'search&_sort=d&view=c&_acct=C000066197&_version=1&_urlVersion=0&_userid=5250395&md5=0a78423cd413f835057868b0cf9f42ca.

280. Ann MacLachlan, *Estimates increase for costs of new nuclear plants in US*, NUCLEONICS WEEK, July 6, 2006, at 13-14. NRG Energy, Inc., concludes that high prices for natural gas are, without more, sufficient to justify construction of nuclear power plants. Totty, *supra* note 118. But the calculations above may overstate the benefits of loan guarantees. As noted above, the amount of any one plant's loan guarantee is a complete unknown. Currently, 17 electric power companies are asking collectively for somewhere between $100 billion and $200 billion in loan guarantees – far above the $18.5 billion authorized by Congress. Jenny Weil and Tom Harrison, *Areva Only Applicant Besides USEC to Seek Front-End Loan Guarantees*, Nuclear Fuel, Oct. 6, 2008, at 9 ($122 billion); *DOE Reviews Nuclear loan Guarantee Requests*, Power Engineering, Oct. 3, 2008, http://pepei.pennnet.com/Articles/Article_Display.cfm?Section=ONART&PUBLICATION_ID=6&ARTICLE_ID=341570&C=PRODJ&dcmp=rss (offering different figures: $188 billion for 21 new reactors at 14 sites).

281. Tom Linke, *Rising costs take glow off nuclear plants*, TEL.-J. (Can.), June 30, 2008, http://telegraphjournal.canadaeast.com/front/article/340525 (CERA "pegged the cost of building new electrical power plants - not just nuclear, but coal and natural gas - as 19 per cent higher than a year ago and 69 per cent higher than 2005"); Tom Fowler, *Power plant costs soar, hampering projects, report to say*, HOUSTON CHRONICLE, Feb. 13, 2008, http://www.chron.com/disp/story.mpl/headline/biz/5539968.html. Regarding the increase in construction costs of power plants generally:

> Since 2000 power plant costs have increased 130 percent. . . . The cost of building power plants in the U.S. has risen 76 percent in the last three years. . . . Candida Scott, who helped develop the Power Capital Costs Index that will be released by [CERA]. . . [says that] the cost increases reflected in the index are part of the reason a number of U.S. coal plant projects have been canceled. CERA figured out the costs of design, labor, equipment, steel, and concrete for the projects and added them to come up with a project cost as of the third quarter 2007.

Fowler, *supra*.

282. *Estimates increase*, *supra* note 280.

drop from 5.6¢/kWh down to 4.2-4.7¢/kWh – which is competitive with pulverized coal plants (4.5¢/kWh), advanced coal plants (4.6¢/kWh), and advanced natural gas plants (4.6¢/kWh).[283]

And, as if there were not already an excess of uncertainty, here's more. The federal tax credit is limited to the first 6,000 MW of new nuclear generating capacity – or about four to six new reactor units (depending upon their sizes). But, under the current rules, the tax credit could be spread among a larger number of reactors, thereby lessening the benefits to each unit.[284] And still more uncertainty stems from the potential development (or combination) of a carbon tax and/or CO_2 emissions restrictions (often described as "cap-and-trade" or "emissions trading" programs). Although the federal government has not yet legislated either of these programs into existence, experts believe that their imposition is no longer a question of "if," but only of "when." For instance, then-Commissioner Jeffrey Merrifield opined in 2007 that "it is inevitable that our government will act to address global warming by enacting either a carbon tax or a cap-and-trade emissions program."[285] Likewise, the Congressional Budget Office stated in September 2006 "that any cost-effective U.S. policy on global warming will require emissions taxes or a cap and trade system similar to Europe's."[286]

One reason for this near-inevitability is that more and more of the country's biggest industrial companies are lobbying for mandatory emissions limits. Or perhaps it is the near-inevitability that is motivating the companies and their lobbyists. Either way, this effort is already yielding fruit at the state and regional levels. The potential development (or combination) of CO_2 emissions restrictions, carbon taxes, and subsidies for non-emitting generators of power would improve the competitive financial position of nuclear energy vis-à-vis its fossil-fuel competition (coal, gas, and oil), thereby further increasing utilities' incentives to seek NRC approval for more nuclear plants. In this regard, the Congressional Research Service calculated in March 2007 that, even ignoring the beneficial effects of the Energy Policy Act's loan guarantees and production tax credits, nuclear plant generation costs would still "break even" with those of coal and gas-fired facilities at carbon-tax levels of $15-$30/metric-ton of CO_2, respectively.[287] Similarly, MIT economist Paul L. Joskow predicted later in 2007 that a Congressionally-imposed $25/ton emissions charge would make nuclear power look quite attractive,[288] while in June 2008 the *Wall Street Journal*

283. Congressional Research Service, "Nuclear Power: Outlook for New U.S. Reactors," Mar. 9, 2007, at p. CRS-15, Tables 3 and 4; Paul Adams, *Economics of Nuclear Power are Rethought*, BALTIMORE SUN, Sept. 4, 2007, http://www.baltimoresun.com/business/bal-te.bz.nuclear04sep04,0,2384711.story.

284. Congressional Research Service, "Nuclear Power: Outlook for New U.S. Reactors," March 9, 2007, at p. CRS-3.

285. Merrifield, *You Ain't Seen Nothin' Yet*, *supra* note 16, at 3.

286. Brad Foss, *Power execs foresee carbon emissions caps*, YAHOO!NEWS, Oct. 22, 2006, http://news.yahoo.com/s/ap/20061022/ap_on_bi_ge/global_warming_business_power;_ylt=AuHUBO1coFGeolSxkTiWAanMWM0F;_ylu=X3oDMTA3bGI2aDNqBHNlYwM3NDk-.

287. Congressional Research Service, "Nuclear Power: Outlook for New U.S. Reactors," March 9, 2007, at p. CRS-22.

288. Paul Adams, *Economics of Nuclear Power are Rethought*, BALTIMORE SUN, Sept. 4, 2007, http://www.baltimoresun.com/business/bal-te.bz.nuclear04sep04,0,2384711.story.

cited $25-$50/ton as the point where nuclear becomes competitive.[289] And in May 2008, the Congressional Budget Office concluded that, even disregarding the Energy Policy Act's benefits, nuclear energy could produce electricity more cheaply than all other forms of electric generation if the emissions credits (carbon allowances) reached $45/metric-ton CO_2.[290] Needless to say, members of the nuclear energy industry are delighted with this possibility. A cap-and-trade system would benefit the nuclear energy industry in two ways. First, the fact that the industry directly emits far smaller quantities of CO_2 into the atmosphere than its fossil-fuel competitors means that the nuclear industry's members would not need to purchase emissions credits. Second, the implementation of a cap-and-trade system would likely result in an increase in the price of electricity in deregulated states. As of the spring of 2008, nuclear power plant owners were offering the following estimated additional profits:

- Exelon: "less than $2 billion"
- FPL Group: $130 million - $727 million
- Entergy: $600 million/yr if a credit/allowance costs $30/ton
- Constellation: $225 million/yr at a credit/allowance costs $25/ton.[291]

As mentioned earlier, even a recent Supreme Court decision regarding CO_2 could indirectly support the nuclear industry in this respect. The Supreme Court's decision in *Massachusetts v. EPA*[292] has reopened the door to EPA regulation of CO_2 emissions – a development which, for the reasons set forth above, would make nuclear energy more attractive to power companies.

At least one state is already a step ahead of EPA. The Kansas Department of Health and Environment, in the first move of its kind in the country, cited CO_2 emissions as the reason for rejecting an air permit for a proposed coal fired generating plant.[293]

Oil, like its fellow carbon fuels, has significant disadvantages when compared with nuclear energy.[294] The increases and fluctuations in the price of oil (*e.g.*, oil prices increased 250% from 2003 through mid-2006[295]— and doubled between July 2006 and mid-July 2008) are attributable in significant part to the instability in the Middle East – a situation that shows no sign of improving in the near future – and the consequent increase in concern about the security of the United States' energy supplies. Approximately 11.6% of the oil

289. Totty, *supra* note 118.

290. Rebecca Smith, *Carbon Caps May Give Nuclear Power a Lift*, Wall St. J., May 19, 2008, at A4; Steven Dolley, *CO_2 charges, incentives would make nuclear energy competitive, CBO says*, Nucleonics Week, May 15, 2008, at 1, 9.

291. Rebecca Smith, *Carbon Caps May Give Nuclear Power a Lift*, WALL ST. J., May 19, 2008, at A4.

292. 127 S.Ct. 1438.

293. Steven Mufson, *Power Plant Rejected Over Carbon Output For First Time*, WASHINGTON POST A1, Oct. 19, 2007.

294. Oil is hardly a meaningful competitor of nuclear energy, as only about 1.6% of the United States' electricity comes from oil-fired power plants. http://www.eia.doe.gov/cneaf/electricity/epa/epat1p1.html (EIA's most current data available at this article's press time).

295. Roscoe G. Bartlett, *Peak Oil Is Coming, and We Must Prepare*, Legal Times, June 12, 2006, at 31.

consumed in the United States in 2006 came from the Middle East.[296] Current and anticipated increases in oil prices also turn on the oil industry's worldwide failure to invest sufficiently in developing new oil resources to replace the diminishing old ones and to provide for the increase in worldwide demand.[297] Such price increases and instability also turn on strife in major producing countries (*e.g.*, Iraq, Iran, and Nigeria) and on governmental control and use of oil supplies for non-economic purposes (*e.g.*, Venezuela and Russia).[298]

Nuclear energy does not suffer from these problems.[299] As of 2006, 80% of the world's uranium supplies[300] and more than half of the world's uranium production[301] lay either within the United States or within two countries friendly to the United States (Canada and Australia)[302] and, according to a 2006 report of the IAEA, the total amount of uranium available worldwide is sufficient to feed nuclear power plants for sixty-five years. [303] Others, less optimistic, place this number as low as twenty-five years, based on projected increases in uranium consumption.

Finally, in a related vein, to the extent that production of pure hydrogen is a potential result from using the high-temperature steam in a "next generation" reactor, nuclear energy could further improve its existing competitive advantage over fossil fuels. It could also reduce the United States' dependence on foreign oil through the eventual use of hydrogen as a supplement, or even replacement, for gasoline, diesel, and aviation fuel.

C. Significant Scientific and Technological Developments

Scientific and technological developments have also played a major role in creating the "nuclear renaissance" – particularly regarding safe plant operation

296. According to the DOE's Energy Information Administration, imported oil constituted about 60% of the United States' oil consumption in 2006, and 19.4% of that amount came from the Middle East, http://tonto.eia.doe.gov/energy_in_brief/foreign_oil_dependence.cfm (60% figure was the most current data available at this article's press deadline); http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_m.htm (19.4% for the monthly imports in May 2008). Sixty percent of 19.4% is 11.6%.

297. Russell Gold and Ann Davis, *Oil Officials See Limit Looming on Production*, Wall St. J., Nov. 19, 2007, at A1, A17.

298. *Id.*

299. *Compare* JUDITH LEWIS, GREEN TO THE CORE? HOW I TRIED TO STOP WORRYING AND LOVE NUCLEAR POWER - PART I, (Nov. 11-17, 2005), http://www.laweekly.com/ink/05/51/features-lewis.php (stating that "[u]ranium . . . is abundant, inexpensive and not controlled by any cartel") *with* James Altucher, *Long past time to consider energy alternatives*, FINANCIAL TIMES, at 11 (Jan. 4, 2006) (the United States is currently consuming more than twice the amount of oil it produces).

300. *Outlook: Nuclear Energy*, WASHINGTON POST, Apr. 17, 2006, http://www.washingtonpost.com/wp-dyn/content/discussion/2006/04/13/DI2006041301125_pf.html (40% of the world's uranium supply is in Canada and another 40% in Australia).

301. *Global Nuclear Expansion Based on Plentiful Uranium Supply*, ENVIRONMENTAL NEWS SERV., June 6, 2006, http://www.ens-newswire.com/ens/jun2006/2006-06-06-03.asp (Canada produced 29% of the world's uranium in 2004; Australia produced 22%).

302. Brazil (another country friendly to the United States) also claims to have one of the world's largest uranium reserves. Carmen Gentile, *Brazil realizes its nuclear ambitions*, INT'L SEC. NETWORK, May 16, 2006, http://www.isn.ethz.ch/news/sw/details.cfm?id=15856.

303. Jacques Lemieux, *Energy industry gears up for "nuclear renaissance,"* Yahoo.com, July 24, 2007, http://news.yahoo.com/s/afp/20070724/wl_canada_afp/canadafrancenuclearenergyuranium_070724073817.

and spent fuel management. Developments in new reactor designs and fuel will be discussed at some length below, followed by a brief discussion of developments in several more areas.

1. New and Advanced Reactor Designs

The NRC's approval of several new reactor designs (and the possibility of still more design approvals) is a significant driver behind the increased expectation of, and interest in, ESP and COL applications. The NRC has certified four new reactor designs: Westinghouse's 600-MW AP600 and 1,100-MW AP1000, General Electric's 1,390-MW Advanced Boiling Water Reactor (ABWR), and Asea Brown Boveri-Combustion Engineering, Inc.'s C-E System 80+.[304] Three more new designs are currently under review: General Electric/Hitachi's 1,390-MW Economic and Simplified Boiling Water Reactor (ESBWR), Areva's 1,600-MW Evolutionary Power Reactor (US EPR), and Mitsubishi's 1,700-MW United States Advanced Pressurized Water Reactor (US APWR).[305] And the NRC is also considering a request for Certification Amendment for Westinghouse's AP1000.[306]

To date, the NRC has received five "reference COL applications:" NRG Energy's South Texas Project for GE's ABWR, TVA's Bellefonte for the Westinghouse AP1000, Dominion's North Anna for the GE ESBWR, UniStar's Calvert Cliffs application for the Areva US EPR, and Luminant's Comanche Peak for the Mitsubishi US APWR.[307]

All of these reactor designs contain significant safety and financial improvements over the previous generation's designs. To offer but one example, "[t]he AP1000, according to Westinghouse, has 87 percent less cable, 83 percent less piping, 50 percent fewer valves and 36 percent fewer pumps than the past generation of reactors."[308] That model also "has 'passive safety' systems that [according to the manufacturer] can prevent a meltdown during an emergency without operator intervention."[309]

In addition to these new designs, the nuclear industry is also working on what are called advanced reactor designs, *e.g.*, Pebble Bed Modular Reactor (Pty) Ltd.'s 165- to 175-MWe helium-cooled Pebble Bed Modular Reactor

304. ENERGY INFORMATION ADMINISTRATION, NEW COMMERCIAL REACTOR DESIGNS, http://www.eia.doe.gov/cneaf/nuclear/page/analysis/nucenviss2.html.

305. *Id.*

306. UNITED STATES NUCLEAR REGULATORY COMMISSION, DESIGN CERTIFICATION APPLICATION REVIEW—AP1000 AMENDMENT, http://www.nrc.gov/reactors/new-reactors/design-cert/amended-ap1000.html.

307. ENERGY INFORMATION ADMINISTRATION, STATUS OF POTENTIAL NEW COMMERCIAL NUCLEAR REACTORS IN THE UNITED STATES, http://www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/com_reactors.pdf. *See also Two COLs for new US nuclear*, World Nuclear News, Sept. 22, 2008, http://www.world-nuclear-news.org/NN-COL_applications_submitted_for_two_sites-1909085.html; Jenny Weil, *Initial COL application reviews more costly than later ones*, Nucleonics Week, Jan. 10, 2008, at 3.

308. William McCall, *New nuclear plant designs are streamlined? theoretically safer*, KGW.com, July 15, 2006, http://www.kgw.com/sharedcontent/APStories/stories/D8ISJN003.html.

309. *Nuclear Dawn*, THE ECONOMIST, Sept. 8, 2007, at 79. The ESBWR design is likewise a passively safe reactor. Elaine Hiruo, *S&P: Active system reactors riskiest cost-wise*, Nucleonics Week, Aug. 14, 2008, at 1,2; EIA, NEW COMMERCIAL REACTOR DESIGNS, *supra* note 307.

(PBMR), and Westinghouse's 335-MWe light-water-cooled International Reactor Innovative and Secure (IRIS).[310]

On an even smaller scale, Toshiba has developed a completely new design for a mini-reactor – the 4S.[311] The name is shorthand for "Super Safe, Small and Simple."[312] This reactor is tiny, only "8 feet by 3 feet in dimension,"[313] designed to be "buried in the ground, requires no operator, and provides 10 megawatts of electricity for 30 years without refueling. After 15 years, the neutron reflectors will have to be rotated; otherwise no maintenance is necessary."[314] Toshiba expects to submit the design for NRC approval in 2009, and the company says that an as-yet-unnamed applicant (likely the town of Galena, Alaska) may seek a COL for a 4S reactor in 2012.[315] According to energy author Ed Hiserodt, "Toshiba has offered a 4S reactor to the town of Galena … at no charge except for the fuel, which would cost less than one-third what the town now pays for diesel fuel."[316] In addition to supplying power to remote locations such as Galena, the mini-reactor could also serve desalination plants and help in the manufacturing of hydrogen as an alternative fuel.[317]

Along similar lines, Hyperion Power Generation, Inc. has approached the NRC with a design for a tiny 25-MW reactor, capable of serving about 20,000 homes for an estimated construction cost of only $25-$32 million per unit – or $1,000-$1,280/kW.[318] (If this estimate is *anywhere near* accurate, the major builders and owners of nuclear energy facilities should sit up and take notice). It is "1.5 meters in diameter, small enough to fit inside the average hot tub,"[319] has "no moving parts,"[320] and requires no operator.[321] The core's estimated life span is "five to seven years,"[322] and the entire reactor would need to be removed from the site and sent to a factory for fuel reprocessing.[323] And its fuel, uranium

310. EIA, NEW COMMERCIAL REACTOR DESIGNS, *supra* note 307.

311. *Id.*

312. *Id.*

313. Tim Bradner, *Toshiba continues efforts for Galena nuclear power plant*, ALASKA JOURNAL OF COMMERCE, Apr. 27, 2008, http://www.alaskajournal.com/stories/042708/hom_20080427006.shtml.

314. Hiserodt, *supra* note 123. A larger, 50-MW, version is currently under development. Bradner, *supra* note 313.

315. AMERICAN NUCLEAR SOCIETY, *Making the nuclear renaissance real: What will it take?*, NUCLEAR NEWS, Jan. 2008, at 37, 47-49; Jenny Weil, *Toshiba works on licensing approach for 2009 filing of 4S application*, INSIDE NRC, May 26, 2008, at 14; Jenny Weil, *Same end goal, different means sought by small reactor projects*, INSIDE NRC, Nov. 26, 2007, at 7; Jenny Weil, *Toshiba ramps up effort to get NRC approval of 4S reactor*, NUCLEONICS WEEK, Oct. 25, 2007, at 8-9.

316. Hiserodt, *supra* note 123.

317. Robert E. Chaney et al., *Galena Electric Power – a Situational Analysis* Nat'l Energy Tech. Lab., Arctic Energy Office Contract, Draft Final Report, Dec. 15, 2004, *available at* http://www.iser.uaa.alaska.edu/Publications/Galena_power_draftfinal_15Dec2004.pdf.

318. Robert Bryce, *Nukes Get Small*, ENERGY TRIBUNE, July 16, 2008, http://www.energytribune.com/articles.cfm?aid=948.

319. *Id.*

320. *Id.*

321. *Id.*

322. *Id.*

323. *Id.*

hydride, raises far less proliferation concerns because its conversion to weapons-grade material would require "massive refining and enrichment."[324]

Other new designs in the works include NuScale Power, Inc.'s Multi-Application Small Light Water Reactor,[325] a modular reactor for use in remote areas, generating 45-50 MW of electricity;[326] the floating "Safe and Green" reactor, a light water reactor with a 30-MW electrical output;[327] and the Department of Energy's Next Generation Nuclear Plant,[328] a high-temperature gas-cooled reactor.[329] Finally, the United States Air Force has expressed interest in building a "small package" nuclear facility at one of its domestic bases; although it is unclear what design the Air Force has in mind.[330]

Such mini-reactors have distinct potential advantages over their larger counterparts: (1) if ordered in sufficient numbers, they could be modularized in a way unavailable for light-water reactors, thereby lowering their cost; (2) their construction would not require the use of reactor vessel cores – the largest of the potential bottlenecks in the construction of large nuclear power units; (3) they could be used in clusters to create a plant which could itself be expanded incrementally with new mini-reactors, as new generating capacity is needed; and (4) they could offer an efficient power source where larger reactors would be inappropriate or unaffordable. [331]

2. Developments in Nuclear Fuel

a. Uranium Fuels

In 2005, nuclear engineers at Purdue University announced the development of a nuclear fuel that is both safer and more efficient than the current conventional fuels.[332] According to these scientists, this potential new fuel "conduct[s] heat at least 50 percent better than conventional fuels... heats up less than current fuel, which decreases the possibility of a catastrophic accident

324. *Id. quoting* Hyperion CEO John Deal, who also commented that it "would be easier [for the weapons-maker] to just start with yellowcake."

325. *Id.*

326. *Id.*

327. Jenny Weil, *NRC has more on agenda than LWRs as small, advanced reactors line up*, Inside NRC, Mar. 3, 2008, at 3, 4.

328. News Release, Dept. of Energy, DOE Seeks Additional Input on Next Generation Nuclear Plant (Apr. 17, 2008).

329. *Id.*; Jenny Weil, *NRC has more on agenda than LWRs as small, advanced reactors line up*, INSIDE NRC, Mar. 3, 2008, at 3.

330. Katherine McIntire Peters, *Air Force pushes the envelope on renewable energy*, GOVERNMENT EXECUTIVE, Aug. 13, 2008, http://www.govexec.com/dailyfed/0808/081308kp21.htm; Caitlin Harrington, *USAF considers nuclear power facility within base*, JANE DEFENCE WEEKLY, Dec. 17, 2007, http://www.janes.com/news/defence/air/jdw/jdw071217_1_n.shtml.

331. Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, *Remarks at the Global Nuclear Renaissance Summit*, S-08-030, at 3 (July 24, 2008), available at http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2008/s-08-030.html. For more information on small reactors, *see* WORLD NUCLEAR ASS'N, SMALL NUCLEAR POWER REACTORS, http://www.world-nuclear.org/info/inf33.htm.

332. PURDUE ENGINEERS CREATE SAFER, MORE EFFICIENT NUCLEAR FUEL, MODEL ITS PERFORMANCE (2005), http://news.uns.purdue.edu/html4ever/2005/050927.Solomon.nuclear.html.

due to melting,... would not have to be replaced as often as the current fuel pellets,"[333] produces more power, and generates less spent fuel.[334]

In 2006, scientists in Australia developed a new technology that promises to greatly reduce the costs of uranium enrichment. According to Michael Goldsworthy (the nuclear scientist leading the project), the technology "may halve enrichment costs, which he estimated accounted for 30 percent of the price of nuclear fuel."[335]

In June 2008, scientists at Oak Ridge National Laboratory announced that they had "chemically extract[ed] the ingredients for making nuclear fuel without isolating the plutonium."[336] According to Jeff Binder, the Global Nuclear Energy Partnership (GNEP) program manager at Oak Ridge, this development "addresses a concern that fuel reprocessing could make it easier to divert fissionable plutonium for use in a nuclear bomb."[337]

b. Thorium Fuels

Other scientists have been exploring thorium as a possible fuel for nuclear reactors, and have made major strides in designing such a reactor. According to a recent reports, such a thorium-fueled reactor would not suffer a meltdown, would generate spent fuel which would remain radioactive for only about 500 years, would create either no weapons-grade byproducts at all or would create material that (due to intense gamma radiation) would be very difficult for bomb-makers to handle, would actually incinerate any plutonium that was added to the fuel mix (helping to dispose of high-level spent fuel from both nuclear reactor fuel and decommissioned nuclear weapons) – oh, and it also would generate cheap electricity.[338]

The idea of a thorium reactor is not mere pie-in-the-sky scientific theory – one American company, Thorium Power Ltd., is devoted solely to the development and promotion of thorium as a fuel for nuclear power plants, with

333. *Id.*

334. *Id.*

335. Hiserodt, *supra* note 123, *quoting* the SYDNEY MORNING HERALD, May 27, 2006.

336. Frank Munger, *Nuclear recycling offers promise: Engineers use pieces of old fuel to make new material*, KNOXVILLE SENTINEL, June 12, 2008, http://www.knoxnews.com/news/2008/jun/12/nuclear-recycling-offers-promise/. *See also* Totty, *supra* note 118 (referring to new processing technologies to limit the amount and accessibility of weapons-grade material . . . by, for instance, producing a form of plutonium that needs further reprocessing before it could be used in bombs").

337. Munger, *supra* note 336.

338. Peter Fairly, *Cleaner nuclear power?*, MIT TECH. REV., Nov. 27, 2007, http://www.technologyreview.com/Energy/19758/; Jack Lifton, *Thorium: An Alternative to Uranium, 2007 Update*, RES. INVESTOR, Feb. 22, 2007, http://www.resourceinvestor.com/pebble.asp?relid=29249; Stephanie Freid, *Taking the danger out of nuclear energy*, ISRAEL21C, Oct. 22, 2006, http://www.israel21c.org/bin/en.jsp?enDispWho=Articles%5el1453&enPage=BlankPage&enDisplay=view&enDispWhat=object&enVersion=0&enZone=Technology. According to Alexei Morozov (a Russian physicist who has experimented with thorium technology since 1994), thorium fuel can achieve a yield of 100 MW-days per kg of fuel, as opposed to an average of only 60 MW-days/kg in most uranium reactors. And the fuel needs to be replaced only every nine years (as compared with three years for uranium), leading him to conclude that a thorium-run reactor could cost up to 10% less than a uranium-run reactor. Sam Knight, *New Power Generation*, FINANCIAL TIMES, May 31, 2008, http://www.ft.com/cms/s/0/ce6878c2-2ead-11dd-ab55-000077b07658.html?nclick_check=1.

fuel specifically designed both to be proliferation-resistant and to reduce spent-fuel volume. Moreover, for plants seeking to burn off excess plutonium, the plutonium seed in the thorium fuel assembly burns "about three times faster and at somewhere between a third and half the cost of the mixed-oxide process" according to the company's Ernie Kennedy.[339] Further, the company is not trying to develop an entirely new reactor design, but just a new fuel element that can be retrofitted into existing conventional nuclear power plants. In fact, Thorium Power expects its technology to be used in a commercial Russian VVER-1000 reactor as early as 2010, and to be "commercially proven" by 2013.[340]

Thorium Power is hardly a fly-by-night company. It has existed for sixteen years; Hans Blix (former head of the IAEA and UN weapons inspector) is one of its advisors; its executive chairman is Tom Graham (one of the world's leading non-proliferation experts); and the United Arab Emirates has recently appointed it as a consultant.

Nor is Thorium Power the only American player in the thorium game. Northamerican Group Corporation has created a new division whose purpose is to develop thorium-based nuclear power generation facilities:

> The new division would undertake research, and develop both Thorium-based nuclear power generation facilities, and Thorium-based power cells.
> The company noted that... three top nuclear scientists, who are experts in the use of thorium and uranium in power generating plants, have agreed to join Northamerican's energy group. The scientists would lead the research and development of Thorium-based nuclear reactor... facilities that would help to ease the crunch on natural gas and fossil fuel electric generating facilities.[341]

In addition, a group of British scientists has "re-discovered" a salt-based thorium reactor design (originally constructed at Oak Ridge, Tennessee, in 1964) and that is now also being revisited by scientists in France, Germany, the Czech Republic, the Netherlands, Norway, Turkey, and Canada.[342] This reactor design also has the advantages of being capable of breeding fuel, making hydrogen, and refueling without a reactor shutdown – plus its advocates claim that it is *in*capable of meltdown.[343] India, which has ample thorium reserves,[344] is seriously considering the construction of thorium-powered nuclear power

339. Pearl Marshall & Ann MacLachlan, *Thorium Power Plans VVER Tests, Eyes US Market*, NUCLEAR FUEL, Nov. 19, 2007, at 1, 7.

340. Knight, *supra* note 338.

341. *Northamerican Energy Signs Deal with Bayport to Launch Thorium Power Generating Research Development Division – Quick Facts*, Aug. 16, 2006.

342. Ariene Sains, *Government commission supports use of thorium reactors in Norway*, Nucleonics Week, Feb. 28, 2008, at 7; *Statkraft considers nuclear power*, Norway Post, May 22, 2007, http://www.norwaypost.no/cgi-bin/norwaypost/imaker?id=80589; Ariane Sains, *Norway's political right presses for use of thorium reactors*, Nucleonics Week, Nov. 23, 2006, at 9; *Salt of the Earth*, The Engineer Online, Nov. 15, 2006, http://www.e4engineering.com/Articles/296876/Salt%20of%20the%20earth.htm.

343. *Salt of the Earth*, THE ENG'R, Nov. 15, 2006. *See also* Ariane Sains, *Norway's Political Rights Presses for Use of Thorium Reactors*, NUCLEONICS WEEK, Nov. 23, 2006, at 3 (regarding impossibility of meltdown).

344. Fairly, *supra* note 338.

plants,[345] and tentatively plans to build a 300-MW thorium-fueled reactor by 2020.[346]

The bulk of thorium reserves are within countries friendly to the United States.[347] This may be one reason why, within the U.S., thorium has "political legs." Senator Orrin Hatch (R-Utah) is seeking to require DOE to develop standards for the use of thorium rather than uranium as fuel for nuclear power plants. His legislation "would force... [the DOE]... and the [NRC]... to create new offices at [those two] agencies to study thorium-fuel options and promote their use abroad."[348] In fact, Sen. Hatch has joined with Sen. Harry Reid (D-Nev.) to sponsor the Thorium Energy Independence and Security Act of 2008, providing $250 million to this end.[349] This is particularly important because DOE is currently wedded to the controversial alternative concept of the closed uranium fuel cycle, which involves reprocessing spent fuel, using a uranium-plutonium fuel blend, and burning the fuel in breeder reactors.

Another likely reason for thorium's political legs is its existing track record within the United States: the first Indian Point reactor outside New York City

345. Ann MacLachlan, *Npcil chief says India plans to build designs of four LWR vendors*, Nucleonics Week, May 31, 2007, at 1, 7; Smita Prakash, *Thorium Reactors Integral To Indian Energy Independence*, Energy Daily, May 8, 2007, http://www.energy-daily.com/reports/Thorium_Reactors_Integral_To_Indian_Energy_Independence_999.html.

346. Ann MacLachlan, *India Rebuffed Iran's Request for PHWRs, Npcil Chief Say*, NUCLEONICS WEEK, May 31, 2007, at 7.

347. WORLD NUCLEAR ASSOCIATION, THORIUM (2008), http://www.world-nuclear.org/info/inf62.html.

Estimated World thorium resources

(RAR + Inferred to USD 80/kg Th):

Country	Tonnes	% of world
Australia	452 000	18
USA	400 000	16
Turkey	344 000	13
India	319 000	12
Venezuela	300 000	12
Brazil	302 000	12
Norway	132 000	5
Egypt	100 000	4
Russia	75 000	3
Greenland	54 000	2
Canada	44 000	2
South Africa	18 000	1
Other countries	33 000	1
World total	2 573 000	

source: OECD/NEA Uranium 2007: Resources, Production and Demand (Red Book) 2008.

348. Fairly, *supra* note 338.

349. Stephen Speckman, *Sens. Hatch, Reid Support Thorium Nuclear Power*, Oct. 4, 2008, http://deseretnews.com/article/1,5143,700264040,00.html.

used a thorium-uranium blend of fuel in the 1960s and 1970s, as did the Oak Ridge Tennessee reactor mentioned above. A third reason for thorium's political legs is that at least some in the environmental community view it as preferable to any other nuclear energy option. For instance, the Natural Resources Defense Council, through its Nuclear Program Director Thomas B. Cochran, considers both Senator Hatch's bill and thorium power to "make[] a lot of sense."[350]

c. Rising Demand for, and Potential Shortage of, Uranium

The increased attention to thorium (and likewise the developments in uranium enrichment noted earlier) are particularly important because demand for uranium is greatly outstripping supply – and has been for some time. According to Jon M. Nones of Resource Investor, "[p]ower plants use most of the 175 million pounds of the metal consumed each year, while mines produce 105 million pounds [and] [t]hat supply deficit will widen as new reactors are developed in Russia, India and China."[351] In 2007, the WNA predicted that "uranium demand would more than double... by 2030."[352] The current shortfall is currently being covered by "down-blending weapons-grade uranium to an enrichment level suitable for commercial use in reactors."[353] (According to the Heritage Foundation, "downblended uranium [from Russia] has provided about one-half of America's nuclear fuel... in recent years." [354]) But, weapons-grade uranium stockpiles are falling and the "[r]egular supplies to the US from Russian stockpiles [under the "Megatons for Megawatts" program] are expected to... terminate by 2013"[355] (though legislation passed in September 2008 seeks to provide Russia an incentive, though not an obligation, to provide more[356]). Commenting on this shortfall, Scott Melbye, Cameco's vice-president for marketing, stated that, despite an increase in exploration, "the nuclear fuel market remains undersupplied by 200 million lbs cumulatively for the period... 2007 [to] 2025."[357]

350. *Id.*

351. Jon A. Nones, *SXR Uranium Slices Off a Piece of U.S. Yellowcake*, RES. INVESTOR, July 10, 2006, http://www.resourceinvestor.com/pebble.asp?relid=21423.

352. Nicky Smith, *Uranium Mining: Boom Time for Uranium*, FIN. MAIL, June 22. 2007.

353. *Id*.

354. JACK SPENCER & NICK LORIS, URANIUM MINING IS IMPORTANT FOR SECURING AMERICA'S ENERGY FUTURE 2 n.6 (Heritage Found. 2008), available at http://www.heritage.org/Research/EnergyandEnvironment/wm1866.cfm#_ftnref6.

355. Smith, *supra* note 352. *See also* Daniel Horner, *Industry Tries to Reach Consensus on Imports of Russian SWU*, NUCLEAR FUEL, Mar. 24, 2008, at 6 (shipments from Russia under U.S.-Russian High-Enriched Uranium Agreement will end in 2013); John Miller, *Companies in Race to Provide Fuel for U.S. "Nuclear Renaissance"*, SEATTLE POST-INTELLIGENCER, Feb. 25, 2008 ("shipments from Russia, which now supplies about 40 percent of enriched uranium for U.S. commercial reactors, are due to be cut roughly in half by 2013"); Mike Reddell, *STP Moves Closer in Permitting Two New Units*, BAY CITY TRIB., July 1, 2007 ("some 50 percent of the uranium fueling U.S. nuclear plants over the last 10 years comes from 10,000 converted warheads from the U.S. and the former USSR").

356. Daniel Horner, *Domenici Amendment on LEU from Russia Becomes Law*, Nuclear Fuel, Oct. 6, 2008, at 19.

357. David Stellfox, *U Market Undersupplied to 2025, Official Says*, NUCLEAR FUEL, June 18, 2007, at 1.

The spot-market price for natural uranium (U^3O^8 or "yellowcake") rose an average of 45% annually for the five years 2002-2006, and increased 81% during 2006 alone.[358] The price skyrocketed from $6.50 in 2001 to $138 in mid-2007, but then dropped back to $53 by early October 2008.

The meteoric rise in price—at least until mid-2007— was due in significant part to renewed interest in nuclear energy, increased investment by hedge funds, and the flooding of both Rio Tinto's Ranger uranium mine in Australia and Cameco's Cigar Lake uranium mine in Canada.[359] United States electric power producers had expected that the Cigar Lake mine would provide them with eighteen million pounds of uranium, or more than 10% of the world's total production in 2005.[360] Now, the Cigar Lake production is expected to remain offline until 2010.[361] The anticipated shortage of uranium for United States power plants due to the Cigar Lake flood is further exacerbated by the fact that Russia has recently locked up Kazakhstan's large uranium production – a source on which Western utilities were also counting.[362]

This price-demand divergent is expected to continue beyond the immediate future:

> Within five years there will only be enough secondary supplies to meet a quarter of the expected demand for uranium. The World Nuclear Association forecasts demand will grow from 170m lbs this year [2006] to 186m lbs by 2010. But Merrill Lynch believes supply will lag behind demand until at least 2015.... "We see no short-term trigger which would reverse this bull trend," [Merrill Lynch] analyst Vicky Binns said.[363]

Neal Froneman, President and CEO of Uranium One Inc., similarly "believes the uranium market will be in a supply deficit until at least 2015."[364] And other "[u]ranium industry experts estimate global demand for the mineral to double in the next 25 year, fueled by China's ambitious plan to increase nuclear energy capacity five-fold to 40 gigawatts by 2020."[365] Indeed, current estimates of available uranium deposits indicates that, at current usage levels, the world has enough for only the next fifty to sixty-five years; and if increased usage is

358. Matthew Dalton, *U.S. Plans to Sell Uranium to Pare Stockpiles*, Wall St. J. Online, Dec. 12, 2006, http://online.wsj.com/article/SB116590245711147390.html?mod=DEN.

359. Bernard Simon, *Activist who Chose the Nuclear Option*, Financial Times, April 9, 2007, at 6; Thomas Olson, *Nuclear Power Companies Hunker Down as Uranium Prices Soar*, Pittsburgh Tribune-Review, June 10, 2007, http://www.pittsburghlive.com/x/pittsburghtrib/business/s_511883.html; Michael Knapik, *Spot Price Shoots Past $100/lb on ERA News*, Nuclear Fuel, April 9, 2007, at 1.

360. Sean Brodrick, *Canadian Flood Isn't Gonna Sink the Uranium Bulls*, TheStreet.com, Oct. 25, 2006, http://www.thestreet.com/markets/metals/10317328.html.

361. Nicky Smith, *Uranium Mining: Boom time for uranium*, Financial Mail, June 22, 2007, http://free.financialmail.co.za/07/0622/cover/coverstory.htm.

362. James Finch, *U.S. Utilities Uranium Supply in Danger*, Investor Ideas, Oct. 24, 2006, http://miningsectorstocks.com/Articles/102406a_page1.asp.

363. Cosima Marriner, *Mineral of Controversy Rockets into the Future*, DAILY TEL. (London), July 20, 2006.

364. Smith, *supra* note 361.

365. *Australian Firm Discovers "Rich" Uranium Deposits in Namibia*, BUS. AFRICA ONLINE, Jan. 12, 2007.

taken into account, the figure drops to perhaps as little as twenty to twenty-five years.[366]

The expected price increase must, however, be placed in context. Nuclear fuel accounts for a relatively small 26% of total electricity production expenses,[367] compared with 78% and 94%, respectively for coal and natural gas-fired electric plants.[368] Fuel costs for an advanced nuclear power reactor would cost $0.66/MMBTU, as compared to $1.40 for a coal plant and a whopping $5.08 for an advanced natural gas plant.[369]

Finally, two countervailing developments deserve mention. In March 2008, DOE announced that it would release uranium from its own inventory in amounts that would eventually equal 10% of the United States' annual requirements and, in addition, would release whatever uranium is needed for initial cores of new reactors.[370] Also, under a recent amendment to the Russian Suspension Agreement, Russia will supply the United States with 20% of the latter's expected requirements of separative work units (SWU)[371] from 2014-2020.[372]

3. Developments in Spent Fuel Disposal

The Bush Administration has announced its support for UREX+, an experimental reprocessing technology. According to Phillip J. Finck of the Argonne National Laboratory which is developing this technology, "UREX+ would [if successful] reduce the nation's eventual need for more nuclear-waste storage by 'a factor of more than 100.'"[373] However, estimates of the time needed to perfect the technology and build a working version of this kind of

366. Shay Totten, *Vermont's Nuclear Ambitions*, VT. GUARDIAN, May 3, 2007.

367. Matthew Dalton, *Nuclear Power Companies hunker Down as uranium Prices Soar*, Wall St. J. Online, Apr. 2, 2007, http://online.wsj.com/article/BT-CO-20070402-706728.html (nuclear fuel comprises 25-28% of total production costs); David Landis, *Nuclear Ambitions*, Kiplinger's Personal Finance Magazine, Feb. 2007, at 42, 43 (26%); Jenny Weil & Tom Harrison, *High uranium prices unlikely to be sustainable, Bowman says*, Nuclear Fuel, Feb. 26, 2007, at 10-11.

368. Keystone Report, *supra* note 8, at 38, Figure 9; Thomas Olson, *Nuclear power companies hunker down as uranium prices soar*, Pittsburgh Tribune-Review, June 10, 2007, http://www.pittsburghlive.com/x/pittsburghtrib/business/s_511883.html. *See also* Michael Knapik, *Analysts: Spot U price could hit $100/lb in 2007*, Nuclear Fuel, Jan. 1, 2007, at 1, 2 (according to NEI, nuclear fuel "accounts for less than 15% of the overall production cost . . . of nuclear energy, versus 50% for coal and 80% for natural gas").

369. Congressional Research Service, *Nuclear Power: Outlook for New U.S. Reactors*, March 9, 2007, at CRS-14, Table 2.

370. Daniel Horner, *DOE Says its U Inventory can Supply 10% of US Need, Plus New Cores*, NUCLEAR FUEL, Mar. 24, 2008, at 1.

371. A separative work unit (SWU) is actually not a measure of uranium's volume or weight, but is rather a "measure of the work done by a machine or plant that separates uranium into streams with higher and lower fractions of U-235." INTERNATIONAL PANEL ON FISSILE MATERIALS, GLOSSARY, http://www.fissilematerials.org/ipfm/pages_us_en/documents/glossary/glossary.php#top. The SWU has nonetheless, over time, become a measuring unit for uranium.

372. Horner, *supra* note 370, at 6. *See also* Daniel Horner, *Domenici Amendment on LEU from Russia Becomes Law*, Nuclear Fuel, Oct. 6, 2008, at 19.

373. John Fialka, *Bush Seeks to Jump-Start Nuclear Power*, WALL ST. J., Jan. 26, 2006, at A4; Matthew L. Wald, *The Best Nuclear Option*, TECH. REV., July 11, 2006; Matthew L. Wald & David E. Sanger, *Bush's Budget to Call for Nuclear Partnership with Russia*, N.Y. TIMES, Feb. 4, 2006.

reprocessing plant vary from nineteen to sixty years.[374] Moreover, the French, who have the most experience with reprocessing, have had dismal success with their Superphénix breeder (reprocessing) reactor – "operated for 14 years at an overall capacity factor of less than seven percent."[375]

German physicist Claus Rolfs, Chair of Experimental Physics at Ruhr University, announced in the Summer of 2006 that he "may have found a way to accelerate the process of nuclear decay, dramatically shortening the half life of dangerous nuclear waste[, by] embedding an alpha emitter in metal and cooling it to just a few degrees Kelvin."[376] This, according to Dr. Rolfs, "could reduce its half life to perhaps just tens of years, instead of thousands. If he is right, the whole business of burying nuclear waste in concrete bunkers could be neatly side-stepped."[377] (Dr. Rolfs acknowledges, however, that his theory needs refining, and it is already being challenged by other physicists.[378]) Along similar lines, "[c]urrent research in... France... is focusing on new chemical processes that would shrink nuclear waste and cool it faster... [but i]t will be at least 2040... before these might be put to use, scientists estimate."[379]

DOE's scientists are making progress in finding or developing a microbe (jocularly nicknamed "Conan the Bacterium") that can change radioactive waste "into insoluble forms... much less likely to leak into aquifers and streams."[380] And other scientists at DOE's Pacific Northwest National Laboratory "discovered a behavior in a common ceramic that might lead to new radiation-resistant materials."[381] They found that "the movement of oxygen atoms heals radiation-induced damage in the engineered ceramic yttria-stabilized zirconia."[382]

Scientists from the United States and Russia are:

> working together to commercialize a new material for radioactive waste storage – [a] phosphate cement called Ceramicrete.... The Ceramicrete formula blocks neutrons and gamma rays, effectively blocking reactions with other particles being

374. *See* Andrzej Zwaniecki, *Global Initiative Aims To Boost Nuclear Energy, Nonproliferation Policy shift to allow aggressive technology development, U.S. says*, Washington File, Feb. 21, 2006, http://usinfo.state.gov/usinfo/Archive/2006/Feb/21-140664.html.

375. ARJUN MAKHIJANI, CARBON-FREE AND NUCLEAR-FREE: A ROADMAP FOR U.S. ENERGY POLICY 184 (2007).

376. Lucy Sherriff, *Astrophysicist Speeds up Radioactive Decay; Other Boffins Skeptical*, THE REGISTER, Aug. 1, 2006. *See also Waste Solution*, THE ENG'R, Aug. 2, 2006.

377. Sherriff, *supra* note 376; *see also Waste Solution*, *supra* note 376 *quoting* Dr. Rolfs as stating that "[w]e are currently investigating radium-226, a hazardous component of spent nuclear fuel with a half-life of 1600 years. I calculate that using this technique could reduce the half-life to 100 years. At best, I have calculated that it could be reduced to as little as two years."

378. Sherriff, *supra* note 376. *See also* Philip Ball, *Nuclear waste gets star attention*, Nature, Aug. 4, 2006, http://www.nature.com/news/2006/060731/full/060731-13.html.

379. Angela Charlton, *Nuclear Revival Rekindles Waste Concerns*, WASH. POST, Jan. 20, 2008.

380. John J. Fialka, *Position Available: Indestructible Bugs to Eat Nuclear Waste*, WALL ST. J., Nov. 16, 2004, at A-1. *See also* John J. Fialka, *Science Advances on Bacteria Made to Fight Pollution*, WALL ST. J., Nov. 14, 2003.

381. *Oxygen Atoms Can Repair Radiation Damage*, UPI, Apr. 22, 2008, *available at* http://www.upi.com/NewsTrack/Science/2008/04/22/oxygen_atoms_can_repair_radiation_damage/7200/.

382. *Id.*

> emitted by stored material nearby,... [and] allows for easy monitoring of closely packed nuclear waste.[383]

Australian researchers announced in September 2008 that they had developed a new, light-weight material to contain nuclear waste water. According to Professor Zhu Huai Yong of Queensland University of Technology, "We have created ceramic nanofibres which attract and trap radioactive cations (positively charged ions), possibly forever." [384]

And last, Northwestern University has developed a new material (called KSM-1) for cleansing nuclear waste. It is composed of potassium, manganese, tin, and sulfur, works well across the entire pH spectrum, and has proven very efficient in removing strontium.[385]

4. Significant Advances in Refueling Techniques, with Concomitant Cost Savings

Drastic reductions in refueling time[386] have significantly increased nuclear power companies' capacity factors – and therefore their profits. "Sharp drops in refueling times and offline maintenance sent capacity factors... from 71 percent in 1997 to more than 90 percent" in 2007.[387] The increased capacity factors have in turn resulted in a decrease in the cost of producing a kilowatt-hour of electricity – from 2.38 cents in 1997 to 1.72 cents in 2005. [388]

5. Advances in Computer Science

In November 2007, the Argonne National Laboratory announced that it had combined a new IBM supercomputer with new nuclear reactor modeling software in a way that should save millions of dollars on reactor design and should also reduce nuclear waste. The combination should also enable scientists to conduct computer-simulated rather than physical experiments. The simulation is focused specifically on the design of the sodium-cooled fast reactor.[389]

D. Strong Governmental Support

Current and recent strong governmental support for the nuclear industry is particularly critical, for it has given the industry both the political cover and the financial jump-start needed for its rejuvenation.

383. Luke Brocki, *Stock Prices Jump in the Junior Uranium Sector*, STOCK HOUSE, May 12, 2008, http://www.stockhouse.com/columnists/2008/may/12/stock-prices-jump-junior-uranium-sector696.

384. *Researchers develop filter for nuclear waste*, The Australian, Sept. 19, 2008, http://www.theaustralian.news.com.au/story/0,,24370728-30417,00.html?from=public_rss.

385. Levi Beckerson, *Researchers Develop Efficient Nuclear Waste Cleanser*, DAILY TECH, Mar. 10, 2008, http://www.dailytech.com/Researchers+Develop+Efficient+Nuclear+Waste+Cleanser/article10977.htm.

386. Margaret L. Ryan, *US Refueling Outages Continue at About 40-day Average*, NUCLEONICS WEEK, Jan. 18, 2007, at 1.

387. Sudeep Reddy, *Warmer Reactions: Climate Improving for Nuclear Power Plants*, DALLAS MORNING NEWS, Jan. 16, 2007.

388. *Id.*

389. *Argonne lab says supercomputer, software to improve reactor design*, Nucleonics Week, Nov. 29, 2007, at 8.

1. The Federal Government

The principal governmental support has come at the national level. In 2001, the Bush Administration issued a new National Energy Policy aimed at expanding the use of nuclear energy by streamlining both the license renewal processes for existing nuclear plants and the COL process for new nuclear facilities. Two years later, in November 2003, the DOE initiated its "Nuclear Power 2010" program – a $1.1-billion public-private partnership aimed at identifying new nuclear plant sites, developing advanced technologies for nuclear power plants, testing the NRC's new regulatory processes, and offering financial support to the first three COL applicants. The Nuclear Power 2010 program "will pay up to half of the nuclear industry's costs of seeking regulatory approval for new reactor sites, applying for new reactor licenses, and preparing detailed plant designs."[390]

The Federal government also initiated two other programs: the Generation IV advanced reactor development program, aimed at developing new, safer, more economical, and more proliferation-proof designs for nuclear reactors; and the Advanced Fuel Cycle Initiative, aimed at investigating advanced reprocessing/recycling strategies for spent fuel. The NRC Chairman Klein describes the Initiative this way:

> [The DOE] is looking at... partitioning the waste so that you take things like the uranium and plutonium and you put it back in as fuel. And at the same time you take the long-lived radioactive isotopes... and... put th[em] in a fast reactor spectrum, a different kind of reactor [which] will destroy those and reduce their toxicity over time so that your volume is significantly reduced. So the plan is partitioning so you'll end up with probably more low-level waste but that has a shorter time constant that you deal with. And the long-lived waste will be reduced by putting it in a different type of fast reactor spectrum.[391]

In August 2005, Congress one-upped the Bush Administration's support by enacting the Energy Policy Act of 2005. This statute provided still further significant financial incentives for power companies to construct and operate new nuclear power plants.[392] Nuclear plant owners' savings have been estimated in 2006 at 30%-36% from the statute's tax benefits alone.[393] The total value of subsidies and tax breaks is estimated to exceed $13 billion.[394]

President Bush in 2005 became the first sitting president to visit a nuclear power plant (Calvert Cliffs) since Jimmy Carter visited the Three Mile Island

390. Securing America's Energy Future, Majority Staff Report to Committee on Government Reform, at 25 n.39 (May 8, 2006).

391. Interview by C-Span with Dale Klein, Chairman, Nuclear Regulatory Commission, (Oct. 22, 2006). *See also Nuclear Dawn*, THE ECONOMIST, Sept. 8, 2007, at 25, 26.

392. 42 U.S.C. §§ 601-09 (renewing the Price-Anderson Act insurance provisions), 621 (providing that the forty-year life of a combined construction permit and operating license begins to run on the date the Commission authorizes the facility's operation), 638 (creating a government-backed risk insurance program for up to six entities who apply for, or have been granted, a COL for a new nuclear power plant), 1306 (creating a tax credit for advanced nuclear reactors placed in service prior to 2021), and 1310 (granting utilities tax deductions for amounts contributed to qualified decommissioning funds) (2006).

393. Jim McTague, *Nuclear Revival Expected*, WALL ST. J., Jan. 22, 2006.

394. Mike Stuckey, *Nuclear Energy's French Connection*, MSNBC, Jan. 25, 2007, http://www.msnbc.msn.com/id/16554514/.

facility under far less auspicious circumstances in 1979.[395] In 2006, President Bush repeatedly announced his support for nuclear energy as one means of breaking America's oil addiction.[396] Also in 2006, the DOE announced the details of its new Global Nuclear Energy Partnership (GNEP), which has as one of its goals the expansion of the nation's use of nuclear energy. Veteran energy reporter Matthew Wald of the *New York Times* describes the GNEP this way:

> Imagine a nuclear industry that can power America for decades using its own radioactive garbage, burning up the parts of today's reactor wastes that are the hardest to dispose of. Add technology that takes nuclear chaff, uranium that was mined and processed but was mostly unusable, and converts it to still more fuel. Then add a global business model that makes it much less likely that reactor by-products such as plutonium will find their way into nuclear weapons in countries like Iran, even as economical nuclear-power technology becomes available to the whole world.
>
> That is the alluring triple play the Bush administration hopes to turn with the Global Nuclear Energy Partnership... it unveiled earlier this year, a proposed long-term research and development program almost as audacious as the Manhattan Project.
>
> * * * * *
>
> [According to Phillip J. Finck, associate director at Argonne National Laboratory, the GNEP] technology... could extract up to 100 times as much energy from uranium as is now possible. With the waste now piled up at reactors around the United States, the theory goes, GNEP could produce all the electricity the country will need for decades, maybe even centuries—assuming enough of the necessary new reactors could be built. That would eliminate about a third of all U.S. carbon dioxide emissions (roughly the portion that today comes from fossil-fuel power plants). All this while reducing waste and thwarting the diversion of fuel to nuclear weapons.
>
> Finck says [the technology] would theoretically cut the heat and toxicity of what is today considered waste enough to make Yucca Mountain last through this century, instead of being fully booked before the first fuel bundle is buried.[397]

The same year, the White House established a special working group to oversee the expansion of the United States nuclear power fleet.[398] In June 2007, President Bush visited the newly re-opened Browns Ferry-1 plant and again advocated for nuclear energy.[399] In late 2007, Congress enacted legislation approving $18.5 billion in loan guarantees for new nuclear plants. And, in January 2008, the President proposed a budget that would nearly double the

395. The following year, President Bush visited Pennsylvania's Limerick nuclear plant.

396. Robert Manor, *Nuclear Energy Nearing Revival: 30 New Reactors are Being Considered as Power Demands Rise*, CHI. TRIB., Dec. 24, 2006; George W. Bush, Address at the St. Louis Convention Center (Oct. 12, 2006), http://www.whitehouse.gov/news/releases/2006/10/20061012-4.html; George W. Bush, State of the Union Address (Jan. 31, 2006).

397. Matthew L. Wald, *The Best Nuclear Option*, MIT TECH. REV., July 11, 2006, http://www.technologyreview.com/read_article.aspx?id=17059&ch=biztech. But the GNEP is not universally accepted. *Keystone Report*, *supra* note 8, at 90-91; *Peddling Plutonium: Nuclear Energy Plan Would Make the World More Dangerous*, NATURAL RESOURCES DEFENSE COUNCIL http://www.nrdc.org/nuclear/gnep/agnep.pdf. Nor is its implementation guaranteed. It has received a frigid welcome at both the National Academy of Sciences and the relevant House Appropriations Subcommittee.

398. Jenny Weil, *Working group devoted to nuclear established in White House*, Nucleonics Week, May 25, 2006, at 13, 14.

399. Eric Fleischauer, *Bush visits Browns Ferry*, Decatur [GA] Daily, June 22, 2007, http://www.decaturdaily.com/decaturdaily/news/070622/bush.shtml.

DOE's funds for "near-term deployment of new reactors and add two years to [the DOE's] loan guarantee program."[400]

Nuclear energy is also gaining new support in Congress. Regarding the pro-nuclear trend on "the Hill," Alex Flint of the Nuclear Energy Institute (NEI) commented in mid-2007 that he could count fewer than twenty "hard-core antinukers in Congress."[401] Representative Greg Walden (R-Oregon) said in late 2007 that "[p]eople can actually mention nuclear power as an energy source and not get booed and laughed out of the room."[402] Derrick Freeman of NEI said in early 2008 he saw a great deal more Congressional acceptance of nuclear energy in recent years: "There's bipartisan spirit that's taking place with nuclear power."[403] And finally, Max Schulz cogently observed:

> If any of these [nuclear] plants actually gets built and the nuclear revival comes to pass, no small part of the credit will be due an unlikely source: liberal Democrats. The recent push for nuclear power couldn't have occurred if not for a softening of the reflexive opposition to nuclear power that has long been a staple of liberal and Democratic political orthodoxy.
>
> The attitude toward nuclear power in leftwing quarters has changed in a relatively short time. The 1984 Democratic Party platform, for instance, "strongly oppose[d] the Reagan Administration's policy of aggressively promoting" nuclear power. The 2004 party platform, on the other hand, limited its comment merely to opposing the siting of a nuclear waste dump in Nevada.
>
> Meanwhile prominent Democrats of all stripes are expressing openness to the possibility that nuclear power should play a significant role in the nation's energy future. The moderate Democratic Leadership Committee issued a report praising nuclear power's "great potential to be an integral part" of America's diversified energy portfolio.[404]

Here are some examples of this bipartisan support. House Speaker Pelosi, a Democrat who used to be fierce opponent of nuclear energy, has more recently said that she thinks nuclear energy "has to be on the table."[405] California Senator Barbara Feinstein (D-Cal.) has taken the same position,[406] and Senator Lamar Alexander (R-Tenn.) has observed that, during the debate over the Energy Policy Act of 2005, not a single anti-nuclear amendment was offered.[407] Both the Republican and Democratic candidates for the open Virginia seat in the Senate this year (Mr. James Gilmore and Mr. Mark Warner, respectively) supported nuclear power.[408]

400. Elaine Hiruo & Daniel Horner, *FY-09 budget request reflects push for nuclear expansion*, NUCLEONICS WEEK, Feb. 7, 2008, at 3.

401. David Whitford, *Going nuclear*, FORTUNE, Aug. 6, 2007.

402. Charles Pope, *Climate change reheats interest in nuclear power*, THE OREGONIAN, Dec. 30, 2007, http://www.oregonlive.com/politics/oregonian/index.ssf?/base/news/1198913116293600.xml&coll=7&thispage=4.

403. *Nuclear poised to take slice of energy pie*, CHATTANOOGA FREE TIMES PRESS, Feb. 25, 2008, http://timesfreepress.com/news/2008/feb/25/nuclear-poised-take-slice-energy-pie/.

404. MAX SCHULZ, A NUCLEAR RENAISSANCE IGNORED (2007), http://www.washingtonpost.com/wp-dyn/content/article/2007/12/19/AR2007121902075.html.

405. Richard Simon, *Nuclear power enters global warming debate*, LOS ANGELES TIMES, Apr. 9, 2007.

406. Schulz, *supra* note 404.

407. *Energy Pie*, *supra* note 403.

408. Sara Murray, *Virginia Senate Seat in Play*, WALL ST. J., June 14-15, 2008, at A5.

Then-Commissioner Jeffrey S. Merrifield offered this assessment of Congress's collective change of attitude regarding nuclear energy:

> I have the occasion to make frequent visits to the House and Senate, and I can easily say that the Congressional enthusiasm for nuclear power is the highest it has been since the late 1960s. While there remain a small number of steadfast opponents to nuclear power in Congress, even those who oppose it won't openly admit it. This is a far cry from the anti-nuclear platform endorsed by a large number of Members of Congress during the 1970s and 1980s.[409]

As the federal regulator of the nuclear industry, the NRC has helped to set the stage for the nuclear renaissance in four ways. First, the NRC promulgated regulations under which reactor designs can be pre-approved, and thereafter require no additional design review other than that concerning site-design interface.[410] This regulatory change is intended to accelerate the licensing process for any new reactor owner and/or operator seeking to use a pre-approved reactor design. Second, the NRC has announced its intent to review generic issues only once, and to adopt the resulting position in all future COL reviews – a principle the NRC calls "one issue, one review, one position."[411]

Third, the NRC promulgated regulations under which an applicant can seek an ESP before deciding whether to build on the site.[412] ESPs are intended to speed up the licensing process by significantly reducing the number of grounds on which a later COL application may be challenged. (The NRC subsequently promulgated still further rules designed to expedite the hearing process for COL applications.) Fourth and finally, for applicants wishing to take advantage of one-stop shopping, the NRC created the COL review process itself – offering applicants a streamlined approach to what had once been a piecemeal review of construction and operations applications.[413]

The COL process has removed plant-owners' fear "that a plant could be built, but then be found unacceptable for operation – a worst-case financial scenario."[414] Hopes for expeditious hearings may be well-founded: the first hearing on the construction and operation of a new nuclear facility (a uranium enrichment plant) took only thirty months to complete,[415] and at least some within the agency are talking about mere twelve-month hearings.[416]

There are, however, three flies in the NRC's ointment: (i) some pre-approved reactor designs are already outdated to the point that reactor designers

409. Merrifield, *Newton's First Law of Physics*, *supra* note 71, at *2.

410. 10 C.F.R. part 52, subpart B (2008).

411. Peter B. Lyons, Comm'r, U.S. Nuclear Regulatory Comm'n, *U.S. – Japan Regulatory Cooperation: Supporting Safety and Security – Meeting Future Challenges*, S-07-049, at *3 (Nov. 8, 2007), http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2007/s-07-049.html.

412. 10 C.F.R. part 52, subpart A (2008).

413. 10 C.F.R. part 52, subpart C (2008). The industry has created a consortium called "NUSTART" which expects to file COL applications for nuclear units on behalf of its members. If the NRC approves any of those applications, then the utilities in NUSTART can "cannibalize" large portions of the approved application(s) and thereby save a significant amount of time and money. Jon Gertner, *Atomic Balm?*, N.Y. TIMES, July 16, 2006,

414. THE COL LEAGUES (2005), http://www.neimagazine.com/story.asp?storyCode=2033035.

415. *Louisiana Energy Serv.*.(National Enrichment Facility), LBP-06-17, 63 NRC 747 (2006).

416. Jenny Weil, *Schedule for COL review not set at 42 months, NRC officials say*, INSIDE NRC, Aug. 20, 2007, at 4.

are seeking to amend those designs, (ii) some prospective applicants plan to skip (and many have already skipped) the ESP stage entirely and apply immediately for a COL, and (iii) of the 15 current COL applications (as of October 2, 2008), only one refers to a currently-certified design.[417] Only time will tell how significant these particular flies will turn out to be.

2. State and Local Governments

State and local governments are also offering significant financial incentives for the construction of new nuclear power plants within their borders. As recently as ten or even five years ago, this kind of political support at the state level would have been unheard of – indeed, it would probably have been political suicide. Consider, for instance, the following comment from Wisconsin State Representative Frank Boyle, on his switching sides in favor of nuclear energy: "If you had told me 10 years ago that I would be here advocating for the lifting of the ban on nuclear construction, I'd say you were crazy."[418] But no longer.

a. The South

The vast majority of new nuclear plants currently under discussion are proposed for the country's most nuclear-friendly area – the South. Examining just the following four states, it is easy to see why.

The Florida legislature has enacted a statute streamlining the approval process for new power plants and no longer requiring competitive bids for building such plants. This legislation makes it easier for utilities both to build new nuclear plants (by stripping local governments of existing zoning powers) and to pass on the plants' construction costs to existing customers even before the plants generate the first kilowatt of electricity. [419]

417. Klein, *Renaissance Summit*, *supra* note 331, at *2 (referring to nine applications, with only one referring to the certified Advanced Boiling Water Reactor). After Chairman Klein's "Renaissance Summit" speech, Ameren submitted a COL application for a new reactor unit at its Callaway plant, and proposed to use Areva's as-yet-uncertified US EPR design. Likewise, in early August, Progress Energy submitted a COL application for a new facility in Levy County FL, and proposed to use Westinghouse's AP1000 design, which has been certified, but the revised version of which is still under Commission review. Final Rule, *AP1000 Design Certification*, 71 Fed. Reg. 4464 (Jan. 27, 2006); Jenny Weil, *NRC accepts Bellefonte COL application*, NUCLEONICS WEEK, Jan. 24, 2008, at 1. On September 2, 2008, Exelon submitted a COL application for an ESBWR reactor at its Victoria Station, Texas, site. In mid-September of 2008, Detroit Edison and Luminant submitted COL applications for new reactors at Fermi and Comanche Peak, using ESBWR and US-ABWR designs, respectively – both of which are still under Commission review. Entergy, on September 25, 2008, filed an application for a new ESBWR unit at its River Bend facility. And UniStar submitted an application on September 30, 2008 to add a US EPR to its Nine Mile Point facility in New York. Jenny Weil, Tom Harrison, and Steven Dolley, *Three more filings bring total to 15 reviews*, Inside NRC, Sept. 29, 2008, at 1.

418. Mike Simonson, *Committee okays lifting of nuclear power plant construction restrictions in Wisconsin*, KUWS-AM RADIO, May 10, 2007, *available at* http://www.businessnorth.com/kuws.asp?RID=1885.

419. As one reporter described the legislation, "the [state] government has removed virtually all of the risk for investors in . . . utilities" wishing "to develop new nuclear plants." Greg Hamilton, *Second Nuclear plant Won't Come Without Risks*, ST PETERSBURG TIMES, June 21, 2006, http://www.sptimes.com/2006/06/21/Columns/Second_nuclear_plant_.shtml. Following close on the heels of this legislation, the Florida Public Service Commission promulgated conforming regulations in February 2007. Paul Adams, *Constellation nuclear plans in fiscal peril*, Baltimore Sun, July 23, 2007,

In 2007, the Louisiana Public Service Commission (PSC) agreed to allow Entergy to recover its interest payments on construction costs for any new reactor it builds in the state. In this regard, Jay Blossman, the chairman of Louisiana's PSC, has announced that "we wanted to be very aggressive in encouraging (Entergy) to build here."[420] And in August 2008, the Shaw Group and Westinghouse agreed to locate a nuclear parts plant in the Port of Lake Charles, LA, in return for more $248 million in tax incentives and other incentives.[421]

In neighboring Texas, the state legislature passed a law in 2006 allowing the state's school districts to grant large property-tax abatements to nuclear power plants. The following year, Texas committed to a seven-year tax abatement period for a facility that Exelon was then considering for Matagorda County. And at the local level, the Amarillo passed a joint resolution promising to "consider providing up to $50 million in financial assistance plus potential tax abatements" for two proposed nuclear power units.[422]

In Maryland, Governor Martin O'Malley declared in 2007 that the state should consider nuclear energy as an option for meeting the state's future electricity needs, and the following year, he declared that a third reactor at Calvert Cliffs was a "moral imperative."[423] At the local level, Calvert County's Board of County Commissioners in 2006 put its money where its mouth was, offering Constellation $300 million in tax breaks if it would build that third reactor. The state and local governments' efforts appear to be paying off – Constellation is moving forward with the state and federal applications that are prerequisites to constructing a new reactor at Calvert Cliffs.[424]

http://www.baltimoresun.com/business/bal-te.bz.nuclear23jul23,0,3564364.story; Tom Harrison, *Florida regulators adopt rule to encourage new nuclear plants*, Nucleonics Week, Feb. 15, 2007, at 16; Joseph Mann, *Florida allows FPL to collect surcharge to help pay for new nuclear plants*, South Florida Sun-Sentinel, Feb. 14, 2007, http://www.sun-sentinel.com/business/local/sfl-znuke14feb14,0,3870235.story?coll=sfla-business-headlines. Progress Energy filed a COL application with the NRC in July 2008 for a proposed two-unit facility in Levy County (http://www.nrc.gov/reactors/new-reactors/col/levy.html), and FPL is planning to add two new units to its Turkey Point facility. Priscilla Greear, *Miami Dade College's Nuclear Energy Program Has Fans at FPL*, Miami Herald, Sept. 21, 2008, http://www.miamiherald.com/news/miami-dade/communities/south/story/694160.html.

420. *States maneuver to lure new nuclear power plants*, MARKETWATCH May 21, 2007, http://www.marketwatch.com/news/story/states-maneuver-lure-new-nuclear/story.aspx?guid=%7B8AE42F93-8213-4704-AF26-4F4BE16B6A31%7D. Under the state's current energy cost-recovery policy, the builder of a new nuclear reactor at River Bend "can pass through about 10% of its . . . development costs to consumers before the new plant is operational." *Id.* Earlier, the Louisiana PSC had passed a resolution favoring the addition of a new reactor at River Bend – as did the local Chamber of Commerce. Alan Sayre, *State OKs Cost Recovery for Nuclear Cos.*, Houston Chronicle, May 1, 2007.

421. Todd Woody, *Louisiana goes nuclear*, Fortune, Aug. 26, 2008, http://greenwombat.blogs.fortune.cnn.com/2008/08/26/louisiana-goes-nuclear/; *Shaw to build nuclear parts plant in Calcasieu*, WXTV.com, Aug. 26, 2008, http://www.wxvt.com/Global/story.asp?S=8902176&nav=menu1344_2.

422. Jenny Weil, *Key officials in Amarillo support ABWR proposal, with conditions*, NUCLEONICS WEEK, Aug. 24, 2006, at 3.

423. Lisa Rein & Christy Goodman, *Little Outcry on Nuclear Reactor Proposal*, WASHINGTON POST, Aug. 4, 2008, at B1; Christy Goodman, *It Is A Moral Imperative*, WASHINGTON POST, May 2, 2008, at B3.

424. However, a subsequent legal battle between Constellation Energy Group and the State of Maryland nearly scuttled the company's willingness to construct a third reactor at Calvert Cliffs. Alan Brody, *Battle*

b. The Midwest

The Midwest has also begun to take a serious interest in nuclear power plants. For instance, the South Dakota state legislature has passed a bill encouraging "research and development related to advanced design reactors... [and]... foster[ing] consideration of the nuclear option for power generation."[425] Kansas lawmakers recently passed a ten-year property tax exemption for any company that builds a second nuclear power plant near the Wolf Creek nuclear facility.[426] To add further incentives, the members of the same legislature proposed a bill in 2008 to permit nuclear power plant companies to recover their construction costs prior to operating the plant.[427] And this in a state, which,

between Constellation, state could jeopardize reactor, MD Bus. Gazette, Mar. 7, 2008, http://www.gazette.net/stories/030708/businew173150_32366.shtml.

Other indicia of the South's pro-nuclear attitude are that:

• Governors Barbour (Mississippi) and Kaine (Virginia) endorsed greater use of nuclear energy. Rusty Dennen, "Dominion hails North Anna reactor progress," Fredericksburg [VA] Free Lance-Star (Nov. 29, 2007), http://fredericksburg.com/News/FLS/2007/112007/11292007/337199; Robert Tanner, *Governors weigh in on energy policy*, Yahoo!News, Aug. 8, 2006, http://news.yahoo.com/s/ap/20060807/ap_on_re_us/governors_oil;_ylt=Asl5F6VUi7SgDG.O6xEdy4Bp24cA;_ylu=X3oDMTA5aHJvMDdwBHNlYwN5bmN.

• Virginia in 2007 approved an additional 2- percent return on investment for utilities that construct nuclear plants; Greg Edwards, *Bids for nuclear power soar*, Richmond [VA] Times-Dispatch, Dec. 10, 2007, http://www.inrich.com/cva/ric/news/business.apx.-content-articles-RTD-2007-12-10-0142.html; Rusty Dennen, *Dominion hails North Anna reactor progress*, FREDERICKSBURG FREE LANCE-STAR, Nov. 29, 2007, http://fredericksburg.com/News/FLS/2007/112007/337199.

• Georgia Public Service Commission Chairman Stan Wise publicly announced his hope that Southern Company would build another nuclear plant in his state. *States maneuver to lure new nuclear power plants*, MarketWatch, May 21, 2007, http://www.marketwatch.com/news/story/states-maneuver-lure-new-nuclear/story.aspx?guid=%7B8AE42F93-8213-4704-AF26-4F4BE16B6A31%7D .

• Port Gibson and Claiborne County, Mississippi and Calvert County, Maryland passed resolutions encouraging construction of nuclear facilities in their jurisdictions. Charles Seabrook, *Mississippi town lobbies hard for nuclear plant*, PULSE-J., May 23, 2005, http://www.pulsejournal.com/news/content/shared/news/nation/stories/05/23_NUCLEAR.html; *Resolutions*, NEI.COM, July 26, 2005, http://www.nei.org/resourcesandstats/documentlibrary/resolutions/resolutions/new_plants_calvert_cliffs_resolution_8905/.

• And Kentucky is considering lifting its 1984 moratorium on nuclear power plant construction. E. Jay Donovan, *Kentucky Bills Would End Moratorium on Nuclear Power Plant Construction*, ENV'T & CLIMATE NEWS, May 1, 2008, http://www.heartland.org/Article.cfm?artId=23071. A rare counterpoint is the vote of Orange County, North Carolina Commissioners to oppose construction of additional units at the Shearon Harris plant. Kirk Ross, *County opposes nuclear plant construction*, THE CARRBORO CITIZEN, Aug. 7, 2008, http://www.carrborocitizen.com/main/2008/08/07/county-opposes-nuclear-plant-expansion/.

425. *Nuclear Power Is Heating Up Again*, BUS. WEEK, June 27, 2006, http://www.businessweek.com/investor/content/jun2006/pi20060627_680870.htm.

426. *Nuclear power plant bill wins initial approval*, TOPEKA CAPITAL-JOURNAL, Feb. 28, 2008, http://cjonline.com/stories/022808/bre_nuclear.shtml.

427. In addition, Kansas Governor Kathleen Sebelius announced this year that "all options should be considered, including nuclear power." Rick Montgomery, *Nuclear question returns as nation weighs energy alternatives*, KANSAS CITY STAR, Apr. 19, 2008, http://www.kansascity.com/news/politics/story/583502.html.

twenty years ago, sought to undermine nuclear power by declaring the Wolf Creek nuclear facility "imprudent" and denying cost recovery for the plant.[428]

In May 2007, Wisconsin's Special Legislative Committee on Nuclear Power issued a report advocating the repeal of the state's de facto ban on new nuclear power plants[429] - a recommendation echoed by Governor Jim Doyle's Task Force on Global Warming and now supported by Governor Doyle (a former long-time opponent of nuclear energy).[430] In 2006,[431] 2007,[432] and 2008,[433] state legislators in Wisconsin (which has a moratorium on construction of nuclear plants) have introduced bills to smooth the way for construction of new nuclear plants in Wisconsin, with the last of these bills being supported by 58 of the state Assembly's 99 members.[434] And nearby Minnesota, which also bans new nuclear power reactors,[435] is likewise considering a law favoring new nuclear development.[436]

And both Ohio Governor Ted Strickland and Jeff Cloud, the Chairman of the Oklahoma Corporation Commission, have likewise publicly supported reconsidering nuclear power plants for their respective states. Jack Money, *Utility regulator seeks funding for a nuclear power plant study*, Oklahoman, May 30, 2008, http://newsok.com/utility-regulator-seeks-funding-for-a-nuclear-power-plant-study/article/3250346/?tm=1212111006; Russell Ray, *Nuclear power plant pushed*, Tulsa World, June 7, 2006, http://www.tulsaworld.com/TWPDFs/2006/Final/W_060706_E_1.PDF; Jim Provance, *Strickland plan could "green" Ohio*, Toledo Blade, Aug. 28, 2007, http://toledoblade.com/apps/pbcs.dll/article?AID=/20070826/NEWS24/708260345/-1/NEWS.

428. Matthew L. Wald, *In Rarity, Utility Seeks Another in Midwest*, N.Y. TIMES, July 24, 1990.

429. For a summary of states' restrictions on nuclear power plant construction (and on-site dry storage), *see Keystone Report*, *supra* note 8, at 74. As of 2007, twelve states had such moratoria. *Id*. at 45.

430. Steven Walters, *Doyle favors lifting nuclear moratorium*, MILWAUKEE J. SENTINEL, Aug. 6, 2008, http://www.jsonline.com/story/index.aspx?id=780673; Scott Bauer, *Doyle: I'm open to more nuclear power in state*, GREEN BAY PRESS GAZETTE, Aug. 6, 2008, http://www.greenbaypressgazette.com/apps/pbcs.dll/article?AID=/20080806/GPG0101/80806149/1978&located=RSS (Gov. Doyle made support of Wisconsin's nuclear moratorium a part of his reelection platform in 2006).

431. Thomas Content, *Is it time to lift the nuclear ban*, MILWAUKEE J. SENTINEL, Sept. 23, 2006, http://www.jsonline.com/story/index.aspx?id=502707.

432. Ryan J. Foley, *Wisconsin considers lifting ban on nuclear power plants*, CHICAGO TRIB., Feb. 29, 2008, http://www.chicagotribune..com/news/chi-ap-wi-xgr-nuclearpower,0,3352923.story; Elaine Hiruo, *California lawmaker again tries to end state's nuclear moratorium*, NUCLEONICS WEEK, Oct. 4, 2007, at 13-14; Jim Soletski, *Guest column: Nuclear power is now a viable option*, GREEN BAY PRESS GAZETTE, May 20, 2007, http://www.greenbaypressgazette.com/apps/pbcs.dll/article?AID=/20070520/GPG07/705200632/1273/GPGsports.

433. Pam Radtke Russell, *Iowa, Wisconsin lawmakers take up bills that promote nuclear power*, NUCLEONICS WEEK, Mar. 6, 2008, at 6.

434. *Nuclear power gaining support Wisconsin Utility meeting discusses energy sources*, Green Bay Press-Gazette, Sept. 26, 2008, http://www.greenbaypressgazette.com/apps/pbcs.dll/article?AID=/20080926/GPG03/809260640.

435. Steven Dolley, *Wisconsin Legislature to consider repeal of nuclear restrictions*, NUCLEONICS WEEK, May 17, 2007, at 12, 13.

436. Pam Radtke Russell, *Minnesota emissions reduction plan includes lifting nuclear moratorium*, NUCLEONICS WEEK, Feb. 7, 2008, at 6; Richard Ryman, *Nuclear power plants may become easier to build*, GREEN BAY PRESS GAZETTE, May 17, 2007, http://www.greenbaypressgazette.com/apps/pbcs.dll/article?AID=/20070517/GPG03/705170526/1247/GPGbusiness.

c. The West

In 2007 and 2008, several California legislators joined their like-minded brethren in Wisconsin and Minnesota by presenting bills to repeal the state's longstanding moratorium on nuclear power plant construction.[437] The sponsors also sought to place the repeal on the 2008 ballot as an "initiative petition" (*i.e.*, voter approval) item.[438] The pro-nuclear legislators' chances for success got a shot in the arm when California Governor Arnold Schwartzenegger opined in March 2008 that nuclear energy has a "great future" and that his state should reconsider construction of nuclear power plants.[439]

Further north, legislators in Washington State started down the same general path as California by proposing a bill in January 2008 to create a task force to study new nuclear generation. And both the current Washington Governor Chris Gregoire and her opponent in that state's recent gubernatorial election, Dino Rossi, agreed that nuclear energy should be "on the table."[440]

In March 2008, Idaho enacted two bills offering the nuclear services company Areva millions of dollars in tax incentives if it would build a uranium enrichment facility in the eastern part of the state. The first bill offered a sales tax exemption for production equipment to handle nuclear fuel, and the second imposed a $400-million cap on an Areva plant's property tax valuations if the company would invest at least $1 billion in the state during the next seven years.[441] Areva's May 2008 decision to locate its facility in Idaho was motivated in part by those tax incentives.[442]

437. Janis Mara, *Nuclear war in California*, CONTRA COSTA TIMES, Mar. 26, 2008, http://www.insidebayarea.com/oaklandtribune./ci_8707143.

438. Elaine Hiruo, *California lawmaker again tries to end state's nuclear moratorium*, NUCLEONICS WEEK, Oct. 4, 2007, at 13-14; David Sneed, *Initiative would lift nuclear plant moratorium in California*, SAN LUIS OBISPO TRIB., July 18, 2007, http://www.sanluisobispo.com/news/local/story/94103.html.

439. Kimberley A. Strassel, *State of Change*, WALL ST. J., Mar. 24, 2008, at R2, R18; *Schwarzenegger Says Nuclear Power Has a "Great Future*," KPBS, Mar. 17, 2008, http://www.kpbs.org/news/local;id=11177.

440. Chris Mulick, *Talks on nuclear power revived in Washington as climate changes*, TRI-CITY HERALD, Apr. 27, 2008, http://www.tri-cityherald.com/901/story/167995.html.

441. *Governor signs tax break bills for Idaho enrichment plant*, LocalNews8.com, Mar. 24, 2008, http://www.localnews8.com/Global/story.asp?S=8062831&nav=menu554_2_6; John Miller, *State Senate backs tax breaks for Idaho uranium plant*, Seattle Times, Mar. 18, 2008, http://seattletimes.nwsource.com/html/localnews/2004289110_apidxgruraniumenrichment2ndldwritethru.html?syndication=rss; *House backs tax breaks for Idaho uranium plant*, ABC Local News 8, Mar. 5, 2008, http://www.localnews8.com/Global/story.asp?S=7972467&nav=menu554_2.

442. Daniel Horner, *Areva picks site for enrichment plant, looks ahead to license application*, Inside NRC, May 12, 2008, at 3, 4; Ruth Campbell, *Andrews out of running for uranium enrichment facility*, Midland [TX] Reporter-Telegram, May 7, 2008, http://mywesttexas.com/articles/2008/05/08/news/top_stories/areva.txt. Also, Utah's state legislature is now pursuing legislation to authorize construction of two nuclear power reactors and to allow them to qualify for renewable energy credits. And in the FAR West, a movement is afoot in Hawaii to repeal the state constitution's prohibition of nuclear power plants, and a territorial legislator in Guam has proposed that his territory study the nuclear energy option. Tom Macdonald, *Concon could be an opportunity to repeal Hawaii's nuclear energy prohibition*, HAWAII R., Jan. 22, 2008, http://www.hawaiireporter.com/story.aspx?e56a2ee3-a3cf-4534-ad9b-c1939908700e; Frank Ishizaki, *We must consider nuclear energy*, Pacific Daily News, June 17, 2007, http://www.guampdn.com/apps/pbcs.dll/article?AID=/20070617/OPINION02/706170314/1014/OPINION.

d. The East

Even in the most nuclear-hostile region of the United States, state politicians are starting to announce their support for nuclear energy. In April 2008, New Jersey Governor Jon S. Corzine called for a review of "siting, permitting, financing and waste disposal issues" involved with bringing a new nuclear plant to the state.[443] In neighboring New York, the Oswego County Legislature passed a resolution in March 2008 supporting construction of a new nuclear unit.[444] And, in the fall of 2007, Maine State Representative Bob Walker introduced legislation to "create a Maine Nuclear Power Council to encourage, co-ordinate and guide interested parties to site nuclear power plants in Maine."[445]

E. Significant Increase in Public Support

Another reason for the current "nuclear renaissance" is the increase in public support for construction of new nuclear power plants. This increase is reflected in any number of polls – both independent and industry-sponsored.

First, the independent polls. Although the questions posed differ somewhat from poll to poll, the patterns of increasing support and decreasing opposition since 2001 is unmistakable:

443. Tom Hester Jr., *NJ to weigh new nuclear plant*, Yahoo!Finance.com, Apr. 17, 2008, http://biz.yahoo.com/ap/080417/nj_nuclear_energy.html?.v=1. *See also* Daniel Horner, *New Reactor Included in New Jersey Energy Plan*, NUCLEONICS WEEK, Apr. 24, 2008, at 1. Governor Corzine's draft energy plan may be found at http://www.nj.gov/emp/.

444. Andy Mattison, *Oswego lawmakers support new nuclear plant*, News 10 Now, Mar. 13, 2008, http://news10now.com/content/top_stories/112283/oswego-lawmakers-support-new-nuclear-plant/Default.aspx.

445. *Lincolnville's State Representative Urges Nuclear Power for Maine and Promises Legislation to Encourage It*, CAMDEN HERALD, Oct. 19, 2007.

Date	Poll	Support	Opposition
June 2008	UPI/Zogby International	67	23[446]
Jan. 2007	UPI/Zogby International	61.8	29.1[447]
Late 2006	Bloomberg/LA Times	61	30[448]
March 2006	Gallup	55	40[449]
Feb. 2006	Pew Research Ctr.	44	49[450]
Sept. 2005	Pew Research Ctr.	39	49[451]
2003	Gallup	43[452]	
2001	Gallup	41	51[453]

Two pairs of Massachusetts-based polls indicate the same trends, though with lower percentages supporting nuclear energy:

Aug. 2007	Ctr. For Economic & Civic Opinion, U Mass	40
2006	Ctr. For Economic & Civic Opinion, U Mass	23[454]
July 2007	MIT	35
2002	MIT	28[455]

Now the industry polls. Frederick Polls conducted the most recent survey of public opinion on nuclear energy, in a poll commissioned by Duke Energy Carolinas (a subsidiary of Duke Energy Corporation). Frederick Poll's September 2008 poll revealed that 63% of those surveyed in North and South

446. Press Release, Zogby International, Zogby Poll: 67% Favor Building new Nuclear Power Plants in U.S. (June 6, 2008).

447. Ben Lando, *Analysis: Americans Favor Nuclear Energy*, UPI ENERGY WATCH, Jan. 26, 2007. The January 2007 poll also found that "62.7 percent 'somewhat agree' or 'strongly agree' nuclear power is safe." *Id.*

448. Robert M. Cook, *Dozens of New Nuclear Projects to be Reviewed*, FOSTERS.COM, Oct. 14, 2007; Richard Simon, *Climate Bill could turn Friends into Foes as some go Nuclear*, L.A. TIMES, Apr. 9, 2007, at A-1; *Nuclear Power: Fission Future*, LYNCHBURG NEWS & ADVANCE, Dec. 26, 2006.

449. *Securing America's Energy Future*, *supra* note 390, at 33. *See also* Beth Gorczyca Ryan, *Nuclear Option Re-emerges in Energy Debate*, WTRF (Wheeling, WV), Feb. 15, 2007. For similar results in an August 2005 poll, *see e.g.* Steven Dolley, *Public Favors Existing Reactors, not new Construction, says IAEA*, NUCLEONICS WEEK, Dec. 22, 2005, at 8; Press Release, Angus-Reid Consultants, Support for Nuclear Power Grows in U.S., Aug. 18, 2005; James M. Pethokoukis, *A New look at Nukes*, U.S. NEWS & WORLD REPORT, Sept. 18, 2005.

450. Peter Baker & Steven Mugson, *Bush Calls for new Nuclear Plants: President Talks of Environmental Benefits, Safety*, WASH. POST, May 25, 2006, at A4.

451. *Id.*

452. Baker, *supra* note 450.

453. *Securing America's Energy Future*, *supra* note 390 at 33; Ryan, *supra* note 449.

454. *Shooting High*, WALL ST. J., Oct. 10, 2007, at B12.

455. Erika Lovely, *Nuclear Industry Wants Green Light*, POLITICO, Jan. 30, 2008; Tim Carpenter, *Renaissance for Nuclear Plants may be Nearing*, TOPEKA CAP.-J., Oct. 28, 2007; Andrea Thompson, *Americans Warm to Nuclear Power and Sour on Soil*, LIVESCIENCE, July 23, 2007, http://www.livescience.com/environment/070723_nuke_power.html.

Carolina favored nuclear energy – a rise of 6% since a similar poll that Frederick had taken in November 2007.[456]

Another industry polling source is Bisconti Research, which is at least arguably biased because it regularly conducts polls about nuclear energy on behalf of NEI. Also, the fact that Bisconti posed somewhat different questions in different polls makes it difficult to discern the same kinds of trends as are shown in the preceding pages. Still, it is safe to draw the general conclusion that Bisconti's polls show strong support for nuclear energy in the U.S.

A Bisconti poll conducted in September 2006 indicated that "[n]early seven of 10 Americans favor nuclear energy and 68 percent support building a new reactor at the existing nuclear power plant closest to where they live, [and that] [s]ixty-three percent say electric companies should 'definitely' build new nuclear power plants in the future."[457] The previous (May 2006) Bisconti poll had "found that 86 percent of Americans see nuclear energy as an important part of meeting future electricity needs and 77 percent agree that utilities should prepare now to build new nuclear plants in the next decade."[458] And two separate 2005 polls revealed that 70% of respondents support the continued use of nuclear energy[459] – the highest percentage since Bisconti began conducting polls on the question in the early 1980s.[460]

Two Bisconti polls from 2005 and 2006 showed rising support for a controversial nuclear plant in New Jersey and provide another example of the populace's changing attitude:

> Public support for the Oyster Creek Generating Station to get a license extension from the federal government is growing, according to a recent poll.
>
> * * * * *
>
> Support for the plant also seems to be growing statewide, according to the group's newest poll results. Among respondents throughout New Jersey, 80 percent approve of renewing the plant's license, compared to 74 percent in 2005.[461]

And, if Bisconti Research's polls are credible, then particularly telling is their revelation that a higher percentage of people living close to existing nuclear power plants supports nuclear energy than does the public at large – a kind of "reverse-NIMBY" (*N*ot *I*n *M*y *B*ack *Y*ard) effect. In a July-August 2007 poll of adults living near each of the sixty-four current nuclear power plant sites, Bisconti Research found that 82% of those living within ten miles of a nuclear plant "said they favor nuclear energy[,...] 90 percent would want their local plant's current operating license to be renewed [, and] 71 percent... said it would be acceptable to build a new reactor on the current site if it were needed to

456. John Downey, *Lee nuclear plant popular in Duke Energy poll*, Charlotte Business J., Sept. 24, 2008, http://www.bizjournals.com/charlotte/stories/2008/09/22/daily33.html.

457. Press Release, Nuclear Energy Institute, Nearly Seven of 10 Americans Favor Nuclear Energy, Support Building New Reactors at Existing Sites (Sept. 25, 2006).

458. Christine Todd Whitman & Patrick Moore, *Nuclear Should be a Part of our Energy Future*, BOSTON GLOBE, May 15, 2006.

459. BISCONTI RESEARCH, INC., U.S. PUBLIC OPINION ABOUT NUCLEAR ENERGY (2005).

460. Mark Levin, *Safe, Efficient Source: To Meet Electricity Demands, U.S. Needs More Nuclear*, RICHMOND TIMES-DISPATCH, Apr. 16, 2006, at E-6.

461. Tristan J. Schweiger, *Poll: Support for Oyster Creek on Rise*, ASBURY PARK PRESS, Aug. 16, 2006.

supply electricity."[462] A similar October 2005 Bisconti poll revealed that "[83] percent of Americans living in close proximity to nuclear power plants favor nuclear energy, and 76 percent are willing to see a new reactor built near them."[463] Not only is public support consistently high near existing reactors, but opposition is decreasing: Bisconti's polls show opposition to such construction falling from 46% in 1980, down to 35% in June 2005, and down again to 24% in August 2005,[464] and to between 20% and 26% in August 2007.[465]

Bisconti's NEI-sponsored polls are funded by the nuclear industry – clearly with its own axe to grind. Richard Karn, although not specifically citing the NEI polls, clearly had industry-sponsored (or, for that matter, anti-industry-sponsored) polls in mind when he criticized both sides of the nuclear energy debate for their "[d]ueling experts and biased polls [which] present agendas as facts or popular opinions."[466] Mr. Karn aptly describes the situation this way: "The politics of fear are applied with equal vigor by either side [and t]he levels of mis- and disinformation are such that getting a grasp on nuclear energy is akin to trying to tackle a greased pig."[467] For this reason, common sense dictates that the MIT, Gallup, and the Bloomberg/Los Angeles Times polls be given more weight than those funded by NEI. But, viewed from 30,000 feet, the conclusions to be drawn from all these polls are generally the same.

F. Budding Financial Support from the Financial Community

Shortly before the press deadline for this article, Wall Street was hit by a financial maelstrom—all five remaining investment banking houses on Wall Street either went bankrupt, converted themselves into bank holding companies, or were purchased by more traditional banks. So, for the most part, the entities to which I have referred collectively as "Wall Street" and which have expressed

462. Katherine Ling, *Residents Closest to Reactors Favor Energy Source, Poll Finds*, GREENWIRE, Aug. 21, 2007; *US Nuclear Neighbors not NIMBY*, WORLD NUCLEAR NEWS, Aug. 21, 2007, http://www.world-nuclear-news.org/nuclearPolicies/US_plant_neighbours_PIMBY_not_NIMBY.shtml?terms=nimby.

463. Press Release, Nuclear Energy Institute, Nuclear Power Plant Neighbors Accept Potential for New Reactor Nearby by Margin of Nearly 3 to 1 (Oct. 12, 2005). *See also* Barbara Miracle, *New Nukes: In Florida and the Nation, Nuclear Power is Poised for a Comeback – and So Far No One Seems to Mind*, FLORIDA TREND, Mar. 22, 2006; Mark Colvin, *Who Wants a Nuclear Neighborhood?*, AUSTRALIAN BROADCASTING CORP., Feb. 20, 2006 (former Commissioner Jeffrey S. Merrifield: "In the US, what we find, interestingly, is the people who live closest to the reactors are those who actually find them the most acceptable…the people who live closest to them seem to like them the most"); Tristan J. Schweiger, *Poll: Support for Oyster Creek on Rise*, ASBURY PARK PRESS, Aug. 16, 2006:

> . . Bisconti . . . found 78 percent of people who live within a 10-mile radius of the [Oyster Creek] nuclear plant favor license renewal "if it continues to meet federal safety standards."
>
> In March 2005, only 70% of respondents living in that area supported renewal, according to a similar poll conducted by Bisconti.

Id.

464. *See* Dolley, *supra* note 449; Press Release, Angus-Reid Consultants, *supra* note 449; Pethokoukis, *supra* note 449; Bruce Boller, *Nuclear Power Doesn't Scare Americans*, ROANOKE TIMES, Feb. 8, 2006.

465. *US Nuclear Neighbors Not NIMBY*, *supra* note 462.

466. Richard Karn, *Nuclear Tide*, RESOURCE INVESTOR, Aug. 1, 2006.

467. *Id.*

tentative interest in financing nuclear construction have either "morphed" into something entirely different or have ceased to exist entirely.

Although it is far too soon to predict the impact of this financial sea change on the nuclear renaissance, I will assume both that the people and attitudes from the now-defunct banking houses will continue to set the terms of the "funding" discussion for the near future and that, consequently, at least some financial institutions will still be willing to consider lending funds for the construction of nuclear reactors. For lack of any better phrase, I will continue to refer to such institutions as "Wall Street" – even though (as discussed next) the lending institutions may actually end up being foreign.

For several months now, the Japanese and French governments have been making noises that one or both might offer their own loan guarantees to U.S. nuclear companies.[468] In late September 2008, Japan "dropped the first shoe" when its Cabinet opened the way for supplemental loan guarantees to companies seeking to build new U.S. nuclear reactors, assuming the construction projects have Japanese investors.[469] The vehicle for such loan guarantees will be the newly-created Japan Finance Corporation.[470] According to U.S. nuclear industry officials, the Japanese investment credits equate to DOE loan guarantees and would in fact permit a U.S. company to reduce the amount of the guarantee it seeks from DOE.[471] This new source of loan guarantees is significant both because of its potentially beneficial effect on the willingness of banks to lend money for reactor construction and because of the risk that the congressionally authorized $18.5 billion in federal loan guarantees may be spread so thin as to make little difference to those same banks.[472] One official has recently opined that, given the recent crisis on Wall Street, "the amount of finance available [for nuclear plant construction] in the US may be very limited."[473]

Prior to the fall of the great banking houses, Wall Street and other investors appeared to be at least *beginning* to accept the idea that construction of new nuclear power plants is a sound financial concept. Wall Street has long been

468. *See* Elaine Hiruo, *Japan clears way for loan guarantees in US*, Nucleonics Week, Sept. 25, 2008, at 1, 2 (discussing Japanese and, to a lesser extent, French loan guarantees); *Japan Finance Corporation (JFC) to be Launched in October, Enabling Investment Credits for U.S. NPP Construction*, Atoms in Japan, Sept. 17, 2008, http://www.jaif.or.jp/english/aij/member/2008/2008-09-17d.pdf (discussing Japanese "investment credits" to support the construction of new U.S. nuclear power plants); Elaine Hiruo, *Japanese government considers loan guarantees for US reactors*, Nucleonics Week, Aug. 14, 2008, at 1. *See also* Erica Mitrano, *Hearings focus on impact of reactor*, So.Md.News.com, Aug. 13, 2008, http://www.somdnews.com/stories/08132008/rectop145133_32164.shtml ("UniStar is also seeking loan guarantees for 80 percent of the anticipated cost from U.S. and French government banks" for the proposed nuclear unit at Calvert Cliffs).

469. Elaine Hiruo, *Japan clears way for loan guarantees in US*, Nucleonics Week, Sept. 25, 2008, at 1.

470. *Id.* at 2.

471. *Id*.

472. As noted above, the amount of any one plant's loan guarantee is a complete unknown. Currently, 17 electric power companies are asking collectively for somewhere between $100 billion and $200 billion in loan guarantees – *far* above the $18.5 billion authorized by Congress. Jenny Weil and Tom Harrison, *Areva Only Applicant Besides USEC to Seek Front-End Loan Guarantees*, Nuclear Fuel, Oct. 6, 2008, at 9 ($122 billion); *DOE Reviews Nuclear loan Guarantee Requests*, Power Engineering, Oct. 3, 2008, http://pepei.pennnet.com/Articles/Article_Display.cfm?Section=ONART&PUBLICATION_ID=6&ARTICLE_ID=341570&C=PRODJ&dcmp=rss (offering different figures: $188 billion for 21 new reactors at 14 sites).

473. Elaine Hiruo, *Japan clears way for loan guarantees in US*, Nucleonics Week, Sept. 25, 2008, at 1.

reluctant to provide financial backing for new nuclear plants. David Schlissel of the Massachusetts-based consulting firm Synapse Energy Economics succinctly describes Wall Street's attitude towards nuclear energy over the last two decades as "'Hell, no, we won't give our money.'"[474]

This reluctance is hardly unreasonable. After all, nuclear energy has had (to say the least) a "checkered financial history."[475] Throughout the 1970s, "[c]ost overruns, regulatory hang-ups and widespread opposition from environmentalists dogged the industry... contributing to the cancellation of dozens of proposed reactors and resulting in more than $17 billion in after-tax write-offs industrywide."[476] The Comanche Peak facility cost 10 times its original estimate; Vogtle, 13 times; Shoreham, variously reported at between 15 and 21 times; and the industry-wide cost overrun for the first seventy-five nuclear power plants was 219%.

According to Standard & Poor's utility industry analyst Dimitri Nikas, "[d]espite billions of dollars in federal incentives to jump-start construction of a half dozen new nuclear plants, any new wave of nuclear construction will have to satisfy [Wall Street] if it's ever going to get off the ground."[477] This will require firm loan guarantees (signed, sealed, and delivered) by the DOE, a ratio of plant value to total company value that is small enough not to scare off Wall Street lenders, some serious construction cost management by the industry (including a large dose of modularization,)[478] and some equally serious risk allocation between the reactor owners and the vendors (*e.g.*, Westinghouse, GE, Areva).[479]

David Crane (CEO of NRG) commented regarding his company's proposed new South Texas reactors: "[o]n an $8 billion project, even if it is 80 percent debt, that still leaves $1.6 billion of equity, and people aren't going to risk the $1.6 billion unless you find someone [*i.e.*, a vendor] who says, 'I'll build that, for X million and in Y months.'"[480]

Toshiba listened and responded, offering to share some of the risk in the construction of NRG's South Texas-3 and 4 reactor units. "Toshiba will contribute $150 million... toward the development costs"[481] of those two units,

474. Judy Fahys, *Lawmakers Balk on Nuclear Proposal for Now*, SALT LAKE TRIB., Sept. 19, 2007.

475. *Securing America's Energy Future*, *supra* note 390, at 33; Paul Adams, *Constellation Nuclear Plans in Fiscal Peril*, BALTIMORE SUN, July 23, 2007, at 1A.

476. Adams, *supra* note 475; Paul Adams, *Economics of Nuclear Power are Rethought: Loan Guarantees could Transform Energy Industry*, BALTIMORE SUN, Sept. 4, 2007, at 1A.

477. John W. Schoen, *Does Nuclear Power Make Financial Sense? Industry must Persuade Wall St. that New Advantages Translate to Profits*, MSNBC, Jan. 26, 2007, http://www.msnbc.msn.com/id/16286304/.

478. Ron Pitts, Presentation at Platts' Nuclear Energy Conference (Feb. 5, 2008), Slides 2 & 3, on file with author. Jeffrey Merrifield (Senior Vice-President of the Shaw Group and a former NRC Commissioner) says that Shaw and its partner Westinghouse are centralizing their module construction at their Lake Charles LA facility and will truck the modules to plant sites as needed. Anna Thibodeaux, *Powering up*, Baton Rouge Business Report, Sept. 9, 2008, http://www.businessreport.com/news/2008/sep/09/powering-indt1/.

479. Steven Dolley, *Exelon COO Says Risk Sharing Needed to Build New Reactors*, NUCLEONICS WEEK, Mar. 6, 2008, at 6.

480. Matthew L. Wald, *NRG Energy Sets up an Entity to Build Nuclear Plants*, N.Y. TIMES, Mar. 26, 2008.

481. Jenny Weil, *New Partnership with Toshiba Spurs Revisions to STP Application*, INSIDE NRC, Mar. 31, 2008, at 12.

"take a 12% interest"[482] in the new Nuclear Innovation North America Company (an NGG-Toshiba partnership), and pay an additional $150 million towards the development costs of four additional units. According to NRG's executive vice president Steve Winn, "[t]he vendor is showing its commitment to stand up to its portion [of] the risk of nuclear development.... [a]nd if there are delays or other issues [that are] vendor-caused, it shares the pain along with the customer."[483]

Wall Street's attitude at least *appeared* to be turning, slowly, in the nuclear industry's favor. Balancing the positive and negative statements reported in the press, this shift to a cautiously positive attitude seemed to reached critical mass in mid-2006 (though, as indicated by some of the pessimistic quotations below from 2006 forward, the cautious optimism was, and is, hardly universal – even before the September maelstrom). Take, for instance, the 2006 statement of Caren Byrd (executive director of Morgan Stanley's Global Utility and Power Group) that "[t]he nuclear industry is getting a lot of interest, but it's still far down the road.... It's important to see whether the capital is available for this industry. Nobody is writing checks yet. But we're pointing in that direction."[484] Or *Business Week*'*s* 2006 report that "[i]nterest in the energy source is on the rise across the country, and financial risks are lower. S&P sees no slowing of the trend."[485] Or now-retired Lehman Brothers Managing Director (and former NRC Commissioner) James Asselstine's 2006 testimony before Congress that, "[o]ver the past nine months,... the financial community ha[s] become increasingly familiar with the level of activity and the seriousness of the industry's efforts leading toward new plant commitments."[486]

Generating this increase in investor interest was, in fact, one main purpose of Congress' providing subsidies to the nuclear industry in the Energy Policy Act of 2005. According to Bob Simon, Democratic staff director of the Senate Energy and Natural Resources Committee, "[t]he real obstacle [to a nuclear renaissance] isn't the Sierra Club but the 28-year-old analysts on Wall Street."[487]

And those twenty-eight year-old analysts will be fully aware that, as of 2007, American utilities were still carrying $80 billion in debt as the result of bad bets on nuclear energy in the 1970s and 1980s,[488] and that it would cost 28% more to construct a new nuclear power plant than the value assigned to existing plants by Wall Street.[489] The analysts will also presumably know that, from June to December 2007, the estimated cost of constructing a nuclear plant in Idaho

482. *Id*.

483. *Id.*

484. Jim Jelter, *Jump-starting the Nation's Next Nukes: Investors Peer into an Industry Intent on Revival*, MARKETWATCH, Oct. 16, 2006, http://www.marketwatch.com/News/Story/Story.aspx?dist=newsfinder&siteid=google&guid=%7B23DB6678-4E75-4890-B943-9D0F3A431CC8%7D&keyword.

485. *Nuclear Power is Heating up Again*, BUS. WEEK, June 27, 2006.

486. Maya Jackson Randall, *NRC Chief: 16 Cos Serious About Building New Nuclear Plants*, DOW JONES NEWSWIRES, May 23, 2006.

487. Adam Aston, *Nuclear Power's Missing Fuel*, BUS. WEEK, June 29, 2006.

488. Tim Harper, *Anti-nuke Groups Gird for New Battle*, TORONTO STAR, May 7, 2007.

489. Elliot Blair Smith, *New Reactor Costs Daunt U.S. Utilities as TVA Restarts Old Unit*, BLOOMBERG, July 9, 2007, http://www.bloomberg.com/apps/news?pid=20601103&sid=agGMCRlWdMyU&refer=us.

jumped from $3.5 billion to $4.5 billion – or about 30%.[490] And they will be concerned that the Olkiluoto-4 nuclear plant in Finland is currently two years behind schedule and already has cost overruns of about 1.3 billion euros (or roughly $1.75 billion, based on the October 6, 2008 exchange rate).[491]

The twenty-eight year-old analysts' skepticism is reflected in statements from both Wall Street and the nuclear energy industry itself.

First, Wall Street. Standard & Poor's Rating Service stated in early 2006 that "an electric utility with a nuclear exposure has weaker credit than one without and... were a utility to embark on a new or expanded nuclear endeavor, Standard & Poor's would likely revisit its rating on the utility."[492] Likewise, one commentator observed as recently as January 2007 that "[b]ond agencies have already made it clear that energy or finance groups that take on the risk of new plants are likely at the same time risking their credit ratings."[493] And a month later, the executive director of Morgan Stanley's global power and utility group opined that investors see nuclear energy investments as "good on paper but... still untested"[494] and that they "still need to be convinced"[495] that nuclear energy is a viable investment.

And now the nuclear industry. Dominion Energy's CEO Thomas Capps stated in 2004 that "[i]f you announced you were going to build a new nuclear plant, Moody's [Investors Service] and Standard & Poor's would assuredly drop your bonds to junk status [and] [h]edge funds would be bumping into each other trying to short your stock."[496] (Most new nuclear power reactors are expected to be funded through the issuance of bonds.) Thomas E. Capps of Dominion Resources similarly opined in mid-2007 that "Moody's would go bananas if we announced we were going to build a nuclear plant."[497]

Indeed, to a minor extent, this very risk came to fruition in December 2007 (although with another company) – Moody's Investors Service dropped the bond rating of SCANA (a South Carolina-based power company) from the lowest of its top-tier ratings (A3) to the highest of its second-tier ratings (Baa1) – in part because the company was *even considering* construction of a new nuclear power facility. Shortly thereafter, Dan Aschenbach, Moody's Senior Vice President for Public Finance, told an industry audience that, roughly speaking, his company would set such a company's credit rating "in the low Bs," though this could

490. Ken Dey, *SLC Firm to Invest in Proposed Nuke Plant*, IDAHO STATESMAN, Dec. 7, 2007.

491. Ann MacLachlan, *Areva official says costs for new EPR rising, exceeding $6.5 billion*, NUCLEONICS WEEK, Sept. 4, 2008, 1, 10; Ariane Sains, *TVO: Olkiluoto-4 could come online by 2020, cost up to $6.2 billion*, NUCLEONICS WEEK, May 1, 2008, at 4; Dan Molinsky, *Dollar Gains on Euro, but Yen Soars*, WALL ST. J.COM, Oct. 6, 2008, http://online.wsj.com/article/SB122328553341907281.html.

492. Peter Bradford and David Schlissel, *Why A Future for the Nuclear Industry Is Risky*, Jan. 2007, http://www.cleanenergy.org/resources/reports/WhyNewNukesAreRiskyFACTSHEET.pdf, quoting Standard & Poor's, "Credit Aspects of North American and European Nuclear Power" (Jan. 9, 2006).

493. Martin Walker, *Nukes and Risk*, UPI, Jan. 29, 2007.

494. Ben Lando, *Uncertain U.S. Nuclear Economics*, UPI ENERGY WATCH, Feb. 24, 2007.

495. *Id*.

496. William Tucker, *Greenpeace Girds for the Nuclear Revival*, AM. ENTER. ONLINE, July 24, 2006, http://www.taemag.com/issues/articleid.19297/article_detail.asp.

497. Glenn R. George, *Financing New Nuclear Capacity: Will the "Nuclear Renaissance" be a Self-sustaining Reaction?*, ELECTRICITY J., Apr. 2007, at 12.

change depending upon the details of the company and the specific project, and how broadly the risk had been spread. And in August 2008, Fitch Ratings revised downward its outlook for SCANA and two subsidiaries – from "stable" to "negative."[498]

Until the DOE agreed in October 2007 to provide 90-percent loan guarantees for new plants,[499] there was considerable doubt whether Wall Street would *ever* back nuclear construction.[500] Goldman, Sachs & Co., Citigroup Global Markets, Credit Suisse Securities, LLC and Lehman Brothers all held this view, considering unsecured debt to be the kiss of death to lenders who seek to "sell the loans in the secondary market, which is essential in such deals."[501] Some, however, do not take the banks' comments at face value. For instance, former NRC Commissioner Peter Bradford (now Vice-Chairman of the Union of Concerned Scientists) counters that Wall Street regularly finances equally risky businesses: "Their claims that the [DOE's] proposed package is not finance-able are just not correct.... They want taxpayers to take 100 percent of the debt risk."[502]

In a sense, both sides may be right. On the one hand, plants in traditional *rate-regulated* states may well be built even without the DOE loan guarantees - for two reasons. First, regulators and politicians in those states have provided generous tax benefits for constructing and operating nuclear plants.[503] Second, a number of traditional rate-regulated states (*e.g.*, Florida, South Carolina, Georgia, Virginia, and Louisiana) have already guaranteed their utilities full or partial recovery of their nuclear development costs through rate increases. Such guarantees should enable utilities to obtain financing more easily. Dan Weekley, Dominion's managing director of Northeast government affairs, stated in August 2008 that "[y]ou're going to have to build a nuclear unit in a regulated environment, not deregulated like Connecticut."[504] And energy attorney Charles Whitney offers the following similar opinion: "I know that there are [prospective] plants that are based on an economic analysis that does not incorporate... [DOE's] loan guarantees, and those plants will probably go forward without regard to what happens at [DOE]." [505] At least one utility has announced as much. AmerenEU spokesman Mike Cleary stated in early October 2008 that his company "will pursue development of the new [Callaway nuclear] plant... regardless of whether the project obtains a federal loan guarantee." [506]

498. *Fitch Lowers Scana Ratings Outlook, Citing Plans for New Reactors*, NUCLEONICS WEEK, Aug. 7, 2008.

499. Some aspects of this guarantee, however, still remain unsettled. Jenny Weil, *Loan Guarantee Costs Still Unclear, Former DOE General Counsel Says*, NUCLEONICS WEEK, Nov. 22, 2007, at 7.

500. Adams, *supra* note 475.

501. *Id.*

502. *Id.*

503. Admittedly, non-regulated states have likewise provided some generous incentives.

504. Liese Klien, *New Nukes?*, CONN. BUS. J., Aug. 4, 2008, http://www.conntact.com/article_page.lasso?id=42186.

505. *Id*. Mr. Whitney is currently a partner at Duane Morris in Atlanta, is a published author on nuclear energy issues, and lectures frequently on the subject.

506. Jeffrey Tomich, *AmerenEU Seeking Callaway 2 Loan Guarantee*, St. Louis Dispatch, Oct. 4, 2008, http://www.stltoday.com/stltoday/business/stories.nsf/manufacturingtechnology/story/C54380843A6FB9BA862574D80000C730?OpenDocument (reporter's paraphrase of Mr. Cleary's statement).

By contrast, power generators in *deregulated* states (*e.g.*, Maryland and Texas) lack such guarantees of cost recovery and fixed profit (or "rate of return"), and some experts have considered it unlikely that any plants will be built in those states[507] – at least without full loan guarantees from the Federal government for at least the first few plants.[508] After all, the unregulated "independent power producers" are by definition taking more risk than their rate-regulated counterparts, and can rarely negotiate electricity sales contracts for periods longer than three to five years. Banks want guarantees of income flow for longer periods than that.

Yet, despite the superficial attractiveness of this regulated/deregulated paradigm, recent developments do not seem to support it. The first complete and the first partial COL applications to reach the NRC were for plants in the two *de*regulated states mentioned above – Texas (South Texas Project) and Maryland (Calvert Cliffs) respectively. Likewise, one of the first three ESP applications was for a plant in the *de*regulated state of Illinois (Clinton). And Midamerican (the likely new owner of Constellation and its plants) says it "is willing to build plants as part of *regulated operations or unregulated* operations, whatever [Maryland] state officials require."[509] So in the real world, the regulated/deregulated distinction seems tenuous at best. Moreover, those applications for Calvert Cliffs and the South Texas Project were filed *before* the DOE announced it was raising the percentage of its loan guarantees to 90%.

Bottom line: for now at least, it appears power generators are willing to start the NRC licensing process to construct nuclear plants *regardless* of whether the host state is regulated.

In addition to loan guarantees, another significant factor restrains Wall Street's interest in nuclear energy investment: political uncertainty. According to Kenneth Medlock III, a fellow in energy studies at Rice University's James A. Baker III Institute for Public Policy, investors are gun-shy because they "need some guarantees up front that the rules won't change again,"[510] and because "[i]t

507. Duke Energy's Chairman James Rogers believes that "there is almost no chance that a new US nuclear plant would be built in a state with a deregulated electricity market." Steve Dolley, *Duke CEO a "skeptical optimist" on future of US nuclear power*, Nucleonics Week, June 21, 2007, at 2, 3. *See also* Peter Bradford and David Schlissel, *Why A Future for the Nuclear Industry Is Risky*, (Jan. 2007), http://www.cleanenergy.org/resources/reports/WhyNewNukesAreRiskyFACTSHEET.pdf (quoting the 2003 MIT Study, "The Future of Nuclear Power - Summary Report," http://web.mit.edu/nuclearpower/pdf/nuclearpower-summary.pdf, that "[t]he market value of nuclear plants is far below their replacement cost, a result that is inconsistent with merchant investment in new nuclear plants").

508. According to Morgan Stanley executive director Caren Byrd, a nuclear finance specialist [f]or the plants that are not regulated, the loan guarantees are essential. Elliot Blair Smith, *McCain Nuclear Energy Revival May Cost $315 Billion (Update1)*, BLOOMBERG, Sept. 11, 2008, http://www.bloomberg.com/apps/news?pid=20601103&sid=aRkagygu04Ks&refer=us. As an indication of how much difference a federal loan guarantee can make, consider its potential effect on the proposed third reactor at the Vogtle facility in Georgia. Paul Bowers (Southern Company's Chief Financial Officer) said on October 2, 2008, that "the loan guarantee would reduce interest rates by as much as 1.1 percent on the [Vogtle] project." Daniel Whitten, *Utilities Seek $122 Billion in Nuclear Loan Support (Update2)*, BLOOMBERG, Oct. 2, 2008, http://www.bloomberg.com/apps/news?pid=20601103&sid=aXjr7wWyb_tw&refer=us.

509. Rebecca Smith, *Midamerican to Push Ahead on CEG Bid*, Wall St. J., Oct. 4-5, 2008, at B6 (emphasis added).

510. Vicki Vaughn, *CPS Energy Taking a Hard Look at Nuclear*, SAN ANTONIO EXPRESS-NEWS, Sept. 4, 2007.

can take 10 years to get one of these things planned and operating, and 10 years is an eternity in politics."[511] As an example of potential political changes worrying "The Street," Illinois periodically appears on the verge of reregulating power rates to residential customers and thereby potentially curtailing power plant owners' ability to pass through capital costs to their customers.[512]

So, from 30,000 feet, what does the financial community's attitude look like? At least prior to the September maelstrom, most (though certainly not all) current or recent indicators suggested a "sea change" favoring nuclear energy. Just before he stepped down as an NRC Commissioner in June 2007, Jeffrey S. Merrifield commented:

> recently, during visits I have made to Wall Street it has become apparent that investors and analysts, although somewhat slow off the mark in embracing this change, seem to be increasingly convinced that events have aligned to a point where building a new plant is economically plausible. Such a theory would have been heresy in New York just a handful of years ago.[513]

Much independent evidence supports former Commissioner Merrifield's conclusion. Consider, for instance, the late-2007 opinion of George Bilicic, head of the Global Power & Utilities Group of Lazard, that "[w]e think pools of capital will be attracted"[514] to investments in nuclear power plant construction. (Indeed, a Utah-based investment company, Silverleaf Capital, has already agreed to front $150 million to start the licensing process for a new plant in Idaho.[515]) Likewise, the big investment banks on Wall Street were, until their recent demise, showing significant interest in the uranium fuel industry[516] – something they would not have done if they had foreseen no future for the nuclear plants that would use uranium as fuel.

Consider also the effect of a nuclear plant construction announcement on the price of a power company's stock. TXU's stock price rose nearly 2% the day it announced that it was considering construction of new nuclear power plants. Analogously, shares of the Shaw Group rose more than 13% during the week following Shaw's purchase of a 20-percent interest in nuclear plant producer Westinghouse. Likewise, the stock market responded favorably to NRG Energy's 2007 application to construct two "[m]erchant [nuclear] generator[s]," *i.e.*, nuclear plants not dependent upon a state public utility commission's construction-approval or rate-making authority.[517] At the close of business on the day NRG announced its intent, its stock had risen 1½%. This "reflects the

511. *Id*.

512. Nicole Gelina, *Is Wall Street Ready to go Nuclear?*, CHIEF EXEC., Sept. 2007.

513. Merrifield, *Newton's First Law of Physics*, *supra* note 71, at *2.

514. Sheila McNulty, *supra* note 177.

515. Shea Anderson, *The Nuclear Option*, BOISE WEEKLY, Jan. 16, 2008, http://www.boiseweekly.com/gyrobase/Content?oid=oid%3A310288; Ken Dey, *SLC Firm to Invest in Proposed Nuke Plant*, IDAHO STATESMAN, Dec. 7, 2007, http://www.idahostatesman.com/business/story/231310.html.

516. Michael Knapik & Tom Harrison, *Renewed Buying Interests Boost Spot U Prices*, NUCLEAR FUEL , Oct. 22, 2007, at 1, 11-12.

517. Jenny Weil & Michael Knapik, *NRG May Build ABWRs at South Texas; Commercial-Grade Parts to Cut Costs*, INSIDE NRC, June 26, 2006, at 1, 15.

market sentiment that 'this was not a crazy idea, and Wall Street is receptive to this plan,'"[518] according to one industry official.

And, as one last example of Wall Street's budding support for nuclear energy, consider the fact that nuclear service provider Energy Solutions announced in October 2007 that it was "going public" in a stock offering backed by a plethora of major Wall Street firms – specifically, Credit Suisse, JP Morgan, Morgan Stanley, UBS Investment Bank, Banc of America Securities, LLC, Citibank, D.A. Davidson & Co., Friedman Billings Ramsey, Lazard Capital Markets, and Wedbush Morgan Securities.[519]

But Wall Street is not the only game in town. Constellation, is garnering financial support from oversees – specifically, from Electricité de France, SA – for its proposed new power reactors. Analysts believe that "[t]he financial backing of [Electricité de France],"[520] which operates 58 nuclear plants and is Europe's leading energy producer, "will give Constellation more credibility with lenders and potential buyers of new plants."[521] But how Constellation's near-bankruptcy in September 2008 and its subsequent rescue by Warren Buffett (or, possibly, EDF) will affect this credibility remains to be seen.[522]

At least until the fall of the great banking houses in September 2008, investment analysts were starting to see that the light at the end of the nuclear tunnel was both "on" and "green." For instance, Barry Abramson (analyst and portfolio manager at GAMCO Investors, Inc., in Rye, New York) concluded in September 2007 that "investors are relatively positive on companies that are... planning the next round of nuclear plants.... The numbers seem to work."[523] And, the next month, a group of private equity firms purchased TXU Corporation (now Energy Future Holdings Co.) for $45 billion.

But whether the financial community still has an appetite for investment in nuclear energy remains to be seen. Right now, funding is the 800-pound gorilla in the corner, but it is hardly the only potential problem that could stop the nuclear renaissance dead in its tracks. And it is to that set of problems to which I now turn.

III. WHAT COULD DERAIL THIS NUCLEAR RENAISSANCE IN THE U.S.?

If one were to consider only such factors as (i) the high and unpredictable coal, oil, and gas prices, (ii) the need to reduce greenhouse gases, (iii) the increased need for energy security, and (iv) expected increases in energy demand (both nationally and internationally), then the nuclear renaissance might appear to be unstoppable. But as recent events on Wall Street have demonstrated, "it

518. Jenny Weil, *NRG First Merchant Company to Look at Nuclear*, NUCLEONICS WEEK, June 29, 2006, at 1, 2.

519. *EnergySolutions Plans IPO of 30M Shares*, YAHOO! FINANCE, Oct. 31, 2007, http://biz.yahoo.com/ap/071031/energysolutions_ipo.html?.v=1.

520. Paul Adams, *Constellation in joint nuclear venture*, BALTIMORE SUN, July 21, 2007, http://www.baltimoresun.com/business/bal-bz.constellation21jul21,0,4014082.story.

521. *Id*.

522. *See supra* note 30.

523. John Wilen, *Utilities press for new nuclear future*, BUS. WEEK., Sept. 18, 2007, http://www.businessweek.com/ap/financialnews/D8RO03VG0.htm.

ain't necessarily so." Any of the following nine potential problems could potentially stop the United States nuclear renaissance dead in its tracks.

A. Political

1. Spent Fuel

Spent fuel is an issue which, from a scientific perspective, has largely been addressed (see Section II.C.3, above). But, scientific reality often differs from political reality, and it does so in spades on this issue. The Bush Administration's proposed solution to the spent fuel storage problem – the Yucca Mountain High-Level Waste Repository – seems "dead on arrival" for now, given Senate Majority Leader Harry Reid's opposition,[524] as well as the Democrats' presumed ability to filibuster if the Republicans retake the Senate in 2008.

Two alternatives to Yucca Mountain are the use of breeder reactors and enrichment of spent fuel for reuse - ideas supported by the Bush Administration but opposed by many in Congress and elsewhere due to concerns about proliferation. (Some argue, however, that the proliferation risk is overrated, since the United States' system for safeguarding nuclear material is well-proven and, in any event, any terrorist attempting to handling plutonium from a reprocessing system would need advanced training and laboratory equipment.[525])

A third alternative is simply to allow the collections of spent fuel to remain at the nuclear plant sites where they currently reside. This option likewise has its political supporters who consider nuclear facilities a safe storage location; and it has its political opponents who are concerned about terrorist strikes against those same facilities.

A fourth alternative is the use of a consolidated central interim storage facility. The United States already has such facilities. But, for political reasons, the chances of another such storage facility appear slim. This option is subject to the same political disadvantage as Yucca Mountain – heavy resistance from a proposed host state's government. Private Fuel Storage, LLC, unsuccessfully attempted to establish such a facility but failed due in part to opposition by Utah.[526] Likewise, a proposal for a "monitored retrievable storage facility" in Oak Ridge, Tennessee, met similar resistance from that state.[527]

But, until the country resolves the spent fuel management issue, it will hinder the development of nuclear energy in the United States. For example, Exelon – owner of the country's largest fleet of nuclear power plants – explicitly refuses even to consider building any new nuclear power plants until the issue is

524. Senator Harry Reid, *Reid, Ensign Slam Yucca Mountain Bill*, Apr. 4, 2006, http://www.state.nv.us/nucwaste/news2006/nn12208.htm. On June 3, 2008, the DOE submitted its application for the Yucca Mountain facility to the NRC, and on September 8, the NRC determined that the application was complete enough to justify a formal review.

525. Op-Ed, *Just Say Oui' to Nuclear Power*, BOSTON GLOBE, Sept. 16, 2007, at 9D.

526. *Keystone Report*, *supra* note 8, at 78.

527. *Id.*

resolved.[528] Along similar lines, at the state level, California and eleven other states currently ban construction of new nuclear power plants until the storage issue is resolved.[529]

Other non-scientific aspects that affect how spent fuel will be managed is the DOE's ability (or lack of it) to meet its own deadlines for the construction of the Yucca Mountain facility,[530] paired with Congressional willingness to fund the project adequately. Another factor is the success (or lack of it) of Nevada's efforts (before the courts, the EPA and the NRC) to derail the Yucca Mountain repository. And finally, there is the political/legal/scientific question of where to put additional spent fuel once the Yucca Mountain repository has been filled.[531]

2. Regulatory and Adjudicatory Delays

Although the NRC has adjudicated to completion three ESP cases under the new Part 52 regulations, it has as yet fully processed no COL proceedings under those regulations.[532] No new regulatory scheme can anticipate all possible issues, and Part 52 will doubtless be no different. For contested COL applications, this will translate almost inevitably into lengthy hearings before the NRC's trial tribunal (the Atomic Safety and Licensing Board Panel) and more complex and time-consuming appeals to the agency head (here, the Commissioners themselves). Indeed, Commissioner Lyons expects the first applications to take longer to review than the NRC has predicted.[533] And then there are the potential judicial appeals, which could drag the process out even longer.

Community activists, environmentalists, and other opponents used this "war of attrition" approach in the 1970s and 1980s, and could certainly re-use that strategy. Many local groups have already expressed their intention to fight

528. But Exelon has taken two steps that seem to contradict this position, First, on September 3, 2008, Exelon, filed a COL application for two 1,520-MW units in Victoria County, Texas. Second, Exelon sought (and was granted) an ESP to augment its Clinton facility. The common assumption is that Exelon filed the ESP application as a means of (i) "banking" the property for future use if Exelon decides to construct a new reactor at Clinton, and (ii) perhaps enabling it to take advantage of the financial benefits provided in the Energy Policy Act of 2005, if and when the spent fuel storage issue is resolved to Exelon's satisfaction). Scott DiSavino, *Exelon III. Clinton Reactor Shut*, REUTERS, Jan. 14, 2008, http://www.reuters.com/articlePrint?articleID=USN1438624720080114 (*regarding* "banking" the property),

529. *Keystone Report*, *supra* note 8, at 78.

530. The DOE's construction schedule has already slipped by about twenty years and, as of 2007, even the DOE was cautioning that its current opening-date target of 2017 is merely a best-case scenario. *Id*. at 70.

531. According to the Keystone Center, Yucca Mountain's statutory limit on capacity is less than the amount of spent fuel the currently-operating United States reactors are expected to produce over their licensed lifetime. *Id*. at 72.

532. *Dominion Nuclear North Anna,, LLC* (Early Site Permit for North Anna ESP Site), CLI-07-27, 66 NRC 215 (2007); *System Energy Resources, Inc.* (Early Site Permit for Grand Gulf ESP Site), CLI-07-14, 65 NRC 216 (2007); *Exelon Generation Co,, LLC* (Early Site Permit for Clinton ESP Site), CLI-07-12, 65 NRC 203 (2007).

533. Tom Fowler, *Snags Seen for Nuclear Power; Project Review Delays Part of 'Learning Curve,' official says*, HOUSTON CHRONICLE, Feb. 16, 2008, at Business 1. The Commission has established a policy of concluding hearings on other construction permit applications within 30 months of the date the application was received. *USEC, Inc.* (American Centrifuge Plant), CLI-04-30, 60 NRC 426, 432 (2007).

individual COLs,[534] and the Sierra Club has pledged to contest *every* COL application.[535] Indeed, such threats are already having an effect in at least some quarters. For instance, Michael Morris (chairman and CEO of American Electric Power) says that his company is hesitating to participate in the "first wave" of new reactor applications due to the likelihood of legal challenges.[536]

Likewise, nuclear opponents could challenge proposed nuclear power plants before state regulatory commissions and local or state governments, any one of which could delay the construction or operation if it wished. Local officials could, for instance, withhold approval for a plant to use river water for cooling, refuse to cooperate in the plant's emergency planning, or deny land-use or environmental permits. The most famous example of state or local governmental opposition involved the Shoreham nuclear plant whose actual operation was prevented by sustained opposition from New York.[537] A recent variation on this theme involved Constellation's concern that Maryland's state regulators would be too hostile to the company's proposal to expand the Calvert Cliffs nuclear facility – with the consequence that Constellation threatened to construct its first new nuclear plant in New York rather than Maryland.[538] Even in as nuclear-friendly a state as Florida, utilities must still run the risk of public opposition before multiple forums—the state's Public Service Commission and Department of Environmental Protection, as well as the Power Plant Siting Board. And that doesn't include local governmental entities.

B. Economic

1. Workforce Constraints

The current shortage of trained workers and nuclear-educated experts could hinder the nuclear renaissance, not only in the United States but also around the world. Europe is already looking beyond its borders for trained workers. Luis Echavarri, director general of the Organization for Economic Cooperation and Development's Nuclear Energy Agency, said in an interview at the World Energy Congress in November 2007 that "'[i]t will be difficult to have a significant number of new reactors over the next 10 years' because of the need to train scientists and technicians."[539] Similarly, Westinghouse has predicted that "[m]ore than half of the world's nuclear engineering workforce will need to be

534. David Brewer, *Public Can Address N-plant Proposal*, HUNTSVILLE TIMES, Apr. 3, 2008, at 2B (Blue Ridge Environmental Defense League, opposing new Bellefonte plant).

535. Katherine Ling, *NUCLEAR POWER: As lawmakers embrace reactors, doubts remain on Wall Street, Main Street*, GREENWIRE, July 3, 2007, at SPOTLIGHT.

536. Fowler, *supra* note 533. On the other hand, this concern has not inhibited other companies who have (as of October 3, 2008) filed 15 reactor license applications, or apparently those who have told the NRC that they intend to submit eight more by the end of 2009. *Supra* note 15 and associated text.

537. Congressional Research Service, *Nuclear Power: Outlook for New U.S. Reactors*, March 9, 1977, at p. CRS-8; *Atomic Renaissance*, THE ECONOMIST, Sept. 8, 2007, at 71, 72-73.

538. CHARLES MCCHESNEY, SCRIBA, NOT MARYLAND MAY GET FIRST NEW NUKE PLANT (Jan. 30, 2008), http://blog.syracuse.com/news/2008/01/report_scriba_not_maryland_may.html.

539. Lars Paulsson & Paul Dobson, *Nuclear Power Expansion Threatened by Staff Shortages*, BLOOMBERG Nov. 14, 2007, http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aa4W51wzAtSg.

replaced in the next 10 years."[540] In short, just when the need for trained nuclear employees is rising, their numbers are falling.

This hiring gap has created, according to one wag, "a talent war going nuclear."[541] Our own country alone will require 90,000 new workers by 2011 (according to Commissioner Peter B. Lyons)[542] and 185,000 workers by 2015 (according to Anthony Topazi, CEO of Mississippi Power)[543] – and this despite the fact that industry consolidation and efforts to improve efficiency are resulting in a reduction of industry staff.[544] For instance, according to Dr. Harold McFarlane, 2007 president of the American Nuclear Society, there are currently fewer than 2,000 nuclear-qualified welders in the United States.[545] (To protect itself from this shortage, Westinghouse in 2007 purchased Carolina Energy Solutions—a South Carolina welding company—along with its welding school.[546])

Likewise, the demand for electricians and plumbers will rise – particularly in the South – due to the increase in other infrastructure construction such as gas and coal-fired power plants, oil refineries, and electricity transmission lines.[547] The "Southern Co. estimates that existing energy facilities already are short 20,000 workers in the Southeast"[548] and that the shortfall will double by 2011, due to new construction.

Similarly, the shortage of geologists is pitting uranium mining companies against not only each other but also the oil and gas industries. During the 1980s and 1990s, those industries faced a downturn (similar to that of the nuclear industry during the same period) and many oil executives, such as ConocoPhillips CEO James Mulva, wonder "whether the industry has enough support services and people"[549] to increase oil production to the 100+ million

540. *Id.*

541. Jane M. Von Bergen, *A Jobs Boom is Shaking Nuclear Industry*, PHILA. INQUIRER, Mar. 9, 2008, at C01.

542. Lyons, *U.S. - Japan Regulatory Cooperations*, *supra* note 411, at *3.

543. Ken Silverstein, *Nuclear Jobs*, ENERGYBIZ INSIDER, Sept. 14, 2007, http://www.energycentral.com/site/newsletters/ebi.cfm?id=383.

544. Ryan Randazzo, *Palo Verde: Now hiring*, AZ REPUBLIC, Feb. 1, 2008, *available at* http://www.azcentral.com/arizonarepublic/business/articles/0201biz-paloverdehiring0203-ON.html; *US Nuclear Generating Costs Move Upward for Second Year*, NUCLEONICS WEEK, Sept. 13, 2007, at 1, 9.

545. Jim Motavalli, *A Nuclear Phoenix*? FAYETTEVILLE FREE WEEKLY, July 19, 2007, http://www.freeweekly.com/2007/07/19/a-nuclear-phoenix/.

546. Elaine Hiruo, *With Welding Company Purchase, Westinghouse Adds to Offerings*, NUCLEONICS WEEK, Nov. 15, 2007, at 5, 6.

547. MARIANNE LAVELLE, *A WORKER SHORTAGE IN THE NUCLEAR INDUSTRY* (2008) http://www.usnews.com/articles/business/careers/2008/03/13/a-worker-shortage-in-the-nuclear-industry.html; Elaine Hiruo, *Workforce Issues Big Challenge for NRC, Nuclear Renaissance*, INSIDE NRC, Nov. 12, 2007, at 2, 3; Elaine Hiruo, *NRG Hires Toshiba as Contractor for Project Services for New ABWRs*, NUCLEONICS WEEK, Aug. 16, 2007, at 1, 10.

548. LAVELLE, *supra* note 547.

549. Russell Gold and Ann Davis, *Oil Officials See Limit Looming on Production*, Wall St. J., Nov. 19, 2007, at A1, A17. *See also id.* (former head of exploration and production of Aramco, Sadad Ibrahim Al Husseine, does not believe there are "enough engineers or equipment to ramp up production fast enough to keep up with the thirsty global economy"); *The oil price: Peak nationalism*, The Economist, Jan. 5, 2008, at 10 ("During the 1980s and 1990s, when the price [of oil] was low and so were profits, [the oil industry] pared back hiring and investment to a minimum. Many ancillary firms that buil[t] rigs or collected seismic data shut

barrel per day level needed to meet anticipated demand. Oil and gas companies did not develop their cadres of engineers, geologists, and other skilled workers and, consequently, they now have a limited and aging pool of such employees. Those companies, like their nuclear counterparts, are now scrambling to fill these expected staffing gaps and, in doing so, they have begun a bidding war. For instance, a newly minted geologist can command 48% more in salary today than five years ago, and the average salary of a petroleum engineer ($101,620) is more than 10% higher than their counterparts in nuclear engineering ($92,040).[550]

Indeed, the overall shortage of skilled workers and professionals has been sufficiently dire that, in 2006, "NEI joined forces with the Edison Electric Institute, the American Gas Association, and the National Rural Electric Cooperative Association to create the Center for Energy Workforce Development, which is focusing on developing strategies for utilities to address future personnel shortages."[551]

Moreover, both the nuclear industry and the NRC will be hit by a wave of retirements just as the industry is preparing for new construction. The NEI reports that the industry will need 19,600 new workers just to replace current employees who will be retiring during the next five years, and that non-retirement attrition may require another 6,300 workers.[552] According to the Department of Labor, more than one-third of the nuclear industry's workers will be eligible to retire by 2012,[553] and the NRC is currently losing about 200 employees[554] – or about 6%[555] - per year. Likewise, three-quarters of the workforce at the DOE's national laboratories will be eligible to retire by 2010.[556]

Unless the pool of qualified workers increases, then the NRC, the nuclear power plants, the national laboratories, the nuclear construction companies, and the university-level nuclear engineering departments will find themselves fighting for the same limited group of newly-available employees, and even raiding each other's personnel. (Indeed, this is already happening in nuclear

up shop. Now [that] oil firms want to increase their output again, they do not have the staff or equipment they need").

550. Russell Gold, *A Gusher for Oil Grads*, WALL ST. J., Feb. 21, 2008, at B1, B2.

551. Jenny Weil, *Training reactor operators for new plants a long-lead effort*, NUCLEONICS WEEK, Aug. 16, 2007, at 10 (comment in October 2007 by Andrew Gould, CEO of Schlumberger Ltd.).

552. John Murawski, *A Nuclear Brain Drain*, CHARLOTTE NEWS & OBSERVER, Mar. 9, 2008, at G1; Hiruo, *Workforce Issues*, *supra* note 547, at 2, 3; Jim Snyder, *Nuclear Advocates Try to Clear Obstacles*, THEHILL.COM, Nov. 8, 2007, http://thehill.com/business--lobby/nuclear-advocates-try-to-clear-obstacles-2007-11-08.html.

553. Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, S-07-043, *Digital Instrumentation and Control Workshop*, Sept. 11, 2007 http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2007/S-07-043.html.

554. Roland M. Frye, Jr., *Restricted Communications at the United States Nuclear Regulatory Commission*, 59 ADMIN. L. REV. 315, 328-31 & nn.39-54 (2007).

555. *2007-2008 Information Digest*, U.S. NUCLEAR REGULATORY COMM'N, at 12, Figure 5 (2007-2008), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/v19/sr1350v19.pdf (the NRC's personnel ceiling for fiscal year 2006 was 3270).

556. Klein , *Digital Instrumentation*, *supra* note 553, at *2.

academia.[557]) According to nuclear industry leaders, their industry needs 550 new nuclear engineers each year, but United States schools graduate only 350 annually.[558] And, according to Rany Edington (chief nuclear officer at Palo Verde), the nuclear navy - once a steady supplier of qualified employees to the industry – is drying up because of the smaller number of nuclear submarines today and the large bonuses the Navy pays in order to keep its nuclear submariners.[559] The NEI reports that demand for radiation-protection experts and nuclear engineers "could exceed the supply... by 200 percent and 150 percent, respectively, in the next decade."[560] This gap between supply and demand is driving some companies to offer "signing bonuses" of more than $10,000 to new graduates.[561]

The renovation of Browns Ferry-1 provides an early – and mild – example of the shortage of qualified workers. There, TVA "had to go outside of [the] region to find [the craft] resources, so it was a challenge."[562] Specifically, "TVA identified a lack of craft labor availability within a 400-mile radius."[563] And TVA's Ashok Bharnagar stated in February 2008, that his company intends to use more oversees technical support in its future nuclear construction.[564] Likewise, Palo Verde is suffering from a shortage of workers at all levels and is seeking to hire literally hundreds of new employees.[565]

The industry is taking action to address the problem:

> NEI, in association with utility owners and several state governments, two years ago began to put in programs to train people for the industry, such as recruiting

557. Alison Go, *The New Hot Job: Nuclear Engineering*, U.S. News & World Report, Aug. 14, 2008, http://www.usnews.com/articles/education/2008/08/14/the-new-hot-job-nuclear-engineering.html.

558. Elliott Blackburn, *Tech to Look at Nuclear Education Studies*, LUBBOCK AVALANCHE-JOURNAL, May 10, 2008, http://lubbockonline.com/stories/051008/bus_277602258.shtml (according to the NRC, "[o]nly 25 such programs existed in 2007, down from 38 in the 1970s"); Lewis Page, *Blighty Admits 'National Shortage' of Nuke Engineers*, [UK] REGISTER, June 9, 2008, http://www.theregister.co.uk/2008/06/09/uk_national_shortage_of_nuclear_engineers/ (Great Britain is facing a similar shortfall). The ANS predicts an annual need for 700 new nuclear engineers, but only 249 graduates to fill that need. Alison Go, *The New Hot Job: Nuclear Engineering*, U.S. News & World Report, Aug. 14, 2008), http://www.usnews.com/articles/education/2008/08/14/the-new-hot-job-nuclear-engineering.html. Dr. William Burchill (adjunct professor of nuclear engineering at Texas A&M University and President of the American Nuclear Society) provides slightly less discouraging figures – 470 engineers lost through retirement and attrition, 200 additional nuclear engineers to prepare for the first eight new reactors, and just 413 new nuclear engineering graduates (B.S., M.S., and Ph.D.) annually. Jeffrey Tomich, *Nuclear power's resurgence generates need for engineers*, St. Louis Post-Dispatch, Aug. 25, 2008, http://www.stltoday.com/stltoday/business/stories.nsf/0/56205D53B4BD3552862574B00011674F?OpenDocument; Jenny Weil, *NRC Credits Early Start to Replace Retirees With New Workers*, NUCLEONICS WEEK, Aug. 7, 2008, at 4, 5.

559. Randazzo, *supra* note 544.

560. *Id.*

561. Ray Russell, *Nuclear Necessity*, TAMPA TRIB., Dec. 17, 2007, at BUSINESS 1.

562. Tom Harrison, *Possibility of New Nuclear Units Among Draws for TVA's New CNO*, NUCLEONICS WEEK, July 19, 2007, at 3, 4.

563. *Keystone Report*, *supra* note 8, at 35 *citing* "GE, Toshiba, USEC, Bechtel, Global Fuel Nuclear America, ABWR Cost, Schedule, COL at TVA's Bellefonte Site" at pp. 4.1-2 and 4.1-23 (Aug. 2005).

564. Ashok Bhatnagar, TVA's Senior Vice President of Nuclear Generation Development and Construction, Platts' "Nuclear Energy" Conference, *Expanding Nuclear Power Generation – TVA's Experience* (Feb. 5, 2008), Slide 7, on file with author.

565. Randazzo, *supra* note 544.

> more college students and junior college students. Ideas that have been installed or are being contemplated are ROTC-like scholarship agreements: a utility gives a student a full-ride scholarship, and the student agrees to work at a utility for a set period after graduation.[566]

The industry has also been "collaborating with colleges and universities to establish innovative programs... set[] up internships... [and] offer internal training programs."[567] Exelon is conducting talks with Victoria College (Texas) to provide training for nuclear employees in its anticipated facility, and is working with Texas Governor Rick Perry to provide money for a degree program in nuclear power plant operation at Texas A&M University.[568] In fact, Texas A&M University founded an institute in December of 2007 "to train 2,000 employees for the nuclear plants slated to open during the next decade."[569] Along the same lines:

- STP Nuclear Operating Company has joined forces with a local college (Wharton County Junior College) to establish a program for associates degrees in nuclear power technology;[570]
- Granite Services International (a subsidiary of GE-Hitachi Nuclear Energy) provides a stipend and free tuition to the students in Cape Fear [NC] Community College's associates degree program for nuclear maintenance technicians;[571]
- Entergy and American Electric Power are providing assistance to Lake Michigan College to start its Energy Production Technology Program in the fall of 2008,[572] and Entergy has engaged in similar collaborations with community colleges in Ohio;[573]

566. Michael Kanellos, *Nuclear Power Looks for Comeback in U.S.*, CNETNEWS.COM, Sept. 13, 2007, *available at* http://news.cnet.com/Nuclear-power-looks-for-comeback-in-U.S./2100-11392_3-6207899.html.

567. Ken Silverstein, *Nuclear Jobs*, ENERGYBIZ INSIDER, Sept. 14, 2007, http://www.energycentral.com/site/newsletters/ebi.cfm?id=383. *See also* Keystone Report, *supra* note 8, at 50 n.76 ("One innovative program leverages Department of Labor grants to universities to develop specialized curriculum for use by community colleges in partnership with local nuclear utilities").

568. Editorial, *Exelon offers a Great Future for Victoria*, VICTORIA ADVOCATE [Tex.], Dec. 19, 2007, at COMMENTARY.

569. Joshua Boak, *supra* note 181.

570. *Sieben named nuclear degree program director*, BAY CITY TRIB. [Tex.], Mar. 4, 2008, *available at* http://baycityTRIB..com/story.lasso?ewcd=ec9b4ecbf5f4f72e.

571. John Murawski and Jonathan B. Cox, *Nuclear Revival Bringing 900 Jobs; State Incentives Help GE Hitachi to Commit to a $704 Million Expansion of its Headquarters Near Wilmington*, RALEIGH NEWS & OBSERVER, May 1, 2008, at D1; "U.S. Nuclear Regulatory Commissioner Visits CFCC," CAPE FEAR COMMUNITY COLLEGE NEWS AND EVENTS, May 1, 2008, *available at* http://cfcc.edu/blogs/news/2008/05/01/us-nuclear-regulatory-commissioner-visits-cfcc/?bcsi_scan_513F405096A035F7=0.

572. Lynn Stevens, *Lake Michigan College to Begin Nuclear Tech Program*, BUSINESS REVIEW WESTERN MICHIGAN, May 02, 2008, *available at* http://blog.mlive.com/wmbr/2008/05/art_view_of_palisades_nuclear.html; Melissa Jackson, *LMC unveils nuclear program*, SOUTH BEND TRIB., Apr. 30, 2008, *available at* http://www.southbendTRIB.com/apps/pbcs.dll/article?Date=20080430&Category=News01&ArtNo=804300391&Template=printart.

573. Stevens, *supra* note 572.

- PPL Corporation has teamed up with Luzerne County Community College to establish a nuclear-technical program; [574]
- Southern California Edison Company has established apprenticeship programs at three Southern California community colleges; [575]
- Idaho Energy Complex is working with Idaho State University to train future workers for a possible 1,600-MW nuclear power plant;[576] and
- Duke Energy has helped to create a radiation protection technology program at Spartanburg Community College in South Carolina, with Duke's own nuclear staff teaching the courses.[577] Sixteen students graduated from this program with associates degrees in the Spring of 2008, and 80 are currently on the program's waiting list for the Fall.[578]

The industry is not just focusing on the college and university levels. The nuclear engineering firm Fluor is soliciting high school students within 100 miles of Bay City, Texas with the following offer:

> After graduation, enter Fluor's training program—free of charge—to learn carpentry, welding, electrical work, or another skilled trade. You'll eventually be sent for work and on-the-job training at one of Fluor's other construction projects in Texas: an oil refinery in Port Arthur or coal plant in Oak Grove. When NRG Energy, the company planning the two south Texas nuclear reactors, receives the government go-ahead to start building, around 2010, Fluor aims to bring those workers back to Bay City for specialized nuclear plant training and to start in on the job. The annual pay: $60,000 to $75,000.[579]

Along the same lines, the United States Department of Labor announced in July of this year a $1-million grant to the Pinellas Technical Education Center in St. Petersburg, Florida, to train welders specifically for the nuclear industry[580] and another $1 million grant to Lakeshore Technical College in Wisconsin.[581]

Likewise, the NRC "has been charged by Congress with distributing $15 million to support scholarships, fellowships, and faculty development at

574. Jane M. Von Bergen, *A Jobs Boom is Shaking Nuclear Industry*, PHILA. INQUIRER, Mar. 9, 2008, at C01.

575. *San Onofre Teams Up With Colleges For Employees*, 10NEWS.COM, May 4, 2008, http://www.10news.com/news/16156037/detail.html.

576. Robert J. Taylor, *Nuclear Power Info Meeting Underway*, MOUNTAIN HOME NEWS, June 11, 2008 *available at* http://www.mountainhomenews.com/story/1436262.html.

577. Trevor Anderson, *Nuclear Plant Set to go Online in 2018*, SPARTANBURG HERALD-J., Apr. 22, 2008, *available at* http://www.goupstate.com/article/20080422/NEWS/804220310/1026/NEWS07&source=rss; John Murawski, *Utilities Try to Nab the Best and Brightest*, CHARLOTTE NEWS & OBSERVER, Mar. 9, 2008, at G4.

578. Anderson, *supra* note 577.

579. LAVELLE, *supra* note 547.

580. *Federal Grant to Help in Nuclear Welders' Training*, ST. PETERSBURG TIMES, July 23, 2008, *available at* http://www.tampabay.com/news/business/energy/article735798.ece.

581. Doug Carroll, *LTC goes nuclear with $1 million grant*, Sheboygan Press, Aug. 15, 2008, http://www.sheboyganpress.com/apps/pbcs.dll/article?AID=/20080815/SHE0101/808150472/1973/SHEnational.

colleges, universities, and trade schools."[582] For instance, in late 2007, the NRC provided a $169,000 grant to upgrade teaching equipment for Clemson University's Nuclear Environmental Engineering and Science Program.[583] In January 2008, the NRC announced a $200,000 grant to Denver University for a Masters Program in Environmental Impact Assessment of possible governmental actions in the nuclear arena. And in June 2008, the NRC issued a $128,000 grant to Alcorn State University in Mississippi, for its program in radiation safety education, training, and technology.[584] Other recent recipients include the University of Pittsburgh, Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, Purdue University, Virginia Tech, and Bloomsburg College.[585] But, though student enrollment and graduation rates have increased,[586] one Commissioner still predicts a shortfall.[587]

Even without dispensing funds, the NRC has also been effective in promoting nuclear programs. For instance, in March 2008, the University of Virginia announced its intent to create a minor in nuclear studies – in part due to the NRC's strong encouragement.[588] And, speaking of Virginia, the state's Tobacco Indemnification and Community Revitalization Commission approved, in the summer of 2008, a $7.6-million grant to build a nuclear research center near Lynchburg, Virginia.[589]

2. Component Manufacturing Constraints

According to NRC Chairman Dale E. Klein, a "potential bottleneck is the ability of the global manufacturing sector to meet the growing demand for high-quality nuclear components in a timely way."[590] This problem recently

582. Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, S-08-009, *20 Years Back, 20 Years Forward: Perspectives on Regulating Nuclear Safety*, Mar. 11, 2008, at *3, *available at* http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2008/s-08-009.html.

583. Anna Simon, *NRC Funds to Boost Engineering Program at Clemson*, GREENVILLE NEWS, Oct. 9, 2007, *available at* http://www.greenvilleonline.com/apps/pbcs.dll/article?AID=/20071009/NEWS01/710090420/1004.

584. *Alcorn Gets Funding for Applied Science Program*, CLARION LEDGER, June 12, 2008.

585. *Pitt Nuclear Engineering Program Nets Grants in Federal Effort to Enhance Nuclear Energy Education*, UNIV. OF PITTSBURGH NEWS, Aug. 12, 2008, http://mac10.umc.pitt.edu/m/FMPro?-db=ma&-lay=a&format= d.html&id=3395&-Find; Alexa James, *Feds offer funds for nuke studies: 60 colleges to share $20 million from NRC for programs*, RecordOnLine.com, Aug. 14, 2008, http://www.recordonline.com/apps/pbcs.dll/article?AID=/20080814/NEWS/808140320/-1/NEWS.

586. For instance, Penn State's nuclear engineering program had 44 graduates in 2007, compared with only six in 2000. Jane M. Von Bergen, *A Jobs Boom is Shaking Nuclear Industry*, PHILADELPHIA INQUIRER, Mar. 9, 2008, at C01.

587. Lyons, U.S. - Japan Regulatory Cooperation, *supra* note 411, at *3.

588. Victoria Hinton, *Nuclear studies minor to be created: Faculty Members Have Been Promoting Nuclear Studies Minor for Past Couple Years*, CAVALIER DAILY, Mar. 17, 2008, *available at* http://www.cavalierdaily.com/CVArticle.asp?ID=32804&pid= 1702.

589. Editorial, *Area Will See Benefits From Nuclear Center*, NEWS & ADVANCE, Aug. 4, 2008, http://www.newsadvance.com/lna/news/opinion/editorials/article/area_will_see_benefits_from_nuclear_center/7142/.

590. Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, *The NRC and the "Safety Business,"* S-07-037 (July 17, 2007) http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=072000138.

manifested itself in the renovation of Browns Ferry-1. There, TVA had to search worldwide – from Japan to Brazil – for the necessary components.

This bottleneck exists, in significant part, because the United States nuclear component manufacturing sector has shrunk severely over the last twenty or so years, due to the absence of construction projects. David Crane (chief executive of NRG Energy) described the problem succinctly: "[w]e don't make anything here anymore."[591] Indeed, the number of ASME Nuclear Certificate (N-stamp)[592] holders today is only 20% of the number in 1980.[593] As NRC Chairman Klein has pointed out, "the number of domestic companies supplying components and services to the nuclear industry has declined steadily over the years... from a high of over 1,350 several decades ago to about 700 today."[594] Along the same lines, Richard Goffi, head of Booz Allen Hamilton's public sector energy business, reports that while "[m]ore than 20 years ago, nearly 1,000 facilities in the US built nuclear-grade components... [n]ow there are fewer than 100."[595] Similarly, the NEI "estimates that only about 10 percent of the U.S. manufacturing capacity that existed to build the current generation of nuclear reactors remains."[596] As one example, "BWXT's Mount Vernon facility [is] the only factory in America that can still build large-scale nuclear components."[597] This shortage in the United States manufacturing sector is captured nicely in the following comparison: the DOE concluded in 2005 that the United States had sufficient manufacturing capacity to build eight new reactors between 2010 and 2017,[598] yet as of late 2007, the industry and the NRC were predicting the possible construction of around thirty new plants.[599]

And outside the United States, there is a shortage of manufacturing facilities that can produce the large components (such as reactor vessels[600]) needed for nuclear reactors, and those facilities already have more orders than they can handle. For instance, Japan Steel Works is currently the *sole* supplier of ultra-large forgings for all countries except Russia, has a waiting list of three

591. Keith Johnson, *Schwarzenegger: Nukes Are Great*, WALL ST. J., Mar. 14, 2008, http://blogs.wsj.com/environmentalcapital/2008/03/14/schwarzengger-nukes-are-great/.

592. For a good summary of the American Society of Mechanical Engineers' (ASME) N-stamp program, *see* Jenny Weil, *Nuclear Certificate Requests Are On the Rise, ASME says*, NUCLEONICS WK., Jan. 24, 2008, at 3.

593. Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, *Past, Present, and Future: Reflections on the State of the Nuclear Renaissance*, S-07-050, at 4 (Nov. 15, 2007) http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2007/s-07-050.pdf. *See also Keystone Report*, *supra* note 8, at 35 (400 suppliers and 900 sub-suppliers in 1987, but only 80 and 200 today, respectively).

594. Klein, *20 Years Back*, *supra* note 582, at *4.

595. McNulty, *supra* note 177.

596. Elliot Blair Smith, *New Reactor Costs Daunt U.S. Utilities as TVA Restarts Old Unit*, Bloomberg, July 10, 2007, http://www.bloomberg.com/apps/news?pid=20601109&sid=ag GMCRlWdMyU&refer=home

597. David Whitford, *Going Nuclear*, FORTUNE, Aug. 6, 2007, at 42.

598. Joshua Boak, *supra* note 181.

599. The NRC's list of expected applications can be found at http://www.nrc.gov/reactors/new-reactors/new-licensing-files/expected-new-rx-applications.pdf.

600. "Reactor vessels are 70 to 90 feet high - the size of a 6-story building - and 22 to 23 feet in diameter. They weigh about 60 tons." John Wilen, *How the U.S. Lost its Forging Groove*, BUS. WK., Sept. 18, 2007.

to eight years[601] and, although it is expanding its capacity, can currently supply only four to eight plants annually.[602] This chokepoint problem could be further exacerbated by the fact that Japan Steel also manufactures large forgings for "petrochemical plants and fossil-fueled power plants, so its attention is divided."[603] All these facts need to be considered in light of the prediction that 10-13 reactors will be built annually throughout the world between now and 2025.

Likewise, NEI sees restricted markets for nuclear-grade pipes, gauges and other parts, [and] construction supplies like steel and concrete. Here is a sample of recent price increases for components and materials used in constructing nuclear power plants, provided by Richard Myers, the NEI's vice president of policy development:

Items	Cost Increases 2004 - Jan. 2007	Cost Increases 2003 – 2006
steam generation plants, transmission projects and distribution equipment	25-35%	
Iron ore		60%
steal scrap		150%
Aluminum		200%
Copper		nearly 400%[604]

601. *More forgings for USEPR*, WORLD NUCLEAR NEWS, (July 25, 2007), http://www.world-nuclearnews.org/newNuclear/More_forgings_for_USEPR_ 250707.shtml. *Cf.* Boak, *supra* note 181 (three-year wait for reactor pressure vessels -- the steel container that fits inside a reactor's core); Katherine Ling, *Nuclear Power: As Lawmakers Embrace Reactors, Doubts Remain on Wall Street*, MAIN STREET, GREENWIRE (2007), http://www.eenews.net/Greenwire/2007/07/03/archive/1?terms=%22NUCLEAR+POWER%22 (three-year backlog). *See also* Dale E. Klein, Chairman, U.S. Nuclear Regulatory Comm'n, *Goldman Sachs*, S-08-019, at 1 (May 5, 2007) http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=081270094; Tim Carpenter, *Renaissance for Nuclear Plants May be Nearing,* TOPEKA CAPITAL-J., Oct. 28, 2007, http://www.cjonline.com/ stories/102807/ kan_212916832.shtml ("'Right now,' Klein said, 'the lead time for delivery of reactor vessels is upwards of four years, and other key components have equally long backlogs.'").

602. Ann MacLachlan, *Japan Steel Works boosts capacity for heavy forging to meet demand*, NUCLEONICS WEEK, Nov. 8, 2007, at 1. At the Platts "Nuclear Energy" Conference on February 5, 2008, Yoshitaka Sato (Japan Steel Works' General Manager for Forgings and Castings Export Sales) explained that his company plans to expand its capacity for heavy and ultra-heavy castings as follows:

	2005	2008	2010
Steel Making (tons)	9,000	10,600	13,500
Ultra-large Ingots (pieces/yr)	24	44	65
Large Ingots (pieces/yr)	200	320	460
Capacity for Forgings (units)	4	5.5	8.5

Slide 9 ("Capacity Expansion at JSW"), on file with author.

603. Tyler Hamilton, *Nuclear revival bumps against atrophy*, TORONTO STAR, May 3, 2008, http://www.thestar.com/Business/article/420941.

604. Jenny Weil & Elaine Hiruo, *MidAmerican cancels project as others reassess nuclear option*, NUCLEONICS WEEK, Jan. 31, 2008, at 1, 14. More recently, steel prices rose 40%-50% from the end of 2007 to mid-May 2008, iron ore rose 71%, and both coking coal and scrap metal (two ingredients essential to manufacturing steel) rose 100%. Robert Guy Matthews, *Fast-Rising Steel Prices Set Back Big Projects*, WALL ST. J., May 15, 2008, at C1.

And similarly, here is a sample of recent average annual price increases compared with earlier price increases, as provided by Jack Bailley, the TVA's vice-president of nuclear generation:

Items	Ave. Annual Cost Increases Dec. 2003 - April 2007	Ave. Annual Cost Increases 1986 – 2003
copper	69.2 %/yr	3.3 %/yr
nickel	60.3 %/yr	3.8 %/yr
iron & steel	19.6 %/yr	1.2 %/yr
cement (the raw materials used to make concrete)	11.6 %/yr	2.7 %/yr[605]

One large factor driving the cost increases is the massive construction taking place in India and China (*e.g.*, China uses more than 80% of the world's cement).[606] Another factor is the need for American companies to import many components from overseas, thereby bringing into play unfavorable exchange rates.[607]

Progress Energy recently reported that one of the simulators required for its new units "needs to be ordered approximately 106 months in advance."[608] And with more troubling news, Tony Ward (director of transaction advisory services in the Energy, Chemicals and Utilities Group at Ernst & Young) pointed out a year ago that thirty nuclear reactors are currently under construction globally, and another eighty are in various advanced stages of planning.[609] The shortages discussed above present dual risks of construction delays and cost increases – indeed, some predict that the shortage could as much as double construction expenses.[610]

Indeed, the nuclear industry is already beginning to experience just such an increase in anticipated costs. Warren Buffett's MidAmerican Nuclear Energy

605. Weil & Hirou, *supra* note 604, at 1, 15. According to Steve Tritch, Chairman and recently-retired CEO of Westinghouse Electric Co., the Westinghouse AP1000 design has an advantage over its competitors in that, comparatively, it uses less copper wiring and "about half" the concrete. *Nuclear plant costs rising*, PITTSBURGH TRIB.-REV., Mar. 7, 2008, http://www.pittsburghlive.com/x/pittsburghtrib/business/s_555961.html.

606. John Murawski, *Shearon Harris fire safety is fine, NRC chief declares*, CHARLOTTE NEWS & OBSERVER, Feb. 2, 2008, http://www.newsobserver.com/print/ saturday/business/story/918850.html.

607. Jone-Lin Wang, *Reducing the Carbon Footprint of Electricity*, WALL ST. J. Feb. 13, 2008, at A15.

608. Jenny Weil, *Training reactor operators for new plants a long-lead effort*, NUCLEONICS WEEK, Aug. 16, 2007, at 10. *See also* Brian Lawson, *A 10-year rally has new plants on the horizon*, HUNTSVILLE TIMES, June 8, 2008, at 1C (according to Jack Bailey, the TVA's vice-president of nuclear generation development, "now you may have to order [key components for a nuclear power plant] five years ahead of time, given the competition of world suppliers for equipment and other components").

609. McNulty *supra* note 177.

610. Boak, *supra* note 181.

Company decided in January 2008 to scuttle its investigation into constructing a nuclear power facility in Idaho. MidAmerican explained that the bids for equipment and materials from the prospective contractors were far higher than MidAmerican had expected[611] – presumably a direct result of the bottleneck (supplies are low, so prices rise). Likewise, also in January 2008, South Carolina Electric & Gas temporarily suspended its plan to file a COL application for two AP1000s at its Summer site – citing rising costs of construction materials as the reason for this suspension.[612]

Supply shortages and their accompanying cost increases are not the only problem with component manufacturing. Quality control also poses a challenge. The nuclear industry will need to monitor the quality of the components it receives from all these manufacturers, in order to identify any counterfeit or substandard parts, and the NRC must continue its vigilance as well.[613] And it is not just the large components that require close scrutiny. Of particular concern are smaller parts and materials – *e.g.*, pumps, valves, motors, fans, pipes, and bolts – produced outside the United States.[614] Indeed, the NRC in 2007 investigated two cases of counterfeit circuit breakers and water valves at United States nuclear plants.[615] (This is a matter of greater concern in nuclear plant construction than in the construction of coal and gas-fired plants, because ASME standards are higher and, in many cases, the manufacturing capacity for N-stamp components is less.)

3. Blocked Transportation of Radioactive Material

An increasing number of air and sea carriers are refusing to carry radioactive material (designated under the United Nations dangerous-goods code as "Class 7" material). While this refusal has, until recently, affected primarily

611. Jenny Weil, *Several proposals surfacing to expand nuclear in western US*, NUCLEONICS WEEK, Apr. 10, 2008, at 4; Weil & Hirou, *supra* note 604, at 1, 14; *Company official confirms ID nuclear plant plans scuttled*, CHI. TRIB., Jan. 28, 2008, http://www.chicagoTRIB..com/ news/chi-ap-id-nuclearplant,0,319779.story; Larry Hurrle, *Firm discards nuke plant idea: Mid American says it will end proposal for Payette-area facility*, ARGUS OBSERVER, Jan. 28, 2008, http://www.argusobserver.com/articles/2008/01/28/news/doc479e7b38e 590f997619006.txt.

612. Weil & Hirou, *supra* note 604, at 1, 15.

613. Mark Hibbs, *Nontransparent lines of command adds [sic] to concern about Chinese equipment*, INSIDE NRC, Apr. 28, 2008, at 1; Peter B. Lyons, Comm'r, U.S. Nuclear Regulatory Comm'n, *The Value of Regulation in the Quest for Safe and Secure Nuclear Energy*, S-08-007, at *4 (Feb. 15, 2008) http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=080510137 . *Cf.* NRC Information Notice, Inadequate Implementation of 10 CFR Part 21 Requirements by Vendors Who Supply Basic Components to Nuclear Power Plant Licensees (Dec. 21, 2007), ADAMS Accession No. ML063380232 ("On December 21, 2007, the Commission announced that some suppliers of basic components to nuclear power plants were not properly reporting defects in their products"). ADAMS is the NRC's Agencywide Documents Access and Management Systems database.

614. Jenny Weil, *Industry revisiting emphasis on procurement, quality of parts*, Nucleonics Week, Aug. 14, 2008, at 3, 4; Hibbs, *supra* note 613; Peter B. Lyons, Comm'r, U.S. Nuclear Regulatory Comm'n, *Contributions of Structural Mechanics to the Science of Nuclear Regulation*, S-07-039, (Aug. 13, 2007) http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=072280212; Jenny Weil, *Klein's first year sees restart of Browns Ferry-1, more units on the way*, INSIDE NRC, June 25, 2007, at 1, 15.

615. Weil, *supra* note 614; Rebecca Smith, *Utilities Fret as Reactor - Part Suppliers Shrink*, WALL ST. J., Apr. 11, 2008, at B1.

the shipment of radioisotopes for medical and industrial use, the shipper's refusals are beginning to affect the shipment of natural uranium.[616] For instance, only one port in Australia (one of the world's leading uranium producers) will currently handle shipments of uranium.[617] The problem seems to stem, for the most part, from a combination of ports' unwillingness to satisfy Code 7's complex regulatory requirements and the transporters' unwillingness to jeopardize their ability to transport a complete cargo of which Class 7 material represents only a small portion.[618] Although this problem is currently small and apparently manageable, it may not remain so – given that the growing number of centers for uranium supply and demand will likely be in areas not served by Class 7 transport.[619]

4. Effects of Recent Turmoil on Wall Street

As noted in Section II.F, above, all five remaining Wall Street investment banking houses have recently gone into bankruptcy (Lehman Brothers), or been sold to more-traditional banking entities (Bear Stearns, Merrill Lynch), or converted themselves into bank holding companies (Goldman Sachs, Morgan Stanley). It is too soon even to speculate on what effect this sea change within the financial community will have on the nuclear renaissance – but it cannot be positive.

After all, these were major sources for the loans that the nuclear industry will need in order to pay for plant construction.[620] As one official recently opined, given the recent crisis on Wall Street, "the amount of finance available in the US may be very limited."[621] Likewise, the Secretary of Energy recently opined that "long term projects" such as nuclear reactor construction "are at risk" because they will be "the most difficult to finance."[622]

In fact, the financial turmoil on Wall Street is already beginning to affect the nuclear industry. Constellation Energy was generally considered a strong company, yet it experienced a liquidity crisis due, at least in part, to the credit crunch associated with the fall of the great Wall Street banking houses. Consequently, Constellation nearly went bankrupt in September 2008.[623] And on a more general level, the nuclear industry's opponents are taking advantage of what they perceive as a new weakness. The Friends of the Earth has launched an

616. Ann MacLachlan, *Industry concerned shippers could block revival*, NUCLEAR FUEL, Nov. 5, 2007, at 1.

617. *Id.*

618. *Id.*

619. *Id.*

620. Amena Saiyid, *Wall Street uncertainties may affect US reactor construction, fuel market*, NUCLEAR FUEL, Sept. 22, 2008, at 13.

621. *Id.* at 13. *See also* Rebecca Smith, *Buffett Could Reshape Nuclear Power Industry*, WALL ST. J., Sept. 26, 2008, at B1, B7.

622. Greg Keller, *Financial crisis could dent nuclear plant growth*, WASH. POST (Oct. 1, 2008), http://www.washingtonpost.com/wp-dyn/content/article/2008/10/01/AR2008100102024_pf.html.

623. Rebecca Smith, *supra* note 621, at B1, B7; Matthew Karnitschnig and Rebecca Smith, *Constellation Sticks to Deal with Buffett, Spurns Rivals*, WALL ST. J., Sept. 22, 2008, at B1 (Constellation's CEO Mayo Shattuck III said his company had been "affected by the 'contagion' that spread through the financial markets . . . and was slammed when investors concluded a $2 billion bank credit facility that was supposed to have been put in place by October [2008] might be in doubt").

internet advertisement campaign comparing DOE's loan guarantees to the nuclear industry with the unpopular $700 billion "Wall Street bailout plan."[624]

C. Disasters

1. A Catastrophe at a Nuclear Power Facility Anywhere in the World

A nuclear energy catastrophe could occur because of aging material and equipment. Or it could stem from any number of different self-inflicted wounds. One example of the latter would be "operator error," *e.g.*, the full or partial meltdowns as occurred at Chernobyl or Three Mile Island. Another would be an error such as the one which began the 1975 fire at Browns Ferry, due to a worker carrying a candle.[625] A third example would be a cover-up. For this last kind of self-inflicted wound, consider the near-disastrous incident at the Davis-Besse Nuclear Power Plant where corrosion ate away a football-sized cavity in the head of the reactor pressure vessel and nearly penetrated the vessel's outermost boundary.

Experts have also raised particular concerns about lax construction practices in both China and Russia[626] – each of which is expected to build a large number of nuclear plants in the near and intermediate future.[627] And India has conducted its nuclear engineering in greater isolation from other nations with nuclear power plants, due in part to its lack of external capital, so India has been less able to profit from the nuclear engineering developments in other nations.[628]

Or a catastrophe could take the form of a terrorist attack.[629] The United States General Accounting Office (GAO, now named the Government Accountability Office) issued a report on September 4, 2003, noting that the nation's commercial nuclear power plants were possible terrorist targets.[630] The GAO also issued a subsequent report pointing to risks of attacks on research reactors.[631]

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624. Erika Lovley, *Greens Use Bailout to Go Anti-Nuke*, WFAA, Oct. 1, 2008, http://www.nfmpolitico.com/2008/10/01/greens-use-bailout-to-go-anti-nuke/.

625. J. SAMUEL WALKER, A SHORT HISTORY OF NUCLEAR REGULATION, 1946 – 1999, at 46, NUREG-BR-0175 (Rev. 1, Jan. 2000).

626. Keystone Report, *supra* note 8, at 59-60.

627. *See, e.g.*, Shai Oster, *U.S.-China Nuclear-Power Pact May Shape Technology Standard*, WALL ST. J., Dec. 18, 2006, at A4 (China intends to build as many as 32 nuclear plants by 2020); *Russia plans major nuclear reactor expansion*, TORONTO STAR, Nov. 28, 2006 (Russia plans to build 42 new nuclear power plants by 2030).

628. *Keystone Report*, *supra* note 8, at 60.

629. For a summary of the "scores" of terrorist threats against nuclear power plants as far back as the 1960s, *see* Anthony L. Kimery, *Scare at Swedish Nuke Plant Evokes Concerns Over Security*, HSTODAY, May 21, 2008, http://hstoday.us/index. php?option=com_content&task=view&id=3468&Itemid=128.

630. U.S. GOV'T ACCOUNTABILITY OFFICE, Report No. GAO-03-752, Nuclear Regulatory Commission: Oversight of Security at Commercial Nuclear Power Plants Needs to Be Strengthened (2003). According to the Project on Government Oversight, "a skilled infiltrator would need just 45 seconds to penetrate the area where Peach Bottom stores its spent fuel." Judith Lewis, *The Nuclear Option*, MOTHER JONES, May/June 2008.

631. U.S. Gov't Accountability Office, Report No. GAO-08-403, NUCLEAR SECURITY: Action May Be Needed to Reassess the Security of NRC-Licensed Research Reactors (Jan. 2008). *See also* Matthew L. Wald, *Report Warns of Threat to Campus Reactors*, N.Y. TIMES, Feb. 12, 2008, at 18.

Regarding a terrorist attack, comfort can be taken from the Progressive Policy Institute's 2003 report entitled *America at Risk: A Homeland Security Report Card*. The report gave the NRC an "A" for securing nuclear power plants and even went so far as to suggest that "[i]f anything, the NRC could be faulted for overkill, as nuclear power plants have always been extremely secure, and additional security measures may not be the best use of resources; worst-case scenarios of terrorist attacks on plants or nuclear waste under transport indicate a very low likelihood of collateral injury."[632]

But, a terrorist attack on a nuclear plant would not necessarily have to be physical – it could be electronic.[633] The Federal Government, private cyber-security specialists, and even the financial community[634] have become increasingly concerned about such an attack. The GAO reported in October 2007 that power plants are more vulnerable today than before to cyber-attacks – noting that, in August 2006, two pumps at an Alabama nuclear plant were shut down when excessive computer activity swamped its control system.[635] Moreover, the Oak Ridge National Laboratories discovered near the end of 2007 that hackers "may have infiltrated a database of names, Social Security numbers and birth dates of every lab visitor between 1990 and 2004."[636] This cyber-attack was apparently part of a larger effort to compromise laboratories and other institutions across the country. Two other nuclear-related labs – the Los Alamos National Laboratory and the Lawrence Livermore National Laboratory – were likewise targeted in the attack.

Researchers at the DOE's Idaho National Laboratory conducted an experimental cyberattack and "managed to make a generator self-destruct."[637] More recently, it took a computer security company less than a day to hack into a nuclear power company's computer – at the utility's request, to test its cyber-defenses.[638] And, in May 2008, the GAO released a report finding that the

632. Opsahi, *supra* note 146.

633. According to Melissa Hathaway, senior adviser and cyber coordination executive at the Department of Homeland Security's Office of the Director of National Intelligence, "terrorist groups have . . . expressed the desire to use cyber attacks to target infrastructure." Ben Bain, *Officials talk cyber initiative with industry*, Federal Computer Week, Sept. 15, 2008, http://www.fcw.com/online/news/153789-1.html.

634. According to Neal Westermeyer, chief operating officer for Aegis Technologies, "Wall Street analysts who cover the utility industry will tell you privately they are concerned about investor-owned utilities not going far enough to protect themselves from threats that range from cyber-mischief to cyber-mayhem." Ken Silverstein, *Securing the Grid*, energybizinsider, Sept. 3, 2008, http://www.energycentral.com/centers/energybiz/ebi_detail.cfm?id=559.

635. U.S. Gov't Accountability Office, Report No. GAO-08-119T, Critical Infrastructure Protection: Multiple Efforts to Secure Control Systems Are Under Way, but Challenges Remain, at * 7 (Oct. 17, 2007). *See also* Keith Epstein, *TVA: Vulnerable to Cyberattack*, BUS. WK., May 21, 2008.

636. Duncan Mansfield, *Hackers Get Data of Federal Lab Visitors*, WASH. POST, Dec. 7, 2007, http://www.washingtonpost.com/wpdyn/content/article/2007/12/06/ AR2007120601879.html.

637. Bob Orr, *Cyberthreats rising against electric grid*, CBS NEWS (2007), http://www.cbsnews.com/stories/2007/10/17/tech/main3379028.shtml; Duncan B. Hollis, "E-war rules of engagement: International law needs to be updated to govern the growing tide of cyberwarfare," L.A. TIMES, Oct. 8, 2007, http://www.latimes.com/news/ printedition/asection/la-oe hollis8oct08,1,4193545.story ?coll=la-news-a_section.

638. *RSA 2008: Only you can prevent cyber-attacks*, CONSUMER REPORTS (2008), http://blogs.consumerreports.org/electronics/2008/04/only-you-canpr.html? EXTKEY=I72RSE0. *See also*

"TVA's Internet-connected corporate network was linked with systems used to control power production, and that security weaknesses pervasive in the corporate side could be used by attackers to manipulate or destroy vital control systems."[639]

The Federal Energy Regulatory Commission (FERC) is proposing to require utilities to submit significantly more information regarding their cyber-defenses, and, in early 2008, "approved eight cybersecurity standards for electric utilities... involv[ing] identity controls, training, security 'perimeters,' physical security of critical cyber equipment, incident reporting and recovery."[640] (Oddly, the FERC initially excluded nuclear plants from these standards – an error it subsequently corrected.[641])

There is good news and bad news regarding the vulnerability of United States nuclear power plants to a cyberattack. According to Scott Morris, the NRC's deputy director for reactor security, "[s]afety systems at most nuclear plants are old and based on analog designs that are not vulnerable to attack... [b]ut as the industry moves forward, many of those systems will be replaced with digital."[642] However, at least one hacker has managed to overcome this obstacle. According to *Government Security News*, the NRC confirmed that,

> in January 2003, the Microsoft SQ L Server worm known as 'Slammer' infected a private computer network at the idled Davis-Besse nuclear power plant in Oak Harbor, Ohio, disabling a safety monitoring system for nearly 5 hours. In addition, the plant's process computer failed, and it took about 6 hours for it to become available again.[643]

Another kind of catastrophe that could scuttle the nuclear renaissance would be a serious radioactive release from a plant due to damage from an earthquake, hurricane, or tornado. Nuclear plants in the United States are generally considered to be sufficiently "hardened" to withstand such events, and they do so with regularity (*e.g.*, in 1992, Category-5 Hurricane Andrew struck Florida's

Andy Greenberg, *America's Hackable Backbone*, Forbes, Aug. 22, 2007, http://www.forbes.com/security/2007/08/22/scada-hackers-infrastructure-tech-security-cx_ag_0822hack.html.

639. Brian Krebs, *TVA Power Plants Vulnerable to Cyber Attacks, GAO Finds*, WASH. POST, May 21, 2008, http://www.washingtonpost.com/wpdyn/content/article/ 2008/05/20/ AR2008052002354.html. The GAO Report, entitled "Information Security: TVA Needs to Address Weaknesses in Control Systems and Networks," can be found at http://www.businessweek.com/pdfs/2008/0520_gaodraft.pdf?bcsi_scan_B666A1DE717DB577=0&bcsi_scan_filename=0520_gaodraft.pdf.

640. Ellen Nakashima & Steven Mufson, *Hackers Have Attacked Foreign Utilities, CIA Analyst Says*, WASH. POST, Jan. 19, 2008, at A4. *See also* Esther Whieldon, *FERC seeks to close regulatory gap in cyber security for reactors*, Inside NRC, Sept. 29, 2008, at 7.

641. Esther Whieldon, *FERC to revisit nuclear exemption that made gap in grid cyber security*, NUCLEONICS WEEK, Apr. 17, 2008, at 9.

642. Garry Lenton, *Cyberterrorism/Computer Hackers Put the Nation's Economy at Risk//Guarding Against High-Tech Terroris*, HARRISBURG [PA] PATRIOT-NEWS, Dec. 26, 2007. *See also* Whieldon, *supra* note 640.

643. *State of affairs: Incidents at federal agencies place sensitive information and systems at risk*, GOVERNMENT SECURITY NEWS, Apr. 16, 2008, http://www.gsnmagazine.com/ cms/market-segments/it-security/679.html. *See also* Greenberg, *supra* note 638. According to an NRC spokesman, the two David-Besse computer systems that were affected "are regularly used by plant operators for monitoring pressure and temperature during accidents, but they are not formally considered safety equipment." *Nuke Plants Get Internet Warning*, CBS News (2003), http://www.cbsnews.com/stories/ 2003/05/01/tech/main551852.shtml.

Turkey Point plant without causing radioactive releases). Nuclear facilities in other countries may not, however, be sufficiently strong to withstand such natural disasters. And, as we saw with Chernobyl, relevant dissimilarities between United States and foreign reactors do not prevent a strong domestic anti-nuclear backlash when disaster strikes a foreign facility.

The factor of weather-spawned damage has received far less attention than potential terrorist attacks, so I offer the following collection of "object lessons" from the *Sarasota Herald Tribune* indicating why weather and elevating ocean levels (due to global warming) are also a serious concern:

> In December 1999, in Blayais, France, dikes that protected a nuclear-power facility—and which were designed to exceed 1,000-year storm-surge projections—were breached by exceptional flooding, winds and waves. Two of the plant's four units "were severely affected by incoming water: One of the essential service water pumps was lost as a result of immersion of the motors," the IAEA report stated.
>
> A July 1993 flood on the Missouri River collapsed a levee upstream of the Cooper nuclear power station in Nebraska. Below-grade rooms in the reactor and turbine buildings suffered leakage—a concern because of the damage it can cause to electrical equipment crucial to plant safety.
>
> In June 1998, the Davis-Besse nuclear power station in Ohio was hit by tornadoes, cutting electricity and telephone communication. Bad switches and other problems complicated the start-up of emergency generators, but they eventually functioned until main power was restarted.
>
> Though no radiation dangers resulted from Hurricane Andrew's direct hit on FPL's Turkey Point plant in 1992, wind and debris knocked out power, communications and a firefighting system—bad news, considering that the site also contained large quantities of flammable fuel oil. Some of it reportedly leaked when debris ruptured a storage tank, but no fire occurred. Officials later said one of the lessons learned in the hurricane was that equipment not directly related to nuclear operations can be damaged in ways that potentially threaten vital safety systems.
>
> * * * * *
>
> It's good to know, for instance, that the thick foundations for FPL's Florida nuclear plants—both adjacent to the waterfront—are 18 feet above sea level, but what happens if a 30-foot storm surge washes in, as it did in Mississippi during Hurricane Katrina?[644]

The flip side of this danger is the effects of drought and heat waves (both of which are predicted to result from global warming) on nuclear power plants. Members of the public are raising drought-related issues regarding Duke Energy's pending applications for the Lee Plant in South Carolina (a state that has suffered severe dry spells for five of the last ten years),[645] the two additional proposed reactors at the TVA's Bellefonte plant in Alabama, and Dominion's proposed third North Anna reactor in Virginia.[646] Whether these challenges to

644. Opinion, *FPL's Risky Proposition; Florida isn't Ready for Another Nuclear Power Plant,* SARASOTA HERALD-TRIB., Apr. 9, 2006, at F2.

645. Bruce Henderson, *Questions about consumption, energy,* CHARLOTTE OBSERVER, May 4, 2008.

646. Some existing reactors have faced, or are now facing, this problem. For instance, TVA temporarily shut down one of its three nuclear reactors at Browns Ferry in August 2007 because the river water used to cool it had become too hot. Roger Harris, *Another dry year would hurt TVA's ability to generate power*, Knoxville News Sentinel, Mar. 30, 2008, http://www.knoxnews.com/news/2008/mar/30/another-dry-year/. And Progress Energy warned in 2008 that drought might force the company to shut down its Shearon Harris reactor, due to

the proposed reactors' new cooling systems pass scientific and legal muster remains to be seen – and will likely turn largely on the amount of water the new designs require for reactor cooling.[647]

Any of these catastrophes described above at *any* nuclear power plant in the world could set back the nuclear renaissance in the United States yet another thirty years, or more – depending upon its severity and consequences. As Chairman Klein has said, "[a] nuclear accident anywhere is a nuclear accident everywhere."[648] And, as Senator Tom Carper (D.-Delaware, chair of the Senate's Clean Air, Climate Change, and Nuclear Safety subcommittee) pointed out, "[i]f (a serious accident) happens because of negligence, a lack of attention to detail or inappropriate oversight or inspection, there won't be a nuclear renaissance."[649]

The risk of a nuclear accident in a foreign country is quite real. Many of the countries now building or planning to build nuclear power plants do not have a strong history of industrial safety. For instance, the *Washington Post* recently reported that "[i]n China... thousands die annually in the world's most dangerous coal mines and thousands more in fires, explosions and other accidents often blamed on insufficient safety equipment and workers ignoring safety rules" – yet that same China plans to construct more than thirty nuclear plants by 2020.[650] Another example: according to a report by the Tampere University of Technology in Finland, Asian nations, other than China and India, have an average industrial accident fatality rate of 21.5 per 100,000 workers (compared with the United States' fatality rate of 5.2 people per 100,000).[651] Yet many of these same Asian countries are expressing interest in constructing nuclear power plants.[652]

Another problem with prospective foreign nuclear energy countries is that many are corrupt – a factor that would directly affect both safety compliance and the reporting of safety violations. Consider the following examples reported by the *Washington Post*:

low levels in the facility's cooling lake. *NRC shuts public out of meeting on Progress Energy nuke*, Facing South, Mar. 11, 2008, http://www.southernstudies.org/facingsouth/2008/01/problems-mount-for-southern-nukes.asp. In fact, 24 of the nation's 104 current nuclear reactor units are located in areas currently suffering from drought. Meghan Cooke, *Drought not yet affecting N.C. nuclear plants*, Daily Tar Heal, Jan. 28, 2008, http://media.www.dailytarheel.com/media/storage/paper885/news/2008/01/28/StateNational/Drought.Not.Yet.Affecting.N.c.Nuclear.Plants-3170926.shtml.

647. According to George Vanderheyden (President and CEO of UniStar Nuclear Energy), the proposed new reactor at Calvert Cliffs would "use[] 98 percent less water for the cooling tower than the previous two reactors." Christy Goodman, *Hearings Set on Building Reactor; Opponents Urge Caution in Calvert*, WASH. POST, Aug. 3, 2008, at SM01. *See* Tricia Bishop, *Nuclear Plant Hearing Today; State Makes First Step Toward Constellation Affiliate's Third Reactor at Calvert Cliffs*, BALTIMORE SUN, Aug. 4, 2008, at 1B, available at www.baltimoresun.com/news/local/politics/bal-md.bz.nuclear04aug04,0,2983879.story.

648. Klein, *Past, Present, and Future*, *supra* note 593 at 4,available at http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2007/s-07-050.html.

649. Jeff Montgomery, *Climate Change brings Calls for New Nuke Plants*, THE DAILY J., Jan. 14, 2008, at 9A.

650. George Jahn, *With Nuke Rebirth Come New Worries*, ABC NEWS, Jan. 13, 2008, http://abcnews.go.com/Technology/WireStory?id=4125337&page=2.

651. *Id.*

652. *See supra* note 32.

> China and India shared 70th place in the 2006 Corruption Perceptions Index, published by the Transparency International think tank that ranked 163 nations, with the least corrupt first and the most last. Vietnam occupied the 111th spot, and Indonesia which, like Hanoi, wants to build a nuclear reactor came in 130th.[653]

Carl Thayer, a Southeast Asia expert with the Australian Defence Force Academy, observes that "[c]orrupt officials in licensing and supervisory agencies in the region could undermine the best of IAEA guidelines and oversight."[654]

2. Terrorist Attack Using Nuclear Material, but Not Aimed at Destroying or Damaging a Nuclear Facility

Many other countries' physical security measures are less stringent that those at the United States' facilities. "[T]he essential ingredients required for making a nuclear weapon exist in more than 40 countries, in facilities with differing levels of security [yet] there are still no binding global standards on how to secure nuclear weapons and weapons-grade nuclear material."[655] In Japan, for instance, the security forces tend to be unarmed[656] – a particularly troubling fact, given that a container of iridium-192 (a potential ingredient for a "dirty bomb") was stolen in that country during April of 2008.[657] And, in November 2007, gunmen were *twice* able, in a single night, to break into and escape from a South Africa's Pelindaba nuclear reactor and research center – a site containing "an estimated 25 bombs' worth of weapons-grade nuclear material."[658] The same center had been broken into about two years earlier, when an individual had breached the security fence.[659]

Perhaps the most famous security breach involved not nuclear material but rather nuclear bomb designs. In September 2008, the IAEA released a report indicating that Abdul Qadeer Khan's nuclear smuggling ring "possessed multiple designs covering nearly every aspect of nuclear weapons development" and that many of the ring's documents were digitized, rendering widespread distribution easy.[660]

Even if a terrorist exploded a radiological device, or "dirty bomb," rather than a nuclear weapon, such an attack could so traumatize the public and the economy as to generate a popular outcry against *anything* nuclear. According to Richard A. Falkenrath, the New York Police Department's deputy commissioner for counterterrorism and a former Bush White House homeland security aide:

> Although a dirty bomb spewing nuclear materials would kill far fewer people than an improvised nuclear explosive, the materials could fuse with asphalt and concrete

653. Jahn, *supra* note 650.

654. *Id.*

655. Micah Zenko, *A Nuclear Site is Breached; South African Attack Should Sound Alarms*, WASH. POST, Dec. 20, 2007, at A29.

656. *Keystone Report*, *supra* note 8.

657. ASSOCIATED FREE PRESS, RADIOACTIVE SUBSTANCE STOLEN IN JAPAN (Apr. 9, 2008), http://www.foxnews.com/story/0,2933,348830,00.html.

658. Zenko, *supra* note 655.

659. *Id.*

660. Joby Warrick, *Nuclear Ring Was More Advanced Than Thought, U.N. Says*, Washington Post, Sept. 13, 2008, at A11.

> and prevent access to critical urban areas such as buildings, train stations or tunnels for years, causing a catastrophic economic impact.[661]

Romania, Uzbekistan, Kazakhstan, and Ukraine are doing a poor job in accounting for and securing their radioactive materials, according to Mohamed El Baradei, director-general of the United Nations' International Atomic Energy Agency.[662] And Jay Davis (founding director of the Federal Defense Threat Reduction Agency) would add Russia and Pakistan to that list.[663]

According to a 2007 Bloomberg news report, the IAEA reported 1266 incidents of nuclear smuggling since 1993[664] (a number that, according to Mr. Davis, increased to more than 1300 by March 2008[665]); 252 reported thefts or losses of nuclear material occurred worldwide in 2006;[666] and of those 252, 150 involved "unauthorized possession;"[667] and of those 150, "14 involved criminal activities, including illegal possession, movement or attempts to illegally trade"[668] plutonium or highly-enriched uranium.

More recently, in April 2008, two high-level government intelligence experts testified before Congress that al Qaeda still intends to attack the United States with a nuclear weapon, though the terrorist organization has not yet developed such a device.[669] Likewise, according to William Nye, the United Kingdom's Home Office director of counterterrorism and intelligence, "al-Qaida is actively seeking high-grade uranium and plutonium in order to detonate a "dirty bomb" in major cities such as London or Washington;"[670] and "[s]ince 2001, there have been several attempts to obtain radiological material for use in a 'dirty bomb.'"[671]

661. Spencer Hsu, *Securing the Cities No Easy Task: Developing System for Detecting 'Dirty Bombs' Hits Snags, Criticism,* WASH. POST, Feb. 3, 2008, at A03.

662. Anca Paduraru, *Assessing the Dirty Bomb Threat*, International Relations and Security Network, Jan. 30, 2008, http://www.isn.ethz.ch/news/sw/details.cfm?id=18583.

663. Jay Davis, *After a Nuclear 9/11,* WASH. POST, Mar. 25, 2008, at A15. For instance, according to Lt. Gen. Robert Gard Jr. (senior military fellow at the Center for Arms Control and Non-Proliferation), "Russian police arrested the foreman of a nuclear plant [in 2006] for attempting to sell about 50 pounds of HEU, enough for a weapon." Op-Ed: Lt. Gen. Robert Gard Jr., *Citizen's voice: Nuclear terrorism is a likely event*, Knoxville [TN] News-Sentinel, May 10, 2008, http://www.knoxnews.com/news/2008/may/10/nuclear-terrorism-is-a-likely-event/.

664. RADOSLAV TOMEK & ANDREA DUDIKOVA, NUCLEAR MATERIAL SEIZED BY SLOVAK POLICE WAS URANIUM, Bloomberg, Nov. 29, 2007, http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aDvHmxTgpnz4.

665. Jay Davis, *After a Nuclear 9/11,* WASH. POST, Mar. 25, 2008, at A15.

666. William Kole, *3 in Eastern Europe Accused of Trying to Sell Nuclear Material,* WASH. POST, Nov. 30, 2007, at A19.

667. "U.S. Official: World Must Tighten Security to Avoid 'Dirty Bomb,'" Wall St. J. Online, Nov. 19, 2007, http://online.wsj.com/article/BT-CO-20071119-712016.html.

668. *See* KAREL JANICEK & WILLIAM KOLE, URANIUM COULD HAVE DIRTY BOMB (Nov. 29, 2007), http://abcnews.go.com/International/WireStory?id=3930475&page=1. *See also* John Zarocostas, *Pre-empting a 'Dirty Bomb' Threat; Global Effort Aims to Stop Illegal Nuclear Trade with Terrorists,* WASH. TIMES, Dec. 10, 2007, at A12.

669. Michael Posner, *Intelligence Officers Call Al Qaeda Nuclear Threat Real*, Government Executive, Apr. 2, 2008, http://www.govexec.com/story_page.cfm?articleid=39686&dcn=agencynews_Energy.

670. U*.S. Official: World Must Tighten Security to Avoid 'Dirty Bomb*,' WALL ST. J. ONLINE, Nov. 19, 2007, http://online.wsj.com/article/BT-CO-20071119-712016.html.

671. Zarocostas, *supra* note 668.

And, in March 2008, FARC[672] guerilla fighters turned over to the Colombian government sixty-six pounds of what appears to be degraded uranium.[673] Depleted uranium's level of radioactivity is too low to make it useful as material for a dirty bomb,[674] and there is some speculation that FARC may have been deceived into believing that the material was actually highly-enriched uranium.[675] A computer file seized from FARC suggests that the group had planned to buy and then sell the uranium.[676] But, regardless of whether FARC was scammed, senior United States officials are concerned that FARC is looking for uranium.[677]

And finally, there is yet another form of terrorist nuclear attack: "ingestion, inhalation and immersion (I3) attacks, in which radiation doses are delivered internally or by direct contact with the skin."[678] (Think Alexander Litvinenko.) I3 attacks "can credibly kill [a]n order of magnitude more people than a dirty bomb, are likely to incite considerably more fear among members of the public, and may require a much lower level of technical skill to execute."[679]

D. Death by a Thousand Self-Inflicted Cuts

For the most part, the nuclear industry currently has the public's and the politicians' trust. But if that trust is lost, the renaissance will fizzle and die and nuclear energy will itself likely fade away. Barring a major catastrophe such as the ones discussed above, the most likely way for the industry to lose such trust is to keep making significant and highly visible mistakes. Chairman Klein listed a number of these:

> cooling towers collapsing, corrosion of safety-system piping ... security guards sleeping[,[680] ...] sirens that don't work, emergency diesels that won't run, safety-related valves that don't work, safety-related breakers that don't work, and ECCS sump suction lines full of duct tape.[681]

To which I would add: the cover-up of the near-catastrophic corrosion of the reactor vessel at Davis-Besse, a collapsing cooling tower, a crane dropping a

672. FARC is the Spanish abbreviation for the "Revolutionary Armed Forces of Columbia. *See* Pablo Bachelet, *Uranium Linked to Colombian Guerrillas Raises U.S. Concerns*, MCCLATCHY-TRIB. NEWS SERVICE, Mar. 27, 2008, http://www.mcclatchydc.com/homepage/story/31829.html.

673. *Id;* Chris Kraul, *Colombia Links Rebels to Cache of Uranium: The Material Could Be Used for a 'Dirty Bomb,' Officials Say,* L.A. TIMES, Mar. 27, 2008, at A9.

674. Bachelet, *supra* note 672 (reporting the opinion of Daryl Kimball , the executive director of the nonpartisan Arms Control Association); Josh Meyer, Paul Richter & Greg Miller, *'Dirty Bomb' Plot Unlikely,* L.A. TIMES, Mar. 28, 2008, at A8 (reporting the opinion of Charles Ferguson, a nuclear affairs specialist at the Council on Foreign Relations).

675. Meyer, *supra* note 674; Bachelet, *supra* note 672.

676. Bachelet, *supra* note 672.

677. Meyer, *supra* note 674.

678. Paduraru, *supra* note 662.

679. *Id.,* citing James Acton, Brooke Rogers & Peter D. Zimmerman, *Beyond the Dirty Bomb: Re-thinking Radiological Terror*, 49 Int'l Inst. for Strategic Studies, at 151 (2007).

680. There were twelve such such incidents in 2007. Peter Lyons, Comm'r, U.S. Nuclear Regulatory Comm'n, *Focus on Safety and Security – How We Make a Difference*, S-08-012, at *5 (Mar. 11, 2008), *available at http://adamswebsearch2.nrc.gov/idmws/doccontent.dll?library=PU_ADAMS^PBNTAD01&ID=080720219.*

681. Klein, *Past, Present and Future*, *supra* note 593, at 2.

ninety-seven-ton dry cask of spent fuel, slipshod cyber-security, five years of falsifying fire patrol records, operators regularly working at least 72 hours per week, security guards testing positive for cocaine, and removal/breakage of the firing pins in plant guards' weapons.

A continuing series of such mistakes could slowly ("death by a thousand cuts") kill the nuclear renaissance. Likewise, a loss of trust in the safety of nuclear reactors in a foreign country or in the integrity of that country's nuclear regulators could have a crippling ripple effect in the United States The most obvious example of this is the effect of the Soviet's initial attempt to hide the full extent of the disaster at Chernobyl. Other less-dramatic breaches of trust include operators of a German reactor delaying the announcement of a fire at the plant in the summer of 2007, and the two-month delay in reports of a potentially disastrous partial breakdown of emergency shutdown mechanism at a Bulgarian nuclear plant in 2006 (whistleblowers rather than the operator ultimately informed the public).[682] Commissioner Lyons' own "observation of new plant construction in other countries indicates that there are instances in which subcontractors are not following procedures, are not well supervised, and are not communicating effectively enough."[683]

Finally, a completely different kind of "cut" would be the failure of the first few nuclear plants to be completed on time and on budget. This could kill whatever tenuous trust the industry has built up in the financial community – a trust that (as discussed above) is critical to the renaissance's success.

IV. CONCLUSION

The United States nuclear power industry has risen, phoenix-like, from the ashes of Three Mile Island. The signs of this resurrection are numerous and unmistakable – the current or expected applications to build and operate as many as 34 nuclear power units, to begin or renew dozens of uranium mining operations, and to renew scores of existing plants' operating licenses; the actual or intended completion of partially built reactors that had been abandoned decades ago; the increase in sales of nuclear plants and the companies that own, operate or manufacture them; the creation of a "uranium futures" market within the New York Mercantile Exchange; and similar frenetic activity in many other countries.

The reasons for this nuclear renaissance are both broad and deep: increasing political support (at the national, state, and local levels), increasing public acceptance/support, environmental advantages (greenhouse gases, mercury and other pollutants, future hydrogen-based fuels), economic advantages (potential carbon taxes or cap-and-trade mechanisms, other cost-based advantages over carbon-based fuels, and – possibly – the support of the financial community), and scientific advancements (developments in reactor design, nuclear fuel creation and disposal, refueling, and radiation-resistant material).

And the potential pitfalls for the industry are equally wide-ranging: political (Yucca Mountain, regulatory delays), legal (adjudicatory delays), economic

682. Jahn, *supra* note 650.

683. Lyons, *Focus on Safety*, *supra* note 680, at *6.

(transportation, workforce/component shortfalls), scientific (spent fuel disposal), nuclear-related catastrophes (electronic and physical attacks on a reactor, dirty bombs, natural disasters), and insufficiently committed employees and management (full or partial meltdown anywhere on earth, death by a thousand self-inflicted cuts).

With so many positive and negative variables, the nuclear industry is hardly the master of its own fate. But with money, dedication to detail, and an unwavering effort to earn and retain the trust of all the industry's stakeholders, the industry can at least maximize its odds for success – taking full advantage of the factors contributing to the current renaissance, and minimizing the chances of its derailment.

The word "trust" is indeed key to the success of the nuclear renaissance. In significant part, it was trust in the nuclear industry that enabled it to resurrect itself after nearly thirty years spent largely in suspended animation. And it is trust that keeps the renaissance moving forward – people's, institutions' and governments' trust that the nuclear power providers will continue to protect the public from any nuclear-related mishaps.

But, if that trust is lost, the renaissance will likely lose momentum and die aborning.