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Nuclear Power in New York's Energy Future

Introduction

Nuclear power has been part of New York's energy supply since 1962. Today, six nuclear plants supply about 26% of the state's electricity, but no new units have come on line for twenty years. Concerns about the contributions of coal and natural gas to climate change, as well as about the price of natural gas, have revived interest in New York and around the U.S. in constructing new nuclear power plants.

UniStar Nuclear Energy has applied to the U.S. Nuclear Regulatory Commission (NRC) for a license to construct a 1600 megawatt Evolutionary Power Reactor (EPR) at the site of three existing nuclear plants in upstate New York.[1] However, without more government financial support than is currently available, the UniStar New York unit is not likely to be built.

This paper explores nuclear power's role in New York's energy future. It begins with a review of the current status of nuclear power in New York. It then discusses the current status of nuclear power nationally and internationally, including the potential for renewed nuclear construction in the context of climate change.

This document is not an energy plan for New York. Decisions about any one energy source must ultimately be made in the context of comparative economics, market results and a planning process that allows full consideration of the costs of all alternatives. Instead, this paper suggests some parameters for appraising future nuclear power proposals.

In assessing the role of nuclear power in New York's energy future, one must consider questions of economics, safety, waste disposal and climate change. As to each of these issues, nuclear power has made gains and suffered setbacks in recent years. Within the climate change issue is also the issue of nuclear power's potential overlap with the spread of nuclear weapons, because a worldwide commitment to expanded use of nuclear power involves the spread of nuclear facilities and expertise in ways that could contribute to nuclear proliferation. Because nuclear power in New York is not in itself a proliferation risk, that issue is discussed only in Appendix A.

New York's Existing Nuclear Power Plants

New York has six operating nuclear power plants, as shown in Chart 1.

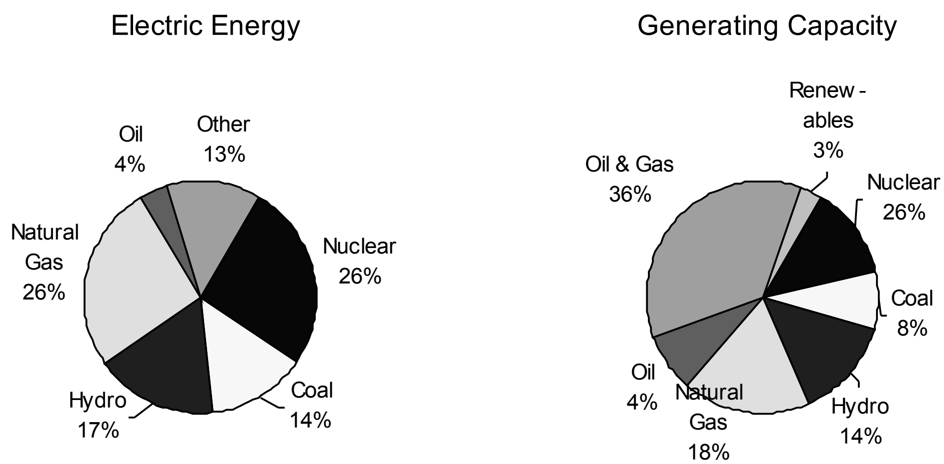
[1] UniStar is jointly owned by Constellation Energy and the EDF Group (formerly Electricite de France). Its purpose is to build the French EPR design in the U.S. Its consortium partners include Bechtel, Areva (the leading French reactor builder), Alstom and Accenture.

Chart 1

Nuclear Power Plant (owner) (location)	**Initial Operation**	**License Expiration[2]**	**Size (MW)**
Nine Mile Point 1 (Constellation Energy) (Scriba)	1969	2029	609
Fitzpatrick (Entergy Nuclear) (Scriba)	1975	2034	838
Nine Mile Point 2 (Constellation Energy) (Scriba)[3]	1988	2046	1148
Ginna (Constellation Energy) (Ontario)	1970	2029	610
Indian Point 2 (Entergy Nuclear) (Buchanan)	1974	2013	1078
Indian Point 3 (Entergy Nuclear) (Buchanan)	1976	2015	1080

The output of these plants represents approximately 13% of New York's electric generating capacity, 26% of New York's power supply (see Chart 2 below) and 11% of the state's total energy consumption.

Chart 2 – New York's Electric Energy Production and Generating Capacity



Despite New York's growth in energy consumption since the last nuclear plant was added twenty years ago, nuclear power's share has remained constant. This is due to more efficient operation as well as the output increases approved by the NRC for all of the New York units except Nine Mile Point I.

[2] All of the New York nuclear units except the two at Indian Point have received 20 year license extensions from the NRC. Indian Point extension applications are under review at the NRC but are opposed by New York State.

[3] Eighteen percent of Nine Mile Point 2 is owned by the Long Island Power Authority. The plant has been given permission for a 154MW increase in output by the Nuclear Regulatory Commission. Upon completion (scheduled for 2012), the plant output will be 1302MW.

The efficiency increases are particularly noteworthy, and are consistent with improved nuclear plant operation nationally. In 1990 the U.S. nuclear fleet ran for 70% of the hours in the year but reached 91.8% in 2007. This represents the approximate equivalent of adding 20 nuclear plants nationally (or one in New York) during that period.[4] This upward trend cannot continue much longer, because nuclear plants must periodically be closed for refueling and maintenance. Even the best run plants will not exceed a 95% capacity factor on an extended basis.

New York also cancelled several nuclear plants at various stages of construction. The best known was the Shoreham plant on Long Island, sold to the Long Island Power Authority for $1 in 1989 and decommissioned after being completed over a span of 20 years at a cost in excess of $5 billion. Six other units were also cancelled during the 1970s and 1980s. In addition, Unit 1 at Indian Point was permanently closed in 1974.[5] New York's nuclear construction experience mirrors that of the nation, with U.S. utilities having cancelled as many plants as they completed.

Nuclear Power and New York's Climate Change Profile

Because nuclear power plants do not emit greenhouse gases, they reduce New York's contribution to climate change relative to scenarios in which they are replaced by coal or, to a lesser degree, by natural gas.[6]

Twenty-four percent of New York's greenhouse gas emissions came from its electric sector in 2006. For the entire U.S., the comparable figure is 33%. As of 2006, the state's emissions had declined by 10% compared to 1990 levels. A 2.4% increase from the transportation sector was offset by significant declines in the electric (23.7%) and industrial (29.6%) sectors.[7] Displacement of coal - through increased output from the six nuclear plants as well as substitution of natural gas for coal - was the primary reason for this improvement.

For the future, New York has made three significant commitments to courses of action that will lead to further reductions:

- The Regional Greenhouse Gas Initiative (RGGI) commits the member states to stabilize greenhouse gas emissions from the electric sector for the years 2009-2014 and to reduce them 10% by 2018.
- The state in early 2007 committed to a "15 X 15 plan", a 15% reduction in projected electricity usage by 2015. This is equivalent to a 4% reduction from 2007 levels[8] and would defer the need for some new generating capacity while helping to meet the RGGI goal.

[4] Some ten plants were permanently closed during the same time period, so the net gain is equivalent to about ten plants.

[5] Other nuclear plant proposals were abandoned at early stages. For example, Con Ed in the early 1960s intended to build six nuclear plants at Indian Point plus one at Ravenswood in Queens and another at Davids Island off New Rochelle. The siting policies of the Atomic Energy Commission precluded a unit in New York City, so Ravenswood was built as a coal plant. The rapidly increasing size of nuclear units in the 1960s meant that units 2 and 3 at Indian Point had as much capacity as the five additional units planned for the site a decade earlier.

[6] Greenhouse gas emissions from the nuclear fuel cycle (mining, processing, enrichment and transport), though not trivial, are small in comparison to coal and gas fired plants of comparable size, especially if the uranium enrichment is performed in modern enrichment plants.

[7] Statistics from "Patterns and Trends: New York State Energy Profiles 1992-2006, New York State Energy Research and Development Administration, January, 2008 (Table A-1, page 50).

[8] See "Power Trends 2008", New York Independent System Operator, Figure 2.2, p. 7.

- New York has adopted a Renewable Portfolio Standard (RPS) that requires 25% of the state's electricity to come from renewable resources by 2013, an increase of some 5% over current levels. These renewable resources coupled with the energy efficiency undertaken pursuant to the 15 X 15 program will meet some of the energy and environmental needs of the next few years. *Nuclear power is not considered to be a renewable resource for purposes of the RPS.*

<u>The New York Power Supply Selection and Financing Process</u>

All of the nuclear power plants built in the U.S. were ordered at a time when electric utilities owned and controlled everything from the power plant to the customer's meter. The utilities served a territory to which they held a state-granted monopoly. When demand forecasts led a utility to believe that new capacity was needed, it sought approval for the new plant from the state. If no imprudence occurred during construction, the cost of the plant was recovered from the monopoly customers.

In 1978, a time when widespread public disillusionment with rising power prices was driven in part by the price of fossil fuels and in part by the cost of nuclear construction, Congress passed the Public Utilities Regulatory Policy Act (PURPA). PURPA required for the first time that utilities buy power from any seller who would offer it for less than the utility's own estimated cost of generating it.

PURPA unleashed a flood of independent power production, ending the era in which the generation of electric power was part of the utility monopoly and opening the door to merchant generators. In time, all of New York's nuclear plants were acquired by such generators.

In the mid-1990s, New York went through a process known as electric restructuring, which established a power market under the oversight of the New York Independent System Operator (ISO). As a result, customers are allowed to buy from the supplier of their choice. Generators get paid almost entirely on the basis of the power that they deliver, and investors no longer have their profits confined to a "fair rate of return" determined by regulators.

This restructuring shifted the risk of cost overruns, poor performance, declining demand or declining costs of alternatives largely from the customers to the investors. Financing nuclear power plants, which had suffered each of these problems in the 1980s and 1990s, became unacceptably risky. *No new nuclear power plant has been bid into such an open, competitive power market anywhere in the world.*

However, the existing nuclear plants have thrived under this framework. They have low operating costs compared to the gas-fired units that determine the price paid to all generators in the new markets. As part of the bargain leading to electric restructuring, much of the capital cost of building these nuclear plants was detached from the competitive power market and added to the monopoly distribution systems as a "nonbypassable" fee. These capital costs need not be recovered in the power market, but the construction costs of new nuclear units enjoy no similar protection. This fact explains investor enthusiasm for expanding the existing units and extending their lives even as the same investors shy away from new construction.

A new unit such as the one proposed for New York by UNISTAR would have to recover not just its operating costs but its total costs from the competitive power market. Current cost estimates for new nuclear units suggest that this will be very difficult.[9] For this reason, UNISTAR has stressed the importance of federal loan guarantees to support the building of new nuclear units in restructured power markets by shifting risks of economic loss from investors and lenders to taxpayers.[10] Current federal loan guarantee authorization is enough for no more than five plants. Because these guarantees are likely to be distributed among several advanced reactor designs it seems unlikely that UniStar's EPR will get guarantees for any project other than its flagship Calvert Cliffs plant in Maryland.[11]

New York's Power Plant Siting Process

For many years, New York had a centralized power plant siting process under which the basic review and approval was by the state power plant siting board, chaired by the Chairman of the Public Service Commission and including the Chair of the New York Energy Research and Development Authority, the Commissioners of the Departments of Health, Economic Development and Environmental Conservation and two public members appointed by the governor. However, this law lapsed in 2002 and has not been renewed despite urgent requests from the New York ISO.[12]

Consequently, a new power plant today will not enjoy a centralized review that can preempt many aspects of local jurisdiction. Instead, the plant will undergo state level review under the State Environmental Quality Review Act and will have to obtain all necessary local permits. Unlike the lapsed process, individual municipalities will have the power – by denying local permits – to stymie a project.

Neither the state nor any local jurisdiction can regulate on site radiation health and safety matters involving nuclear power plants. Federal law reserves that topic to the NRC, and federal courts have repeatedly rebuffed state efforts to perform this function. However, states do have the power to prevent the construction of new nuclear plants on other grounds. For example, states can prohibit new nuclear plant construction until a permanent waste repository exists. California's power to take this position on general energy policy grounds was affirmed by the U.S. Supreme Court.[13] This decision made clear that the preemptive features of the Atomic Energy Act are not to be read broadly, and that traditional state prerogatives as to energy policy, economics and land use are not preempted. California's position has since been followed by some 11 other states.

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[9] The EPR design being proposed by UNISTAR for New York is now under construction in Finland, where it is more than two years behind schedule and $1.5 billion over budget. Because the builder, Areva, agreed to a fixed price contract, the conditions that it faces bear some resemblance to New York's competitive market. Areva has announced substantial write offs. A second EPR unit has commenced construction in France.

[10] "'Without the (federal) loan guarantees, there is no nuclear', says George Vanderhyden CEO of Unistar Nuclear Energy", Public Utilities Fortnightly, February 2008, p. 19.

[11] Constellation is in the process of being taken over by MidAmerican Energy Holdings Co. In a recent filing with the Maryland Public Service Commission, MidAmerican affirmed its support for Constellation's commitment to prioritize the development of a new nuclear unit at the company's Maryland nuclear power plant site over the development of a nuclear facility at any other site.

[12] See for example Powertrends 2008, New York ISO, pp 3, 26.

[13] *Pacific Gas & Electric Company v. State Energy Resources Conservation & Development Commission,* 461 U.S. 190, 103 S. Ct. 1713 (1983).

New York's Need for New Power Plants

With the development of competitive power supply markets, responsibility for meeting customer demand no longer rests with vertically integrated utilities. Instead, general forecasts are prepared by the New York ISO, but the ISO does not choose particular locations or technologies. That choice is left to private developers, who may contract with distribution companies or with customers for the output of their plants. They may also sell the output into the power market.

Electricity prices in New York (especially downstate) have historically been among the highest in the mainland U.S. The reasons for this have included high property taxes on utility plant, distance from fuel supplies, and high historic nuclear construction costs.

Electricity demand growth in New York has averaged about 1% per year for the last 15 years and is expected to continue at this level. Upstate growth has been nonexistent, whereas downstate growth (especially New York City and Long Island) has exceeded 2%. The New York ISO forecasts a likely need for new generating capacity in the on the order of 500MW in 2012 and growing to 2700 MW by 2017, driven primarily by downstate load growth and by power plant retirements [14]

This need for new supply and greater end use efficiency will be considerably larger if one or both of the Indian Point nuclear plants are not relicensed. A National Research Council study completed in 2006 indicated that these units could be replaced without causing power shortages if planning and construction of alternatives were promptly undertaken.[15] Under the RGGI regime, overall CO2 emissions would not be allowed to rise even if the Indian Point units were closed, but additional emission credits would have to be purchased to offset any resulting increases in emissions.

Nuclear Power in the United States

Nuclear power generates some 19% of the electricity in the United States. However, no new plants have been ordered since the mid-1970s. The costs of cancelled plants and multibillion dollar cost overruns led to large electric rate increases and tumultuous political opposition.[16] Even large industrial customers – traditional utility allies – became skeptical of nuclear power. Forbes

[14] Powertrends 2008, New York ISO, page 16. But see more recently Rebecca Smith, "Surprise Drop in Power Use Delivers Jolt to Utilities" Wall Street Journal, November 21, 2008, noting "An unexpected drop in U.S. electricity consumption has utility companies worried that the trend isn't a byproduct of the economic downturn, and could reflect a permanent shift in consumption that will require sweeping change in their industry. Numbers are trickling in from several large utilities that show shrinking power use by households and businesses in pockets across the country. Utilities have long counted on sales growth of 1% to 2% annually in the U.S., and they created complex operating and expansion plans to meet the needs of a growing population."

[15] "Alternatives to the Indian Point Energy Center for Meeting New York's Electric Power Needs", National Research Council, 2006.

[16] Some nuclear industry spokespeople blame this history on the nuclear licensing process and on environmental opposition. More balanced reviews suggest that the U.S. industry grew too fast in the 1960s and 1970s, that many new capital-intensive plants were under construction during a time of very high inflation without having had time to incorporate the lessons of operating experience in their design. See, for example, Irvin Bupp and Jean Claude Derian, Light Water: How the Nuclear Dream Dissolved, (Basic Books, 1978)

magazine proclaimed in 1985 that "The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale."[17]

Because nuclear power costs have been higher than those of various combinations of alternatives, the U.S. need for electricity has been satisfied without new nuclear construction. Renewable energy other than hydroelectricity has played a minor nationwide role to date, but recent growth rates have been substantial. Wind energy and biomass have added several thousand megawatts to the grids of California, Texas and the Midwest. Even large scale solar electricity is becoming competitive in some parts of the country.

Since mid-2007, the NRC has received applications for 26 new units. It anticipates another nine by the end of 2010.[18] In addition, the NRC has approved three advanced reactor designs for future construction and has several others under review.[19]

Federal Support for New Nuclear Plants: The Energy Policy Act of 2005 contained substantial incentives for a few new nuclear plants. The most important provisions offer three types of support. The first provides for federal loan guarantees, increased to $18.5 billion in 2007. Second, a limited number of new nuclear power plants can receive a 1.8¢/kwh production tax credit.[20] The third benefit provides up to $500 million in risk insurance for the first two units and $250 million for units 3-6. This insurance is to be paid if delays not the fault of the license applicant slow the licensing of the plant.

These provisions lower the price of nuclear power without lowering its cost, at least not for many years. This occurs because some of the costs and risks are moved out of the price charged to customers and onto the taxpayers. For example, the production tax credit deprives the U.S. treasury of funds that must be made up from other sources. Whether the benefit flows through to customers or is retained by investors will vary with the economic regulatory approach used, but either way prices can be kept lower than would be the case if the credit did not exist. Similarly, the loan guarantees assure lenders of repayment no matter what happens at the power plant. Essentially, their loans are converted into government obligations. This lowers both the interest rate and the amount of more expensive equity capital that must be raised, but it does so by shifting risk to taxpayers and is therefore not a societal saving of the sort produced by a decline in the cost of steel or cement.

In addition to the financial support, the federal government has eased the path for new nuclear units in other ways. The nuclear power plant licensing process has been modified to provide for approval of both designs and sites in generic proceedings, so that a preapproved design can be referenced in the application for a particular site, minimizing litigation risk as to most aspects of the design and siting at the time that the actual site is announced for a particular design. Furthermore, the former process – in which a construction permit was issued before construction but a far more detailed operating license review took place after the plant was nearly finished – has been replaced by a single licensing proceeding to be held before construction commences. In

[17] James Cook, "Nuclear Follies" Forbes Magazine, February 11, 1985, p. 82.

[18] The pacing and total number of these applications is likely to be affected both by the extent of federal support and by the impacts of the ongoing economic crisis.

[19] The NRC's schedule for review of the Constellation EPR design calls for a decision in 2011. The Nine Mile Point project in New York is scheduled for a licensing decision in 2012.

[20] This production tax credit, which approximates the credit available for wind power, is available to the first 6 GW of new nuclear power over the next eight years and is to be divided among the eligible plants. So if 12 GW worth of new plants meet the criteria each one would get the credit only as to 500 MW.

addition, the NRC has modified its procedural rules to make the raising of contentions more difficult and rule out cross-examination and discovery in all but exceptional circumstances.

Despite all of these measures, the potential rate impact of new nuclear plants is substantial (see chart 3).

Chart 3 – Relative per kWh costs of new nuclear, coal and gas, from 2003 MIT study "The Future of Nuclear Power". More recent estimates are considerably higher for all sources.

Base Case	25 Year	40 Year
Nuclear	7.0¢	6.7¢
Coal	4.4¢	4.2¢
Gas (low, $3.77MMBtu, levelized over 40 years)	3.8¢	3.8¢
Gas (moderate, $4.42MMBtu)	4.1¢	4.1¢
Gas (high, $6.72 MMBtu)	5.3¢	5.6¢
Gas (high w. 10% plant efficiency gain)	4.9¢	5.1¢

Furthermore, cost estimates have escalated dramatically in the five years since the MIT study. A 2007 Keystone fact-finding report estimated the cost of a new nuclear unit at between 8.3 and 11.1 cents/kWh ($3600-$4000 per kW or $3.5- $4 billion per 1000 MW).[21] In October, 2007, a Moody's analysis upped this estimate to $5000-$6000 per kW. In 2008, utilities seeking approvals from regulators in three southern states have submitted testimony containing estimates on the order of $6500 to $7,000 per kW. These estimates remain well above the projected cost of new conventional coal plants and even the upper end of projected price ranges for gas-fired plants. They are also far above existing costs of generation in New York.

State Support for New Nuclear Plants: Several southern states have undertaken to facilitate nuclear construction by assigning more of the risks to the customers. Thus Florida, the Carolinas and Mississippi – all states that did not follow the electric restructuring path chosen by New York – have passed laws allowing utilities to seek an early determination of the prudence of the decision to build a nuclear plant. Once such a determination has been made, the utility is assured of recovery of costs not found imprudent by the regulators. The prudence reviews are not likely to be as thorough as those undertaken during the last round of nuclear construction.[22] Furthermore, this cost recovery is assured even if the plant is later cancelled, another departure from the allocation of risks under traditional utility regulation.

Despite nuclear power's high costs, the federal and state support outlined above – combined with other benefits recently conferred on the industry such as the 20 year extension of the law limiting

[21] Keystone Center "Nuclear Power Joint Fact Finding", June 2007, www.keystone.org/spp/documents/FinalReport_NJFF6_12_2007(1).pdf

[22] For a detailed examination of the ways that these laws shift risk from investors to customers, see testimony of Peter A. Bradford, filed April 16 at http://www.psc.state.fl.us/dockets/cms/docketFilings2.aspx?docket=080148.

nuclear power plant exposure to liability for the costs of a serious accident[23] - has substantially increased the likelihood of a few U.S. nuclear power plant orders.

The significance of new nuclear orders under these risk shifting approaches for the long term future of nuclear power is uncertain. Plants ordered today will not be licensed by the NRC before 2011 and will not be online before 2016, at the earliest. They will have to operate competitively for a few years before their performance can inspire the confidence needed for a fleet of privately financed orders based on principles of standardization.

An approach more compatible with electric restructuring and with conventional economic theory would put a comprehensive price on the carbon dioxide emissions that are a major contributor to climate change. Such a step would improve nuclear power's prospects in comparison to coal or natural gas (in the absence of carbon sequestration) but not in relation to energy efficiency or noncarbon electric energy sources. It would also encourage CO2 reductions from sectors other than electricity, where the reductions might (or might not) be less expensive.

If New York wanted to promote nuclear construction at the state level independently of national climate change policies, the state could

- offer loan guarantees of the type now offered by the federal government.
- adopt legislation like that passed in the aforementioned southern states.
- assign nuclear power a place in the state's renewable portfolio standard or otherwise assure a market for new nuclear units regardless of their cost (by, for example, having the New York Power Authority build such units or sign open-ended contracts for the power.

In each of these situations, the risks that investors have proven unwilling to bear would be assigned to the state's taxpayers or to its electricity customers, reversing the economic theory that the state embraced in its electric restructuring decisions a decade ago.

Nuclear Power Elsewhere in the World

As Charts 4 and 5 show, nuclear power is not growing rapidly elsewhere in the world, and especially not in the West. The plants under construction (and the capacity increases) netted against the plants scheduled to be shut down suggest that nuclear power will post a net gain of about 5 GW per year for the next five years, barely enough to retain its existing share of the world electricity market

Chart 4 – Rate of Growth in Worldwide Nuclear Capacity

[23] The industry asserts that without this limitation on liability no new plants would be built. However, General Atomics, a would-be vendor of the Gas Turbine Modular Helium Reactor, testified in 2005 that this limit was a disincentive to safety and should be phased out. Congress's subsequent reenactment of the law means that the GT-MHR gains no economic advantage from the safety features that made it willing to assume full exposure to potential accident costs.

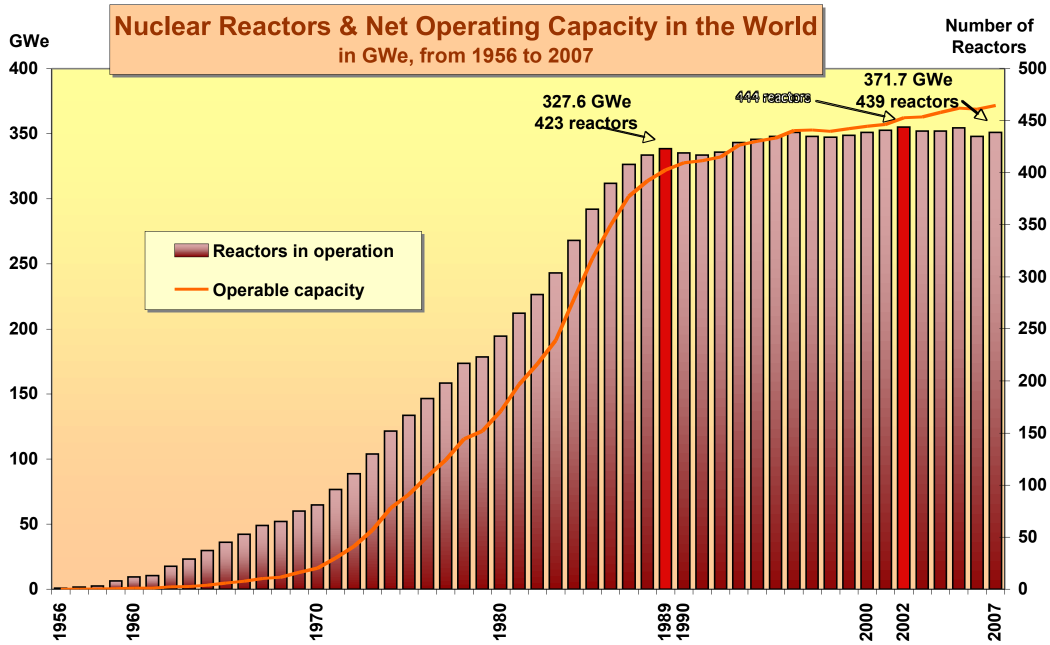

Chart 5 – Nuclear Power Capacity and Growth in Selected Countries

Country	Nuclear capacity GW (plants)	Percent of electric production	Plants under construction
United States	100.3 (104)	19	1
France	63.3 (59)	79	1
Great Britain	11.0 (19)	18	0
Japan	47.6 (55)	34	1
Russia	22 (31)	14	7
Canada	12.6 (18)	13	0
Germany	20.3 (17)	29	0
South Korea	17.5 (20)	40	3
India	3.8(17)	03	6
Ukraine	13.1 (15)	48	2
China	8.6 (11)	02	5
World total	372 (439)	16	34

Three important conclusions emerge from this international picture:

1) For nuclear power to make a significant additional contribution in combating climate change, a dramatic increase in the pace of nuclear construction would have to occur. But such a dramatic increase is at least a decade away because the industrial and the manpower infrastructure needed to support it does not now exist. Manufacturers certified to undertake the high quality manufacturing required by nuclear safety systems no longer exist in large numbers. In some bottleneck areas like heavy forgings, there are only one or two qualified plants in the world.

Furthermore, there is already a shortage of trained personnel for existing nuclear power plants and manufacturing facilities.[24]

2) Only government intervention on a massive scale could channel the necessary financial resources to nuclear power. The energy policies of a single U.S. state – even one as significant as New York – will not be of much importance.

3) For reasons discussed in Appendix A, world energy policies designed to favor nuclear power will pose daunting challenges in the context of nuclear weapons proliferation. These challenges have nothing directly to do with New York's energy policies, but they are an inescapable part of treating expanded nuclear power as an essential part of the world's response to climate change.[25] Curing defects in the international safeguards system will need to be addressed in advance of any such national or international policy priority.

Climate Change and the Economics of Nuclear Power

Nearly 8% of the world's CO2 emissions come from the coal fired portion of the U.S. electric power sector, with another 2% coming from U.S. natural gas and oil-fired plants. In total, the U.S. contributes 24% of the world's CO2 emissions. So reducing U.S. CO2 emissions is crucial to stabilizing the climate. A broad consensus now exists that stabilizing emissions over the next 50 years requires substantial reductions starting promptly. Therefore, technologies that already exist and can be rapidly expanded are likely to be given the highest near-term priority.

A study by Princeton professors Stephen Pacala and Robert Socolow introduces the useful concept of a "wedge," defined as any measure that would, over the next 50 years, lead to a global reduction of 25 billion tons of carbon dioxide emissions relative to business as usual. The number of wedges that will be required to avoid dangerous climate change will depend on many factors. Under optimistic assumptions, some seven wedges will be needed; this number could increase significantly under less optimistic assumptions.[26]

The study provides a list of fifteen measures from technologies to public policy initiatives that exist today and could be scaled up to become one or more wedges. Energy efficiency and conservation comprise three wedges. Alternatives to gasoline-powered transportation account for another four. Increasing natural sinks provides two wedges. Generating electricity in less carbon intensive ways contributes four wedges. *Of the latter, at most one wedge would be contributed by a world-wide tripling of nuclear power.*[27]

This point is reinforced by other work. The 2003 MIT study notes that 1000 GW of nuclear power worldwide in 2050 would displace about 14% of the carbon equivalent emissions in that

[24] See, for example, Rebecca Smith, "Utilities Fret as Reactor Part-Suppliers Shrink", Wall Street Journal, April 11, 2008, p. B1.

[25] See for example Sharon Squassoni, "Mapping Global Nuclear Expansion" November, 2007, http://www.carnegieendowment.org/static/npp/nuclear_expansion_maps.pps

[26] "A Plan to Keep Carbon in Check", by Robert Socolow and Stephen Pacala, Scientific American, September 2006, p. 50. See also "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies" S. Pacala and R. Socolow, Science, 13 August 2004, pp. 968-972. http://fire.pppl.gov/energy_socolow_081304.pdf.

[27] See Kurt Gottfried and Peter Bradford "Nuclear Deficits", TomPaine.com September 15, 2006, http://www.tompaine.com/articles/2006/09/15/nuclear_deficits.php. A tripling of nuclear power achieves a wedge only if it displaces coal. To the extent that it displaces natural gas or large hydro (as it might in China), a tripling is not sufficient for a wedge.

year, assuming that it displaced only coal and that no carbon sequestration would have occurred.[28] Using a different basis, Robert Williams estimates that if 2700 GW of nuclear power were replaced entirely by coal in 2100, emissions of greenhouse gases would rise by 20% and that if all projected coal power in 2100 were displaced by 4900 GW of nuclear power greenhouse gas emissions would fall by 20%.[29]

A tripling of nuclear power over the next fifty years is not just a formidable economic and infrastructure challenge. It would also require that uranium mining, enrichment and spent fuel disposal be undertaken on scales not seen before. Uranium mining – an activity that itself has a legacy of serious environmental and health damage in the U.S. – would have to scale up substantially as well, though the short term needs could be met through continued or accelerated downblending of uranium from nuclear warheads. Moreover, the U.S. alone would eventually need several permanent waste repositories of the same size as the one that it has been unable to site.

In short, nuclear power is not a "silver bullet" answer to climate change.[30] Its potential contribution does not eliminate the need for major contributions from many other sources of greenhouse gas reduction. This is particularly true given the inevitable slowness involved in scaling up this technology. Because the current pace of net nuclear capacity addition is so far below the 19 GW per year that a trebling over 50 years requires, the pace of new construction in the later years of the 50 year period would have to be breathtaking in comparison to anything achieved to date.

A more realistic prospect would involve keeping nuclear power at somewhere near its present 20% share of U.S. electric demand. This would contribute to climate stabilization in itself (though perhaps not economically), since replacement of the existing nuclear power plants with coal as they are retired would be a negative tenth of a wedge. This level of new plant construction will be attainable if the first new plants are built and operated safely and at economically competitive costs over the next two decades and other low carbon technologies prove to be inadequate.

Nuclear Waste

Each nuclear power reactor produces several hundred tons of spent fuel over its operating lifetime. The spent fuel contains highly radioactive isotopes, some of which decay quickly but some of which require many thousands of years to become harmless.

Almost all of the fuel extracted from all U.S. reactors remains in temporary storage at the reactors, awaiting the opening of a permanent repository. Storage and disposal have been a source of concern and a major technical challenge since the dawn of the civilian nuclear power

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[28] The Future of Nuclear Power, p. 3.

[29] See Robert Williams, "Nuclear and Alternative Energy Supply Options for an Environmentally Constrained World: A Long-term Perspective" in Nuclear Power and the Spread of Nuclear Weapons: Can We Have One without the Other, Paul Leventhal, Sharon Tanzer, Steven Dolley, eds, (Brassey's Inc., Dulles, Va., 2002), p. 88..

[30] The "silver bullet" scenario has been a recurring theme in nuclear revivalist literature. See, for example, "It's Scary. It's Expensive. It Could Save the Earth", National Geographic, April, 2006 and "Nuclear Now: How Clean, Green Atomic Energy Can Stop Global Warming", Peter Schwartz and Spencer Reiss Wired Magazine, February 2005

program in the 1950s in part because of the radiation and in part because plutonium can be used to make nuclear weapons. No country has yet established a permanent nuclear waste repository.

In 1982, Congress enacted the Nuclear Waste Policy Act, which mandated that spent fuel be disposed of in a geological repository which was to commence operation no later than 1998. This law levied a charge of one-tenth of a cent per kilowatt hour on all nuclear power plant output to pay for the eventual repository. Total electric customer payments and obligations in the fund exceed $25 billion, of which New York's share in mid-2007 was $1.8 billion.

Until November 2004, the schedule for a Yucca Mountain repository called for the Department of Energy to submit a complete license application to the NRC in December 2004 and for the repository to begin accepting waste in 2010. However, in December 2004 DoE announced that the deadline for license submission would not be met. An application was finally submitted to the NRC in June, 2008.

In August 2006 DoE announced a new repository opening target date of 2017, calling it "the best achievable date". More recently, DoE spokespeople have set 2020 as the opening date, but President-elect Obama is opposed to opening Yucca Mountain at all. Overall, the date of repository operation has slipped more than one year for every year that has passed since 1977, when the repository was forecast to open in 1985.

Nuclear power plant owners have been unsuccessful in litigation to force the federal government to take the spent fuel. However, the federal government has been held liable for damages caused by failure to meet the 1998 deadline. Litigation to measure the amount of the damages is ongoing.

Given the stalemate over Yucca Mountain, interim storage at the reactor sites or in one or two centralized facilities seems increasingly likely to be the de facto U.S. waste solution for at least three more decades. Even if Yucca Mountain were to open in 2020, many years would be required to transport the accumulated waste into the repository. Furthermore, Yucca Mountain as presently designed will only be able to accept about half of the spent fuel expected to be discharged from existing U.S. reactors, so many plants may well have to wait until a second repository is licensed and built. In short, there is no certainty as to many vital aspects of the disposal of spent fuel, and scant basis for confidence that it will be gone from the individual power plants in the next 20 years.

Interim waste storage, primarily in dry casks (whether at the reactor site or in a facility built for interim storage), can probably accommodate the needs of newly constructed power plants in New York or elsewhere for several decades. No technical difference exists between additional spent fuel from license extensions at existing plants and that from new plants. But politically a major expansion of nuclear power with no clear long term waste solution will be problematic.[31]

Similarly, the political challenges of arranging for off site interim storage are formidable. Not only must a host site be found, but additional transportation and fuel handling would be inevitable. Storage at the reactor avoids these problems but disperses the problem of additional decades of storage of spent fuel to dozens of communities throughout the country.

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[31] The CEO of the company owning the most U.S. nuclear capacity and generally considered among the most likely to build new units has said, "We have to be able to look the public in the eye and say, 'If we build a plant, here's where the waste will go.' If we can't answer that question honestly to our neighbors, then we're playing politics too high for us to be playing." (John Rowe, CEO of Exelon Corporation and current Chair of the Nuclear Energy Institute, as quoted in Fortune, "Meet Mr. Nuke", May 9, 2006).

Nuclear Waste Disposal in Other Countries

Several countries with substantial nuclear power programs are accumulating large dedicated funds to pay for the storage and disposal of their spent nuclear fuel. Some (Canada, Sweden, Finland, South Korea and Taiwan) are storing their spent fuel at the power plants as part of a program to move to long term disposal in an underground repository, as the U.S. proposes at Yucca Mountain. Of these countries, Finland and Sweden have the most advanced programs toward actually disposing of spent fuel in permanent sites, though neither country has yet done so.

South Korea and Taiwan have explored several possible interim storage arrangements in other countries, most recently Russia, which has amended its laws to permit importation of spent fuel for interim storage. In addition, the South Korean and Japanese governments have offered several hundred million dollars to communities willing to allow an interim nuclear waste storage facility to be built there.

Some other countries with substantial nuclear power programs did not follow the U.S. in abandoning the reprocessing of spent nuclear fuel (See Appendix A).[32] France, Japan, Russia and India operate reprocessing plants. Japanese and German spent fuel (as well as fuel from several other European countries) has been reprocessed in France and Britain.[33] Both France and Britain have retained the right to return the wastes from much of their reprocessing to the country of origin. Thus, reprocessing is serving in part as a type of international interim storage, a means to remove the fuel from the reactor sites while each country works out its own long term strategy. Britain has become increasingly skeptical of the economics of reprocessing and may discontinue this activity altogether, as it has already discontinued new reprocessing contracts for other countries.

Reprocessing does not improve the problem of spent fuel disposal. It does reduce the volume of spent fuel, but because only the uranium and plutonium are actually recycled, almost all of the radioactivity and the heat remain to be disposed of as waste from the reprocessing plant. In addition, reprocessing poses substantial radioactive emission challenges of its own.

Furthermore, reprocessing is not, as once thought, essential to assure adequate reactor fuel supplies. Fuel from mined uranium is available at costs well below those of reprocessed fuel under any likely nuclear expansion scenario for many years.[34]

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[32] A reprocessing plant chops up spent fuel rods and removes the uranium and plutonium for reuse as fuel.

[33] About one-third of all of the spent nuclear fuel produced through nuclear power programs in the world has been reprocessed. Harvard University's Project on Managing the Atom and the University of Tokyo's Project on Sociotechnics of Nuclear Energy, Matthew Bunn, John Holdren, Allison Macfarlane, Susan Pickett, Atsuyuki Suzuki, Tatsujiro Suzuki, Jennifer Weeks, Interim Storage of Spent Nuclear Fuel, bcsia.ksg.harvard.edu/BCSIA_content/ documents/spent_fuel.pdf, June 2001, p. 2, 22.

[34] See, for example, Richard Garwin and Georges Charpak, Megawatts and Megatons, (Alfred A. Knopf, 2000), pp. 165-166, or Matthew Bunn Steve Fetter, John Holdren and Bob van der Zwaan, "The Economics of Reprocessing v. Direct Disposal of Spent Nuclear Fuel", Project on Managing the Atom, Harvard University, December 2003, http://bcsia.ksg.harvard.edu/BCSIA_content/documents/repro-report.pdf, esp. pp. ix-x, or Steve Fetter and Frank von Hippel, "Is U.S. Reprocessing Worth the Risk?". Arms Control Today, September 2006, http://www.armscontrol.org/act/2005_09/Fetter-VonHippel.asp , p. 8.

Nuclear Power Plant Safety

The existing fleet of U.S. nuclear power plants has established a favorable safety record. The accident at Three Mile Island – while causing little harm to health - turns out to have resulted in far more serious core damage than was understood at the time. There have been a few other near misses.[35]

Chernobyl was a far more serious accident in terms of radiation release and health effects. Reactors of the Chernobyl design are no longer being built, although a few remain in operation in Russia. The design was more dangerous than that of other reactors, and it was misoperated to produce the accident. The plant also lacked Western style-containments, though it is not clear that any containment would have stood up to the forces of the explosions and fire that took place at Chernobyl.

Among the other electric generation sources, coal offers a record of potential environmental harm that is in significant ways (mineworker health safety, land degradation, air pollution) worse than nuclear power. Comparisons between the two principal sources of baseload generation are unsatisfactory, due to the differences between constant predictable ongoing damage and the remote possibility of different kinds of catastrophic harm.

As the existing plants age, occasional events indicate that aging components, when coupled with lax regulation and economic pressure to keep plants running, remain a dangerous combination. For example, the rusting of the vessel head at the 889MW Davis-Besse nuclear power plant in Ohio very nearly caused a substantial hole in the pressure vessel, an event for which the safety systems are not designed and from which a substantial release of radiation at least into the containment might well have occurred. The report of the NRC's Inspector General found a clear connection between cost considerations and NRC laxity:

> The fact that (the licensee) sought and staff allowed Davis-Besse to operate past December 31, 2001, without performing these inspections was driven in large part by a desire to lessen the financial impact on (the licensee) that would result from an early shutdown.[36]

Nuclear power's role in constraining climate change in New York or elsewhere can be undermined by an accident anywhere in the world, because such an event would prevent the kind of rapid scaling up that would be needed to provide a wedge.

A second area of concern is the threat of terrorism. Much of the information as to terrorism defense is classified, but the threat level against which plants must be protected does not included a group of nineteen trained and suicidal attackers of the type that occurred on September 11. Should such an attack occur, its impact would almost certainly be a substantial setback to a large scale expansion of nuclear power.

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[35] The only U.S. breeder reactor ever put into commercial service (Fermi I in Laguna, Michigan) destroyed its core in a 1965 accident. Though the plant returned to service, it never operated well and was retired in the early 1970s. An earlier experimental sodium cooled reactor also suffered a partial core melt down at the Santa Susana Field Laboratory in California in 1957.

[36] "NRC's Regulation of Davis Besse Regarding Damage to the Reactor Vessel Head", NRC Inspector General, December 30, 2002, p. 23.

The proposed advanced reactor designs offer cost and safety advantages in comparison to their predecessors.[37] However, they are neither foolproof nor terrorist proof, and the extent of the net safety gain that they offer will depend in large part on the actual NRC requirements in licensing processes that will not be completed for several years.

In light of ongoing concerns about the safety of nuclear power, the safety culture of the Nuclear Regulatory Commission is important both as to power plant safety and as to public confidence. The record on this score is troublesome. The aforementioned Inspector General's report on Davis Besse is not alone in suggesting that the NRC is not providing the safety culture needed to support public confidence in expanded nuclear power.

No one event is conclusive. Indeed, the performance of the nation's operating plants continues to be generally excellent. However, recent national experience with economic regulatory failure and risk management demonstrates that inadequate regulation cannot be counted on to reveal itself in ways and times that allow for correction before great harm occurs. Those who favor new nuclear construction and those who oppose it both point to aspects of the NRC's record to support their conclusion. Proponents point to the overall industry/NRC record and the many advances in equipment, training and management in recent years. Opponents, though not questioning the professionalism and dedication of most of the NRC staff, see in episodes like those set forth in Appendix B a picture of NRC leadership and Congressional oversight that have at times focused unduly on furthering the interests of the industry.

Public Involvement and Nuclear Power

To a greater extent than any other type of energy generating facility, nuclear power plants are controversial neighbors. The 2003 MIT study observed, "A majority of the American public approve the use of nuclear power, but oppose building additional nuclear power plants to meet future energy needs. Since the accident at Three Mile Island in 1979, 60 percent of the American public has opposed and 35 percent have supported construction of new nuclear plants although the intensity of public opposition has lessened in recent years."[38]

A number of the changes to the nuclear licensing process (discussed above at pp. 8-9**)** make sense in efficiency terms, but they also make effective public involvement more difficult. More problematically, the NRC has been systematically reducing the rights of the public to raise issues in regulatory proceedings. The ability to obtain information through discovery of documents and through cross-examination has been circumscribed in ways such as a requirement that all questions be submitted to the chair of the hearing panel to be asked by the chair if he or she so chooses rather than by the attorneys for the intervenors. Cross-examination will be permitted if the Board finds that certain criteria are met, criteria that will be very difficult to establish without discovery rights.

[37] These designs employ "passive" safety features to a greater extent than today's plants, lessening the need for rapid operator response. In addition, they are designed to require less equipment and material, such as piping and concrete, lessening material and construction costs. Because no such plants have yet been completed in the U.S. and several of the designs have not yet been approved by the NRC, such claims cannot be yet be verified for U.S. conditions.

[38] MIT Study, p. 71. A March 2006 Gallup poll found that 56% of Americans supported the use of nuclear-generated electricity and 38% opposed it.

As a result of these changes, the public now has less right to question the location of a nuclear power plant in their vicinity than they do in most states with regard to any other type of industrial facility. One court of appeals has held that the new hearing procedures are legal,[39] but they have yet not been reviewed as applied to a specific proceeding.

Several aspects of the new procedures remain unclear. For one thing, hearings were rarely if ever a source of delay, so the procedures are not likely to speed construction.[40] Intervenors will be motivated to use their remaining hand holds (such as the NRC's process for filing citizen petitions) to try to force a hearing on issues of concern to them. If the new procedures are applied to foreclose examination of legitimate issues or to protect the NRC or the applicant from embarrassment, a reviewing court may not sustain the procedures as actually applied.

Finally, the impact of the procedures on the credibility of the NRC is untested. As the licensing proceedings unfold around possible new reactors, they will be highly publicized. Intervenor lawyers explaining that the new rules foreclose meaningful participation are likely to command attention.

Many state governments are likely to accept the new procedures, but some of the most populous states may not. Nuclear power's ability to fulfill a role as a wedge in the Pacala-Socolow analysis is challenging enough in any case. It is unlikely to succeed if it is foreclosed from significant expansion in California, New York and New England, to name the regions least likely to accept expanded licensing from which the public is effectively excluded.

Nuclear Power Issues and Choices for New York

Three general scenarios seem to frame the possibilities for nuclear power in New York over the next four decades.

- **Making nuclear power a centerpiece of New York's climate change strategy**

  This scenario assumes that new nuclear power plants become a significant part of the U.S. energy future, enough to constitute the U.S. share of a "wedge" in the Pacala-Socolow analysis. This is a daunting and probably a prohibitively expensive undertaking unless the costs and risks of nuclear power are underwritten by the federal government. Such a climate change strategy would entail not only replacing

[39] Citizens' Awareness Network v. U.S. Nuclear Regulatory Commission, 391 Fed. 3rd 338 (Ist Cir, 2004).

[40] Indeed there is evidence that the hearings contributed to safety. The chairman of the NRC's Atomic Safety Licensing Board panel described the benefits of the NRC public hearing process as follows:

> (1) Staff and applicant reports subject to public examination are performed with greater care; (2) preparation for public examination of issues frequently creates a new perspective and causes the parties to reexamine or rethink some or all of the questions presented; (3) the quality of staff judgment is improved by a hearing process which requires experts to state their views in writing and then permits oral examination in detail. (Memorandum of B. Paul Cotter, May 8, 1981, quoted in The Union of Concerned Scientists, Safety Second: The NRC and America's Nuclear Power Plants (Indiana University Press, 1987), p. 58)

This conclusion was echoed in the independent analysis of the Three Mile Island accident commissioned by the NRC, which stated, "Intervenors have made an important impact on safety in some instances – sometimes as a catalyst in the prehearing stage of proceedings, sometimes by forcing more thorough review of an issue or improved review procedures on a reluctant agency". (Report of the Nuclear Regulatory Commission Special Inquiry Group on the Accident at Three Mile Island, Vol. 1 at 143-44).

the existing New York nuclear capacity but committing to quadruple it (because that much nuclear in New York will be displacing lower carbon content oil and natural gas as well as coal) by mid-century. Even with several larger units like the 1600MW UNISTAR EPR, some 16-20 new units would be necessary, or one every three years starting immediately. For New York even to approach such a scenario, legislation mandating the purchase by distribution companies and by the New York and Long Island Power Authorities of nuclear power would be essential, as would reviving a strong centralized siting process for new power plants above a specific size. These would have to be combined with some or all of the New York specific incentives listed on page 9.

Also essential would be a public consensus that existing public policies favoring efficiency and renewables, competitive power markets and local control of power plant siting are insufficient and should be revamped to accommodate new nuclear power. Such developments seem very unlikely in New York, at least not before the first new units built in the U.S. have proven competitively successful in order to assure that capital would be available to build new unit. Given construction times plus the need for a few years of operation, this cannot happen before 2020.

To combat public concerns about whether the NRC is an effective safety regulator, New York could consider establishing its own nuclear plant inspectorate, as Illinois, Vermont and Maine have done. These offices have no power to issue orders but can highlight areas of concern. Or the state could urge its Congressional delegation to review the question of whether the preemptive features of the Atomic Energy Act – which have been part of the nuclear legislative framework since the 1950s – have outlived their usefulness.

- **Maintaining nuclear power's current share of New York's electric power market**

This scenario assumes that New York undertakes to maintain nuclear power's share of its current electricity production. A scenario in which the existing 26% share of the state's electric generating capacity is maintained requires replacing all of the existing units with new nuclear plants or operating them for considerably longer than is now projected. A few additional plats would be needed (depending on the rate of demand growth as well as the size of the plants).

This more moderate scenario allows time for the first new units built in New York or elsewhere in the U.S. to demonstrate whether or not they can meet cost and operating norms sufficient to attract private capital or whether the same measures needed for rapid expansion would remain necessary for all new nuclear power plants. This scenario also allows for an appraisal of the other ambitious low carbon policy initiatives to which New York is already committed.

Strict adherence to this scenario would also require extending the Indian Point plant licenses (because replacement nuclear units cannot come on line before their 2013-2015 expiration dates), a step now opposed by the state.

- **Phasing out nuclear power in New York**

This scenario entails retirement at the end of the licensed lives of the six existing units. By mid-century, New York would no longer have any operating nuclear plants. Additional uprates and license extensions might still assist with the carbon reduction requirements imposed by RGGI, substantially only in the case of license extension at the Indian Point units.

Assuming that the NRC does not extend nuclear plant licenses beyond sixty years, that federal credit support does not expand and that nuclear power does not emerge a winner under comprehensive climate legislation, this scenario is the likely result of existing state policies. Neither growth in energy demand nor available private sector resources will support construction of new nuclear units at pace sufficient to maintain nuclear power's existing market share.

More fundamental decisions regarding power supply in New York and nationally need to be made before particular nuclear expectations are defined. The departures from existing state policies needed to support significant nuclear growth (or even to assure that the nuclear market share does not shrink) are very large. They include some combination of customer and taxpayer support. Steps of this magnitude also require abandoning New York's current presumption that the state's power market, working under the parameters set by RGGI, 15 x 15 and the renewable portfolio standard, will be sufficient to achieve New York's carbon reduction goals.

In summary, measures are available that would increase the likelihood of new nuclear units being built in New York, though at considerable cost. However, for New York as for the nation as a whole, the energy policy challenge for the next few years will be how best to choose and implement the measures that will protect the climate at minimum cost and maximum benefit, not how best to promote any one technology.

Appendix A: The Connection between Nuclear Power and Nuclear Weapons

Nuclear power contributes to the potential spread of nuclear weapons in at least the following ways:

1) The most commonly used reactor types (light water cooled and moderated) require enriched uranium.[41] While the necessary enrichment level is low compared to the highly enriched uranium needed to make a bomb, the enrichment process is not linear. Once uranium has been enriched to 4%, more that two-thirds of the separative work necessary to reach 90% will have been done.[42] Consequently, the enrichment facilities necessary to a nuclear power program are potential factories for bomb material. An enrichment plant is central to the ongoing dispute over the Iranian nuclear program.

2) The other nuclear bomb fuel is plutonium. All nuclear reactors produce plutonium during the fission process that generates electricity. Indeed, the plutonium itself becomes a fuel source as soon as it is produced. Plutonium is only harmful to health when it is inhaled. As long as it is surrounded by the deadly radioisotopes contained in spent fuel, it is inaccessible and useless as a bomb material. However, when separated through reprocessing, the plutonium is immediately accessible.

For nuclear power's first 20 years, the official policy of all countries with nuclear power programs was that spent fuel would cool for several years at its power plant before being moved to a reprocessing plant, where the plutonium would be separated for reuse. Thus, the spent fuel rods were considered to be a resource, not a waste. The West Valley plant that operated in New York in the early 1970s was to have been the pioneering unit for this approach.[43] Other types of nuclear waste were shipped from the power plants to burial sites in several states.

In the mid-1970s, Presidents Ford and Carter concluded that reprocessing should not go forward in the U.S, because the worldwide spread of reprocessing technology would increase the potential for proliferation of nuclear weapons. The Carter administration also concluded that reprocessing could not produce fuel at an economically reasonable price.

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[41] The uranium isotope U-235 is only 0.7% of the uranium existing in nature. For use in light water reactors, this level must be between 3 and 5%. For a nuclear weapon, the enrichment level should exceed 90%.

[42] Nuclear Proliferation and Diversion, H.A. Feiveson, Energy Encyclopedia 2004, p. 6

[43] In 1962, Governor Nelson Rockefeller hailed the opening of a facility to reprocess spent nuclear fuel at West Valley as being "in the best tradition of the American free enterprise system…this state sponsored project, operating through private enterprise with federal cooperation, places NY in the forefront of the atomic industrial age now dawning".

This facility operated 18% of the time from 1966 until 1972 when it closed for "retrofitting" and "expansion". It never reopened.

The state of New York was the landlord, meaning that it owned the site and built a number of the support facilities, including those for waste storage. In 1976, the tenant, Nuclear Fuel Services Corporation, notified the state that it would not renew its lease. NFS turned the entire contaminated facility plus considerable spent nuclear fuel over to New York.

A federal takeover of the cleanup responsibilities was arranged in 1980. It is still not complete. The New York share of the cleanup costs was set at 10% of the total. That amount had reached $250 million in 2006, so the cleanup has to date cost federal and state tax payers $2.5 billion in unadjusted dollars.

3) A nuclear power program requires the training of a group of technically competent individuals. Such training is available in many nations and can include training in enrichment and reprocessing. The graduates of such programs may return to their own countries, or they may be employed in the nuclear power programs of other countries.

The Pakistani nuclear engineer A.Q. Kahn was employed for several years at the European enrichment facility URENCO in the early 1970s. He used the knowledge and plans acquired during his time at URENCO to further the Pakistan bomb program. He also became a main source of information for the bomb programs in other countries, including Iran, Libya and North Korea.

4) A nuclear power program can provide seeming justification for the facilities needed for a weapons program. A reprocessing plant or an enrichment facility in a country without a nuclear power plant has no obvious justification other than a bomb program. Indeed, such facilities in countries with few nuclear power plants make little economic sense. However, such countries can – as Iran currently does – assert that Article IV of the Nuclear Nonproliferation Treaty affords them an "inalienable" right to pursue nuclear energy as they see fit within the Treaty framework.

Appendix B: Examples of NRC Leadership and Congressional Oversight That Raise Concerns about NRC Capability and Impartiality

- In the months before the discovery that a significant hole in its reactor pressure vessel had been developing for many months, the Davis Besse plant received the top NRC safety rating in all eighteen possible categories.[44]
- The NRC twice recommended for the highest possible federal bonus the employee who bore overall responsibility for the mistakes at Davis-Besse, an employee who – during the same time period – had been found by the NRC Inspector-General to have knowingly inserted a false statement in a letter signed by NRC Chair Richard Meserve;
- Before being appointed to the NRC, current chairman, Dale Klein, offered paid testimonials supporting the Yucca Mountain repository in industry sponsored advertisements. In confirming Dr. Klein, Congress made no demand that he restrict his involvement in Yucca Mountain proceedings.[45]
- Despite continuing national alerts over terrorism, the NRC has ruled the likelihood of terrorist attacks "too speculative" to be litigated in NRC proceedings.[46] The original staff position to this effect was submitted to the licensing board on September 12, 2001. A Court of Appeals has reversed this decision.
- A 2002 internal NRC survey showed that almost half of all NRC employees thought that their careers would suffer if they raised safety concerns and nearly one-third of those who had raised safety concerns felt they had suffered harassment and/or intimidation as a result. NRC Chair Meserve said that this survey was good news because the 2000 survey had shown that more than 50% of all employees had feared that raising safety issues would hurt their careers;
- The NRC claimed without foundation immediately after the September 11 attacks that nuclear power plants were designed to withstand such plane crashes. This claim was later withdrawn;
- One commissioner attacked intervenor groups with a long history of responsible involvement in NRC proceedings;[47]

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[44] This example and several of the others are cited in the Keystone Report (footnote 19 above) in support of the view of the members of that panel who felt that the most NRC commissioners "have emphasized industry economic and promotional interests inappropriately in relation to public protection" (Keystone Report, page 52).

[45] Another commissioner, Dr. Gregory Jaczko, an aide to Nevada senator (and Yucca Mountain opponent) Harry Reid, was required to avoid involvement in Yucca Mountain matters during his first years on the NRC.

[46] Matt Wald, New York Times "NRC Excludes Terrorism as Licensing Concern", January 7, 2003

[47] Remarks by the late Commissioner Edward McGaffigan at the 14th Annual Regulatory Information Conference, March 6, 2002 attacking the Nuclear Control Institute. See also letter of April 18, 2003 from H.A. Feiveson to McGaffigan, quoting McGaffigan stating at an NRC meeting that Princeton had become "the house journal of some of these antinuclear activists". At the same NRC meeting, McGaffigan ordered the NRC Office of Research to produce "a hard-hitting critique that sort of undermines the study (Reducing the Hazards from Stored Spent Power-reactor Fuel in the United States, *Science & Global Security,* Spring Issue, 2003) deeply"
http://www.cipi.com/PDF/ResponseToPeterson.pdf#search=%22McGaffigan%20Alvarez%20pools%22.

- NRC Chair Nils Diaz promised during a trip to China – in advance of any decision by the NRC - that a license would be issued to a pending reactor design application by Westinghouse. Westinghouse was then competing to sell the design to China.[48]
- Senator Pete Domenici, generally considered the most powerful member of the Senate on nuclear power matters, claimed that he had successfully persuaded the NRC to reverse its "adversarial attitude" toward the nuclear industry by threatening to cut its budget by one-third in a 1998 meeting with Chair Shirley Jackson.[49]

[48] "The top U.S. nuclear regulator vouched for the safety of a new Westinghouse nuclear reactor -- yet to be built anywhere in the world -- in a sales pitch to supply China's growing power industry", Associated Press, October 19, 2004

[49] Senator Pete V. Domenici, A Brighter Tomorrow: Fulfilling the Promise of Nuclear Energy, (Rowman & Littlefield, 1998), pp. 74-75.