

Table of Contents

<u>Executive Summary</u>	<u>3</u>
<u>Introduction</u>	<u>4</u>
<u>Historical Perspective</u>	<u>5</u>
Origins of nuclear energy	5
reasons for and against nuclear energy	6
<u>Current Situation: case study of Fukushima accident</u>	<u>7</u>
failure to adhere to safety regulations	7
role of the japanese government	8
mismanagement of nuclear energy	9
debate over the continuity of nuclear energy	10
<u>Future Considerations</u>	<u>11</u>
<u>Conclusions</u>	<u>12</u>
<u>Bibliography</u>	<u>13</u>

Executive Summary

Nuclear Energy has been around since the early 1950s and been a useful source of energy. The developments of nuclear energy have advanced that it can provide up to 30-40% of a country's supply of energy. However, after the Fukushima accident, the continuity of nuclear energy power plants have been uncertain.

This paper uses the Fukushima accident as a case study, investigating the reasons for the disaster as well as evaluates the lessons that can be drawn which can be used to apply to the further. Following that, the reasons for and against the continuity of nuclear energy addressing the safety or social concerns of the public.

For nuclear energy to be a revolutionary or disruptive change in the world there are also other factors that have to be further developed in order for this change to happen.

Background/ Introduction

Before the invention of nuclear energy, the world mainly relied on fossil fuels as the source of energy. Fossil fuels are the primary source of energy, amounting to close to the majority of the world's primary energy consumption. However, there are several major issues of this energy source. They are non-renewable resources as they take millions of years to form. Next, the process of obtaining energy from fossil fuels has by-products such as emission of greenhouse gases and soot that causes pollution and global warming. Lastly, fossil fuels are only found in certain countries. Countries that possess the most fossil fuels are Russia, Iran and Venezuela, and this relates to political dominance of these countries over those who rely on them for energy.

There have been other alternative energy sources like hydroelectric energy, solar energy and wind energy, but none of them can provide substantial energy. More over, these energy sources rely on external and uncontrollable factors, thus making them more difficult to provide constant supply of electricity.

During the 1950s came the invention of nuclear energy power plants by the USA. Since then countries have been using nuclear energy as a reliable source to power their electricity and infrastructures.

The world was contented with the success of nuclear energy plants and its contributions to the energy sources. The future of nuclear energy looked very promising as more countries witness the success of the present nuclear power plants and leaning towards implementing policies of having their own.

However, on 11 March 2011, the explosion of Fukushima Plant Power Plants due to the tsunami shocked the world. This incident had caught the attention of the world, portraying the mass destruction, death toll and implications of such an accident. Making things worse, Nuclear Emergency was declared by the Japanese government. This was due to the failure of cooling systems, which in turned led to undermining the safety protocols and causing unrest among the general public of Japan as well as those nations with the possession of nuclear power plants. The incident led to widespread panic and fear, people were protesting against the use of nuclear energy and to resort to other means of alternative energy. Currently, Japan is made the center of conflict of approving nuclear energy. It is used by countries as a debating argument between citizens and their governments on whether nuclear energy should be allowed to be operational and the future construction of them.

This incident has aroused my interest in nuclear energy. A technology that has so much potential in solving the energy crisis in the world, but also possessing such a threat to the safety of the lives of the citizens. Nuclear energy will be considered a revolutionary change in the world of energy resources, but there are many issues and obstacles that must be met first before it can be such a change.

Historical Perspective

Origins of Nuclear Energy

After world war two, the United States government shifted the emphasis of nuclear energy from military might or atomic bombs to the development of nuclear energy for peaceful civilian purposes. In 1946, the United States Congress created the Atomic Energy Commission (AEC), with the purpose to foster and control peacetime development of atomic science and technology. The first breakthrough was in 1951, where the reactor was able to generate electricity from nuclear energy.

The first commercial nuclear energy power plant was located in Shippingport, Pennsylvania, reaching its full design power only in 1957. The designs, light-water reactors, used ordinary water to cool the reactor cores during the chain reaction. They were the best designs then for nuclear energy power plants. (U.S Department of Energy)

From this point onwards, countries all over the world starting investing and developing nuclear energy power plants as a source to generate energy. Later in the 1990s, the United States had faced several major nuclear energy issues and developed goals. The goals were to maintain exacting safety and design standards, to reduce economic risks, to reduce regulatory risk and to establish an effective high-level nuclear waste disposal program. Countries that were constructing nuclear energy power plants had to adhere to the set of regulations laid down by United States. (U.S Department of Energy)

Though the goals set by the United States were in the best interest to protect countries from the implications of a nuclear power plant failure or accident, they could have aligned their goals more towards creativity and further development of the power plants. The major flaw on the rule of safety and design standards was that this will limit the creativeness and further enhancement of security or safety standards that was drawn up by the AEC. Perhaps the U.S could have stated these regulations as compulsory with an addition of feedback or addition of other safety features by experts within and outside the boundaries of the States. This would have sped up the process in all aspects of nuclear energy. For instance, addition thought should have been given to application of different structure of nuclear power plants in relation to geographical locations. In the case of accidents, the protocols will definitely be different in a remote location as compared to one in the urban area.

Historical Perspective

Reasons for and against nuclear energy

Below are the main reasons for the construction as well as concerns of the Nuclear Power Plant

Pros

- Clean energy, one with minimal pollution other than the concern of the disposal of nuclear waste material
- Able to generate a large amount of energy
- Reliable source as compared to the alternative resources
- Decrease in the reliance on countries for fossil fuels, nuclear power plants can be built in any location. This decreases political clout of countries with large amount of natural energy resources or fossil fuels

Cons

- Safety issues which comprises of explosion of the nuclear power plant; radiation exposure to citizens working and living near the plant; disposal of spent fuel rods which remain radioactive for hundreds of years; and the possibility of the spread of nuclear weapons to unreliable owners

On the side of the government in its decision to go ahead with the construction of the power plant, it has to consider the social, economical, environmental and political aspects. In the aspect of the society, the citizens will definitely be exposed to danger in the risk of an accident, but with the huge amount that the power plants can generate, it stands to see that it will be able to meet the rising demand of energy in the future. As for economical, the government and country stands to gain large capital and investments, leading to an increase in the overall GDP and an increase in the employment rate. The construction of nuclear power plants will benefit the environmental aspects, allowing 'clean' energy and sustainability. Finally as mentioned, creating a stable alternative energy source will decrease the reliance of countries with no natural energy resources on others with, hence decreasing the political clout or dominance in other matters.

Current Situation: Case Study of Fukushima Power Plant

There have been debates between activist and governments on the continuity of nuclear power plants since the Fukushima power plant explosion and its after effects. The incident was caused by the tsunami and not the totally on the fault of Japan's preparedness for such an event, but it sparked off wide spread awareness and reminded the public of the dangers and implications of having a nuclear power plant.

Though the accident was due to the tsunami, a natural disaster, there were a number of 'man-made' errors that led to the terrible outcome of the disaster. There are many implications that were brought into the picture as to who is to blame to the disaster. Two main factors were failure to adhere to safety regulations and the failure on the part of the government before and after the accident. Even in these two factors, there are many faults and details. An elaboration on the key faults will be analyzed.

Failure to adhere to Safety Regulations

After the Fukushima incident, it was discovered that this power plant as well as other in Japan had failed to adhere to the safety regulations. Sloppy checks and cover-ups by Japan Nuclear Energy Safety Organization (JNES) and TEPCO, the monopoly company of nuclear energy plants in Japan, were evident throughout the years.

Below is a list of some of the more vital mistakes made in relation to safety regulations.

1. Japan Nuclear Energy Safety Organization (JNES) was supposed to check whether the values could contain radioactive substances in the reactor under normal condition. But the pressure applied to the valves during the test was not sufficient. If valves that were not highly water-tight were installed, larger quantities of radioactive substances than normal could be released from the reactor container. (Nuclear organization improperly tested safety valves for Fukushima reactor, 2011)
2. Two inspectors from JNES instructed TEPCO employees to check the valves. Of the six valves, two of them had been tested with insufficient pressure. It was a simple mistake by TEPCO, but JNES inspectors failed to spot the error and gave their approval. (Nuclear organization improperly tested safety valves for Fukushima reactor, 2011)
3. There had been several past flaws with the Fukushima power plant. This should have lead to the JNES taking a closer inspection of the power plant as a whole. (Japan Plant Had Troubled History, 2011)
 - a. In 2007 an emergency diesel generator began smoking during testing. An investigation found that part of the generator's circuit breaker had been put

together backward.

- b. In February 2009, pressure levels spiked inside Reactor 1, forcing the release of steam through an emergency valve. Workers found a broken bolt and shut down the reactor. An investigation found that a nut hadn't been tightened properly and wasn't being inspected regularly.
4. Genkai Power Plant: An interim report that Kyushu Electric submitted in 2008 also contained the errors, but NISA did not notice them and put its assessment of the data as "reasonable." The errors were found when the Japan Nuclear Energy Safety Organization rechecked the data. Also, Japan's nuclear regulatory agency that it had discovered errors in Kyushu Electric Power Co.'s report on safety assessments of the No. 3 reactor at its Genkai plant. (Errors in Genkai plant report threaten to delay restart of nuclear reactors, 2011)
5. Setsuo Fujiwara, now 62 years old, started filing complaints in July 2009 with the Japan Nuclear Energy Safety Organization about what he considered lax safety-management practices, and later that year took his complaints to the nation's main nuclear-regulatory body, the Nuclear and Industrial Safety Agency, or NISA. Mr. Fujiwara says JNES forced him into an early retirement in March 2010. Mr. Fujiwara says he was wrongly terminated because of his whistle-blowing. (Hayashi, 2011)

On the subject about the flaws of the power plant, accompanied with the 'sloppy' checks that inspectors could have been the reason for the extent of damage and leaking of radiation that has brought so much harm to the citizens of Japan. This suggests sloppiness in a variety of areas, including insufficient staffing for inspections, and record-keeping that in some ways falls below international standards. It can be inferred that JNES got complacent and feel that Japan power plants, as a whole, is safe and secure. Perhaps the reason for this can be linked to the success of Japan in managing natural disasters, hence leading to the complacency.

In the scenario of the whistle blowing, JNES should be penalized by the government for covering-up and ignore the warnings that Setsuo had with the lax safety-management practices of the nuclear power plant. If the complaints was heeded, JNES could have done more to prevent the extent of mishap that Japan faced on March 11. A reason for this can be due to the culture of Japanese society, where a firm's style is autocratic and no one likes to bring 'bad news' to the top management until necessary. The government or higher authority should have stepped in to do something about such matters. This reflects very poorly on not just the company, but on Japan as a whole.

Role of the Japanese Government

The inefficiency and complacency of the Japanese government was seen in the incident too. Government roles can be divided into two sections: before the Fukushima accident and immediate measures taken after the accident.

Events before the Fukushima accident that displays the inefficiency and/or complacency of the Japanese government:

1. The power plant, whose first reactor became operational in 1971, had the highest rate of accidents of any big Japanese nuclear power plant for the five years from 2005 to 2009, according to data from the Japan Nuclear Energy Safety Organization, a group that gets government funds to monitor safety. (Morse, 2011)
2. Just a month before a powerful earthquake and tsunami crippled the Fukushima Daiichi plant at the center of Japan's nuclear crisis, government regulators approved a

- 10-year extension for the oldest of the six reactors at the power station despite warnings about its safety. (Tabuchi & Onishi, 2011)
3. Before March 11, scholars had repeatedly warned at academic conferences and other occasions that a massive tsunami could hit the Tohoku region in the future. However, the government's Central Disaster Management Council and TEPCO never factored such studies into their estimates of the damage that earthquakes and tsunami could cause to nuclear power plants. (Japanese daily examines reasons behind nuclear disaster in country, 2011)
 4. When asked why the government failed to act on tsunami warnings, industry minister Banri Kaieda said his ministry had blindly believed Japan's nuclear plants "were the safest in the world." (Japanese daily examines reasons behind nuclear disaster in country, 2011)

Despite numerous warnings from scholars and researches, the government had turned a blind eye on these warnings. The government and TEPCO had not factored these warnings as necessary into their estimates of the damage that tsunami and earthquakes can cause. One of the roles of a government is to ensure the three basic foundations of a nation, social, economical and political aspects. By ignoring the warnings, they have failed to protect the social and economical aspects of Japan and this hence has lead to the catastrophe. With all the flaws and problems of the facilities, Banri Ka (Japan govt body detailed tsunami risks before March 11, 2011)ieda is plain ignorance to think that Japan's nuclear plants "were the safest in the world".

The short-term goal of the government was for Japanese State agencies to clear debris, build temporary housing and rehabilitate industrial facilities. As for medium and long-term targets, it was creating disaster-resilient local communities, an eco-friendly social system and a welfare-orientated society.

Events after the Fukushima accident that displays the government inefficiency and complacency:

1. To ensure the safety of drinking water, the Japanese government has implemented measures based on stringent criteria for radionuclides, monitoring the radionuclide level every day. Japan inspects radioactivity in food every day and restricts distribution of food that fails to meet provisional regulation values, taking into consideration the spread of contamination. (Nuclear Crisis, 2011) However, a new government estimate that showed potentially higher radiation outside the government's 20-kilometer evacuation zone around the plant renewed concerns about radiation data. Food that had not been inspected outside the initial zone could have been contaminated.
2. Engineers were still struggling to bring the plant north of Tokyo under control two months after the disaster. More than 15,000 people were killed in the disaster and about 9,500 are still missing. (Japan govt body detailed tsunami risks before March 11, 2011)
3. Since the tsunami, officials at Fukushima Daiichi have tried to relieve rising pressure inside the reactors, several times resorting to releasing radioactive steam into the atmosphere, a measure that in turn has contributed to the contamination of food and water in the area. (Nuclear Crisis, 2011)

The government did not implement enough immediate measures that were able to cope with the number of problems. First concern was the exposure of radiation to the public. But after two months, the government was still struggling with the problem of radiation. This displays

the inefficiency of the government in handling the crisis. Following that, contamination had affected the agriculture sector of Japan. Government had put in efforts to ensure the safety of Japanese food and drinking water. This was due to the inefficiency of decision making on the part of the government. The government was slow in its reaction due to the fear of losing the trusts and support of its people, and the acknowledgement of their failure. To make things worse, while thousands had been stranded without proper housing and food, the parliament was in conflict on the immediate measures taken by prime minister Kan and this led to him deciding to step down. Rather than playing politics during such a crisis, the parliament and government should concentrate their efforts in attending and aiding to the needs of their people.

Mismanagement of Nuclear Energy

The aim of nuclear power plants was to curb the factors of pollution, increase economic revenue and help the society by providing a larger amount of electricity. Japan has proved that by mismanaging this precious resource, it had proved detrimental to its country in all aspects. The country's economical aspect is in a mess, with money spent on ensuring the containment of radiation, extra efforts in ensuring edible food and repairs on the affected areas. Socially, the Japanese are resentful with the government and TEPCO with its irresponsible policies and safety precautions on the power plant, with many with a lack of food and a roof over their heads. Politically, it's worse, with the public and parliament pressure on the government, pointing fingers on whose to blame. Instead of helping the country, Japan went through a political instability inside the government. All these factors prove that technology, as volatile as nuclear energy, if mismanaged, proved much more costly than without.

Debate over the continual of nuclear energy

With the uproar of activists on the issue of safety concerns of nuclear energy, governments everywhere have to re-evaluate their own situation in their countries and decide if they want to continue with this energy source or look for other alternatives. (Energy - Panel delays plans to develop nuclear plant, 2011) For countries such as Russia and USA, they took the Fukushima incident as a lesson to be learnt and doubled up on their own power plants and further imply higher security measures to address this concern. (Russia to develop nuclear energy despite Japan's accident-Putin, 2011) Other countries such as China, Brazil and South Africa, decided to take a safer route and evaluate the situation and will most likely continue with the nuclear power plants in the near future. They feel that nuclear energy will continue to be an important element in the near future and its energy source will be vital. However, countries such as Scotland and Germany had decided to scrap nuclear energy totally. For Scotland, the government plans to look for renewable resources such as wind energy to account for the energy required. (Forsyth, 2011) Germany pledges to phase out nuclear energy totally by 2022, but this means that there will be an increase in carbon and other emissions and greater dependence on Russia for energy. (Issues & Insights: Germany Nixes Nukes, 2011) The main priority on the part of the governments is to ensure the safety of their present nuclear power plants and reassure their citizens, as this is their main concern.

Looking at nuclear energy from a larger perspective as a whole, nuclear energy still has a lot to offer and the benefits of it can be a huge impact to the environment in terms of global warming and the obvious economic benefits. The Fukushima Power Plant accident is not the first accident nor is it the most disastrous in history. Based on the Nuclear power station accidents and incidents reports, the International Nuclear Events Scale (INES) level for the incident is rated 5. The Three Mile Island's damage of a reactor was rated the same. On top of that, Chernobyl in USSR Ukraine was rated a 7, resulting in widespread health and

environmental effects. These two examples can be comparable to the Fukushima incident, but these examples happened some 20 odd years ago. Nothing was done to stop nuclear power in such large scale, but rather, countries possessing nuclear power plants or those that intent to construct learned valuable lessons from these incidents so as to not repeat such mistakes. This can be applied to Fukushima's incident too. Perhaps the only reason of the uproar in safety is due to the death toll, substantial damages in Japan and the mass media coverage of the accident. Geological location of the power plant should now be taken into consideration when constructing a nuclear power plant, bringing in the factors of probability of natural disaster disruptions and the approximate distance between the plant and the nearest city or community. This was something that was lacking during the initial guidelines by the USA on building power plants.

Future Considerations

Taking into account that nuclear energy strategies are being adopted in the future, there are many other factors that needs to be developed before nuclear energy can be considered a revolutionary change. First and for most, the most important and vital issue now is the safety and security of nuclear power plants. Those operating nuclear power plants have to gain the support from the people and assurance that measures are taken to ensure the optimal safety protocols are taken. These are the other factors that needs to be considered: (Zyga, 2011)

1. Land and Location

An average nuclear power plant requires about 20.5km² of land. The land area is to accommodate for the power station, as well as other infrastructures such as enrichment plant, ore processing and exclusion zone. Moreover, the power plants need to be near a huge body of coolant water for the nuclear reactors, but also away from dense populations and locations with natural disasters. As nuclear energy's popularity increases, it will be challenging to find locations that fit these requirements.

2. Lifetime

A nuclear power plant needs to be decommissioned after about 50years of operation. It is due to the cracks that develop on the metal surfaces of the structure from radiation. At this present moment, it takes about 6 to 12 years to build a nuclear power plant, and up to 20 years to decommission one. This makes the replacement rate of nuclear power plant within a country, especially countries with limited land.

3. Nuclear waste

The estimated time for nuclear waste to allow its radioactivity to decay is about 40-50 years. They are stored in canisters that are stored underwater in special ponds, or in dry concrete structures or casks. However, it is still uncertain if burying the spent fuel and the spent reactor vessels have the possibility of causing radioactive leakage into groundwater or the environment.

4. Proliferation

Being nuclear energy power plants, it obviously involves nuclear which may also be used in making nuclear weapons. This will be a major concern for the United Nations in maintaining accountability of all the reactors sites worldwide as the number of nuclear energy power plants increases.

5. Resources needed to built and sustain a power plant

The nuclear containment vessel needs a variety of exotic rare metals to control and contain the nuclear reaction. There are issues involving the extraction of these metals, costs, sustainability and environmental impact. These issues have to be met before nuclear energy can be considered a 'clean' energy resource. Perhaps with the rapid advances in technology, these issues can be addressed such as to either find alternative metals, extend the lifetime of these metals or improve on the designs on conventional nuclear energy plants to ensure higher efficiency rate of the plant with the same resources used.

For nuclear energy to be a revolutionary change, all these other factors have to be taken into consideration. With the rapid development of technology, perhaps in the near future, at least some of these issues can be addressed to improve the efficiency and sustainability of nuclear energy.

Conclusion

Presently, the governments need to reassure their people on the safety measures taken for nuclear energy power plants. Governments should once again promote the promising aspects of nuclear energy. At the same time, more research and development should be done on nuclear energy, on factors that was mentioned earlier. This will improve the effectiveness and efficiency of nuclear energy.

For the debates on the continuity of nuclear energy power plants that are ongoing, there is another perspective of looking at it. Rather than taking a linear approach to choosing between nuclear energy and alternative energy sources, one can possibly look at this diversion of focus as a positive note. With one side focus on further developing nuclear energy and the other focusing on alternative energy resources such as wind, solar and hydro, it is a possibility that both bodies of countries will have significant developments in their own arenas and this will lead to advancements of energy as a whole.

Nuclear energy will only be considered a revolutionary change in the scenario that most of the other factors are met in the near future. The effect will be immense to the world's energy sources and it serves as a key to reducing global warming.

Bibliography

1. U.S Department of Energy. (n.d.). *The History of Nuclear Energy*. Retrieved from U.S Department of Energy:
<http://www.ne.doe.gov/pdfFiles/History.pdf>
2. International Atomic Energy Agency. (2007, May). *Managing the First Nuclear Power Plant Project*. Retrieved from IAEA.org:
http://www-pub.iaea.org/MTCD/publications/PDF/te_1555_web.pdf
3. Anderson, C. (2011, June 20). *Q&A: Bill Gates on the World's Energy Crisis*. Retrieved from WIRED:
http://www.wired.com/magazine/2011/06/mf_qagates/all/1
4. Zyga, L. (2011, May 11). *Why nuclear power will never supply the world's energy needs*. Retrieved from PHYSORG.com:
<http://www.physorg.com/news/2011-05-nuclear-power-world-energy.html>
5. World Nuclear Association. (2011, September). *World Energy Needs and Nuclear Power*. Retrieved from world-nuclear.org:
<http://world-nuclear.org/info/inf16.html>
6. Rogers, S. (2011, March 18). *Nuclear Power Plants Accidents: listed and ranked since 1952*. Retrieved from The Guardian:
<http://www.guardian.co.uk/news/datablog/2011/mar/14/nuclear-power-plant-accidents-list-rank>
7. *Natural Disasters and Accidents*. (n.d.). Retrieved from Oracle ThinkQuest:
http://library.thinkquest.org/17940/texts/nuclear_disasters/nuclear_disasters.html

8. AS Philippines Japan Nuclear Energy. (2011, March 16).
9. Nuclear organization improperly tested safety valves for Fukushima reactor. (2011, June 15).
10. Issues & Insights: Germany Nixes Nukes. (2011, June 21).
11. Hayashi, Y. (2011, June 21). Former Inspector Complains of Regulators' Practices.
12. Energy - Panel delays plans to develop nuclear plant. (2011, April 28).
13. Japan Plant Had Troubled History. (2011, March 21).
14. FACTBOX- Nuclear power plans and capacity around Europe. (2011, May 31).
15. Nuke plant meltdown warning went unheeded. (2011, April 19).
16. Errors in Genkai plant report threaten to delay restart of nuclear reactors. (2011, July 23).
17. Russia to develop nuclear energy despite Japan's accident-Putin. (2011, June 21).
18. Shimizu, M. a. (2011, August 22). Resilience must be key part of policy approach to disaster response.
19. Forsyth, T. (2011, May 31). Scotland favouring renewables policy.
20. Kaul, A. (2011, April 14). Japan effect: BBRRICS press for strict adherence to N-safety.
21. Japanese daily examines reasons behind nuclear disaster in country. (2011, June 12).
22. After Fukushima, Nations Put Nuke Plant Development On Hold. (2011, April 6).
23. Morse, A. (2011, March 25). Japan plant saw high rate of problems.
24. Nuclear Crisis. (2011, April 28).
25. Mason, J. a. (2011, March 18). Update 4- Obama requests nuclear review, sees risk in Japan.
26. Tabuchi, H., & Onishi, N. a. (2011, March 22). Japan Extended Reactor's Life, Despite Warning.

