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US Nuclear Industry Back in the 'Fast lane'?

Keeping nuclear in the future energy mix

Warner ten Kate, April 2008

Introduction

When the National Petroleum Council (NPC) presented its "Hard Truths" last July, the most prominent conclusion was that there was not one single all encompassing measure that could address these "Hard Truths" simultaneously.[1] The world is not running out of energy resources, even though accumulating risk concerned with the expansion of conventional energy resources create significant challenges for the future. The council stated that: *"To mitigate these risks, expansion of all economic energy sources will be required, including coal, nuclear, renewables, and unconventional oil and natural gas"*.[2] Various countries acknowledge the same risks, and it is therefore no surprise that nuclear energy is making a comeback on the international policy makers agendas.[3] This includes the US, where since the 1979 Three Mile Island incident, no new constructing licences for new nuclear plants have been requested.

At the same time, the nuclear industry is on a promotional tour highlighting its reliability, its relative independence from politically unstable regions of the world, and its low carbon footprint as reasons to expand nuclear electricity generation in the United States. As a consequence of the Northeast blackout that hit the United States in 2003, reliability of electricity supply has become an issue of increasing concern to American policy makers. In addition, the general unease amongst the American public concerning the United States dependence on foreign oil supplies (although not very relevant in electricity discussion) gives the nuclear industry an extra advantage to reclaim its role in the US

[1] Warner ten Kate, *'No "Silver Bullet": The 2007 National Petroleum Council Report in the US Energy Debate'* CIEP Briefing Paper 6 (The Hague 2007).

[2] *'Hard truths: facing the hard truths about energy'* National Petroleum Council (Washington D.C. 2007) 5.

[3] *'Nuclear power's new age'* The Economist, September 8, 2007, page 11.

electricity sector. Finally, increasing consensus amongst consumers, industry and policy makers within the United States finds that global climate change is a grave threat that must be dealt with. Increased use of nuclear power is viewed as indispensable to these climate change mitigating efforts.[4] Although heightened concern for the global environment and the US security of supply are laudable, they are hardly solid grounds for investing in emission free nuclear electricity generation, given the huge investments concerned. The wish of the current administration to increase the share of nuclear in the US energy mix, challenges policy makers in Washington D.C. to create an energy policy that efficiently provides economic and fiscal assurances for utilities to invest in nuclear power generation.

The US is not the only country looking at nuclear energy to address the security and climate issues associated with energy consumption. Notably developing nations, who seek to meet their increasing demand for electricity, could set off an revival of nuclear energy in the international energy mix.[5] This international expansion of nuclear energy poses strategic choices for policymakers in Washington: How to secure the supply of nuclear fuel worldwide and at the same time control the waste and proliferation issues that arise at the back cycle of the fuel supply?[6]

This CIEP Briefing Paper will address American efforts to control the availability of nuclear power nationally and internationally. The Briefing Paper will look at the American efforts to align the international nuclear expansion to American interest. It will then expand on certain developments in the current administration's efforts to facilitate nuclear plant construction and the increase in applications for construction permits. It will further discuss whether the current American energy policy developments are likely to facilitate the expansion of nuclear electricity generation in the future. The Briefing Paper will conclude with certain observations about the future of US nuclear policy.

American nuclear energy policy

The foundation of the current American energy policy was laid in the first days of President George W. Bush's term in office. Under the leadership of Vice-President Cheney a National Energy Policy Group was established to develop a policy that promotes "*dependable, affordable and environmentally sound energy for the future*".[7] The National Energy Policy (NEP) that was released in May 2001, signalled the start of a legislative effort that culminated in the Energy Policy Act of 2005.[8] The EPA2005 focussed on government action only when market forces fail to deliver. It thereby set American energy policy on a course that favoured creating conditions for businesses to invest in the US energy sector to increase domestic availability of oil, coal, gas and nuclear power.[9]

The 2001 NEP can be viewed as the guiding document for American energy policy-making during the two Bush administrations. The government has an agenda setting advantage over the US Congress, since Congress works generally slower and is therefore often limited to oversight of the US

[4] Warner ten Kate, *'No "Silver Bullet": The 2007 National Petroleum Council Report in the US Energy Debate'*.

[5] *'Nuclear power's new age'* The Economist, September 8, 2007, page 11.

[6] See also: Ruud Lubbers, *'Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* CIEP Briefing Paper 3 (The Hague 2005).

[7] *'National Energy Policy'* National Energy Policy Development Group (Washington D.C. 2001) 3. Available at: http://www.whitehouse.gov/energy/2001/index.html.

[8] *'Energy Policy Act of 2005'*. Available at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h6enr.txt.pdf.

[9] Katrin Jordan, *'Changes and continuities in US energy policy'* German Institute for International and Security Affairs (Berlin 2005) 11.

international nuclear policies developed by the government.[10] One of the recommendations in the 2001 NEP was: *"The NEPD Group recommends that the president support the expansion of nuclear energy in the United States as a major component of our national energy policy."*[11] It signalled the Bush government's intention to expand the available nuclear generating capacity in the American energy mix, during their term(s) in office.

Apart from increasing domestic availability, the Bush government stated in the 2001 NEP its intention to develop new forms of international nuclear cooperation. *"The United States should also consider technologies in collaboration with international partners with highly developed fuel cycles and a record of close cooperation, to develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste intensive, and more proliferation-resistant."*[12] The external component of the US nuclear energy policy hereby focussed on proliferation and technology cooperation with technological advanced states, a policy which did not exclude any states beforehand.

International nuclear renaissance: How to manage Haves and Have-nots?

While United States government continued to build its case to increase the share of nuclear electricity generation, other nations have tried to increase the share of nuclear in their electricity mix as well. Developing economies like India, China, Pakistan and Iran, but also developed nations such as Japan, Canada, and recently the United Kingdom, have signalled their intentions to increase nuclear electricity generation.[13] At the moment 34 reactors are being built around the world with an additional 94 or more scheduled to come online within 10 years; whilst an additional 200 reactors are being proposed.[14] Compared to a total of 439 reactors operating world wide this would mean a substantial increase in the available nuclear generation capacity. With the expected near doubling of world electricity demand in 2030, demand for nuclear reactors world wide could rise even further.[15]

For the United States these developments pose a controversial set of risks and opportunities. The international expansion of nuclear generation capacity poses the risk of the spreading of sensitive nuclear fuel cycle technology for non-proliferation reasons. As an increasing number of developing nations join the ranks of nations that seek nuclear power generation (often perceived as part of their inalienable right to determine their own fuel mix) the United States is confronted with the challenge to manage the haves and have-nots of the nuclear fuel cycle (and eventually the advanced nuclear fuel cycle). The recent developments around the Persian Gulf have shown that the ambitions of certain states to acquire (advanced) nuclear fuel cycles are of grave concern to the United States and the international community.

Although no state currently has a full functioning fuel cycle (including final waste disposal), the drive to acquire one poses challenges to the US because the technology would enable states to enrich uranium and plutonium in sufficient quantities to produce "bomb grade" materials. Two stages in the nuclear fuel cycle are especially sensitive to these concerns, namely the enrichment phase of nuclear

[10] Congress has four main roles in oversight related to nuclear fuel cycle proposals: 1: Providing funding and oversight of US domestic nuclear programmes. 2: Policy direction and/or funding for international measures to assure supply. 3: Implementing the international component of GNEP. 4: Approval of nuclear cooperation agreements.

[11] *'National Energy Policy'* National Energy Policy Development Group (Washington D.C. 2001) 5-17.

[12] *'National Energy Policy'* National Energy Policy Development Group (Washington D.C. 2001) 5-17.

[13] For an international reactor overview see appendix 1.

[14] *'Plans for new reactors worldwide'* Australian Uranium Association, Nuclear Issues Briefing Paper 19, October 2007. Available at: http://www.uic.com.au/nip19.htm.

[15] *'World Energy Outlook 2007'* International Energy Agency (Paris 2007) 593.

fuel, and the reprocessing of spent nuclear fuel from reactors. The "closed" nuclear fuel cycle is displayed in figure 1 below.

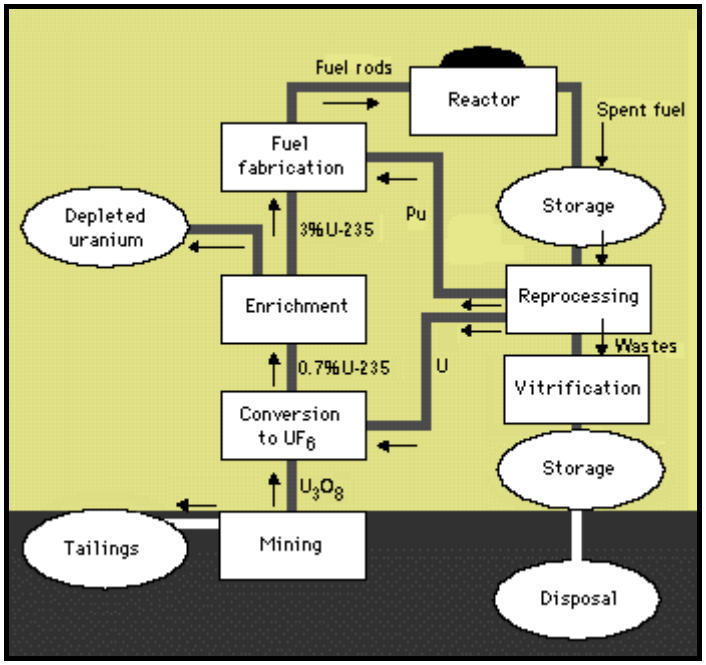

Figure 1: The "closed" nuclear fuel cycle[16]

The United States never fully developed the nuclear fuel cycle as displayed above. The US established a *"once-through fuel cycle"* policy under the Carter administration in 1977. This policy allowed uranium to be used only once for electricity generation, after which the depleted uranium would be stored in a permanent repository. This policy was initiated due to proliferation concerns, and the cheap and plentiful uranium supplies (at that time) that made reprocessing relatively expensive. This policy creates relative large volumes of nuclear waste that have to be stored in permanent repositories for a very long time.

To limit the volumes of waste, spent fuel can be reused via commercial reprocessing. In this process unused uranium (and potentially plutonium) is recovered from the waste and reinserted in the fuel cycle, leaving smaller volumes of high level radioactive waste to store. Although the United States has never implemented a full fuel cycle with reprocessing, several other states (Japan, the United Kingdom, Russia, and France) have. No state has yet developed a permanent disposal repository, so technically speaking no "closed" fuel cycle exists in the world today.[17]

The US Department of Energy (DOE) signalled an interest in the technology to limit the volume of high level nuclear waste that will be stored in the permanent repository under construction at Yucca Mountain, Nevada.[18] In 2003 the Advanced Fuel Cycle Initiative (AFCI) was launched by the DOE to develop proliferation resistant reprocessing technologies (UREX+ technology).[19] In addition, the US has embarked on a research program to develop generation IV reactors that are able to *"burn"* a greater amount of the spent fuel of older generation reactors, leaving smaller volumes of waste for

[16] Available at: http://www.uic.com.au/nip65.htm.

[17] Nowadays nuclear waste is generally stored on the reactor site for the "short" term of about 100 years.

[18] Reprocessing technologies are also beneficial if uranium prices continue to climb in the future, making it competitive with the processing of yellow cake.

[19] Mark Holt, *'Nuclear energy policy'* 11.

final disposal.[20] The US effort is part of the Generation IV International Forum (GIF) established in 2000.[21] This international forum seeks development of new nuclear reactors that are safer, more proliferation resistant, cost competitive and seek to minimize waste and optimize natural resource utilization.[22] The commercial introduction of generation IV reactors is not expected before 2030, which leaves existing reprocessing technologies as the primary option to limit the volume of nuclear waste for permanent disposal in the short- to mid-term. This effectively means the abolishment of the *"once-through fuel cycle"*, and a departure from the US policy discouraging the use of plutonium as a nuclear fuel.[23]

A simultaneous drive for the expansion of nuclear power world wide and efforts to limit the volume of nuclear waste via existing reprocessing technology (and eventually generation IV reactors) are accompanied with considerable proliferation concerns that need to be addressed at an international level. However, the international safeguards in place are considered to be inadequate to meet the non-proliferation challenges that accompany the world wide expansion of nuclear power.[24] Increasing international debate has arisen, and is needed, on the strengthening of international nuclear safeguards. The United States has developed various initiatives that contribute to this ongoing (but so far fruitless) debate.

Multilateral efforts: Strengthening the consumer producer bond

The United States has had a long standing tradition in the field of multilateral international nuclear cooperation. In 1953 president Dwight D. Eisenhower laid the foundations for future US efforts to expand peaceful use of nuclear power with the *"Atoms for Peace"*-initiative. Since then *"atoms-for-peace"* has continued to be the leading principle in international efforts to strengthen the non proliferation regime. In a response to president Eisenhower's initiative the International Atomic Energy Agency (IAEA) was founded in 1957. The agency is part of the United Nations family and has currently 144 member states that work to promote safe, secure and peaceful nuclear technology.[25]

The IAEA remains the primary international organisation concerning peaceful military development to date, and this role was strengthened after the Non Proliferation Treaty (NPT) entered into force in 1970. Under the NPT, five states (P5) were recognized as nuclear weapon states while other states committed themselves to peaceful usage of nuclear power, and the IAEA is the main instrument of verification of the peaceful intentions of NPT states. Despite a considerable number of signatories to the NPT, an small number of nuclear states have not signed the NPT.[26] Debate has arisen on ways to strengthen the NPT regime, however there is a lack of meaningful progress in the following area's: nuclear disarmament, nuclear non-proliferation, and access to peaceful usage.[27]

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[20] Mark Holt, *'Nuclear energy policy'* Congressional Research Service (Washington D.C. 2007) 9.

[21] GIF members are: Argentina, Brazil, Canada, Euratom, France, Japan, South Africa, South Korea, Switzerland, United Kingdom, United States, Russia and China, with the OECD-Nuclear Energy Agency and the International Atomic Energy Agency as permanent observers.

[22] Available at: http://nuclear.energy.gov/genIV/neGenIV2.html.

[23] Mary Beth Dunham Nikitin, Jill Marie Parillo, and Sharon Squassoni, '*Managing the nuclear fuel cycle: policy implications of expanding global access to nuclear power'* Congressional Research Service (Washington D.C. 2007) 32.

[24] *'The future of nuclear power'* Massachusetts Institute of Technology (Boston 2003)

[25] 144 member states as of march 2007. See also: www.iaea.org.

[26] Namely Israel, India and Pakistan.

[27] Ruud Lubbers, *'Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* CIEP Briefing Paper 3 (The Hague 2005) 7.

The current debate revolves around the question whether a strengthened regime should involve a more supranational approach or that intergovernmental agreements could achieve non-proliferation objectives as well. Most recent international proposals focus on the front end of the nuclear fuel cycle, namely the enrichment (or reprocessing) phase of nuclear fuel fabrication. The debate on how to create new safeguards that create a "water tight" system, consistently runs at loggerheads with the sovereignty principle.[28] Supporters of a strengthened supranational IAEA, look for international ownership of the nuclear fuel cycle as the best way to ensure non-proliferation, much like Euratom within the European Union.[29]

The calls for an increased supranational approach might be in the best interest of all participants, however in the current international political constellation it is very unlikely that the large powers (namely P5) are willing to hand over control of something they consider a source of their international strength.[30] Most far reaching proposals that have been tabled are: the IAEA proposal from its Secretary General ElBaradei in 2005 and President's Putin proposal in January 2006.[31] These look to secure nuclear fuel deliveries to non-processing and enriching states by transferring ownership of the fuel supply to a supranational body.[32] However, the proposals yet to receive meaningful international support.

Most of the supranational proposals are built on the 1946 United states' *"Baruch plan"*, calling for a International Atomic Development Authority that has a monopoly of mining uranium and thorium, refining the ores, owning materials, and constructing and operating plants necessary for the use of nuclear power.[33] The United States proposed this supranational initiative in an era where only the United States possessed nuclear power. After the conclusion that the UN Security Council would never reach consensus in the cold war era, the US focussed on non-proliferation via the NPT and the Nuclear Suppliers Group (NSG), established in 1974.

As a consequence of its *"once-through fuel cycle"* policy, the United States did not have much interest in international nuclear reprocessing technology cooperation. The US tried to prohibit any transfer of reprocessing technologies to other nations as well. It argued that as the largest user of nuclear energy did not need reprocessing technologies, other nations would not need it either.[34] Despite the US *"once-through fuel cycle"* example, other states have continued to developed reprocessing capacities, while other states are looking to develop enrichment capacities.

Since the US government has made the expansion of the use of nuclear power a central part of its national energy policy, a turnaround on the *"once-through fuel cycle"* policy within the United States is considered a necessity. In addition a international framework to facilitate expansion of a complete fuel cycle was deemed necessary as well. In 2004, president George W. Bush declared that: "*The*

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[28] Ruud Lubbers, *'Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* 5.

[29] Ruud Lubbers, *'Follow up on briefing paper number 3: Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* CIEP Briefing Paper 4 (The Hague 2006) 2-3.

[30] Ruud Lubbers, *'Follow up on briefing paper number 3: Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* 2.

[31] Ruud Lubbers, *'Follow up on briefing paper number 3: Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* 2.

[32] Mary Beth Dunham Nikitin, Jill Marie Parillo, and Sharon Squassoni, '*Managing the nuclear fuel cycle: policy implications of expanding global access to nuclear power'* 36-37.

[33] Ruud Lubbers, *'Moving beyond the stalemate; addressing the nuclear challenge by supranational means'* 5.

[34] *'Risk of GNEP's focus on near term reprocessing'* Testimony of Matthew Bunn for the Committee on Energy and Natural Resources United States Senate, November 14, 2007. Available at: http://energy.senate.gov/public/_files/BunnTestimony111407.doc

world must create a safe, orderly system to field civilian nuclear plants without adding to the danger of weapons proliferation".[35] This proposal would keep uranium enrichment and plutonium reprocessing technology in the hands of current technology holders, while providing fuel guarantees to those countries that abandon the option.[36]

In 2006, the abovementioned proposal was followed up by the Global Nuclear Energy Partnership (GNEP), which is simultaneously a research and technology development initiative and an international policy initiative.[37] The GNEP is an international initiative that builds on the national Advanced Fuel Cycle Initiative. Originally the GNEP proposed that certain recognized fuel cycle countries would ensure reliable supply to the rest of the world in return for commitments to renounce enrichment and reprocessing. The initiative also proposed solutions for recycling of spent fuel and storage issues, and thereby also addresses the back end of the fuel cycle.[38]

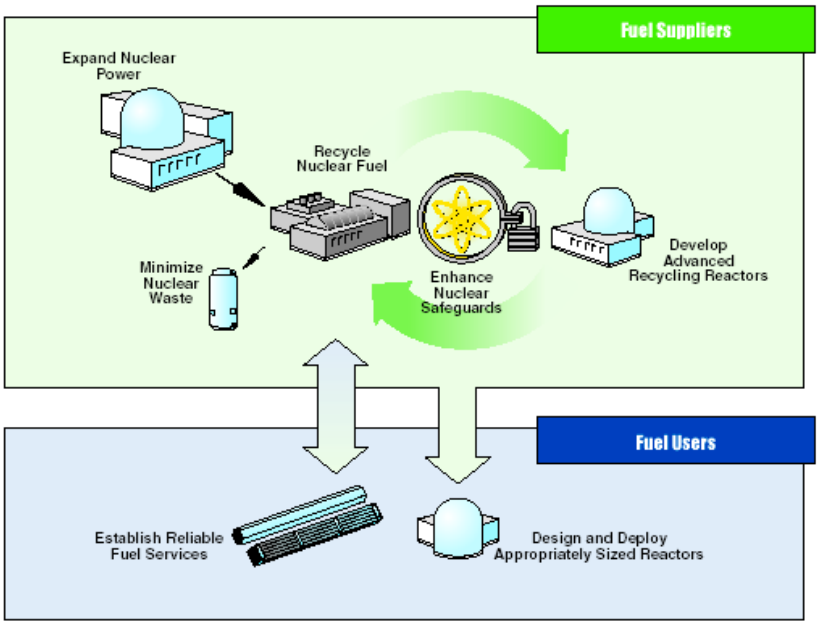

Figure 2: The GNEP model of nuclear international cooperation[39]

The GNEP currently has 21 members[40], the partnership aims to expand nuclear power world wide and to increase international technical cooperation to develop comprehensive recycling of nuclear fuel, while at the same time limiting the spreading of proliferation sensitive technology. The GNEP initiative has hereby changed the US international proliferation policy into a policy that promotes technological cooperation amongst the current technology holders, while discouraging further transfer

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[35] *'The Global Nuclear Energy Partnership fact sheet'* Department of Energy, available at: www.gnep.energy.gov.

[36] Mary Beth Dunham Nikitin, Jill Marie Parillo, and Sharon Squassoni, a.o., *'Managing the nuclear fuel cycle: policy implications of expanding global access to nuclear power'* Congressional Research Service (Washington D.C. 2007) 3.

[37] *'Global Nuclear Energy Partnership'* Australian Uranium Association, Nuclear Issues Briefing Paper 117, October 2007. Available at: www.uic.com.au/nip117.htm.

[38] Mary Beth Dunham Nikitin, Jill Marie Parillo, and Sharon Squassoni, '*Managing the nuclear fuel cycle: policy implications of expanding global access to nuclear power'* Congressional Research Service (Washington D.C. 2007) 3.

[39] Available at: *'The Global Nuclear Energy Partnership fact sheet'* Department of Energy, available at: www.gnep.energy.gov.

[40] GNEP members are: Australia, Bulgaria, Canada, China, France, Ghana, Hungary, Italy, Japan, Jordan, Kazakhstan, Lithuania, Poland, Romania, Russia, Senegal, Slovenia, South Korea, the United Kingdom, Ukraine and the United States. Observers are the IAEA, Generation IV international forum (GIF) and Euratom.

of these technologies by guaranteeing fuel deliveries to states that do not have advanced fuel cycles. The flow of nuclear fuel between producer countries and user countries together with all other commitments and international obligations under the GNEP will adhere to safeguards set by the IAEA.[41] The IAEA is also an observer to the GNEP, and therefore actively involved in the partnership.

The GNEP members commit themselves to United Nations Security Council (UNSC) resolution 1540 that stipulates that all states should refrain from distribution of Weapons of Mass Destruction (WMD) and technology to develop these to non-state actors.[42] The nuclear consumer and producer bond will be strengthened by guarantees of nuclear fuel deliveries under safeguards of the IAEA.[43] The United States has hereby shifted its international nuclear policy from strictly non-proliferation to technological cooperation *and* non-proliferation. These technological and non-proliferation cooperation efforts will not include a strengthened supranational institution and will therefore continue on a intergovernmental level. However, it is unclear what the United States expects to do about states that reject fuel delivery guarantees and continue to pursue their independent nuclear fuel cycle.

Bilateral nuclear cooperation: Between friends and foes

When considering the current US international nuclear policy towards individual states the phrase: *"in collaboration with international partners with highly developed fuel cycles and a record of close cooperation"*[44] in the NEP2001 is of the utmost importance. In bilateral nuclear relations two striking examples of the ambivalence that this sentence provokes can be observed.

Firstly, there is the Republic of India, a country that is a member of the IAEA but has not signed the NPT. The IAEA safeguards are therefore only applied on a case by case basis in its civil nuclear programme.[45] India has a considerable civil nuclear reactor fleet that is to be expanded to about 20.000Mw capacity in 2020.[46] As part of a broader effort to increase cooperation with the world's biggest democracies, president Bush announced in 2005 that he would *"work to achieve full civil nuclear cooperation with India"*.[47] These intentions were followed-up with an agreement between President George W. Bush and the Indian Prime Minister Manmohan Singh on nuclear cooperation on March 2nd, 2006.

Under this agreement India is to separate its civil nuclear programme from its military nuclear programme in the next eight years, allowing international inspections at its civil nuclear reactors.[48] The agreement resulted in the *"United States-India Peaceful Atomic Energy Cooperation Act of 2006"*, signed by president George W. Bush on December 18, 2006.[49] Technically this act was an

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[41] *'Global Nuclear Energy Partnership statement of Principles'* Washington D.C. September 16, 2007. Available at: http://www.gnep.energy.gov/pdfs/gnepSOP_091607.pdf.

[42] *'Resolution 1540'* United Nations Security Council (New York 2004).

[43] The IAEA arrangements of assuring nuclear fuel to user countries have yet to be specified.

[44] *'National Energy Policy'* National Energy Policy Development Group (Washington D.C. 2001) 5-17.

[45] Sharon Squassoni, *'US nuclear cooperation with India: issues for Congress'* Congressional Research Service (Washington D.C. 2006) 2.

[46] *'China, India & NPT'* Australian Uranium Association, Nuclear Issues Briefing Paper 80, October 2007. Available at: http://www.uic.com.au/nip80.htm.

[47] Sharon Squassoni, *'US nuclear cooperation with India: issues for congress'* 2.

[48] Jim VanderHei and Dafna Linzer, *'US, India reach deal on nuclear cooperation'* The Washington Post, March 3, 2006.

[49] Text available at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h5682enr.txt.pdf.

exempt to the *"Atomic energy Act of 1954"* to allow for a follow-up agreement to establish a framework for nuclear commerce between the two nations. This framework was laid down in the *"123 agreement"*, of which the final text was presented on August 3, 2007.[50] Apart from the ratification of the *"123 agreement"*, two large hurdles remain for the cooperation to continue.[51]

The ratification of this *"123 agreement"* has been delayed by political opposition in the national assemblies of both countries. Opposition parties in India have spurned increased cooperation with the United States. In the United States grave concerns have risen that uranium deliveries to India will allow India to produce more fissile material for nuclear bombs, making international influence over its military nuclear programme even harder to maintain. The Bush government, has countered these arguments by declaring that IAEA inspections of the Indian civilian nuclear programme, has been an important breakthrough in the relations between the two countries, and a solid gain for the international non-proliferation regime.[52] To international observers it seems clear that greater geopolitical considerations (namely countering Chinese influence in Asia) are fundamental to the US government's reversal of a policy that determined Indo-US relations for the past thirty years.[53] In the case of India nuclear cooperation is increased to strengthen overall cooperation.

A totally different picture emerges with regard to the Islamic Republic of Iran, which is a party to the multinational Non Proliferation Treaty (NPT) and the additional protocol. However, the United States considers Iran's nuclear programme a threat to peace and security in the Middle East and is therefore vehemently denied nuclear power by the US. In 2006 this view was underlined by a resolution from the board of governors of the IAEA which stated: *"a solution to the Iranian nuclear issue would contribute to global non-proliferation efforts and to realizing the objective of a Middle East free of weapons of mass destruction, including their means of delivery"*.[54] In response to the IAEA resolution the United Nations Security Council (UNSC) adopted resolution SC 1696 (2006) that calls for an immediate freeze of Iranian nuclear enrichment activities.[55] The Iranian government has refused to halt their enrichment activities, arguing that it is Iran's sovereign right to enrich under the NPT. The IAEA holds that it is still not fully informed on Iran's nuclear programme, despite Iran's promise to do so. This has lead to an increase in regional tension, and a continued strengthening of international sanctions against Iran. The latest response from the UNSC to Iran's failure to fully inform the IAEA, involved a strengthening of sanctions in UNSC resolution 1803, adopted on March 3rd, 2008.[56] The United Nations Security Council continues to be the main platform for US efforts to control the Iranian nuclear programme.

However, the US effort in the UNSC should be regarded in the overall policy of the US towards Iran. The United States developed its unilateral sanction regime by establishing the Iran Libya Sanctions Act (ISLA) in 1996. ILSA was established to enforce an overall US policy towards Iran. This policy

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[50] Text available at: http://www.state.gov/r/pa/prs/ps/2007/aug/90050.htm.

[51] The two other obstacles are negotiations between India and the IAEA to agree upon inspections, and the unanimous consent from the Nuclear Suppliers Group (NSG) a group formed to control the NPT's nuclear commerce rules.

[52] *'President's statement on House passage of India civil nuclear cooperation legislation'* The White House Press Release, July 27, 2006. Available at: www.whitehouse.gov/news/releawses/2006/07/20060727-2.html.

[53] Ashton B. Carter, *'How Washington learned to stop worrying and love India's bomb'* Foreign Affairs, January 10, 2007. Available at: www.foreignaffairs.org.

[54] *'Implementation of the NPT safeguards agreement in the Islamic Republic of Iran'* International Atomic Energy Agency GOV/2006/14 (Vienna 2006) 2. available at: http://www.iaea.org/Publications/Documents/Board/2006/gov2006-14.pdf.

[55] *'Resolution 1696 (2006)'* United Nations Security Council (New York 2007). Available at: http://daccessdds.un.org/doc/UNDOC/GEN/N06/450/22/PDF/N0645022.pdf?OpenElement.

[56] *'Resolution 1803 (2008)'* United Nations Security Council (New York 2008). Available at: http://www.iaea.org/NewsCenter/Focus/IaeaIran/unsc_res1803-2008.pdf.

was: "*The Congress declares that it is the policy of the United States to deny Iran the ability to support acts of international terrorism and to fund the development and acquisition of weapons of mass destruction and the means to deliver them by limiting the development of Iran's ability to explore for, extract, refine, or transport by pipeline petroleum resources of Iran.*"[57] The Bush government (and any US government thereafter) will continue to oppose the Iranian nuclear ambitions on the basis of proliferation concerns and broader geopolitical goals in the region.

Even though the recent National Intelligence Estimate (NIE) released in December 2007 threw severe doubts on the Iranian ambitions and capabilities to acquire nuclear weapons, the current Iranian government can hardly be viewed by the US as an international partner with a "*record of close cooperation*".[58] US diplomatic ties with the Iranian regime have been severed since the hostage crisis in 1979. Since then, Iran and the United States have been at odds over nearly everything.[59] The US stance on the Iranian nuclear programme will therefore not change unless very significant progress is made in other policy areas. As opposed to India, in the case of Iran overall cooperation between the US and Iran needs to increase to strengthen nuclear cooperation in the future.

In its bilateral relations with nuclear or nuclear aspiring states, greater geopolitical interest have taken priority in the US policy. With regard to Iran the broader bilateral relations are obstruction cooperation on nuclear energy issues, while Iran is a party to the NPT treaty and its additional protocol. At the same time nuclear cooperation is used to improve the broader bilateral relations with India, not a member to the NPT. The underlying reason for the difference in the US approach towards these nations is the perceived "*record of close cooperation*" with the two countries.

Intergovernmental technology cooperation with bilateral non-proliferation safeguards

The current US government efforts to strengthen the international non-proliferation regime focus on its proposed Global Nuclear Energy Partnership, that ensures fuel delivery for reactor states that renounce nuclear fuel production technology. This partnership is under IAEA safeguards but remains intergovernmental in principle. Outsiders to the GNEP, such as India and Iran, will continue to be dealt with bilaterally.

The focus on international technology cooperation via GNEP and GIF, requires the United States to develop a strong, technologically advanced nuclear power sector. This would put something to offer on the table in cooperation with other nuclear states. Especially in the nuclear fuel reprocessing area, where the United States has discouraged its own commercial industry to engage in such activities.[60] While France, the United Kingdom and Russia offer commercial services to reprocess nuclear fuel, the United States has effectively none.[61] To advance knowledge on these technologies, the development of a strong advanced nuclear industry will have to be paramount. The Global Nuclear Energy Partnership programme builds on the current efforts of the Bush administration to expand the role of nuclear electricity generation, including the Nuclear Power 2010 programme (NP2010).[62] The

[57] *'Iran Libya sanctions act of 1996'* 104th Congress, Sec. 3. Available at: http://www.fas.org/irp/congress/1996_cr/h960618b.htm.

[58] Peter Baker and Robin Wright, *'A blow to Bush's Tehran policy'* Washington Post, December 3, 2007.

[59] There have been some diplomatic contacts, but these have been strictly limited to the current turmoil in Iraq, however these efforts were abandoned by Iran on May 6th 2008,

[60] Due to the "*once-through fuel cycle*" policy since 1977.

[61] Japan is currently building a reprocessing plant at Rokkaho.

[62] *'The Global Nuclear Energy Partnership fact sheet'* Department of Energy, available at: www.gnep.energy.gov.

international nuclear agenda of the United States is therefore closely linked to the advancement nuclear energy in the US energy mix.

Kick-starting the US nuclear industry: electricity demand or government incentives?

Last September, the NRG Energy Company filed the first application for a Combined Operating License (COL) for a nuclear reactor in the US in 29 years.[63] The dead-stop in applications with the Nuclear Regulatory Commission (NRC) for new operating licences was a consequence of the Three Mile Island plant partial meltdown in 1979 and the nuclear disaster in Chernobyl in 1986. Both accidents caused widespread public fear for nuclear power, which led to a strengthened regulatory regime for the nuclear industry. These developments have limited the number of US nuclear reactors at 104 for the last nine years. These reactors were supplying about 19% (nearly 100 GW capacity in 2006[64]) of US electricity demand in 2005.[65] In addition to the NRG Energy application, the NRC expects to receive 20 additional applications for a total of 31 new reactors before the end of 2009.[66] Nine of these applications were received by the NRC in April 2008, while one engineering, procurement and construction (EPC) contract has also been signed.[67] Compared to the 29 year standstill in applications and EPC contracts, it seems that the flood gates for nuclear power in the United States have opened.

Most experts believe that the current rising demand for nuclear generation capacity is driven by the predicted increase in demand for electricity in the United States.[68] The US has a predicted annual increase in electricity demand of 1% between 2006 and 2030 (see table 1 below). According to IEA projections this would mean a near 30% increase in electricity demand in the United States of about 5947 TWh in 2030.[69] Another factor stimulating nuclear demand is the high natural gas price that the United States has recently experienced.[70] However, despite the recent rise in natural gas and oil prices, it is very uncertain whether these prices will allow for profitable nuclear generation in twenty or thirty years. The construction and operation of future nuclear, gas, and coal plants will in the end be determined by business decisions[71], based on the expected demand for electricity, the price of alternative sources, and the expected legal regime concerning low carbon electricity generation.

Nuclear facilities will not only be constructed to increase base load power generation capacity, but also to compensate for the decommissioning of current nuclear facilities in the future. Any construction in the coming decades will also have to take into account that all of the 104 nuclear reactors currently in operation will be decommissioned before 2056.[72] To replace all these reactors

[63] Steven Mufson, *'Nuclear power primed for comeback'* Washington Post, October 8, 2007.

[64] *'Monthly energy review October 2007'* Energy Information Administration (Washington D.C. 2007) 125. Available at: http://www.eia.doe.gov/emeu/mer/pdf/pages/sec8_3.pdf.

[65] *'World energy outlook 2007'* International Energy Agency (Paris 2007) 608.

[66] See appendix 2: *'Expected COL applications for new nuclear reactors in the United States'*.

[67] 'Georgia power signs EPC contract for two AP1000 at Vogtle' Platts, April 8, 2008. Available at: www.platts.com.

[68] Matthew L. Wald, *'Approval is sought to build two reactors in Texas'*.

[69] The growth figures used here are from the reference scenario, which implies that current policies are unchanged. *'World energy outlook 2007'* International Energy Agency (Paris 2007) 608.

[70] Matthew L. Wald, *'Approval is sought to build two reactors in Texas'*.

[71] Charles D. Ferguson, *'Nuclear energy: balancing benefits and risks'* Council on Foreign Relations (Washington D.C. 2007) 9.

[72] Given the maximum life span (under current legislation) of a nuclear facility of 60 years (40 years with a possible 20 years extension), with the last reactor started operations in 1996. Available at: http://www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/operational.xls

will require the construction of one reactor every four or five months during the next forty years.[73] This means that even if the share of nuclear in electricity generation is to remain stable, considerable investments will have to be forthcoming. Emphasizing this, US Energy Secretary Bodman recently stated that about 130 to 230 reactors will have to be build in the future to expand the share of nuclear generation in the electricity mix.[74]

United States Electricity Mix 2006 - 2030 (Quadrillion Btu)[75]									
Source	**2006**	**2007**	**2008**	**2010**	**2015**	**2020**	**2025**	**2030**	**Annual Increase 2006 - 2030**
Distillate Fuel Oil	0,18	0,17	0,17	0,18	0,17	0,20	0,22	0,22	0,8%
Residual Fuel Oil	0,46	0,39	0,40	0,39	0,37	0,38	0,39	0,39	-0,7%
Natural Gas	6,42	6,96	6,93	6,79	7,14	6,66	5,85	5,26	-0,8%
Steam Coal	20,48	20,52	20,47	21,00	22,17	23,98	26,30	28,51	1,4%
Nuclear Power	8,21	8,34	8,34	8,31	8,41	9,15	9,68	9,89	0,8%
Renewable Energy[76]	3,74	3,65	3,89	4,52	5,10	5,68	6,08	6,31	2,2%
Electricity Imports	0,06	0,09	0,08	0,06	0,04	0,05	0,05	0,07	0,7%
Total [77]	**39,68**	**40,24**	**40,41**	**41,38**	**43,53**	**46,23**	**48,69**	**50,77**	**1,0%**

Table 1: US Electricity Mix 2006 –2030[78]

The 31 nuclear plants that are currently proposed do not only stem from the expected future demand for electricity (both through the growth in electricity consumption as well as the decommissioning of older nuclear facilities), since the market does not favour nuclear electricity generation over other sources. Nuclear electricity generation has been unpopular due to the huge financial investment that need to be made on an uncertain long term basis (in a short term market). Nuclear reactors are expensive (estimated 4 to 5 billion USD per 1200 MW reactor[79]), have long lead times and are usually plagued with cost overruns. CEO's of major energy companies in the US see the economics of new nuclear plants as unfavourable under current market and regulatory conditions.[80] Due to the long lead times for nuclear reactors, governments that favour nuclear energy try to create assurances that provide security of return on investment for the industry in the long(er) run. In the last decades the United States government tried to create these assurances.[81]

[73] Charles D. Ferguson, *'Nuclear energy: balancing benefits and risks'* 9.

[74] Ed Crooks and Francesco Guerrera, *'GE chief urges incentives to fuel nuclear switch'* Financial Times, November 18, 2007.

[75] Includes consumption of energy by electricity-only and combined heat and power plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes small power producers and exempt wholesale generators. Recent energy policy measures in the *"Energy Independence and Security act of 2007"* are not included in the projections..

[76] Includes conventional hydroelectric, geothermal, wood and wood waste, biogenic municipal solid waste, other biomass, petroleum coke, wind, photovoltaic and solar thermal sources. Excludes net electricity imports.

[77] Includes non-biogenic municipal waste not included above.

[78] *'Annual Energy Outlook 2008 with Projections to 2030 (Early Release)'* Energy Information Administration (Washington D.C. 2008). Available at: http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_2.xls.

[79] Edmund L. Andrews and Matthew L. Wald, *'Energy bill aids the expansion of atomic power plants'*.

[80] Sheila Mcnulty and Ed Crooks, *'US utilities sceptical over nuclear plants'* Financial Times, November 18, 2007.

[81] Mark Holt, *'Nuclear energy policy'* 8.

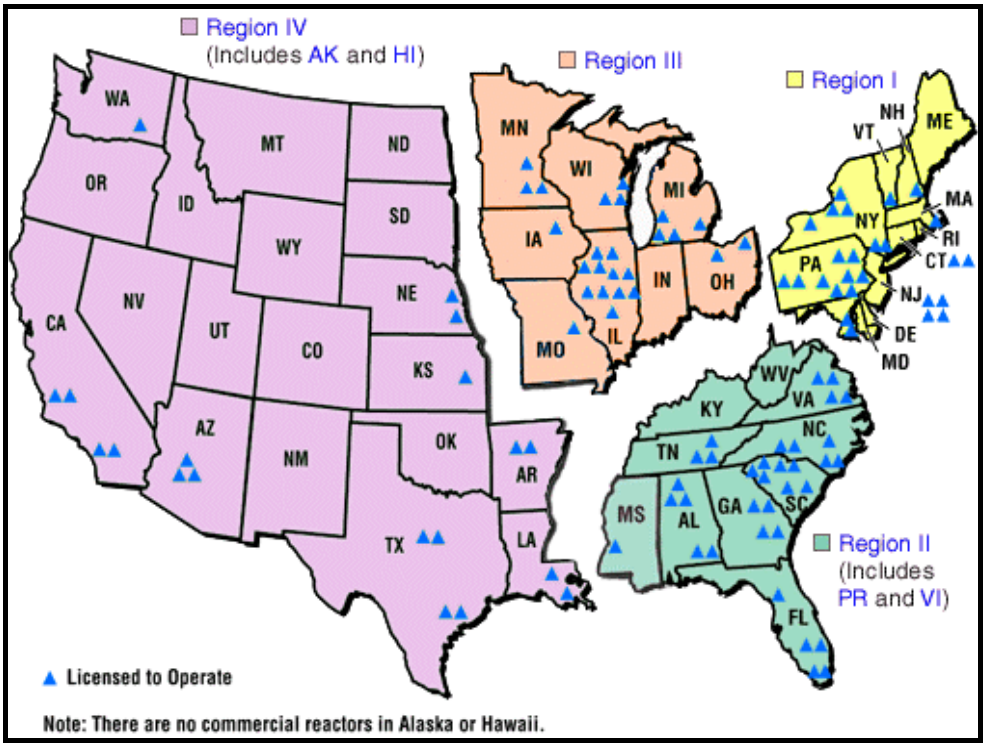

Figure 3: Locations of the currently operating commercial nuclear reactors in the United States[82]

The current Bush government has promoted nuclear energy as a clean, reliable and unlimited source of base-load electricity.[83] The government incentives that were developed can be divided in measures to limit the lead time on reactor development by reducing overall application time with the NRC, and tax incentives to increase profitability of nuclear electricity vis-à-vis other sources (namely coal and gas). In a comment on NRG's recent application, its CEO David W. Crane stated that government benefits were *"the whole reason we started this path"*.[84] These government benefits can therefore be regarded as the primary driver for the recent "flood" in licence applications from utility companies.

Limiting lead time on nuclear development: streamlining NRC-regulations

Acting upon the advice in the 2001 National Energy Policy[85], the United States government initiated the Nuclear Power 2010 Programme (NP-2010) in 2002. This programme created financial governmental support for new streamlined procedures that were already drawn up in 1989, but had not been used so far.[86] The NP-2010 programme sought to demonstrate and further streamline the new Early Site Permits (ESP) and the Combined Construction and Operating License (COL) by offering to pay up half of the licensing costs for future projects.[87] This would have to result in at least one new nuclear power plant before 2010.[88] At the same time the NP-2010 programme could be used to

[82] Available at the NRC website: http://www.nrc.gov/info-finder/reactor/.

[83] *'Bush backs nuclear power expansion to reduce emissions'* Platts, September 28, 2007. Available at: www.platts.com.

[84] Ibidem.

[85] *'National Energy Policy'* National Energy Policy Development Group (Washington D.C. 2001) 5-17.

[86] The changes in the application procedure were established with the new licensing process: 10 CFR Part 52. These changes were affirmed and strengthened by Congress with the 1992 Energy Policy Act.

[87] *'World energy outlook 2006'* International Energy Agency, 351.

[88] Larry Parker and Mark Holt, *'Nuclear power: outlook for new US reactors'* Congressional Research Service (Washington D.C. 2007) 9.

establish best practices within the NRC (possibly resulting in even more limited time for regulatory procedures in the future), and at the same time demonstrate to the industry that the new application procedure is working.[89]

The licensing for a typical new nuclear development project (COL) can be divided in three parts: Early Site Permit, Combined Construction and Operational Licence, and Design Certification. As shown below, the Early Site Permit and Design Certification can be obtained simultaneously, before a COL is applied for. Applying for an Early Site Permit and a Standard Design Certificate for the reactor and location a company wants to use are optional, but need to be inserted in the COL for final review. The Standard Design Certification can also be obtained simultaneously with the COL application and then inserted at the end of the application process. These new regulatory procedures allow for more flexibility for companies on generation capacity (off-the-shelf purchase of a specific reactor design) or construction site with regards to changing market conditions.

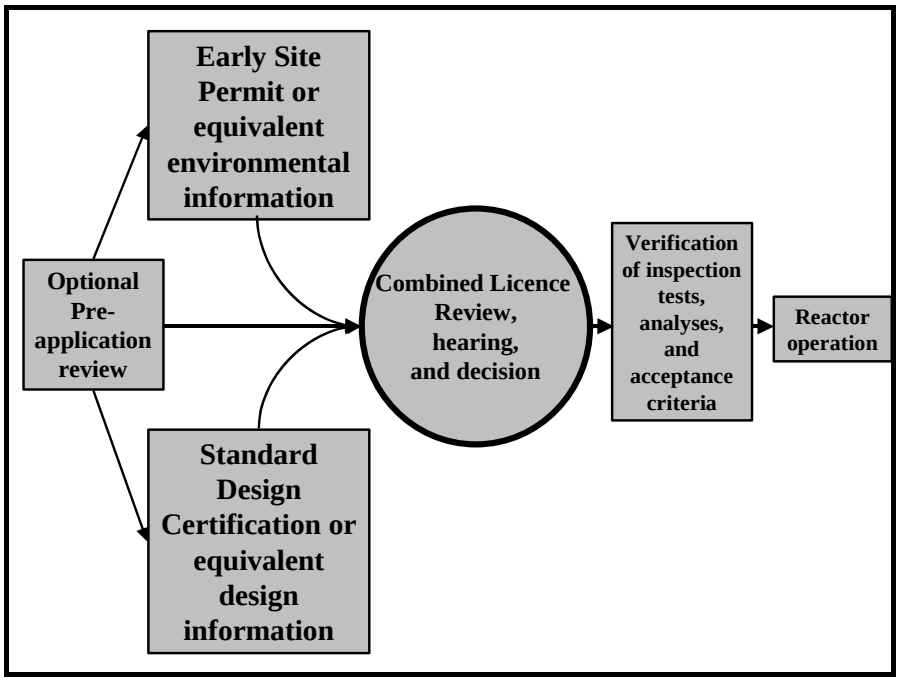

Figure 4: The renewed regulatory procedure for nuclear reactors since 1989[90]

A Combined Construction and Operating Licence: Ensuring future operation

A major step forward in regulations was the Combined Construction and Operation Licence, which provided for a one step approval process. Therefore, if a COL is granted, permission is granted to construct a site and start operating it immediately after it is ready.[91] The COL application does not need an ESP or Standard Design Certification in advance; however, the applicant needs do deliver an equivalent level of information for a combined licence application. Apart from a reduced time frame, the COL application also increased operational certainty. In the old system a construction permit would not automatically lead to an operational permit (to start selling electricity to the grid). This has led to various bankruptcies of utility firms in the eighties that had committed billions of USD in investment but were not able to make good on their investments. In 2004, the NP-2010 programme

[89] *'Nuclear Power 2010'*, Department of Energy website. Available at: http://www.ne.doe.gov/np2010/neNP2010a.html.

[90] Larry Parker and Mark Holt, *'Nuclear power: outlook for new US reactors'* 7.

[91] Ibidem.

granted two consortia 550 million USD in COL assistance over eight years to demonstrate the new COL application.[92] The new COL application procedure should reduce review time to 42 months.[93]

Early Site Permit: Making room for future growth

New regulations allow utilities to get a proposed reactor sites approved by the NRC before a decision is made whether or not to build the plant.[94] An ESP application consists of three components: a site safety analysis, an environmental report and emergency planning information.[95] An Early Site Permit enables utility companies to reserve a site for ten to twenty years, and then build the nuclear plant when the time is right.[96] Energy companies can thus strategically reserve sites for the future, and shorten the time to apply for a COL when the economics are favourable. Under the NP-2010 programme three companies have opted for an ESP for three sites that are expected to submit a COL in 2008, one of the ESP has led to a COL in 2007.[97] All ESP's are for already existing nuclear plants, where more reactors could be added.[98] On average these applications take 12 to 24 months to prepare for the industry, with an additional 33 months for the NRC review.[99]

Reactor design certifications: off-the-shelve purchases

Design certification was created to certify a reactor design, which would effectively make mass production possible.[100] The old nuclear plants constructed in the sixties and seventies were effectively one-of-a-kind reactors for which a separate design certificate was required before a plant was build. The new design certification process makes a reactor legitimate for construction for 15 years. The design certification review will take up at least four years, depending on the complexity of design. However, design certification can be done alongside ESP, and/or the COL review which should reduce overall lead time for nuclear projects.

Other possible delays: Not In My Back Yard!

As demonstrated below for the NRG project, total lead time before a nuclear reactor will start recouping on its investment will be almost eight years, even with a design that is already approved and will be build on a site that is already in use for nuclear power generation. However, no one can actually predict whether the newly proposed designs (All generation III+ reactors) will take the same amount of time. Although some designs have already been build in Europe and Asia, design

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[92] These included their Early Site Permit, which were granted in 2005 for the North Anna nuclear plant and Grand-Gulf nuclear plant. Both consortia are expected to file their COL application in 2007 and 2008.

[93] *'Report of the combined license review task force'* United States Nuclear Regulatory Commission. April 18, 2007. Available at: http://www.nrc.gov/reading-rm/doc-collections/commission/comm-secy/2007/2007-0001comdek-jsm-enclosure.pdf

[94] Ibidem, 6.

[95] *'Fact sheet: licensing nuclear power* plants' Nuclear Energy Institute, September 2007. Available at: http://www.nei.org/filefolder/licensing_new_nuclear_power_plants_0907.pdf

[96] The Early Site Permit can be extended for ten or twenty years.

[97] Utilities that have an ESP and who are expected to file a COL in 2008 are: Southern Nuclear Operating Co. (Vogtle location), NuStart Energy (Grand Gulf location), Exelon (Victoria County location). Dominion filed an COL in 2007 and had already an ESP. See also appendix 2.

[98] Two ESP's asked for sites in 2005, namely North-Anna plant in Virginia and Grand-Gulf in Mississippi. In 2006 a third site was also applied for the Vogtle power plant in Georgia. All these sites needed shorter review time for an ESP since reactors are already present, usually 12 months.

[99] *'Fact sheet: licensing nuclear power plants'* Nuclear Energy Institute, September 2007.

[100] A "best practice" copied from the French, who essentially mass produced various designs. *'Fact sheet: licensing nuclear power plants'* Nuclear Energy Institute, September 2007.

certification in the United States is still a prerequisite for building one there.[101] However, if certification for a reactor design is obtained relatively quickly, these reactors might also be available for off-the-shelve purchase between 2009 and 2011.[102] This will all depend upon the expedient procedures within the NRC.

Apart from design certification, the actual construction of reactors might induce severe delays due to the fact that there are only few steel producers that can actually forge the quality grade of steel used in nuclear rectors.[103] The limited high quality steel making capacity available right now could send reactor prices through the roof. NRC chairman Dale E. Klein recently stated that there is currently a three year waiting list for nuclear reactors with the only steel mill (Japan Steel Works) in the world that can produce reactor grade steel.[104] However, Chairman Klein held that as companies continue to order reactors, despite this waiting lists, economics must be profitable. In addition policy makers and the nuclear industry hold that mass production of a specific type of reactor (through Design Certification) will guarantee economics of scale, and should therefore (eventually) drive the price down.[105] However, as the capacity of steel mills world wide will have to be upgraded, delays seem likely.

Apart from construction delays, issues beyond the companies control will be the people living near the new reactors. Residents may severely oppose a new reactor in their backyard and might do anything to stop construction. *"Not In My Backyard"*-issues will be a powerful force to reckon with; Therefore it seems logical that utilities will favour sites that are already in use for nuclear electricity generation. Apart from residents that are already accustomed to nuclear power in their backyard, this will also have the benefit of a shorter Early Site Permit procedure, and usually considerable grid capacity in place to transport electricity. The expected licence applications seem to confirm this view since two-third (14) of the expected applications are on sites already in use for nuclear electricity generation.[106]

In addition to the operational risks that accompany nuclear electricity generation, various concerns have been ushered about the back-end of the nuclear fuel cycle, especially the concerns over final waste disposal. The US government has appointed Yucca mountain in Nevada as the United States' only long term disposal facility. However, various regulatory problems have postponed the actual start-up of the site. The planned year for the repository to accept high level nuclear waste was 1998, however this target is to be missed by nearly twenty years.[107] Currently the utilities need to be financially compensated for the costs they incur due to the prolonged on-site interim storage of their high level waste.[108] The financial implications have been legally dealt with for utilities, as they have to contribute a 1-mill-per-kilowatt-hour-fee on nuclear power to the federally managed Nuclear Waste Fund for future waste disposal. The waste programme is run by the Deportment of Energy's Office of Civilian Radioactive Waste Management. Thereby the back-end of the commercial nuclear cycle is financially accounted for in investment schemes in nuclear power. However, the practical

[101] *'New commercial reactor designs'* Energy Information Administration.

[102] Ibidem.

[103] Charles D. Ferguson, *'Nuclear energy: balancing benefits and risks'* 13.

[104] *'NRC Chairman Dale E. Klein remarks at the North American energy summit'* Nuclear Regulatory Commission, May 1, 2008. Available at: www.nrc.gov.

[105] *'Fact sheet: licensing nuclear power plants'* Nuclear Energy Institute, September 2007.

[106] See appendix 2.

[107] Mark Holt, *'Nuclear energy policy'* Congressional Research Service (Washington D.C. 2007) 18.

[108] This compensation was agreed upon after a breach-of-contract suit by the Exelon energy company against the DOE for not accepting high level waste in 1998.

arrangements of high level waste disposal still have to be worked-out; Therefore further delays in transfer of nuclear waste to Yucca mountain are likely.

The given timeframes for ESP, DC and COL might be under scrutiny of public opinion and might suffer delays at various points in the regulatory and building procedure. For now, it seems clear that the NP-2010 programme will not meet its stated goal of the construction of a new nuclear reactor before 2010. The programme has succeeded in starting up some Design Certificate and Early Site Permit reviews. A Combined Operating License was not applied for until NRG's South Texas Project expansion. NRG admitted that it would like to take the lead in the NRC regulatory process ahead of its competitors since federal tax incentives were most favourable for the first companies that would file a COL application.[109] These incentives were developed under the Energy Policy Act 2005 (EPA2005), and aimed to increase financial security for investors in nuclear projects.

EPA 2005: Securing return on investment from nuclear generation

Apart from regulatory streamlining and the financial incentives to use the newly developed regulatory procedures in the NP-2010 programme, further fiscal support was created with the Energy Policy Act of 2005. Fiscal incentives in the EPA2005 consisted of production tax credits, loan guarantees, insurance against regulatory delays, and an extension of 20 years of the Price-Anderson Act Nuclear Liability system.[110] In addition to these federal incentives there are various regional incentives for nuclear power facilities.[111]

Tax credit: Lowering the price of electricity

The EPA2005 established a tax credit of 1.8 cents per kilowatt-hour for the first 6000 MW of newly installed nuclear generation capacity for the first eight years of operation. The tax credit is a deduction of the tax owed to the government dependent on the amount of electricity production. This credit will amount to a total tax credit of 6 billion USD for eight years. A utility would be eligible for the tax credit if it filed a COL before December 31, 2008, and begin rector construction prior to January 1, 2014. If the total amount of COL application amount to less than 6000 MW before December 31, 2008, the period will be extended until the 6000 MW is reached. If the total amount of capacity applied for is larger than 6000 MW, the tax credits will be proportionally distributed amongst the applicants.

A risk concerned with the tax credit and its proportional distribution is that when too much COL applications are launched, a tax credit reduction might result for all. This could lead to a watering down of the tax credit up to a point where the credit no longer provides a construction incentive.[112] Only four or five rectors with a 1.200 – 1.500 MW capacity could be build to receive the 100% tax credit over eight years. These incentives were build to achieve economics of scale for certified designs, but it does not seem that the cost reduction achieved will make reactors economically viable on their own.[113] The tax credit will therefore only stimulate the construction of a handful of reactors, but will not create the long term stable economic conditions needed for large-scale reactor construction.[114]

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[109] Matthew L. Wald, *'Approval is sought to build two reactors in Texas'*.

[110] Sharon Squassoni, *'Risk and realities: the "new nuclear energy revival"'* Arms Control Association, May 2007. Available at: http://www.armscontrol.org/act/2007_5/squassoni.asp

[111] These will not be discussed in this Briefing Paper because the focus lies with US federal policy making.

[112] Larry Parker and Mark Holt, *'Nuclear power: outlook for new US reactors'* 10.

[113] Ibidem.

[114] Charles D. Ferguson, *'Nuclear energy: balancing benefits and risks'* 35-36.

Loan guarantees: improving the investment climate?

The EPA2005 arranged for federal loan guarantees that cover the costs of energy projects that reduce carbon emissions. These loan guarantees may cover up 100% of the loan to about 80% of total project costs. The loan guarantees are specifically designed to secure investment flows in low emission electricity generation, including new nuclear power plants.[115] If a borrower would default it would mean that the federal government will pay off the loan and can takeover the project, or reach an agreement with the borrower to continue the project.[116] The loan guarantee programme was especially developed to make investment in large and risky energy projects (what nuclear reactors are perceived to be) less of a liability for Wall Street investors.

The nuclear industry claims that federal loan guarantees are essential to nuclear plant financing. However, the loan guarantees programme was limited at 2 billion USD in the EPA2005, and was therefore very limited in its scope (considering that 2 billion US is about half the cost of a nuclear reactor). The loan guarantees program has been expanded for FY 2008 up to 7 billion USD this sum was allocated towards specific technologies which did not include nuclear technology.[117] However, on December 26, 2007, President Bush signed the *"Consolidated Appropriations Act, 2008"* which did increase the available loan guarantees for nuclear plant construction to 18.5 billion USD for 2008 and 2009.[118] Although the nuclear industry applauded the measure, it was far from the 50 billion USD in loan guarantees the industry had vied for.[119] The utilities consider this loan guarantee programme to be sufficient to mover three or four projects forward.[120] Future appropriations bills may, or may not increase the availability of loan guarantees. The current loan guarantee programme in place will limit the financial risk of a few nuclear projects, but does not stimulate a long term stable investment climate for a large number of reactors.[121]

Insurance against regulatory delays

One of the aimed advantages of the new regulatory procedures was the speeding up of the regulatory process to allow for faster development times that would then in turn allow for faster recovery of investments. However, to reduce risk for unforeseen delays in the NRC, or by delays caused by licence related litigation in state, federal or tribal courts, the EPA2005 provides for risk insurance.[122] This risk insurance would cover costs for interest on debts and costs to buy replacing power caused by the delays.

The risk insurance is limited in the EPA2005 at 2 billion USD, providing standby support up to 500 million USD for the first two nuclear reactors, and support for up to 250 million USD for the next four.[123] While the first six nuclear plants announced already have their design certification (except for the North Anna Unit, however an ESP is already granted for this reactor[124]) there seems to be smaller

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[115] Mark Holt, *'Nuclear energy policy'* Congressional Research Service (Washington D.C. 2007) 5.

[116] Charles D. Ferguson, *'Nuclear energy: balancing benefits and risks'* 36.

[117] Mark Holt, *'Nuclear energy policy'* 5-6.

[118] The "Consolidated Appropriations Act, 2008" is available at: http://thomas.loc.gov/cgi-bin/bdquery/z?d110:h2764:

[119] *'DOE gets approval for nuclear energy loan guarantees'* Platts, January 7, 2008. Available at: www.platts.com.

[120] *'DOE gets approval for nuclear energy loan guarantees'* Platts.

[121] Larry Parker and Mark Holt, *'Nuclear power: outlook for new US reactors'* 13.

[122] Charles D. Ferguson, *'Nuclear energy: balancing benefits and risks'* 36.

[123] *'DOE issues conditional agreement for nuclear plant agreements'* Platts, September 25, 2007. Available at: www.platts.com

[124] See appendix 2.

regulatory risk for these developments than the applications for reactors without design certification. Since most of the plants that are proposed have no design certification from the NRC (yet), namely Economic Simplified Boiling Water Reactor (ESBWR) and Evolutionary/European Pressurized Reactor (EPR), the regulatory risk will mostly lie with those reactors. However, these proposals are not covered since already six reactors have been applied for. It is therefore very questionable whether the standby support has added to the incentives for the "flood" of further applications predicted to be filed with the NRC until 2009.

Extension of the Price-Anderson Act Nuclear Liability system

The EPA2005 extended the Price-Anderson Act until 2025. The Price-Anderson Act limits the liability for commercial operators in case of nuclear accidents. Under the act the owners of commercial reactors must assume all liability for nuclear accidents to the public awarded by the court system. However, at the same time the act creates about 10.8 billion USD in public compensations, which is the current cap for the nuclear industry for these liabilities per accident.[125] The extension of the Price-Anderson Act limits the insurance costs for operating a nuclear plant in the future, limiting overall costs for utilities at least until 2025.

It seems clear that the incentives that were developed in EPA2005 are of great importance for an independent power producer like NRG. CEO David Crane of NRG Energy stated that the government had: *"put together precisely the amount of incentives"*, to make NRG's planned investment viable.[126] NRG's lead time expectations and bid for the most larger share of government incentives are explained in the box below. However, the current EPA2005 incentives and added loan guarantees are far too limited to cause the expected 31 reactors that will be applying for a Combined Operating Licence (let alone the 130-230 that are needed according to Secretary Bodman).

The NRC chairman Dale Klein said that he expected to see all planned COL applications to result in reactor "eventually", however al lot of the dynamics (between utilities, vendors and NRC) still have to play out.[127] He hereby implied that reactor construction will not go as fast as expected. Jeffrey Immel, the chief executive of General Electric (one of the biggest reactor engineering companies in the world) remained sceptical on the economics for the expected COL applications. He stated that any further and rapid rise in nuclear generation would demand a *"much clearer set of incentives"*.[128] Despite these serious concerns about lead time on construction and economic profitability of nuclear generation, the large amount of expected applications implies that the industry has very positive expectations about future market conditions for nuclear electricity.

[125] Mark Holt, *'Nuclear energy policy'* 16.

[126] Sheila McNulty and Ed Crooks, *'US utilities sceptical over Nuclear plants'* Financial Times, November 18, 2007.

[127] Daniel Horner, *'All planned COL's likely to lead to reactors 'eventually''* Platts, January 23, 2008.

[128] Sheila McNulty and Ed Crooks, *'US utilities sceptical over Nuclear plants'*.

NRG's South Texas Project COL application: securing a maximum of financial benefits

The new reactors (2) that NRG has recently proposed will be located in the state of Texas, at the South Texas Project nuclear power station in Matagorda County.[129] These reactors will more then double the 2500 MW capacity already present.[130] Both of the reactors are of a new type of reactor called the Advanced Boiling Water Reactor (ABWR). The ABWR design obtained its certification from the NRC in May 1997. The design has proven itself in Japan where four ABWR's are in operation.[131] General Electric has designed the new reactors for the South Texas Project, and Toshiba is selected by NRG to lead construction.[132] The 2700 MW project has an estimated cost of 6 to 7 billion USD.[133] NRG expects the new reactors to be online in 2014 and 2015.[134]

Considering that:

- An ESP procedure for the South Texas Project will likely take 12 months.[135]
- Design certification is already available for the ABWR reactor and will be inserted in the COL.
- The COL application itself will take up to 42 months to review by the NRC (with 33 month ESP review parallel).
- Construction of an ABWR and ITAAC will take about 39 months.[136]

These considerations make for a total lead time of investment of 93 months (about eight years) this makes the time schedule that NRG has put forward somewhat ambitious, but doable (if no construction or regulatory hick-ups occur). NRG is an independent power producer which builds plants and earns back their costs by selling power on the grid, not by charging regulated customers for investment at a rate base.[137] The inability of NRG to charge regulated customers for the investments made in nuclear generation makes electricity prices critical to its financial results in the future. The price NRG will have to ask for their electricity will have to be competitive with alternatives, otherwise electricity will simply not be bought by distributors. NRG's strategy is therefore clear: it will try to secure the maximum amount of government benefits for its South Texas Project 2700 MW expansion. By filing its COL first and before December 31, 2008, NRG applies for nearly half of the tax benefits for the first 6000 Mw nuclear capacity in one go. As the South Texas Project expansion will mean the construction of two ABWR reactors (with design permit) the COL will at the same time snap up 1 billion USD worth of standby support in the event of regulatory delays. While competitors will have to do with far less (250 million for the next four). At the same time the loans guarantees are currently capped at 2 billion USD. Although the predicted applications will cause a far greater capacity increase than 6000 MW (which will delude the total tax incentive), from a strategy point of view securing the greatest share by filing first makes perfect sense. By filing their application first NRG will snap up a large share of the standby support, while taking the lead in acquiring production tax credits, and loan guarantees.

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[129] *'NRG applies for first US nuclear power license in 29 years'* Environment News Service, September 25, 2007. Available at: http://www.ens-newswire.com/ens/sep2007/2007-09-25-091.asp

[130] *'Application starts to roll in for new US nuclear plants'* World Gas Intelligence, October 3, 2007.

[131] Two of the reactors are at the Kashiwazaki-Kariwa nuclear power plant in Niigata that were rocked by an earth quake and are shut down for the time being. See also: Jan-Hein Chrisstoffels**,** *'Earthquake Alarm - The Kashiwazaki nuclear incident and the consequences for Japan's nuclear policy'* CIEP briefing paper 5 (The Hague 2007).

[132] Matthew L. Wald, *'Approval is sought to build two reactors in Texas'* The New York Times, September 25, 2007.

[133] Matthew L. Wald, *'Approval is sought to build two reactors in Texas'*.

[134] *'NRG energy submits application for new 2,700 megawatt nuclear plant in South Texas'* Press Release NRG Energy, September 24, 2007. Available at: www.nrgenergy.com.

[135] Considering that the South Texas Project is a site currently used for nuclear power generation, preparation time is therefore slashed by 12 months in comparison to a new site.

[136] ITAAC is the Inspection Test Analysis Acceptance Criteria, these test will be conducted while the reactor is build and will therefore not (provided everything is approved) influence overall construction time.

[137] Matthew L. Wald, *'Approval is sought to build two reactors in Texas'*.

In(creasing) the future mix?

The public, corporate and political climate in America is shifting in favour of secure and emission-free electricity generation in an effort to address the future challenges of global climate change. Nuclear energy is increasingly viewed as an important option for emissions-free electricity generation. The nuclear industry will continue to emphasize the above role, together with the improved safety records and reliability of the industry. This way the nuclear industry seems to have found a way to muscle itself into the energy debate after being set aside for nearly thirty years.

Due to support from the current government, new regulatory procedures are being demonstrated, while insurance is provided against the first delays. This will reduce lead times for new nuclear generation capacity, while off-the-shelve reactor designs are available for speedy construction. However, the current flood in applications seems not solely driven by government incentives, since it seems unlikely that under the current legislation (EPA2005) construction will go beyond five or six reactors. Additional energy legislation were to be developed if any further nuclear capacity is added, since market conditions in eight years are to difficult to predict and can not explain the surge in COL applications.

Recent Legislative efforts

Since the start of the 110th Congress various legislative proposals have been tabled.[138] The most notable of these efforts was the "*Renewable Fuels, Consumer Protection, and Energy Efficiency Act of 2007"*.[139] This legislative proposal was passed by the House of Representatives in January 2007, which was amended and passed by the Senate in June 2007. The two versions of the bill were expected to go into conference in October 2007, were the differences between the Senate and the House versions would be resolved.

One of the more notable differences between the two proposals was that the Senates proposal removed the 2 billion USD limit on loan guarantees for nuclear electricity generation, potentially releasing about 50 billion USD in loan guarantees to support the nuclear industries applications in the next two years.[140] The current ranking member (R-NM) on the Senate's national recourses committee Peter V. Domenici (retiring in 2008) has supported the nuclear industry in their effort to get the limit removed.[141] Various law makers in the House of representatives have vehemently protested at the outlook of such a large public guarantee for the nuclear industry. House Speaker Pelosi (D-Cal) announced on October 10, 2007, that a conference on the energy bill would not be likely.[142] In addition, senator Cornyn (R-TX) blocked conferencing the bill due to the proposed withdrawal of tax

[138] Amongst these proposals were: Biofuels for Energy Security and Transportation Act of 2007, Carbon Capture and Sequestration Act of 2007, Energy Diplomacy and Security Act of 2007, Energy Efficiency Promotion Act of 2007, High-Performance Green Buildings Act of 2007, No Oil Producing and Exporting Cartels Act of 2007, NOPEC, Petroleum Consumer Price Gouging Protection Act, Public Buildings Cost Reduction Act of 2007, Ten-in-Ten Fuel Economy Act, United States Energy Storage Competitiveness Act of 2007.

[139] *'H.R. 6: Renewable Fuels, Consumer Protection, and Energy Efficiency Act of 2007'* Available at: http://www.govtrack.us/congress/bill.xpd?bill=h110-6

[140] Edmund L. Andrews and Matthew L. Wald, *'Energy bill aids the expansion of atomic power plants'* The New York Times, July 31, 2007.

[141] Edmund L. Andrews and Matthew L. Wald, *'Energy bill aids the expansion of atomic power plants'*.

[142] *'Domenici statement on energy bill status'* Senate Committee on Energy & Natural Resources, October 11, 2007. Available at: http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=235389&Month=10&Year=2007

breaks for the oil and gas industry.[143] On December 6, 2007, the House approved a renewed version of the energy bill that was deemed acceptable to the Republicans in the House. The renewed bill mandated that 15% of electricity generation would be from renewable sources, with the notable exception of nuclear power generation.[144] However, this renewable generation provision was altogether dropped when the Senate reviewed the bill. On December 17 the Senate approved the (renamed) *"Energy Independence and Security Act of 2007"* which was subsequently passed in the House of representatives on December 18. Finally president Bush signed the *"Energy Independence and Security Act of 2007"* into law on December 19, 2007.[145]

This resulted in the adaptation of an altogether slimmed down *"Renewable Fuels, Consumer Protection, and Energy Efficiency Act of 2007"* with the focus of the bill on the strengthening of the Corporate Average Fuel Economy (CAFE) standards, increased bio-fuel production and energy efficiency incentives. However the bill was stripped from its most controversial passages, and did not include any specific passages on nuclear electricity generation.

As representative Boucher (D-VA) of the House natural resources committee stated in September 2007, a conference on an energy bill would be useless without the opportunity to bring a climate change bill to the floor.[146] Since then, representative Boucher has released a white paper on a cap-and-trade system that he expects to bring to the House floor at the end of fall 2007.[147] The white paper has been submitted to spur debate on a cap-and-trade system that should reduce US carbon emissions by 60 to 80 percent from current levels in 2050.[148]

This House initiative came in addition to two Senate initiatives to implement an economy wide cap-and-trade system. The most advanced legislative proposal is the *"Low Carbon Economy Act of 2007"*, from senators Bingaman (D-NM) and Specter (R-PA) that was introduced in the senate on July 11, 2007.[149] This bill tries to reduce green house gas emissions to 1990 levels by 2030, adopting best practices from the Acid Rain Program.[150] The *"Low Carbon Economy Act of 2007"* envisages an economy wide cap-and-trade program to obtain these objectives. In a review of the possible impact of the act on the US energy sector the EIA concluded that: *"Projected nuclear capacity additions range from 24 to 107 Gigawatts"*(in 2030).[151] Although the expansion of nuclear capacity in the EIA review depends heavily on the development of future technologies (namely CCS and clean coal), it is clear that even an addition of 24GW in capacity would increase current US nuclear generation capacity by 24% in 2030.[152]

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[143] *'Texas Republican senator blocks energy bill conference with house'* Platts, October 23, 2007. Available at: www.platts.com.

[144] *'NEI laments the House decision not to include nuke as a renewable'* Platts, December 7, 2007. Available at: www.platts.com.

[145] Text available at: http://thomas.loc.gov/cgi-bin/bdquery/z?d110:h6.

[146] *'US lawmaker to push climate bill through House by end of fall'* Platts, September 18th , 2007. Available at: www.platts.com.

[147] *'US lawmaker to push climate bill through House by end of fall'* Platts.

[148] *'Climate change legislation design white paper: scope of a cap-and-trade program'* Committee on Energy and Commerce (Washington D.C. 2007) Available at: http://energycommerce.house.gov/Climate_Change/White_Paper.100307.pdf.

[149] *'Low Carbon Economy Act of 2007'* United States Senate. Available at: http://energy.senate.gov/public/_files/END07842_xml1.pdf

[150] *'Bingaman-Specter "Low Carbon Economy Act" of 2007'* Executive summary. Available at: http://energy.senate.gov/public/_files/LowCarbonEconomyActTwoPager0.pdf

[151] *'Energy market and economic impacts of S1766, the low carbon economy act of 2007'* Energy Information Administration (Wshington D.C. 2008) vi.

[152] The need for nuclear reactors will increase even further due to nuclear reactors that are going to be decommissioned and will need to be the replaced to make capacity additions possible.

Another Senate proposal is that of Senators Warner (R-VA) and Lieberman (ID-CT.) called: *"America's Climate Security Act of 2007"*.[153] The bipartisan proposal was launched August 2, 2007, and was introduced in the Senate October 18, 2007.[154] The act proposes a mandatory, market-based cap-and-trade system used to reduce the United States carbon emissions by 70 percent below current levels in 2050. The *"America's Climate Security Act of 2007"* was recently approved in the Senate environmental and public works committee. The impact of the *"America's Climate Security Act of 2007"*on the US energy sector are currently under review by the EIA.

The industry always wins!

Although, the industry might loose sight on a further expansion of federal loan guarantees needed to attract investors for nuclear reactor construction, all might not be lost. A economy wide climate change bill with a cap-and-trade regime for utilities will suit the nuclear power industry. Although almost 80% of the now proposed reactors will not receive fiscal benefits, plans to construct them are still being developed.[155] The other applications for Combined Operation Licences (beyond the first six) are based on future expectations and the industries strategic view on the future of nuclear power. A former member of the Nuclear Regulations Committee stated: "*While companies must apply for licenses by the end of 2008 to qualify for federal subsidies, they can decide later whether to proceed after learning more about climate related legislation, construction costs, competing technologies and electricity demand"*.[156]

Rather than building on future fiscal incentives, the nuclear industry is positioning itself as a emissions free alternative in a cap-and-trade environment.[157] The nuclear industry knows that momentum is building for more emission free energy and is strategically positioning itself as an viable alternative for coal and gas fired power stations. New nuclear power plants can become more speedily available as new regulatory procedures will be demonstrated in the next four years (initiated by the short term incentives in the EPA2005).

Investment in this emission free nuclear regulation capacity does not come cheap: at least 18,5 billion USD in government loan guarantees over the next two years to attract investments in the current proposed expansion of nuclear power, without providing incentives for all proposed nuclear reactors and without an increase in the overall share of generating capacity in 2030.[158] For an increase in emissions free, safe and independent (from foreign sources) electricity generation even more public money will have to be committed. If the American people do not opt for a large increase in public guarantees for nuclear power generation, the only viable alternative will be to make alternatives more expensive by implementing a carbon cap-and-trade regime. It seems clear why Duke energy, NRG, General Electric and other energy companies, are simultaneously pushing for a cap-and-trade regime via the United States Climate Action Partnership (USCAP)[159], as well as pursuing federal support for

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[153] *'S2191: America's climate security act of 2007'* Available at: http://www.govtrack.us/congress/billtext.xpd?bill=s110-2191.

[154] *'Lieberman and Warner introduce bipartisan climate legislation'* News Release Senator Joe Lieberman, October 18, 2007. Available at: http://lieberman.senate.gov/newsroom/release.cfm?id=285619.

[155] Considering that the first six reactors that are applied for will receive any fiscal incentive.

[156] Steven Mufson, *'Nuclear power primed for comeback'*.

[157] *'Nuclear Energy 'Indispensable' Part of Portfolio Approach to Climate Change, Says NEI Policy'* Nuclear Energy Institute, October 9, 2007. Available at: http://www.nei.org/newsandevents/newsreleases/nuclearenergyindispensable/.

[158] Edmund L. Andrews and Matthew L. Wald, *'Energy bill aids the expansion of atomic power plants'*.

[159] *'A call for action: consensus principles and recommendations from the US Climate Action Partnership'* United States Climate Action Partnership. Available at: www.us-cap.org

low carbon technology via other legislation. Either way, the nuclear industry in the United States will benefit.

Conclusion

The Bush government has made the consolidation of nuclear power a cornerstone of its energy policy and its efforts to combat climate change. The replacement and possible expansion of the ageing American nuclear reactor fleet has several international policy aspects. The international focus continues to be on proliferation and waste aspects of nuclear electricity generation. Via the Global Nuclear Energy Partnership, multilateral technical cooperation and strengthening of producer-consumer bond is pursued. Influenced by a broader geopolitical agenda, proliferation concerns with states outside the GNEP are dealt with on an individual basis. Therefore, the 2001 statement on nuclear cooperation with "*international partners with highly developed fuel cycles and a record of close cooperation"* firmly indicates what concerns are leading for the U.S. government when selecting international partners. India, a country that has remained outside the NPT treaty, is treated favourable as it is considered a large and strategically important democracy which would make it a natural cooperative partner. Meanwhile, Iran, a signatory state to the NPT and its additional protocol, is not considered such a partner due to its record of non-cooperation with the US and should therefore be barred from access to nuclear enrichment technologies.

At the same time the expansion of the American reactor fleet is pursued via financial incentives and the streamlining of procedures. The streamlined regulatory procedures, as well as design certifications for generation III+ reactors have been made available recently. Even with these new regulatory procedures fast construction of nuclear reactor in the US might be delayed by local not-in-my-backyard concerns and bottlenecks in construction capacity. To mitigate these concerns and make the use of the new regulatory procedures likely (in other words: see the expected number of applications actually materialize) long term profitable economics will be required for the next decades. Therefore, the currently expected "flood" in applications for Combined Operating Licences cannot be justified without the belief that alternatives will become more expensive in the future. The current tax incentives are not enough to justify an increase of more than six reactors. It is highly unlikely that the American taxpayer will put up with more then the 18,5 billion USD in public guarantees already in place for an expansion that does not even cover a third of the replacement reactors needed before 2056.

To keep the US nuclear industry in the fast lane, a cap-and-trade environment might be a substantial stimulus as the review of proposed legislation has shown. The nuclear industry will therefore continue to push for a cap-and-trade regime in the United States. A new dawn for nuclear power might not be considered all bad, because it could provide environmental opponents of nuclear industry with a major breakthrough on a cap-and-trade regime for carbon emissions. Likewise, the international efforts to create a follow-up to the Kyoto protocol, famously opposed by the current US government, may get an unforeseen boost from an industry that the government considers central in their efforts to avoid the need for such an follow-up.

Appendix 1: Operational, under construction, planned, and proposed nuclear reactors world wide[160]

January 2008	REACTORS OPERABLE[161]		REACTORS BUILDING[162]		REACTORS PLANNED[163]		REACTORS PROPOSED[164]	
	No.	MWe	No.	MWe	No.	MWe	No.	MWe
Argentina	2	935	1	692	1	740	1	740
Armenia	1	376	0	0	0	0	1	1000
Bangladesh	0	0	0	0	0	0	2	2000
Belarus	0	0	0	0	2	2000	0	0
Belgium	7	5728	0	0	0	0	0	0
Brazil	2	1901	0	0	1	1245	4	4000
Bulgaria	2	1906	0	0	2	1900	0	0
Canada*	18	12652	2	1500	4	4000	2	2200
China	11	8587	5	4540	30	32000	86	68000
China: Taiwan	6	4884	2	2600	0	0	0	0
Czech Republic	6	3472	0	0	0	0	2	1900
Egypt	0	0	0	0	0	0	1	1000
Finland	4	2696	1	1600	0	0	1	1000
France	59	63473	1	1630	0	0	1	1600
Germany	17	20339	0	0	0	0	0	0
Hungary	4	1826	0	0	0	0	2	2000
India	17	3779	6	2976	10	8560	9	4800
Indonesia	0	0	0	0	2	2000	0	0
Iran	0	0	1	915	2	1900	1	300
Israel	0	0	0	0	0	0	1	1200
Japan	55	47577	2	2285	11	14945	1	1100
Kazakhstan	0	0	0	0	0	0	1	300
Korea DPR (North)	0	0	0	0	1	950	0	0
Korea RO (South)	20	17533	3	3000	5	6600	0	0
Lithuania	1	1185	0	0	0	0	2	3200
Mexico	2	1310	0	0	0	0	2	2000
Netherlands	1	485	0	0	0	0	0	0
Pakistan	2	400	1	300	2	600	2	2000
Romania	2	1310	0	0	2	1310	1	655
Russia	31	21743	7	4920	8	9600	20	18200
Slovakia	5	2064	2	840	0	0	0	0

[160] Available at: http://www.uic.com.au/reactors.htm.

[161] Operating: connected to the grid.

[162] Building/Construction: first concrete for reactor poured, or major refurbishment under way (* In Canada, 'construction' figure is 2 laid-up Bruce A reactors).

[163] Planned: approvals, funding or major commitment in place, mostly expected in operation within 8 years, or construction well advanced but suspended indefinitely.

[164] Proposed: clear intention or proposal but still without firm commitment.

Slovenia	1	696	0	0	0	0	1	1000
South Africa	2	1842	0	0	1	165	24	4000
Spain	8	7442	0	0	0	0	0	0
Sweden	10	9086	0	0	0	0	0	0
Switzerland	5	3220	0	0	0	0	1	1000
Thailand	0	0	0	0	0	0	4	4000
Turkey	0	0	0	0	0	0	3	4500
Ukraine	15	13168	0	0	2	1900	20	27000
United Kingdom	19	11035	0	0	0	0	0	0
USA	104	99049	0	0	7	10180	25	32000
Vietnam	0	0	0	0	0	0	2	2000
WORLD	**439**	**372,059**	**34**	**27,798**	**93**	**100,595**	**222**	**193,095**

Appendix 2: Expected COL applications for new nuclear reactors in the United States[165]

Expected and Applied for New Nuclear Power Plants in the US 2007 - 2009				
Company	**Design Type**	**Site under Consideration**	**State**	**Existing Plants**
2007 Applications (Received by NRC)				
Duke*	AP1000	William Lee Nuclear Station (2 Units)	SC	No
Nustart Energy*	AP1000	Bellefonte (2 Units)	Al	No
Dominion*	ESBWR	North Anna (1 Unit)	AV	Yes
NRG Energy*	ABWR	South Texas Project (2 Units)	TX	Yes
2007 Total number of applications: 4 Total number of units: 7				
2008 Applications (Received and Expected by NRC)				
Progress Energy*	AP1000	Harris (2 Units)	NC	Yes
Unistar*	EPR	Calvert Cliffs (1 Unit)	MD	Yes
Progress Energy	AP1000	Levy County (2 Units)	FL	No
South Carolina Electric & Gas*	AP1000	Summer (2 Units)	SC	Yes
Southern Nuclear Operation Co.**	AP1000	Vogtle (2 Units)	GA	Yes
Entergy	ESBWR	River Bend (1 Unit)	LA	Yes
Nustart Energy*	ESBWR	Grand Gulf (1 Unit)	MS	Yes
Exelon	ESBWR	Victoria County (2 Units)	TX	No
PPL Generation	EPR	Berwick (1 Unit)	PA	Yes
AmerenUE	EPR	Callaway (1 Unit)	MO	Yes
Unistar	EPR	Nine Mile Point (1 Unit)	NY	Yes
TXU Power	US APWR	Comanche Peak (2 Units)	TX	Yes
Detroit Edison	TBD	Fermi (1 Unit)	MI	Yes
Amarillo Power	EPR	Vicinity of Amarillo (2 Units)	TX	Unk
Alternate Energy Holdings	EPR	Bruneau (1 Unit)	ID	No
2008 Total number of applications: 15 Total number of units: 22				
2009 Applications (Expected by NRC)				
Florida Power and Light	AP1000	Turkey Point (2 Units)	FL	Yes
2009 Total number of applications: 1 Total number of units: 2				
2007 - 2009 Total number of applications: 20 Total number of units: 31				

*** Received**

**** Received and EPC signed**

[165] Available at: http://www.nrc.gov/reactors/new-licensing/new-licensing-files/expected-new-rx-applications.pdf, and updated through company websites.