Appendix

Background Paper for Submission to the International Commission on Nuclear Non-proliferation and Disarmament Concerning the Civilian Use of Nuclear Energy

1. Introduction

Myth and reality frequently become confused in discussions about the civilian use of nuclear energy. This paper attempts to shed light on some of the prevalent myths associated with the following issues: International Atomic Energy (IAEA) safeguards, multilateral approaches to the nuclear fuel cycle and the prospects for a "nuclear renaissance".

2. Safeguards

2.1 Background

The "peaceful use of nuclear energy" was first promoted in the 1950s following US President Dwight Eisenhower's famous 1953 "Atoms for Peace" speech. The IAEA was established in 1957 and countries wishing to develop nuclear programs signed safeguards agreements with the IAEA. These agreements were supposed to ensure that materials and technology obtained through civilian nuclear energy programs were not diverted to the development of nuclear weapons, but the safeguards system was grossly inadequate to the task. It is probably more by good luck than good management that to date nuclear weapons have been acquired by "only" nine countries.

As the use of nuclear energy spread, improvements to the IAEA's safeguards system failed to keep pace with the increased risks. The IAEA was expected to take on increased responsibilities, despite the fact that it had neither the resources, nor the technical capability to carry out these responsibilities adequately. At times it appeared that the IAEA safeguards system was being used to provide a veneer of respectability for nuclear energy programs, when in fact the practical utility of the safeguards was very limited. The safeguards agreement reached between India and the IAEA in July 2008 is a recent example. It served the political purpose of justifying an exemption for India from international restrictions on nuclear trade, namely the guidelines of the Nuclear Suppliers Group, without limiting India's ability to produce nuclear weapons.

Now, when the IAEA's safeguards system is breaking under the strain of existing nuclear programs, the dawn of a "nuclear renaissance" is being heralded. If this "nuclear renaissance" ever eventuates, there is a danger that, as when the "peaceful use of nuclear energy" was first proclaimed, demands for a quantitative and qualitative expansion of nuclear energy will go racing ahead of efforts to

reform the safeguards system. Safeguards agreements with the IAEA will serve to provide an illusion of security, while the real danger of proliferation increases.

2.2 Key Questions

A detailed analysis of the fundamental challenges facing the IAEA safeguards system by the Strategic Studies Institute, *Falling Behind: International Scrutiny of the Peaceful Atom*[1] asks the question, "What is possible?" In answering this question it tackles the following additional questions:

> "Precisely what nuclear activities and materials can the IAEA monitor to detect a diversion early enough to prevent it? What inherent limits does the IAEA nuclear inspections system face? In light of these limits, what new initiatives should the IAEA Department of Safeguards attempt and, even more important, stay clear of? What additional authority and technical capabilities might the IAEA secure to help achieve its nuclear material accountancy goals? In the end, what is or should be protected as being "peaceful" under the Nuclear Nonproliferation Treaty (NPT) or the IAEA charter? What is the proper balance between expanding the use of nuclear energy and making sure it is not diverted to make bombs?" (p.4)

The International Commission on Nuclear Non-proliferation and Disarmament's discussion of safeguards would be deficient if it did not consider these questions. Proposals to address the proliferation problems arising from the civilian use of nuclear energy which do not address these issues are likely to exacerbate the problems they purport to solve.

2.3 Underlying Problems

The strain on the IAEA's safeguards system has three underlying causes: a lack of resources, a lack of legal authority and the inherent technical limits of the inspections system.

It might be argued that the lack of resources is simply a matter of political will. While that is probably true, it would be a mistake to underestimate the difficulty of adequately resourcing an effective safeguards program. Theoretically this should be the easiest problem to address, but history does not inspire confidence in the ability of the international community to summon up the political will to provide adequate resources for international institutions. However, if the

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[1] Henry D. Sokolski (Ed.), *Falling Behind: International Scrutiny of the Peaceful Atom*, Strategic Studies Institute, February 2008.
http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=841

international community is unwilling to provide adequate resources to effectively safeguard nuclear energy programs, there can be no justification for expanding the use of nuclear energy.

In regard to legal authority, the IAEA does not have the powers it needs to verify with certainty that states are not engaged in nuclear weapons development. For example, existing safeguards agreements only allow the IAEA to inspect declared facilities. Even for these facilities, it is difficult for the IAEA to gain access at short notice. In an effort to improve the safeguards system, an Additional Protocol and a system of integrated safeguards were introduced, but it is up to each state to decide whether or not it wishes to accept these additional conditions. It is hard to imagine all states accepting universalization of the Additional Protocol as the standard safeguards agreement. The chances of the 45-member Nuclear Suppliers Group making the Additional Protocol a requirement for supply might be marginally greater, but it cannot be said that this is likely in the near future. Furthermore, while the Additional Protocol is an improvement on standard safeguards agreements, it is not fool-proof. There is a danger that acceptance of the Additional Protocol and the implementation of integrated safeguards will lead to a false sense of security.

In order to reduce the risk of nuclear proliferation, it will be necessary to enhance the IAEA's powers and to establish new conditions and global norms governing civilian nuclear power programs and the nuclear fuel cycle. However, even if the political obstacles to adjusting the legal framework seem insurmountable, the limitations of the current system should not be fudged. Partial fixes must not be used as an alibi to justify expanding the use of nuclear energy.

While the problems of resources and legal authority have been widely acknowledged, including by the current IAEA Director General, Mohamed ElBaradei, the inherent technical limits of the IAEA inspections system have received less public attention. The IAEA's safeguards objectives are defined as "the timely detection of diversion of significant quantities of nuclear material". However, it is doubtful whether this objective can be met for some types of facilities. Henry Sokolski explains the current situation as follows:

> "Currently, the IAEA is unable to provide timely warning of diversions from nuclear fuel-making plants (enrichment, reprocessing, and fuel processing plants utilizing nuclear materials directly useable to make bombs). For some of these plants, the agency loses track of many nuclear weapons-worth of material every year."[2]

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[2] Henry D. Sokolski, "Assessing the IAEA's Ability to Verify the NPT" Chapter 1 in Henry D. Sokolski (Ed.), *Falling Behind: International Scrutiny of the Peaceful Atom*, Strategic Studies Institute, February 2008, p.7.

The following examples illustrate the point.

In 2003 it was discovered that of the 6.9 tons of plutonium separated at the Tokai reprocessing facility in the period from 1977 to 2002, the measured amount of plutonium was 206kg less than it should have been.[3] Given that the IAEA defines a "significant quantity" of plutonium as 8kg, this would mean that enough plutonium went missing to make about 26 bombs. After further investigations, the Japanese government claimed that it could explain where some of the missing plutonium had gone and reduced the figure to 59kg, but that is still enough for 7 bombs.

Compared to the 6.9 tons of plutonium separated in the fourteen odd years up to 2002 at Tokai, the design capacity of the Rokkasho Reprocessing Plant, which is now undergoing active tests, is 8 tons per year. That represents a very significant safeguards challenge. Japan Nuclear Fuel Ltd (JNFL), which owns and operates the plant, admitted that in large reprocessing plants, no matter how much measurement precision is improved, detecting "significant quantities" is "problematic" (a euphemism for "impossible"). JNFL staff said that a simple estimate of "material unaccounted for" (MUF) at Rokkasho could be in the order of 20~30 kgPu at the end of a one year accountancy period.[4] This is a far smaller error than other authorities estimate.[5]

Technical advances and the involvement of the IAEA from the design stage at Rokkasho have produced the most sophisticated (and the most expensive) safeguards in the world, but materials accountancy limitations remain. Other elements besides materials accountancy, including containment and surveillance, increase confidence in the system, but they do not replace materials accountancy, which is the central component of IAEA safeguards.[6] It is also important to remember that the effectiveness of the safeguards depends on the cooperation of the parties involved - the IAEA, the host state and the operator. Even in countries which have no intention of

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[3] Japan Atomic Industrial Forum, "Better Accounting of Plutonium Urged at JNC's Tokai Reprocessing Plant", *Atoms in Japan*, May 2003, pp.19~20.

[4] Hironobu Nakamura, Toshihiko Utsugi, Yoshihiko Noguchi, Hideto Adachi, Tomonori Iwamoto, "Material Accountancy and NDA Approach for U-Pu Co-Denitration Area (MBA-4) at RRP", *The 25th Annual Meeting of the INMM (Institute of Nuclear Materials Management) Japan Chapter: Record of Proceedings*, 2005 p.203, 207. (Meeting held 11 November 2004, Japanese article.)

[5] The IAEA suggests an "expected measurement uncertainty" for reprocessing plants of 1%, which would represent 80 kgPu for Rokkasho. See *IAEA Safeguards Glossary*, 2001 Edition, p.53.

[6] International Atomic Energy Agency, INFCIRC/153 (Corrected), June 1972
"29. …the Agreement should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures."

developing nuclear weapons, relations can become strained, so it is unrealistic to expect that safeguards will always perform as well in practice as they do in theory.

The Rokkasho example illustrates the difficulty of safeguarding large commercial reprocessing plants. At the other end of the scale, small-scale "quick-and-dirty" reprocessing operations can be carried out with "technology little more advanced than that required for the production of dairy products and the pouring of concrete".[7] Such facilities can be hidden from IAEA inspectors, while plutonium is extracted for use in nuclear weapons. Finally, the stockpiles of plutonium produced by reprocessing facilities are a continual temptation for terrorists. As the following quote points out, securing facilities and materials against non-state actors presents major challenges:

> "The problem is that aspects of domestic security that are important in countering internal threats, such as access authorization programs, would remain out of the IAEA's formal domain, even under the provisions of the revised Convention on Physical Protection of Nuclear Material (CPPNM). This dichotomy between state and nonstate actors, which appears more and more artificial today in a world where their interests are often intertwined, will hinder efforts to build comprehensive systems to effectively ensure that civil nuclear facilities cannot become covert sources of fissile material for either states or subnational groups."[8]

It is hard to see how nuclear weapons can be eliminated in a sustainable way unless reprocessing is phased out. To attempt to safeguard ever-expanding stocks and flows of plutonium is to fight a losing battle. As an interim measure it is important to apply the best safeguards available to existing facilities, but the goal must be to eliminate reprocessing. Fortunately, this will be no great loss. Whereas uranium enrichment is an unavoidable component of light water reactor based nuclear power programs, reprocessing is both unnecessary and uneconomic.[9,10]

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[7] Henry D. Sokolski, "Assessing the IAEA's Ability to Verify the NPT" Chapter 1 Appendix II (The Proliferation Dangers of LWRs) in Henry D. Sokolski (Ed.), *Falling Behind: International Scrutiny of the Peaceful Atom*, Strategic Studies Institute, February 2008, p.58.

[8] Ed Lyman, "Can Nuclear Fuel Production in Iran and Elsewhere be Safeguarded Against Diversion?" Chapter 5 in Henry D. Sokolski (Ed.), *Falling Behind: International Scrutiny of the Peaceful Atom*, Strategic Studies Institute, February 2008, p.103-104.

[9] For analysis in support of this claim, see Frank von Hippel, *Managing Spent Fuel in the United States: The Illogic of Reprocessing*, A research report of the International Panel on Fissile Materials, January 2007.

[10] See also the following comment about the cost of the Rokkasho Reprocessing Plant by Liberal Democratic Party Diet Member Taro Kono (currently chair of the House of Representatives Foreign Affairs Committee) in an interview with the Japanese consumer magazine *Tsuhan Seikatsu*:

2.4 Inconvenient Truths

As explained in section 2.1, "the peaceful use of nuclear energy" was promoted and is still promoted without due consideration of the resource, legal and technical limitations of the IAEA safeguards system. Under these circumstances it is highly likely that any expansion of nuclear power will exacerbate the already serious risk of further nuclear proliferation. In this regard, the Commission should consider the advice of a December 2008 report commissioned by the US Congress.[11]

> "Concern about the spread of nuclear weapons intensifies with the possibility of a large increase in nuclear power production to meet growing energy demands—a nuclear renaissance. As additional countries acquire nuclear facilities—particularly if they build uranium enrichment facilities or reprocessing facilities, ostensibly to provide fuel for their power plants and reduce the waste associated with the spent nuclear fuel—the number of states possessing the knowledge and capability to "breakout" and produce nuclear weapons will increase significantly." (pp.14,15)

> "The spread of nuclear technology and nuclear material heightens concern that non-nuclear-weapon states might decide to develop nuclear weapons, building on their civilian nuclear industry. It also increases the possibility that terrorists might be able to steal—or buy from an insider—the materials or technical knowledge needed to construct a nuclear weapon. We should discourage, to the extent possible, the subsidizing of nuclear energy in ways that would cause states to choose it over other energy sources, without fully accounting for this risk." (pp.55,56)

There are fundamental issues for the prevention of nuclear proliferation which must be solved

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"If you divide [the difference in the cost of electricity with and without reprocessing] by kilowatt hours, it works out to a difference of 0.5 yen, but the total difference is 10 trillion yen....If the next plant is built, the cost will be even greater. Already for construction alone 2.1 trillion yen has been spent on the Rokkasho Reprocessing Plant. That is 3 times the original estimate of 0.7 trillion yen. In the end it is the consumers who will have to foot the bill." (Spoken in response to comments by Hajimu Yamana of Kyoto University.)
"Heated Debate: Considering Japan's Energy Problem - Should the Rokkasho Reprocessing Plant be Operated or Abandoned?" (An interview which took the form of a debate between two supporters (Taro Kono and Hitoshi Yoshioka) and two opponents (Hajimu Yamana and Kumao Kaneko) of the Rokkasho Reprocessing Plant), *Tsuhan Seikatsu* No. 234, October 2008, p.205. Published by Catalogue House. (Translation by CNIC.)

[11] *World at Risk: The Report of the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism*, Vintage Books, December 2008.

before any expansion of nuclear energy can be contemplated. "Political realism" must not become an excuse for avoiding inconvenient truths.

3. Multilateral Approaches

In an attempt to solve proliferation problems associated with the civilian use of nuclear energy, many proposals have been put forward to internationalize particularly problematic stages of the nuclear fuel cycle, notably uranium enrichment, reprocessing, fuel fabrication and waste disposal. Despite the superficial appeal of these proposals, they have not come to much so far.

IAEA Director General, Dr. Mohamed ElBaradei, who is a strong proponent of this approach, commissioned a team of experts to investigate multilateral approaches to the nuclear fuel cycle. Given the circumstances under which the investigation was commissioned, it is not surprising that the experts tended to support multilateral approaches. Perhaps it is more surprising that they did not come down unequivocally in favor of them. Their report identified many problems with multilateral approaches, some of which would be very hard to solve.[12] For example, it is clear that it is impossible to eliminate the danger of a so-called "breakout" scenario, where a country hosting an international facility withdraws the facility from multilateral control and uses it to produce nuclear weapons material. Furthermore, technical skills gained within multilaterally controlled civil programs could be transferred to weapons programs. Some proponents of multilateral approaches downplay these and other risks, or argue that the risks of not adopting multilateral approaches are even greater. Inevitably judgments are subjective, but it would be a great mistake to pretend that internationalization will solve all the problems of the nuclear fuel cycle.

One specific proposal to develop an international response to the nuclear proliferation problems associated with the civilian use of nuclear energy is the Global Nuclear Energy Partnership (GNEP). When GNEP was first proposed by the Bush Administration in February 2006, it was described on the Department of Energy's web site as follows:

> "…the Global Nuclear Energy Partnership (GNEP) seeks to develop worldwide consensus on enabling expanded use of economical, carbon-free nuclear energy to meet growing electricity demand. This will use a nuclear fuel cycle that enhances energy security, while promoting non-proliferation. It would achieve its goal by having nations with secure,

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[12] *Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report to the Director General of the International Atomic Energy Agency*, International Atomic Energy Agency, 22 February 2005.

advanced nuclear capabilities provide fuel services — fresh fuel and recovery of used fuel — to other nations who agree to employ nuclear energy for power generation purposes only. The closed fuel cycle model envisioned by this partnership requires development and deployment of technologies that enable recycling and consumption of long-lived radioactive waste."[13]

The "closed fuel cycle model" would employ so-called "proliferation-resistant recycling" technologies. This represents a departure from past US policy, which eschewed reprocessing of spent nuclear fuel. However, it has become increasingly clear that the proliferation resistance of the proposed technologies ranges from very limited to virtually nil.[14] The nature of the partnership remains vague, cost and technical barriers are high and it is likely that the Obama Administration will restrict GNEP, or even abandon it altogether.

In the quest for solutions to intractable proliferation problems, internationalization must not be seen as a panacea. Proposals to implement multilateral approaches to solve problems associated with the nuclear fuel cycle should be rigorously scrutinized, in order to ensure that they will not exacerbate the problems they purport to solve.

4. Nuclear Renaissance

4.1 Background

At this point in history it is far from certain that a "nuclear renaissance" will in fact occur. Three countries in Asia - China, India and South Korea - account for almost half the reactors currently listed as under construction on the IAEA PRIS web site (22 out of 46).[15] Several of the reactors listed as under construction in Eastern Europe have been "under construction" for over twenty years, while only two reactors are currently under construction in Western Europe. Construction of the only reactor listed as "under construction" in the US was started in 1972. On this basis, it would be a very loose use of the English language to claim that a "nuclear renaissance" is already underway.

There are many proposals for new reactors in the US, but no firm commitments have been made. At this stage no one knows how many of these reactors will actually be built. Many countries have expressed an interest in building nuclear power plants for the first time, but it is far from clear

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[13] *Global Nuclear Energy Partnership*, US Department of Energy Website: http://www.gnep.energy.gov/

[14] Frank von Hippel 2007 op. cit.

[15] IAEA Power Reactor Information System web site: http://www.iaea.org/programmes/a2/

whether any of these plans will materialize. As discussed below, there are grounds to doubt the optimistic predictions of some commentators.

At this stage all that can be said about the "nuclear renaissance" is that a significant revival of nuclear construction might be just around the corner, or it might not be. The following quotes and comments which illustrate the gap between rhetoric and reality. Some of these quotes also cast doubt on claims that nuclear energy is an appropriate way to address climate change.

4.2 Selected Quotes and Comments

(a) Rising cost estimates and credit risk

Quote 1 (May 2008): "[Nuclear] technology is very costly, potentially reaching over $7,000 per kilowatt (kw) of capacity – by some estimates almost twice as much as new, scrubbed coal-fired power plants and three times as much as new, combined cycle natural gas power plants."[16]

Quote 2 (July 2006): "Projected costs of new nuclear power plants in the US have risen significantly in the recent past, as labor and materials costs rise and vendors complete a greater portion of detailed engineering, according to executives at Westinghouse, Areva NP, and General Electric. While all cautioned that it's difficult to compare numbers without knowing the precise scope of a given estimate, the three vendors quoted figures between $1,600 and $2,000 per installed kilowatt, a far cry from the $1,200/KW that some were vaunting at the beginning of the decade."[17]

Quote 3 (June 2008): "The cost and complexity of building a new nuclear power plant could weaken the credit metrics of an electric utility and potentially pressure its credit ratings several years into the project, according to a new report from Moody's Investors Service."[18]

Comment: Comparing the first and second quotes, it can be seen that the Moody's estimate, which is typical of recent estimates, is several times higher than earlier estimates. Rising cost estimates and credit risks put a damper on expectations of a nuclear revival.

(b) Extravagant demands for subsidies in the US

Quote: "The Nuclear industry wants as much as $100 billion in DOE loan guarantees for new reactors during President-elect Barack Obama's administration. Industry officials have long criticized the current pool of $18.5 billion to support the deployment of new reactor designs as

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[16] Moody's Corporate Finance, *New Nuclear Generating Capacity: Potential Credit Implications for U.S. Investor Owned Utilities*, May 2008, p.2.

[17] Ann MacLachlan, "Estimates increase for costs of new nuclear plants in US", *Nucleonics Week*, Platts, 6 July 2006.

[18] Moody's Investors Service Global Credit Research Announcement, "Moody's: Nuclear plant construction poses risks to credit metrics, ratings", 2 June 2008.

inadequate. The 14 new-reactor applications already filed with DOE total $122 billion..."[19]

Comment: There are many proposals for new nuclear reactors in the US, but there is no certainty that any of them will actually proceed. It has always been doubtful whether nuclear power projects could attract finance without massive government support. This is now even more uncertain, due to the financial crisis. Furthermore, President Obama has not so far shown any enthusiasm for nuclear energy. He might not be as willing as his predecessor to bankroll a massive new construction program.

(c) Problems with construction of new plants in Finland and France

Quote 1: Finland's Okiluoto-3 plant (1,600-MW, EPR) - "On October 17, TVO said startup of the unit is about three years behind schedule."[20]

Quote 2: France's Flamanville-3 plant (1,650-MW, EPR) - "Inflation and technical and regulatory changes share the bulk of the 20% cost overrun announced last week on the overnight cost of the Flamanville-3 EPR under construction in Normandy, Electricite de France said."[21]

Comment: These are the only new plants under construction in Western Europe and they have both been plagued by problems. They are already way over-budget and behind schedule. They were meant to be showpieces for a new generation of nuclear power plants, but in fact they are exposing once again the unreliability of cost and construction time estimates for untested large-scale equipment.

(d) Stagnant demand in Japan

Quote: "A look at the plan for construction of new nuclear reactors reveals that the dates have been pushed back year after year. Some have been postponed for over 10 years…Decisions to construct power stations are determined by peak power output, so as long as peak power output does not increase, [Electric Power Companies] want to postpone construction of new nuclear power plants."[22]

Comment: Decisions to build new plants are based on both minimum demand and peak demand. In Japan, minimum demand has been growing. This favors nuclear energy, which is used for base-load generation, but as long as peak demand does not also grow, Japanese power companies are not keen

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[19] *Nuclear News Flashes*, Platts, December 11, 2008.

[20] Ariane Sains and Ann MacLachlan, "TVO CEO sees improved workflow, potential for problems at Olkiluoto-3", *Nucleonics Week*, Platts, 20 November 2008.

[21] Ann MacLachlan, "EDF: Flamanville-3 cost rise due to inflation, technical/regulatory changes", *Nucleonics Week*, Platts, 11 December 2008.

[22] Baku Nishio, "Electric Power Supply Plan in an Era of Saturated Demand", *Nuke Info Tokyo No. 124*, Citizens' Nuclear Information Center, May/June 2008. http://cnic.jp/english/newsletter/nit124/nit124articles/electsupply08.html

to increase nuclear generation capacity.

The Japanese government's greenhouse gas emissions reduction plan was premised on the construction of a large number of new nuclear power plants. Had the government relied less on nuclear and more on energy efficiency and renewable energy, it might not be falling so woefully short of its emissions reduction target.[23] Also, there is an inherent contradiction in relying on the construction of new nuclear power plants to achieve a reduction in greenhouse gas emissions. New nuclear power plants will not be built unless energy demand grows, but the most effective way of reducing emissions is energy efficiency, which results in lower energy demand.

(e) Stalled and cancelled projects

Quote 1: South Africa - "South African utility Eskom last week scrapped its tender for a turnkey nuclear power station, saying the magnitude of the investment was too much for it to handle."[24]

Quote 2: Turkey - "After more than a year of preparation, the sole bid to construct Turkey's first nuclear power plant at Akkuyu on the Mediterranean Sea was submitted September 24 by Russia's Atomstroyexport, or ASE, in partnership with Ciner Holding, a Turkish company with interests in media and mining…"[25]

Quote 3: Indonesia - "Because of unfavorable political constellations and public reaction to a series of natural disasters which has beset the country since 2004, Indonesia will miss the target set two years ago by nuclear energy planners to begin generating electricity with uranium fuel on Java no later than 2017, Indonesian officials told Platts last week."[26]

Comment: South Africa already has two reactors, while Turkey and Indonesia are hoping to build their first nuclear power plants. In the Turkish case, several other bidders withdrew and it is doubtful that the project will proceed on the basis of a single bid. In the Indonesian case, the local branch of the nation's largest Islamic organization, Nahdlatul Ulama, declared the proposed Muria

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[23] Greenpeace International and European Renewable Energy Council, *energy [r]evolution: A Sustainable Japan Energy Outlook*, June 2008, p.5.

> "While the required reduction target for Japan is 6% below the 1990 level, Japan's emissions on the contrary have been increasing. In fiscal 2005, the year with the most up-to-date official figures available, Japan's emissions were 7.8% higher than the base year. This means Japan will actually have to achieve a reduction of about 14%, if it is to meet Kyoto Protocol commitments."

[24] Ann MacLachlan, "Eskom cancels tender for initial reactors", *Nucleonics Week*, Platts, 11 December 2008.

[25] Mark Hibbs, "Council of Ministers to decide future of Turkey's reactor bid", *Nucleonics Week*, Platts, 6 November 2008.

[26] Mark Hibbs, "Politics and calamities stalking Jakarta's nuclear power ambitions", *Nucleonics Week*, Platts, 27 September 2007.

nuclear power plant to be "haram" or "forbidden". There is considerable uncertainty about the future of each of these projects, but their failure to date casts serious doubt on the prospects for nuclear energy in developing countries.

(f) Industry bottlenecks

Quote: "The limited number of manufacturers and suppliers could cause bottlenecks in construction if there were multiple orders for new nuclear power plants in the US and abroad, industry officials said last week."[27]

Comment: Predictions of a "nuclear renaissance" tend to overlook the decline in the nuclear industry's capacity and the lack of skilled staff. Even if money could be found to finance the construction of new nuclear power plants, industry would not be able to build them fast enough to meet the more optimistic scenarios, or to make a useful contribution to reducing greenhouse gas emissions (see (h) below).

(g) Real trends in nuclear generation

Quote: "The IAEA has revised upwards its nuclear power generation projections to 2030, while at the same time it reported that nuclear's share of global electricity generation dropped another percentage point in 2007 to 14%. This compares to the nearly steady share of 16% to 17% that nuclear power maintained for almost two decades, from 1986 through 2005…[W]hile projections for nuclear power's future rose, its share of the world's electricity generation today dropped from 15% in 2006 to 14% in 2007. "The reason is that while total global electricity generation rose 4.8% from 2007 to 2008, nuclear electricity actually dropped slightly", Rogner commented."[28]

Comment: Reading the full IAEA staff report, one gets the impression that the prospects for nuclear energy are bright, even though the report announces the results of a disastrous year for nuclear power generation. Although the dates are rather confusing, it is clear that the reduction in nuclear generation was an absolute reduction, not just a relative reduction. The disjunction between rhetoric and reality should alert people to the fact that projections by organizations such as the IAEA, which are dedicated to promoting nuclear energy, are invariably over-optimistic. Projections for the year 2030 are unlikely to bear much relation to what will actually happen in 2030. At this very uncertain point in history the only basis for projecting the future of nuclear power is binding construction contracts.

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[27] Jenny Weil, "Supply chain could slow the path to construction, officials say", *Nucleonics Week*, Platts, 15 February 2007.

[28] IAEA Staff Report, "Nuclear's Great Expectations: Projections Continue to Rise for Nuclear Power, but Relative Generation Share Declines", 11 September 2008 http://www.iaea.org/NewsCenter/News/2008/np2008.html

(h) Climate change and nuclear power

Quote: "Even a massive, four-fold expansion of nuclear power by 2050 would provide only marginal reductions (4%) in greenhouse gas emissions, when we need global emissions to peak at 2015 and 50 - 80% cuts by 2050. Nuclear energy's 'contribution' to fighting climate change would come too late (long after 2020), with huge costs (US$ 10 trillion) and would create a myriad of other serious hazards related to accidents, waste and proliferation. These large costs and negative impacts make nuclear energy an obstacle to the necessary development of effective, clean and affordable energy sources – both in developing and industrialised countries."[29]

Comment: The figures in this quote are based on a comparison of the OECD International Energy Agency's (IEA) *Energy Technology Perspectives 2008* Blue Map scenario and the World Energy Outlook 2007 450 ppm case.

4.3 Conclusion

The above quotes and comments suggest that reports of a "nuclear renaissance" are premature. The good news is that there is no cause for alarm if an expansion of nuclear energy does not eventuate. Nuclear was not going to solve the problem of climate change anyway. Nevertheless, the fact that so many countries which do not currently possess nuclear power stations, including countries in regions of tension, have expressed interest in nuclear power is reason enough to make a concerted effort to address the proliferation implications of the civilian use of nuclear energy.

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[29] Quoted from a call to remove "nuclear activities" as an option in the Clean Development Mechanism of the Kyoto Protocol. The call was endorsed by over 300 organizations representing millions of members in 48 countries and submitted at the United Nations Climate Change Conference in Poznań on 10 December 2008 (COP 14).