OPEN LETTER AND QUESTIONS CONCERNING THE RELEVANCE OF NUCLEAR POWER IN ADDRESSING THE PROBLEM OF GLOBAL WARMING

26 April 2007

Dear Professor James Lovelock,

We wish to express our deep respect for your keen insight in sounding the alarm from a very early stage concerning the threat of global warming to human society and the ecosystem of the planet, and for explaining through your "Gaia Theory" how the planet behaves as one being.

At the same time, however, we cannot agree with your view that maximizing the use of nuclear fission energy [1] is an appropriate way to address global warming.

At the 43rd anniversary symposium commemorating Nuclear Energy Day organized by the Japan Atomic Energy Relations Organization (JAERO) on 25 October 2006, you gave a keynote speech entitled "The Revenge of Gaia". Shortly thereafter, on 29 October, JAERO published full-page advertisements in Japan's major national newspapers, featuring your keynote speech as a promotion for nuclear power[2]. In 2004 also, you appeared in a newspaper advertisement taken out by this same organization [3].

As you are aware, this organization is an organ created by the national government to promote nuclear power to the Japanese public. We find it very regrettable that Japan's nuclear program is being promoted by you in this manner.

We believe, for the reasons elaborated below, that the expansion of nuclear power is not an effective way of preventing global warming. We believe that, instead of promoting nuclear power, we should actively encourage the introduction of safer and more reliable alternatives.

On this 21st anniversary of the Chernobyl accident, we convey to you our views and, at the same time, sincerely ask you to reply to the questions listed below. We are addressing this open letter and questions to you, and, at the same time we are making the letter available to the public.

Signatory Organizations

Citizens' Nuclear Information Center (CNIC)

Consumers Union of Japan

Global Peace Campaign

Green Action

Greenpeace Japan

Group of Ten Thousand Plaintiffs for the Lawsuit to Stop the Nuclear Fuel Cycle

Institute for Sustainable Energy Policies (ISEP)

Japan Congress Against A-and H- Bombs (GENSUIKIN)

Kiko (climate) Network

Osaka Citizens against the Mihama, Ohi and Tkahama Nuclear Power Plants

Peace Boat

Peace food action net. ILFA (International life & food association)

Sun & Wind Power Trust for Citizens

Women's Democratic Club

(The attached is an initial list of signatory organizations. There will be additional organizations signing on to this letter)

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When the Japanese government promotes nuclear power, it quotes your views as follows[4]:

"Nuclear energy would pose an insignificant threat. Renewable energy sounds good, but so far it is inefficient and expensive. It has a future, but we have no time now to experiment with visionary energy sources. I see nuclear energy as the only effective medicine we have now."

1) In your view how many nuclear power plants will be needed worldwide and by when in order for nuclear power to become an effective medicine to combat global warming?

Our View:

1. Nuclear power is not an effective medicine for the problem of global warming.

You advocate switching from fossil fuels to nuclear power.

Even if carbon dioxide emissions were to be immediately reduced to zero, due to human-induced CO_2 emissions to date, it seems certain that we will still not be able to avoid a rise in the earth's mean temperature[5]. According to the most up-to-date scientific information, in

order to avoid a catastrophic impact from climate change, it will be necessary to limit the rise in the earth's mean temperature to within 2 degrees of pre-industrial times (pre-1850). In order to accomplish this, within the next 10 years we will need to switch from increasing global CO_2 emissions to decreasing them, and by 2050 attain a 50 percent reduction from 1990 emission levels.

As we explain below, at a time when urgent action is required, nuclear energy cannot be a realistic means of combating global warming.

At the end of 2003, there were 434 nuclear reactors worldwide producing electricity. These reactors produced only 16 percent of total electricity supplied and 6 percent of total primary energy[6]. Assuming the life-span of a reactor to be 40 years, by 2025 more than half, and by 2050 all of the reactors presently operating will have ended their operating lives[7].

At present fossil fuels produce 66 percent of all electricity[8]. If nuclear power plants were to replace all fossil fuel plants and all the current nuclear power plants which will be decommissioned, about 2,230 new nuclear reactors (1000 MW(e) reactors operating at 70 percent capacity) would have to be built, even if future electricity demand is assumed to be flat. If this increase is to be accomplished by 2025, two new reactors will have to go on line every week, or if the increase is to be accomplished by 2050, then one new reactor must go on line every week.

At present there are 55 nuclear power reactors operating in Japan. These reactors produce approximately 30 percent of total electricity and 10 percent of total primary energy. About 145 new reactors will be required in Japan if the same conditions indicated above prevail, where new reactors replace old ones and additional reactors are built to replace fossil fuel plants which currently produce about 60 percent of electricity. This is assuming that electricity demand remains flat. If this is to be accomplished by 2050, then every 3 – 4 months, a new reactor will need to go on line.

If worldwide electricity demand were to increase, then the rate at which new reactors would need to be built would increase proportionally. If one considers the cost of bringing a nuclear reactor on line (several billion US dollar per reactor), the time taken from planning to actual operation (approximately 10 years), and - depending on the country - the infrastructure needed (such as high voltage lines), it is for all practical purposes impossible for nuclear power to solve the problem of global warming during this coming crucial decade, during which time we must go from increasing CO_2 emissions to decreasing them.

2. Conservation and Energy Efficiency are Paramount

The most effective measures for reducing greenhouse gases are energy conservation and increased energy efficiency. The International Energy Agency (IEA), Japan's National Institute for Environmental Studies and others state likewise in their reports[9]. Considering that the electricity sector, which is responsible for nearly 40 percent of world CO_2 emissions, wastes a large portion of its energy, it is vitally important that this sector's energy efficiency be improved.

In Japan, approximately 40 percent of primary energy is used to generate electricity. The efficiency of nuclear power plants does not exceed 35 percent. Even electricity production efficiency of the most up-to-date fossil fuel plants is only around 50 percent.

At present a large portion of the heat produced by electricity generation is thrown into the environment as waste heat. In other words, the majority of the energy used to produce electricity is wasted. In the case of nuclear power, the plants are by necessity built in locations far from areas with high electricity consumption. Therefore, there are also large transmission losses.

Compared to this type of massive, centralized electricity system, decentralized systems supply electricity on-site where it is needed. Energy losses in production and transmission can be minimized. If, in addition, cogeneration systems are employed, maximum use can be made of "waste heat" for heating, cooling, hot water and steam. The end result is that total energy efficiency is increased to over 80 percent. Thus energy conservation and significant CO_2 emissions reductions can be achieved. In Denmark, already 50 percent of electricity and 80 percent of district heat is supplied by cogeneration plants[10].

On the other hand, as we state below, because of its inherent nature, nuclear power actually impedes development of the most important measures to prevent global warming – energy conservation and energy efficiency -- by entrenching a society which is wasteful in its use of energy.

3. Nuclear Power Runs Counter to Energy Conservation

Because nuclear reactors cannot adjust output readily, they cannot deal with the constantly fluctuating demand for electricity. Fossil fuel plants are the main means of dealing with these fluctuations. Hence, nuclear power plants and fossil fuel plants come in tandem.

Nuclear power also has structural problems stemming from the large amounts of electricity

produced per unit. When demand is low, either seasonally or during the late night hours, electricity production exceeds demand. In order to consume this surplus electricity, in Japan additional facilities (for example pumped storage generation stations, which consume more electricity than they produce) and systems (such as late night lower electricity rates) have been put in place. The effect of these measures is to in fact increase electricity demand.

With nuclear power, because output per unit is very large, if a reactor is shutdown due to an accident or a scandal, this has an adverse effect on the stability of supply. Because electricity from nuclear power plants supplies large metropolitan and industrial areas, sudden shutdowns can cause economic and social disruption. Fossil fuel plants are built in order to assure an immediate supply of large quantities of replacement electricity.

As a result, in order to deal with fluctuations in demand and to supply back-up energy, if more nuclear power plants are installed, additional fossil fuel plants and other types of power plants will also be required. Since power companies are reluctant to waste these investments in additional facilities by keeping them closed or operating them below capacity, they promote schemes to increase demand for electricity, such as the “all electric” campaign for residential buildings.

For the above reasons, nuclear power does not help to conserve energy.

4. It is Impossible to Ensure the Reduction of CO_2 Emissions with Nuclear Power

The capacity factor of Japan’s nuclear power plants is about 70 percent. However, the Japanese government calculates CO_2 emissions reduction estimate based on the assumption that the capacity factor will rise to 88 percent[11].

Nuclear power carries with it the latent risk of serious accidents. Therefore, if there is some kind of problem or accident at one reactor, it may be necessary for other reactors of the same model to be shutdown simultaneously for inspections[12]. The risk of accidents also increases if nuclear reactors are pushed to continue operation in order to achieve production efficiency targets[13].

Because electricity supply shortages resulting from the shutdown of nuclear reactors are, for the most part, managed using fossil fuel plants, emissions of CO_2 shoot up every time as an accident or incident takes place at any plant and the plant is shut [14]. This actually happened between 2002 and 2003 in Japan, when a scandal involving falsification of inspection data at several of Tokyo Electric’s nuclear power plant units resulted in the shutdown of all of the

utility's 17 nuclear reactors. As a result, greenhouse gas emissions in Japan increased 4.8% during this period. Such unscheduled, long-term shutdowns have occurred time and again, and with the further aging of nuclear reactors, the frequency of such unscheduled shutdowns will no doubt increase[15].

It now appears unlikely that Japan will be able to meet its commitment of decreasing its annual CO_2 emissions by 6 percent, as promised under the Kyoto Protocol. Japan will not be able to attain a steady decrease in CO_2 emissions as long as it depends on nuclear power in a major way to accomplish this reduction.

5. Expansion of Nuclear Power Aggravates Global Warming

According to an opinion poll undertaken in 2005 by the International Atomic Energy Agency (IAEA), 76 percent of the Japanese public is opposed to building more nuclear power plants in Japan[16]. Because of the difficulties of building more nuclear reactors domestically, the Japanese nuclear industry is planning to go abroad to build nuclear reactors in developing countries, including countries in Asia. The Japanese government is actively supporting this by stating that it is "a response to global warming"[17].

Under the Kyoto Protocol, reductions of CO_2 emissions resulting from projects undertaken abroad can be counted as reductions in the emissions of the country investing in the project. The Clean Development Mechanism (CDM) is one of the mechanisms adopted under the Kyoto Protocol. Nuclear power, however, is not regarded as a part of the CDM.

The Japanese government has decided on a policy to push for the inclusion of nuclear power projects under the CDM in the next round of the Kyoto framework[18]. By doing so, it hopes to encourage the domestic companies to invest in infrastructure for the export of nuclear power plants so as to create a favourable environment for nuclear industry to enter foreign markets.

However, the transfer of nuclear technology to developing countries is nothing but the export of an inefficient energy system. Since nuclear power requires planning decades into the future, if energy policies that include nuclear power go ahead, it will be difficult to change this path, thus societies based on massive energy consumption will be created. This is exactly what Japan and other nations with nuclear power plants have already experienced. Also, as mentioned above, more adjustment and backup fossil fuel plants will have to be built.

The introduction of nuclear power to developing countries will not help to reduce greenhouse gases. What should be developed and disseminated instead are decentralized

systems based on renewable energy sources.

2) Do you believe that accidents like the Chernobyl Accident (1986) and the Tokai Criticality Accident (1999) will never happen again?

Our View:

Even conservative risk assessments estimate that the probability of a core meltdown occurring is once every 4,000 reactor years[19]. Such a risk means that if there were 2,000 operating reactors in the world, there would be one core meltdown accident every two years. Of course, past accidents demonstrate that Probabilistic Risk Assessment is incapable of accurately assessing the risk of accidents[20].

The big difference between accidents at nuclear facilities and other types of accidents is that the former involve the release of radioactivity. In general, the core of operating reactors can accumulate as much as 1,000 times the fission products released by the Hiroshima bomb.

Therefore, if an accident involving the release of large quantities of radioactivity were to occur, the damage that would be inflicted on people, the environment, society and the economy would be orders of magnitude larger.

The whole of the Northern Hemisphere was contaminated with radioactivity from the Chernobyl accident. It is thought that the number of people who suffered as a result of the accident exceeded 7 million[21], but there is considerable variation in estimates of the number of cancer deaths[22]. The Chernobyl Forum estimated that only 4,000 people would die of cancer as a result of the accident[23]. One reason for this very low estimate was the extremely restricted target population. Greenpeace, for example, estimated that 93,000 would die of cancer as a result of the Chernobyl accident[24].

In regard to the damage caused by this accident, you said, “If the dam burst, perhaps as many as a million people would be killed in the wave of water … Many think that tens of thousands if not millions died as a result of the Chernobyl accident. As we will see, it was no more than seventy-five.”[25] In the first place, comparing the number of deaths resulting from the breach of a dam with the number resulting from a nuclear accident goes against scientific common sense. Secondly, it is not possible to assess the damage from an accident involving radioactivity from the number of cancer deaths alone. An increase in the rate of thyroid cancer amongst young people has been confirmed in the affected regions and a wide range of other

physical and psychological impacts has been reported[26]. Furthermore, the survivors suffer from direct and indirect effects, which they will have to live with for the rest of their lives.

If there is an expansion of nuclear power, the risk of a serious accident like this occurring again somewhere in the world will increase. This is especially true for earthquake prone countries like Japan. To prevent ever more people becoming nuclear victims, we believe that energy policies must be changed. Policies must be chosen which do not make us dependent on nuclear energy.

3) How do you propose that low, medium and high-level radioactive waste, accumulated as a result of the operation of nuclear reactors, should be disposed of?

Our View:

Many developing countries will soon begin building up their energy systems in earnest. On the other hand, developed countries are approaching a period when they will have to replace aging buildings and power plants. Hence, the choices of energy systems and energy sources that are made now have great significance in the context of our response to global warming.

One of our reasons for not supporting nuclear energy as a viable energy choice is that the waste it produces is radioactive. When nuclear power plants end their operating lives, the buildings and equipment, including but not limited to the reactor itself, become huge piles of radioactive waste.

All countries that have introduced nuclear energy have postponed the problem of dealing with radioactive waste to a future date. For most countries there is no prospect that they will establish a disposal site for high-level waste (spent nuclear fuel and vitrified high-level waste) anytime soon. The method proposed in existing plans is geological disposal, but it will be millions of years before the radioactivity contained in the waste will decrease to the point where it can be said to be harmless. During that period, the possibility that massive earthquakes and upheavals will cause changes in the earth's crust cannot be eliminated. There are also other dangers posed by contamination of ground water and the possibility of terrorism[27].

Expanding nuclear power means generating more and more radioactive waste, which will be handed down as a legacy to future generations. We cannot consent to such an irresponsible "response to global warming".

You have proposed disposing of high-level radioactive waste in tropical forests[28]. Tropical forests are the most biologically diverse places on earth and their ecosystems are extremely fragile. By absorbing carbon dioxide, they also help maintain the balance of carbon dioxide in the atmosphere. It is inconceivable that a huge radioactive waste disposal facility could be built without destroying the surrounding forest. The destruction of the forest would probably actually exacerbate global warming.

4) What is your view on the dangers of nuclear proliferation and terror?

Our View:

The expansion of nuclear energy is one of the biggest threats to global security. You claim that nuclear weapons and nuclear power plants are different[29]. However, if one looks at the history of the development of nuclear weapons, one sees that nuclear energy was a bi-product of nuclear weapons production. The basic principles, the ingredients and the processes are the same. What will happen if lots of countries introduce technology and equipment for nuclear power, train nuclear scientists and engineers and obtain large quantities of nuclear material? It is impossible to deny that nations and sub-national groups with the necessary specialist knowledge and skills and access to such equipment and material could make a nuclear weapon. The history of nuclear proliferation is testimony to this fact.

Not only plutonium and highly enriched uranium, but also materials such as low, medium and high-level radioactive waste can be used as weapons ingredients. Explosive devices containing radioactive materials are called “radiological weapons” or “dirty bombs”. They use conventional explosives to disperse radioactivity. Thus there is an inextricable link between the spread of nuclear power and the proliferation of nuclear and radiological weapons.

If nuclear power is expanded, safeguards and protection of nuclear materials must also be strengthened. This costs money and uses up human resources. Furthermore, it will no doubt be necessary to constrain human freedoms. Above all, it will be necessary to maintain a continual state of alert throughout the whole world for military or terror attacks aimed at nuclear facilities and nuclear materials[30].

5) Are you aware that the overwhelming favouritism towards nuclear power is holding back the development and introduction of other alternative energy

sources?

Our View:

You have said, “The nuclear industry can hardly afford pro-nuclear demonstrations and advertisements”, whereas “….the true costs [of renewable energy] have been hidden from the public by subsidies and the distortion of market forces through legislation.” [31] This is far removed from the true situation.

Governments and nuclear industry in countries which have introduced nuclear power go to great lengths to promote public acceptance of nuclear energy. One example of the scale of these efforts are the advertisements placed by the Japan Atomic Energy Relations Organization (JAERO) in all the major Japanese newspapers, in particular the full-page advertisement featuring your photograph and lecture.

It is also well known that countries which have introduced nuclear power have given it extremely favourable treatment. The Japanese government has placed nuclear power as national energy policy, poured vast amounts of taxpayers’ money into its research and development, and granted subsidies to regions which accept nuclear facilities. At the same time it has also borne the economic risks associated with nuclear power. The title of a Japanese policy document published in 2006 translates as “Nuclear Energy Nation-Building Plan”. This plan and the Basic Energy Plan, as amended in March 2007, indicate that nuclear power will receive even more favourable treatment in future.

As mentioned above, nuclear power cannot exist without a long-term plan. For this reason the extreme favouritism towards nuclear energy deprives energy planning of any flexibility. Development of renewable energy and decentralized energy system, which should by rights be the pillars of our response to climate change, are overwhelmed by this favouritism towards nuclear energy.

In 2004, for example, 64 percent of Japan’s budget for energy research and development went to nuclear energy. By contrast, renewable energy (commonly referred to as “natural energy” in Japan, but referred to as “new energy” by the government) received a mere 8 percent[32].

6) You see fission energy as a provisional power source until fusion energy becomes practical. When do you predict that electricity produced from nuclear fusion will

be supplied to national electricity grids?

Our View:

Neither uranium nor fossil fuels are inexhaustible resources. Consequently, countries which introduced nuclear power originally planned to reprocess spent nuclear fuel, extract the plutonium and burn it in fast breeder reactors. In this way, it was claimed, energy from nuclear fission could be used for thousands of years.

However, most countries have withdrawn from the reprocessing and fast breeder reactor path. This is because problems such as cost, technical difficulties, radioactive contamination, radioactive waste, the risk of nuclear proliferation, and so on are incomparably greater than if only uranium fuel is used.

Japan alone, under the name of "response to global warming", has continued to pour huge sums of public money into research and development for this program[33]. Nevertheless, according to government estimates, the fast breeder reactor cycle will not replace light water reactors until next century at the earliest[34]. In the first place, it has not even been established that it is possible to breed plutonium effectively.

You speak as if electricity produced from nuclear fusion will, in the near future, be supplied to national grids[35]. If human beings wish to use fusion energy, they must induce a fusion reaction between two hydrogen isotopes, deuterium (2H) and tritium (3H) (the so-called "D-T reaction"). However, there is at present no material on earth capable of withstanding for any length of time the intense neutron radiation which accompanies this reaction. For the foreseeable future it will be impossible to build commercial scale fusion reactors, so there is no possibility that fusion will become a major source of energy. The only conceivable large-scale use of fusion energy is in thermonuclear weapons.

You also claim that fusion energy does not produce significant amounts of radioactive waste. In fact, large quantities of radioactive waste contaminated with tritium and other radionuclides will be produced[36].

Fusion reactors and fast breeder reactors are no more than desk-top schemes. Wasting huge amounts of time and money developing such technologies actually obstructs the introduction of the radical measures for climate change required now.

7) You say that renewable energy is impractical. Please tell us why you think so.

Our View:

You say, “almost every engineering development … took about forty years to pass from open enthusiasm to widespread application in the first world” and reject renewable energy as “a romantic, impractical dream” [37].

In fact, renewable energy is now one of the fastest growing industries. For example, wind power has grown at a rate of over 30 per year for the last few years [38].

Germany is the leader in the field. In the 1990s it passed legislation to broaden the market penetration of sustainable energy. This led to a wind power boom and by 2006 wind power had grown to 5 percent of total electricity supplied[39]. By 2020 the German government aims to increase this to 20 percent and to increase total renewable energy to 26 percent[40].

Judging from the record to date, attainment of these targets seems assured. The Germany’s Atomic Act stipulates phase out of nuclear power (currently 30 percent of electricity supply), but it is reasonable to expect that renewable energy and energy conservation will amply make up for this.

Examples of other countries which have increased the use of wind power by adopting similar policies to Germany include USA, Denmark., Spain and India. Thanks to this rapid market expansion, costs of wind power have fallen 20 percent in the last few years and in some countries it is already competitive with conventional electricity sources[41].

Germany also passed Japan in cumulative installed capacity of solar power to become number one in the world in 2005. This was a result of policies promoting the introduction of renewable energy.

The cost of solar electricity systems is coming down as a result of large-scale production. According to the leading Japanese photovoltaics maker, residential solar power systems today are one third of the price that they were ten years ago[42]. If policies promoting the spread of such systems are introduced, it can be expected that the cost will fall further.

In addition, if the use of fuel cells spreads, the growth of micro-power, a key element of decentralized energy systems, will jump.

In Japan, however, which places nuclear power at the center of its response to climate change, the renewable energy obligation is now a tiny 1.35 percent of total electricity sales and the target for 2014 is just 1.63 percent[43].

It is clear from the above that renewable energy is not impractical. It is utterly practical. The

expansion of renewable energy is not a technical problem. It is a policy problem.

8) A safer and more reliable climate change response exists. Do you nevertheless believe that nuclear power is essential?

Our View:

The most effective ways to minimize climate change are energy conservation and the spread of renewable energy. These can be achieved through distributed energy systems. Since climate change was recognized as a real threat, renewable energy has been growing rapidly throughout the world, particularly in Europe. This is largely due to the fact that these technologies emit essentially no carbon dioxide, but it is also because they are superior to nuclear power in terms of cost and the time required to install them. They also have many other benefits, including increasing energy independence and promoting the development of local industry and employment.

You say that the success or failure of responses to global warming depends on how appropriately we make use of science and technology[44]. However, as argued above, the science and technology which should be used are not the massive scale science and technology represented by nuclear energy.

Footnotes:

1. *Yomiuri Newspaper*, 29 October 2006. Japan Atomic Energy Relations Organization (JAERO) advertisement. The original source is a Japanese translation of a keynote speech by Professor Lovelock at the Nuclear Energy Day symposium in 2006.
2. *Yomiuri Newspaper*, 29 October 2006.
3. *Mainichi Newspaper*, 11 September 2004.
4. *Nuclear Policy Issues and Responses: Nuclear Power Nation Plan*, Ministry of Economy, Trade and Industry (METI), 2007. See website of document in Japanese http://www.enecho.meti.go.jp/policy/nuclear/pptfiles/zenntai.pdf
5. *Climate Change 2007: The Physical Science Basis Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Summary for Policymakers)*, Intergovernmental Panel on Climate Change (IPCC), February 2007.
6. *Energy Technology Perspectives 2006*, International Energy Agency (IEA), 2006.

7. Mycle Schneider et al., '*The World Nuclear Industry Status Report'*, 2004
8. IEA, *op.cit.*,
9. IEA, *op.cit.*, '*Japan 2050--Scenario for a Low-Carbon Society: Examining Possibilities for 70% Reduction of Global Warming Gases'*, National Institute for Environmental Studies (Japan), 2007, *Energy [r]evolution*, Greenpeace & European Renewable Energy Council (EREC), 2007.
10. Greenpeace and EREC, *op.cit.*,p21
11. *'State of progress of specific measures and policies under the Plan for Achieving Kyoto Protocol Targets*', METI, 26 March, 2007.
12. In 2002, voluntary safety inspection data were found to have been falsified at three nuclear reactors of Tokyo Electric's Fukushima Nuclear Power Plant. As a result, all 17 of Tokyo Electric's nuclear power plants where shut down until May 2003 in order to undergo comprehensive inspections.
13. In August 2004, an accident at Kansai Electric's Mihama Nuclear Power Plant Unit killed 5 and injured 6 workers. The accident occurred when a carbon steel pipe carrying hot water under high pressure burst. The utility was aware the pipe had not been inspected since start-up of the plant 28 years earlier, but had chosen to delay inspection until the next outage.
14. The rise in green house gases emissions due to unscheduled shutdown of nuclear power plants was 4.8% in 2003 and 2.8% in 2004. Data from Ministry of Environment (MoE) Japan, Central Environmental Council, Global Environment Committee, June 2006, and MoE data published 17 October 2006.
15. In March 2007, it was discovered that Hokuriku Electric had, in June 1999, covered-up an uncontrolled criticality accident due to control rod slippage. The accident took place during a periodic inspection (outage) at the Shika Unit 1 nuclear power reactor. Subsequently it was found that similar cover-ups of control rod slippage during outages had also occurred at Tokyo Electric, Tohoku Electric and Chubu Electric.
16. *Global Public Opinion on Nuclear Issues and the IAEA Final Report from18 Countries*, prepared for the International Atomic Energy Agency, GlobeScan Incorporated, 2005.
17. *Framework for Nuclear Energy Policy*, Japan Atomic Energy Commission, 2005.
18. *New National Energy Strategy*, METI, 2006.
19. *NUREG/CR2497*, NRC,1982. "One reactor year" signifies operation of one reactor for one

year.

20. The National Aeronautics and Space Administration (NASA), USA, had calculated the probability of the Space Shuttle Challenger encountering an explosion accident upon launch to be 10,000 to 1. The explosion occurred on the 25th launch.
21. Tetsuji Imanaka and Citizens' Nuclear Information Center (CNIC) (eds) , *Reconsidering Chernobyl*, CNIC, 2006, p20. Between 1,000 and 2,000 plant workers and firefighters were onsite at the time of the accident and "liquidators" numbered between 600,000 and 800,000. About 120,000 people within a 30-kilometer radius of the reactor were evacuated and 250,000 to 300,000 people have left the "most contaminated areas". There are still 6 million people living in contaminated areas (more than 1 Curie/km^2).
22. See for example, the following estimates; World Health Organization (2006): 9,000; International Agency for Research on Cancer (2006): 16,000; "Chornobyl+20: Remembrance for the Future" Conference in Kyiv (2006): 30,000~60,000; Greenpeace (2006): 93,000.
23. Chernobyl Forum was made up of the IAEA, WHO, several UN agencies and the governments of Belarus, the Russian Federation and the Ukraine. *Chernobyl's Legacy: Health, Environmental and Socio-economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine*, Chernobyl Forum, IAEA, September 2005, p. 10. A target population cancer death assessment was about 600,000, including emergency workers, residents of the "most contaminated areas" and evacuees from a 30-kilometer area surrounding the plant. But 5 million people residing in "other contaminated areas" were neglected.
24. *The Chernobyl Catastrophe - Consequences on Human Health*, Greenpeace International, 2006.
25. James Lovelock, *The Revenge of Gaia* (Penguin Books:2007), p127-128
26. Tetsuji Imanaka et.al., *Multi-sided Approach to the Realities of the Chernobyl NPP Accident: Summing-up of the Consequences of the Accident Twenty Years After*, research supported from the Toyota Foundation, 2006.
27. Due to concerns about nuclear terrorism, the USA, UK, Germany, and France include vitrified high-level radioactive waste and spent nuclear fuel under nuclear material to be safeguarded. Japan is also planning to include vitrified high-level radioactive waste under the same category.

28. James Lovelock, *op.cit.*, p117.
29. *Mainichi Newspaper*, 13 May 2006
30. In Japan, based on the Civil Protection Law, training assuming an attack on a nuclear power plant is carried out in host regions. Israel, Iran and Iraq have attacked each others' nuclear facilities.
31. James Lovelock, *op.cit.*, p107.
32. *Energy Policies of IEA Countries 2004 Review*, IEA, 2006.
33. *Framework for Nuclear Energy Policy*, Japan Atomic Energy Commission, 2005. India, Russia and China also have fast breeder programs, but, unlike Japan, fast breeders are not central to the energy policies of these countries. Japan's FY2007 budget for its fast breeder program was 40 billion yen. The budget for the five-year period FY2006-FY2010 is 250 billion yen.
34. The government does not expect the fast breeder cycle to be in place and supplies of natural uranium to cease to be necessary until after 2100.
35. James Lovelock, *op.cit*., p115.
36. Petition by Masatoshi Koshiba (Nobel Laureate, Physics) and Akira Hasegawa (James Clerk Maxwell Prize for Plasma Physics Recipient, former chair of the American Physical Society Division of Plasma Physics) urging the Japanese government not to push for siting of the International Thermonuclear Experimental Reactor (ITER) in Japan, 2003.
37. James Lovelock, *op.cit*., p108
38. *Wind Force 12: A blueprint to achieve 12% of the world's electricity from wind power by 2020*, Greenpeace International, June 2005
39. *Entwicklung der erneuerbaren Energien im Jahr 2006 in Deutschland*,BMU,2006
40. *Themenpapier: Windenergie*, BMU,2006
41. *Energy [r]evolution*, Greenpeace, 2007.
42. Kouji Tomita, *'Solar Energy Market'*, a chapter in *Energy Market of Renewables*, edited by Tetsunari Iida (Tsukiji Shokan: 2005)
43. *Special Energy Measures Act*, METI, 2007.
44. JAERO advertisement, *Yomiuri Newspaper*, *op.cit.*