ABOLITION OF NUCLEAR POWER

An Appeal from the Catholic Church in Japan

Catholic Bishops' Conference of Japan
Compilation Committee for *Abolition of Nuclear Power*

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Published and Printed in Japan, July 2020

Abolish Nuclear Plants Immediately
～Facing the Tragedy of the Fukushima Daiichi Nuclear Plant Disaster～

To all living in Japan,

The accident at the Fukushima Daiichi Nuclear Plant triggered by the Great Eastern Japan Earthquake contaminated the ocean and land by radiation, and tragically disrupted the daily life of an enormous number of people. Even now, almost one hundred thousand people are evacuated from the neighboring area of the nuclear plant, and numerous people are forced to live in fear and anxiety.

With regard to the pros and cons of nuclear plants, we, Japanese bishops, expressed in our message "Reverence for Life – A Message for the Twenty-First Century from the Catholic Bishops of Japan" as follows:

> It has provided a totally new source of energy for humanity, but as we can see in the destruction of human life in a moment in Hiroshima and Nagasaki, the disaster at Chernobyl and the life-threatening criticality accident at Tokaimura, it also has the potential to pass huge problems on to future generations. To use it effectively, we need the wisdom to know our limits and exercise the greatest care. In order to avoid tragedy, we must develop safe alternative means of producing energy.[1]

The "tragedy" in this message was brought about by nothing less than the accident in the Fukushima Daiichi Nuclear Plant. This nuclear disaster wiped out

[1] *Reverence for Life –A Message for the Twenty-First Century from the Catholic Bishops of Japan* (Catholic Bishops' Conference of Japan, 2001, pp.104-105). Another message on nuclear plants announced by the Catholic Church in Japan is "Petition on the Criticality Accident at the Uranium Conversion Facility, JCO Co. Ltd" (1999).

the "safety myth", which was created because people put too much trust in science and technology without having "the wisdom to know our limits".

In the message "Reverence for Life", we, Japanese bishops could not go so far as to urge the immediate abolishment of nuclear plants. However, after facing the tragic nuclear disaster in Fukushima, we regretted and reconsidered such attitude. And now, we would like to call for the immediate abolishment of all the power plants in Japan.

With regard to the immediate abolishment of nuclear plants, some people voice concerns about energy shortage. There are also various challenges such as the reduction of carbon dioxide. However, most important of all, we as members of the human race, have responsibilities to protect all life and nature as God's creation, and to pass on a safer and more secure environment to future generations. In order to protect life, which is so precious, and beautiful nature, we must not focus merely on economic growth by placing priority on profitability and efficiency, but decide at once to abolish nuclear plants.

Because of the prediction that a new disaster will occur due to another earthquake or tsunami, all the 54 nuclear plants in Japan are at risk of horrific accidents like the latest one. Therefore, in order to prevent human-generated calamities associated with natural disasters as much as possible, it is essential to eliminate nuclear plants.

Although nuclear plants have been supplying energy in the context of "peaceful use" to society until now, they have also released an enormous amount of radioactive waste such as plutonium. We are going to place the custodial responsibility of these dangerous wastes on future generations for centuries to come. We must consider this matter to be an ethical issue.

Nuclear power has been encouraged by national policies up to now. As a result, natural energy has fallen behind in development and popularity. We urge that the national policies be changed to place top priority on development and implementation of natural energy, which will also contribute to reducing carbon dioxide. On the other hand, it takes a long time and enormous labor to decommission

a nuclear plant. Therefore, the decommissioning of reactors and the disposal of radioactive waste must be conducted with extreme caution.

Indeed, electricity is essential for our lives today. However, what is important is to amend our ways of general life by changing the lifestyles that excessively depend on electricity.

Japan has its culture, wisdom and tradition that have long co-existed with nature. Religions such as Shinto and Buddhism are also based on the same spirit. Christianity has the spirit of poverty as well. Therefore, Christians have an obligation to bear genuine witness to the Gospel especially through the ways of life expected by God; "simplicity of life, the spirit of prayer, charity towards all, especially towards the lowly and the poor, obedience and humility, detachment and self-sacrifice".[2] We should choose anew a simple and plain lifestyle based on the spirit of the Gospel,[3] in cases like saving electricity. We live in the hope that science and technology will develop and advance based on the same spirit. These attitudes will surely lead to a safer and more secure life without nuclear plants.

From Sendai
November 8, 2011
Catholic Bishops' Conference of Japan

[2] Pope Paul VI, Apostolic Exhortation *Evangelii Nuntiandi*, 76(1975).
[3] Cf. Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 486 (2004).

Foreword

When the Editorial Committee on Nuclear Power of the Catholic Bishops' Conference of Japan was established in September 2014, it intended to publish an English translation of the Japanese text it would eventually produce. We wanted to inform the world of the situation, viewpoint and responsibility of Japan, the scope of the Fukushima nuclear power plant disaster, and the response of the Japanese Catholic Church. The actual preparation was expected to take one year from the start of the work in the fall of 2016.

Since the project had a limited time frame and budget, it was decided that Chapter One of the second part, "Radiation, Nuclear Energy, and Nuclear Power," which contained information readily available from other sources would be omitted from this translation.

Even so, for various reasons the work took longer than the committee anticipated. I apologize for the delay to all those involved in the work and those who awaited its conclusion. Please note that the situation described in Chapter 1, Part 2 of damage caused by the nuclear power plant accident has changed somewhat between the time it was first written and this translated version in 2020.

During his visit to Japan in November 2019, Pope Francis met with victims of the Fukushima nuclear accident, and later referred to the dangers of nuclear power generation during an in-flight press conference on his way back to Rome. We are thrilled that the pope's experience in Japan deepened his awareness of the dangers of nuclear power.

I am pleased that today we are finally able to inform the rest of the Church and the world of the opposition by the Catholic Church of Japan to nuclear power generation.

I want to express my deep gratitude to Rev. William Grimm MM and Rev. Patricia Ormsby who translated the text. Rev. Masayuki Semoto SJ and Prof. Mami Yoshikawa of Sophia University provided a detailed review of the translation.

This book is dedicated to the late Rev. Michael Siegel SVD. Mick was the central figure in the preparation of this English text but succumbed to cancer in the early morning of July 3, 2019.

Editorial Committee on Nuclear Power,
Catholic Bishops' Conference of Japan
Ichiro Mitsunobu SJ
Tokyo, Easter 2020

Introduction

At 2:46 on the afternoon of March 11, 2011, an earthquake of magnitude 9.0 occurred on the sea floor 130 kilometers off the Oshika peninsula in Miyagi prefecture. The quake registered seven on the Japanese scale and produced a tsunami that caused massive damage along the Pacific coast of the Tohoku and Kanto regions. About one hour after the quake, a tsunami 14 to 15 meters high slammed into the Tokyo Electric Power Company's Daiichi nuclear power plant in Fukushima, knocking out power to all but one unit. With the loss of power, it became impossible to cool the nuclear reactors. As a result, the cores of Units 1, 2 and 3 had meltdowns, a catastrophic accident that caused the leakage of large amounts of radioactive material. This disaster that contaminated both land and sea with radiation and destroyed the livelihood of many people has not yet been remedied. More than 90,000 people who had to be evacuated have still not been able to return to their homes.

In November 2011, eight months after the accident, the Catholic Bishops Conference of Japan issued *Abolish Nuclear Plants Immediately: Facing the Tragedy of the Fukushima Daiichi Nuclear Plant Disaster*. The statement pointed out the dangers of nuclear power generation and called for the abolition of nuclear power.

The attitude of Japan's Catholic bishops toward nuclear power generation was earlier put forth in their 2001 message *Reverence for Life: A Message for the 21st Century from The Catholic Bishops of Japan*. In Section 75 of that message, the bishops said,

> [The development of nuclear energy] has provided a totally new source of energy for humanity, but as we can see in the destruction of human life in a moment in Hiroshima and Nagasaki, the disaster at Chernobyl and the life-threatening criticality accident at Tokaimura, it also has the potential to pass huge problems on to future generations. To use it effectively, we need the wisdom to know our limits and exercise the greatest care. In order to avoid tragedy, we must develop safe alternative means of producing energy.

This paragraph lays out important issues for today. Those of us who live in Japan know from our history how destructive the unprecedented power of nuclear technology

can be, and how it puts even future generations at risk. We know the absolute necessity of recognizing the limits of our technology and the need to develop alternative forms of energy.

The Fukushima Daiichi nuclear plant disaster confronts us harshly with this tragic reality. We know from experience that human wisdom and effort are not sufficient to control the dangerously destructive power of nuclear energy. This latest disaster destroyed the lives and livelihoods of many people.

Five years have passed, yet there is still no prospect of restoring those livelihoods or repairing the economic and social damage wreaked by the disaster. The cause of the disaster has still not been fully explained, and various experts point out problems with newly-developed safety standards for nuclear power generation. Even if nuclear generation were to be halted, ongoing problems of nuclear waste disposal remain unresolved. In spite of this, in 2014, the Japanese government adopted the policy of restarting those of the 48 nuclear reactors shut down following the earthquake and tsunami whose safety is considered to "have been ascertained".

When the bishops presented *Reverence for Life* they had not yet reached the point of calling for the abolition of nuclear power. At that time, our awareness of the problems of nuclear technology, the devastating impact of nuclear accidents and the deeper question of whether a life dependent upon electricity produced by nuclear power is compatible with Christian faith was still unsure. Even after experiencing the March 2011 disaster at the Fukushima Daiichi nuclear power plant, our understanding of the issues was still underdeveloped and so we went along with the reopening of nuclear plants.

It is time for us to reconsider the lessons of the Fukushima disaster. In the event of a severe accident in a nuclear power plant, the lives of people are upended and the environmental effects of radiation spread across borders and generations. Even without accidents, the accumulation of nuclear waste harms the environment. The energy of the atom is so powerful that it is difficult for humanity to control it over a long period. Given that fact, what are we to do? How shall we take a new look at our own lives? With whom must we unite in order to open a new future?

In May 2015, Pope Francis promulgated his encyclical *Laudato Si' – On Care for Our Common Home*. Relying upon the latest research into environmental issues, the pope looks at various ecological crises such as climate change, water issues, loss of biodiversity and ecological debt, and sounds an alarm.

This book, inspired by *Laudato Si'*, builds upon our 2011 statement calling for an end to nuclear power generation and renews the warning of its danger. This volume has been prepared by a committee of experts in theology, philosophy, religion, science and technology who came together in October 2014 as the Catholic Church and Atomic

Power Committee of Japan.

The first part of the book looks at the history behind the Fukushima nuclear plant disaster, seeking to understand responsibility for the accident. In addition, it looks at the situation of the victims of the disaster and explores ways to show solidarity with them.

Part Two explains radiation, nuclear energy and the science and technology of nuclear power generation. It will also look at some of the ethical problems of the science involved in the use of nuclear technology.

The third part is, in a sense, the heart of this book. It presents ways to look at the use of nuclear energy in light of Catholic social teaching and contemporary environmental ethics. The encyclical *Laudato Si'* shows how traditional Catholic thought on the environment can combine with new insights. In order to develop a broad perspective on the nuclear power issue, we will introduce viewpoints and initiatives from other countries, churches and religions.

The final summary will spell out requirements that nuclear phase-out involves: concrete measures for "reducing dependence on electricity," the use of renewable energy sources, the effort of power saving, and transformation of our lifestyles. The call for a "simple and plain lifestyle" in the bishops' 2011 statement is echoed by Pope Francis in *Laudato Si'* when he speaks of an "ecological spirituality" or an "integral ecology."

There are many points from which to examine the pros and cons of atomic energy: economic profitability, the health of children, public safety, responsibility for reliable energy supplies and maintaining international competitiveness in the nuclear industry among others. However, for the Catholic Church that has been told by Jesus Christ, "Love one another" (John 13:34), consideration of the pros and cons of nuclear energy must begin by taking into account the life and dignity of all, including future generations. In other words, we are convinced that the starting point for reflection must be the fact that humanity is part of God's creation and has a responsibility to unite to protect the environment we share with the rest of creation. Therefore, this book provides material to the church and civil society for thinking about the problem of nuclear power from an ethical and evangelical point of view.

We hope that this book will be an aid to reflection and discussion about how to build a lifestyle that precludes more nuclear disasters in the future.

Catholic Bishops Conference of Japan
June 14, 2016

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Chapter 1

(The material Chapter 1 of Part 2 in the Japanese edition of this book can be read in *books* on nuclear power generating technology, so we have omitted it here. For that reason, there is a gap in the footnotes from No. 40 to No. 50.)

Chapter 2

Chapter 3

Part 3

Chapter 1

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Part 1

From Nuclear Development to the Fukushima Nuclear Accident —Historical and Social Issues—

The task of this work is to endorse the November 2011 message of the Catholic Bishop's Conference of Japan. That message was, "We would like to examine the tragic disaster known as the Fukushima Daiichi nuclear accident, reflect on it, and call for all nuclear power plants in Japan to be abolished immediately." In other words, our task is to present material to the Church and civil society to enable them to consider this issue from an ethical, gospel-based perspective as a stance (moral opinion) toward accepting information and acting on it.

In Part 1, we consider the relationship between the atom and humans reliant on nuclear energy and the problems that this causes. This book therefore first reviews the history of nuclear energy's use and consider Japan's responsibility as the country where Tokyo Electric Power's Fukushima Daiichi nuclear accident occurred. It then considers ways to bring the various victims together. Particularly in Fukushima, while no relief is in sight, circumstances exist that make it difficult for people to talk and share opinions on nuclear energy, even within the Church. We wish for restoration of livelihoods and amicable restitution for people who have lost everything due to the accident. They include people whose livelihoods had been supported by nuclear energy-related jobs, and people whose relationships to important others were torn asunder by differences in response to the accident. We lend an ear to people suffering from damage and consider courses for protecting their rights as human beings.

Chapter 1
History of Nuclear (Atomic) Energy Usage and Radiation Exposure

The Japanese language has long used the terms *"kaku"* (nuclear) and *"genshiryoku"* (literally, "atomic energy") for different purposes. By tying the former to weaponry, and having the latter refer to the generation of electricity, the difference between military use and peaceful (civil) use came to be emphasized. Differentiating between these words like this also expresses a value judgement: nuclear weapons, which are weapons of mass destruction, are bad; but atomic energy, which produces energy useful to society, is good. Whether nuclear weapons or atomic energy, though, either still involves a technique (nuclear technique) of utilizing nuclear energy produced by changes in atomic nuclei (nuclear fission).[1]

The Fukushima Daiichi nuclear accident was not merely a power plant accident likely to happen in Japan, where earthquakes and tsunamis frequently occur, it was a dire calamity to all people who had come to use nuclear energy. The damage wrought by this accident, especially exposure to radiation and severe environmental contamination, is common to other instances of nuclear damage experienced by humanity thus far. As with the Chernobyl nuclear accident that occurred a quarter century prior (in 1986), the radioactive materials released spread beyond national boundaries, affecting broad swaths of the world. Its negative effects will be felt even by future generations.

The peaceful use of nuclear energy in Japan cannot be separated from the tragic history of nuclear technology. That has included Hiroshima and Nagasaki and events

[1] English, unlike Japanese, also utilizes "nuclear" the adjectival form of "nucleus" in "nuclear power plants," thus referring to weaponry as well as energy. This way it is easier to see that nuclear power plants and nuclear weapons are both technologies that use nuclear energy. On the other hand, by distinguishing between "nuclear" and "atomic," Japanese makes it more difficult to realize that atomic power and nuclear weapons both utilize nuclear energy and entail the same dangers. To make it clear that atomic energy and nuclear weapons are both based on nuclear technology, the original Japanese version of this book rephrased the Japanese term *"genshiryoku,"* literally "atomic energy," as *"kaku enerugi"* (nuclear energy). Similarly, because the term "peaceful use" of nuclear energy has its roots in a speech given by U.S. President Eisenhower before the United Nations General Assembly ("Atoms for Peace," December 1953), the term "civil use" is frequently used in place of "peaceful use."

experienced by humanity since then.[2] Japan has suffered nuclear-technology-derived tragedies five times, starting with humanity's first use of nuclear energy in war, with the two atomic bombs dropped in 1945. Those were followed by exposure to radioactivity from the Bikini Atoll hydrogen bomb tests, the Tokaimura JCO criticality accident, and then the Fukushima Daiichi nuclear accident. Of the world's nations, only Japan has suffered from all forms of hardship caused by nuclear technology—exposure to radiation from a nuclear attack and from nuclear testing and major accidents at nuclear facilities (nuclear fuel manufacturing plants and nuclear power plants). In this sense, it would seem that the Japanese people have a bigger responsibility than others to scrutinize societies that use nuclear energy and the way such societies are organized, and consider the significance and appropriateness of this. This chapter will review the history of nuclear (or atomic) energy use and radiation exposure.

1. The Atomic Bomb and Radiation Exposure

Nuclear Energy Unleashed

Development of technology for using nuclear energy began in the late 1800s with advances in research on radiation-producing devices. In the early years of the 20th century, different forms of radiation and radioactive substances were discovered in succession. Atoms were also found to consist of a nucleus and electrons, and the nucleus to be made up of protons and neutrons. Then, in 1939, in an experiment involving bombarding uranium nuclei with neutrons in Nazi-controlled Germany, atomic fission was achieved for the first time.

Splitting the nucleus of a uranium atom results in two lighter atomic elements being produced with the release of two or three neutrons. These neutrons collide with other atomic nuclei, causing subsequent nuclear fissions in a chain reaction. When that happens, an enormous amount of energy is released instantaneously. Scientists around the world knew immediately that the discovery of atomic fission would lead to development of the atomic bomb (A-bomb). The Jewish physicist Leo Szilard, who was born in Hungary but fled to America, feared A-bomb development by the Nazis. In America, he penned a letter to President Roosevelt, to which Einstein also added his signature, ad-

[2] Wada (2014) provides a comprehensive overview of the history of human involvement with nuclear energy, which began in 1898 with the discovery of radioactivity and continues to the present. Also, for a history of incidents involving nuclear energy, we referred to Nishio (2015). Wada (2011) explained basic terminology regarding atomic/nuclear issues. We have included some of Wada's explanations of events mentioned herein. In addition, Nakagawa (2011) published a monograph summarizing the history of radiation exposures.

vising him to initiate a project to develop an A-bomb (Yamagiwa et al. (1993) *Einstein's Correspondence*, August 2, 1939, pp. 4-5).

World War II broke out in response to Germany's invasion of Poland in September 1939. In America, the National Academy of Sciences committee on nuclear fission issued a report in May 1941 on the possibility of producing an A-bomb. In Britain as well, a report was issued in September 1941 on the possibility of realizing an A-bomb with uranium, and work began on plans for developing it. That report was conveyed to America, an Allied power, in October of that year, and the US government decided to work together with Britain on developing an A-bomb. Toward the end of that year, the war in the Pacific between Japan and America started, and in September 1942, the US government launched top secret A-bomb development plans. Since the project was originally headquartered in New York, it was referred to in secret as the "Manhattan Project."[3] About 120,000 scientists and technicians were assigned to it. In collaboration with industry, a new town was built for the purpose of researching and producing an A-bomb. About 2 billion dollars was spent on the project, an astronomical figure in those times.

The US government initially feared that Germany would succeed at developing an A-bomb before America could. Hurrying with development to avoid falling behind, America proceeded with two different projects at once within the Manhattan Project. One of those was to separate uranium-235 from naturally occurring uranium and make an A-bomb from enriched high-purity uranium-235. The other was to make an A-bomb from plutonium-239 produced from a nuclear reactor. The cost of producing plutonium-239 was less than that of enriching uranium-235. Because plutonium is easy to mass-produce, it became the mainstream choice for A-bomb production after World War II. As part of the Manhattan Project, a nuclear reactor for producing plutonium and a reprocessing plant for separating the plutonium out were built near the town of Hanford, Washington. Uranium enrichment facilities were built in Oak Ridge, Tennessee. The Los Alamos Laboratory in New Mexico was established for designing and assembling the A-bombs.

In the early stages of the Manhattan Project, Germany was being considered as the target of the atomic bombing. In 1944, however, it became clear that Germany lacked the ability to develop an A-bomb. On the European front, the defeat of Germany also began looking certain. The initial reason for developing an A-bomb, confronting Germany, no longer existed. By that point in time, however, so many people had been mobilized, and Congress had secretly appropriated such a gigantic amount of money for this colossal project that it was impossible to call it off. Predicting the surrender of Germany

[3] For the history of the Manhattan Project, we referred to Yamazaki and Hinokawa (1997).

before an A-bomb could be completed, the US government decided in mid-1944 to make Japan the target of the atomic bombings instead. With Roosevelt's sudden death on April 21, 1945, Truman assumed the presidency. Newly informed of the secret development of the A-bombs at that time, Truman was persuaded by his close confidants to approve the established policy of using the A-bombs on Japan. Thus, on June 21, the US government made it a policy to drop the A-bombs as soon as possible with no warning, targeting cities of a size that would allow the effects of the atomic bombs to be measured. The cities targeted were to have military bases or arsenals present and to have been minimally damaged by air raids. Hiroshima, Kokura and Niigata became candidates for bombing, with Nagasaki finally added to the list.

In July 1945, one uranium-type bomb and two plutonium-type bombs were completed. A test explosion of one of the plutonium-type bombs was done (July 16), and Truman, who received notification of this in Potsdam near Berlin, approved the strategy of dropping the other A-bombs on Japan (July 25).

The Atomic Bombing of Hiroshima and Nagasaki

A uranium-type bomb was dropped on Hiroshima on August 6, 1945, and three days later, on August 9, a plutonium-type bomb was dropped on Nagasaki. These A-bombs were dropped so as to hit the centers of these cities, and they exploded at an altitude calculated beforehand to result in maximal damage (580 meters above ground in Hiroshima, and 503 meters above ground in Nagasaki). The power of the blasts resulting from nuclear fission of about 800 grams of uranium and about 1,000 grams of plutonium were equivalent in terms of TNT yield to about 16,000 tons and 21,000 tons, respectively (according to Radiation Effects Research Foundation estimates; RERF, 2013, p.4). This far surpassed the total amount of explosives used in the air raid firebombings that devastated low-lying parts of Tokyo, which came to 1,685 tons.

Unlike conventional explosives, A-bombs release large amounts of radiation. There are two types of radiation from an atomic bombing: "initial radiation" released during the explosion and "residual radiation," which is released after the explosion.[4] Unlike initial radiation, residual radiation does not dissipate quickly. Radioactive substances spread about by the rising mushroom cloud and winds high in the sky gradually fall to earth over

[4] The initial radiation consisted of gamma rays and neutron rays released from the high–temperature fireball during the explosion. The area within a radius of 500 meters from ground zero received a lethal amount of radiation. Residual radiation was released by radioactive substances such as (1) remaining uranium-235 and plutonium-239 that did not undergo fission, (2) products of nuclear fission of uranium or plutonium such as cesium-137, and (3) substances with induced radioactivity from exposure to neutron rays, such as manganese-56 and sodium-24.

a wide region. Since the atomic bombing occurred in summer, when the humidity was high, the radioactive substances floating in the sky fell back to earth by and by with the rains. In some cases, this radioactive rain came mixed with black soot that had been carried aloft from the terrible fires ignited by the bombing. This later came to be known as "black rain," and became the common term for radioactive rain. Substances in the atmosphere, ground and buildings were pierced by neutron rays and turned radioactive. Just like the radioactive fallout, they became a source of radiation exposure.

One danger of residual radiation is that it causes secondary exposures among people who escape direct harm at the time of the blast itself (primary exposure). Directly after the A-bombs fell, people entered the devastated cities to check on family members or give assistance to the injured. Medical personnel were working in first-aid stations and temporary shelters hastily constructed in the cities. Police and government officials were carrying away the dead and clearing up the burnt out ruins. People were consuming food and water contaminated with radioactive fallout without realizing it. They and the people residing in the areas where black rain fell were receiving large doses of radiation that are known with certainty to be hazardous to health.

A-bomb Victims' Suffering and the Cover Up

After the A-bombs were dropped on Hiroshima and Nagasaki, Japan's government filed a protest against America (August 10) via Switzerland, a neutral country, of the atomic bombings as a violation of international law. Immediately after that, however, Japan accepted the terms of the Potsdam Declaration on August 14 and issued ceasefire orders to its armed forces the next day, bringing the war to an end.

What do you suppose the real reasons were for dropping the A-bombs? As suggested by the fact that two types of A-bombs were used, uranium and plutonium, dropping the bombs may have been seen a way to verify the effects of the new weapons experimentally. Other goals of America may have been involved as well, such as intimidation of the Soviet Union and establishing itself as a global hegemon. The explanation that dropping the A-bombs helped end the war more quickly and was aimed at minimizing the number of war victims (the so-called "A-Bomb Myth") was created after the war as a logical justification for the nuclear attack. A number of studies by historians have revealed that such an explanation is not in strict conformity with historical fact (Kimura & Kuznick, 2010, pp. 6-10).

The immense destructive force of a nuclear blast not only kills non-combatant citizens indiscriminately,[5] but by scattering large amounts of radioactive substances over a

[5] The numbers of fatalities from the atomic bombings that appear to have resulted from acute

wide region, it also causes suffering from radiation injuries among the survivors. The injuries suffered by the A-bomb victims included burns from heat rays, external wounds from the blast wave and damage from radiation. These are known together as "atomic bomb disease." This constituted cruel damage unlike any mankind had ever experienced before, and no one had any methods for treating it. Doctors are still at a loss in treating the acute period of atomic bomb disease in particular, which lasts up to four months after exposure. Even people not suffering fatal burns or trauma are beset by hair loss, vomiting, anemia, leukopenia, diarrhea and other terrifying symptoms, and in serious cases die off one by one.

Radiation from atomic blasts also has severe effects on fetuses, which are highly susceptible to radiation. According to one survey, the fetuses of expectant mothers exposed in the area within 2 kilometers of a ground zero who suffered acute radiation injury had rates of miscarriage or stillbirth about nine times as high as those whose mothers were a good distance away from it. Moreover, it became clear later on that death rates among children whose mothers had been exposed to radiation during their gestation were higher than those of others and many of them suffered from poor development or weak constitutions (Editorial Committee of Journal on Hiroshima and Nagasaki Atomic Bomb Disasters, 2011, pp. 147-150 (in Japanese only)).

The suffering from atomic bomb disease continues for the rest of the victim's life. Even after the acute injuries have healed, many of the surviving A-bomb victims suffer from some kinds of health problems, or they have after-effects from their injuries such as disfiguring keloid scars, or are tormented in mind and body by fatigue and debility in what translates literally from Japanese as "A-bomb lingering illness." Disease-prone A-bomb victims fall into poverty due to medical expenses and loss of employment, and they become socially isolated due to the psychological shock of losing family members and household assets. In addition, they are hurt by discrimination due to biases and inconsideration. They are refused marriage and employment and turned down for life insurance. This has forced many to conceal the fact they are A-bomb victims. One in four respondents to a survey of victims 60 years after exposure by the Japan Confederation of A- and H-Bomb Sufferers Organizations said that they had lived their lives concealing the fact they had been exposed (Japan Confederation of A- and H-Bomb Sufferers Organizations, 2005, p. 4).

Even worse, delayed effects of radiation exposure occur in many cases. Cataracts be-

radiation injury by the end of 1945 are estimated to have been about 140,000 in Hiroshima and about 70,000 in Nagasaki. A 1985 survey by Japan's Ministry of Health and Welfare found that by the end of 1950, 201,990 people had died in the case of Hiroshima and 93,966 in that of Nagasaki. That brings the total for the two cities to approximately 300,000 people.

gin increasing starting three years after exposure; and from five to 15 years after exposure, leukemia. From 10 years after exposure, cases of thyroid, breast, lung, stomach, colon and ovarian cancer, multiple myeloma and other malignancies begin increasing. Increased death rates from leukemia have been observed not only among those with primary exposures, but also among those with secondary exposures who entered the cities shortly after the blasts. As this reality became clear, the A-bomb victims were forced to live with worry over illnesses, possibly fatal, that could happen to them at any time in the future.

Psychological damage from having experienced an atomic bombing also continues to haunt the A-bomb victims. In the survey of victims 60 years after exposure, about 40% of the respondents acknowledged that the events of that day had left them with psychological wounds. One A-bomb victim said, "Even now the stench of blood, pus and death from that time stays in my nostrils. If I try to recall the situation at that time to draw a picture of the scene that I experienced, I get an abnormal heart beat (arrhythmia) or otherwise find it unbearable" (Japan Confederation of A- and H-Bomb Sufferers Organizations, 2005, pp. 7-8). Some responses in that survey spoke of the fear of death in occasional flashbacks or psychological wounds aggravating mental disorders. That the psychological wounds borne by the A-bomb victims have been ignored by almost all of society and no care has been provided are problems that must not be overlooked.

The government of America, the country that inflicted the atomic bombing, and the government of Japan, which had a responsibility to help the A-bomb victims, have continued to take an extremely cold attitude toward these victims, who have had to bear insult upon injury. American scientists had studied the health impacts of radioactive substances and were aware of their toxic effects even before the atomic bombings. The danger that the A-bombs could create victims gratuitously by scattering radioactive substances had been foreseen. Some took the view that the nuclear fission products created by the explosion would be carried aloft to the stratosphere, where they would scatter widely and dissipate enough that residual radiation would pose no danger. That this was a mistake that underestimated the impact of residual radiation was demonstrated in the aftermath of the atomic bombings (Hiroko Takahashi, 2012, pp. 57-65). The U.S. government, however, denied that anyone was being exposed to residual radiation. General Headquarters (GHQ) subjected all reporting on the A-bombs to strict censorship, striving to prevent the wretched conditions of the bomb sites and the misery of the A-bomb victims from being conveyed to international society. Meanwhile, the National Academy of Sciences of the U.S. set up the Atomic Bomb Casualty Commission (ABCC) in Hiroshima and Nagasaki to gather data on the effects of A-bomb radiation on the human body. The information gained from examining many of the A-bomb victims was treated as classified military data on damage to the human body from a nuclear attack. These data were never used in treating the

A-bomb victims (Kimura & Takahashi, 2016, pp. 198-208). Until the Act Regarding Support for Atomic Bomb Victims (Medical Treatment for Atomic Bomb Victims Act) was enacted in 1957, these A-bomb victims were left on their own with no support for 12 years. It must be noted that the governments of both Japan and America shirked their administrative responsibility to restore the dignity of the A-bomb victims.

The Bikini Hydrogen Bomb Tests and Pacific Islanders

Having won the Second World War, America decided to conduct nuclear testing at the Bikini and Enewetak atolls to study the use of atomic bombs and develop new nuclear weapons. These atolls are now part of the Republic of the Marshall Islands, which established its independence in 1986. The Marshall Islands are located in the Micronesian region of the western Pacific Ocean near the equator. Previously they had been a territory under Japan's mandate, but after the war, they came under American military administration. America relocated all of the inhabitants to different islands in March 1946, and conducted two A-bomb tests at the uninhabited Bikini Atoll in July of that year.

The year after that, the Marshall Islands became a United Nations trust territory. America, which had gained administrative authority over them, conducted one nuclear test after another at Bikini Atoll and at Enewetak Atoll to the west, totalling 67 times from 1946 to 1958 (Takemine, 2015, pp. 36-39). The total yield of the nuclear weapons detonated during that period came to 108 megatons TNT equivalent. That would be equal to 6,750 Hiroshima-type A-bombs (16,000 tons). England, which had lagged behind America in success at developing nuclear weapons, conducted nuclear tests 21 times from 1952 to 1958, and France, 199 times from 1966 to 1996, mostly in the South Pacific region, including Australia (Maeda, 2005, pp. 41-42). One factor in making the central southern Pacific such a "nuclear sea" was the nuclear arms race during the Cold War. When the Soviet Union successfully tested an A-bomb in August 1949, America lost its nuclear monopoly. In response, President Truman decided to develop a hydrogen bomb (H-bomb), which utilizes a nuclear fusion reaction between hydrogen atoms (deuterium or tritium) and is more powerful. America conducted its first H-bomb test on October 31, 1952 at Enewetak Atoll.

From March 1 to May 13, 1954, America conducted six tests of the new H-bomb, its strategic ace in the hole against the Soviet Union. In the first test, on March 31 at 6:45 a.m. local time, a 15-megaton H-bomb (code named "Bravo") was detonated at the test site on Bikini Atoll. The humongous explosion that ensued vaporized part of the coral reef in a flash and shattered much more into rubble, creating a crater 2 kilometers in diameter and about 80 meters deep. Three islands vanished. The stupendous power of that explosion equaled about 1,000 Hiroshima-type A-bombs, and was equivalent to five

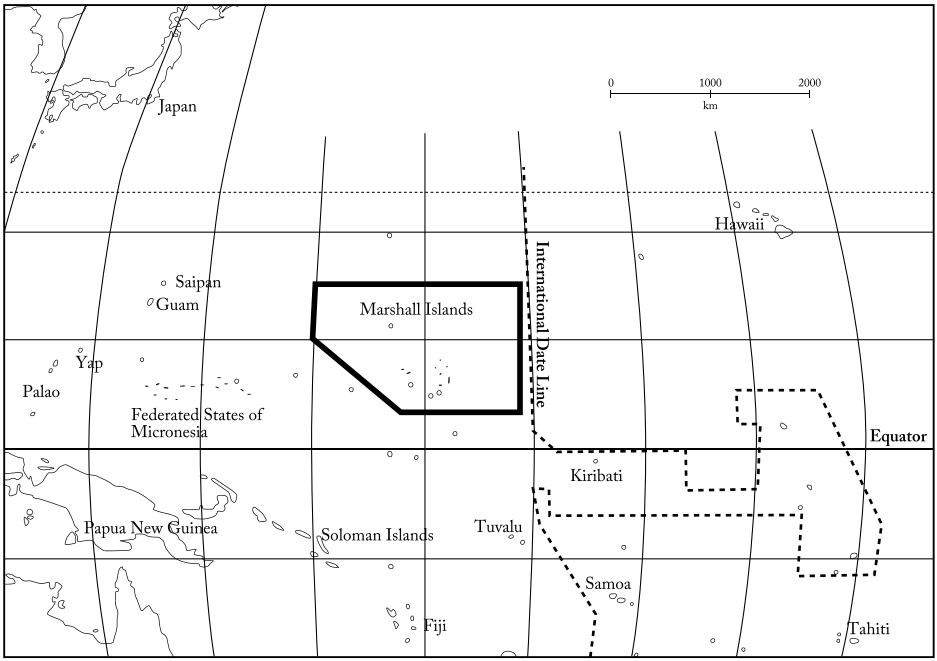


Fig. 1.1.1 Japan and the Pacific Island Nations
(prepared with reference to Pacific Islands Center, 2011, p. 4)

times that of the total explosives used during World War II (three megatons).

Several hours after the tremendous flash and explosive blast, white pulverized coral combined with radioactive substances began falling from the sky into the sea around the atoll. A Japanese newspaper article reporting later on the events of that day first coined the term *"shi no hai"* (death ashes) for the radioactive fallout produced by these nuclear explosions (nuclear fission and nuclear fusion) (*Yomiuri Shimbun*, March 16, 1954).

At Rongelap Atoll in the Marshall Islands, 180 kilometers east of the blast center, the white powder fell like snow. Eighty-two islanders, including four pregnant women, were exposed, and symptoms of acute radiation injury appeared among them the same day. There was no means of treating it on the islands, which had no hospitals, and unable to evacuate, the islanders had to wait three days for an American rescue ship to arrive while they continued to be exposed to external radiation from the "death ashes." They also breathed air and ingested water and food carrying radioactive contamination.

After being evacuated to American military facilities at Kwajalein Atoll, the Rongelap islanders spent three years living on different islands. They returned to Rongelap in June 1957 once the US government had declared it safe, but suffered a succession

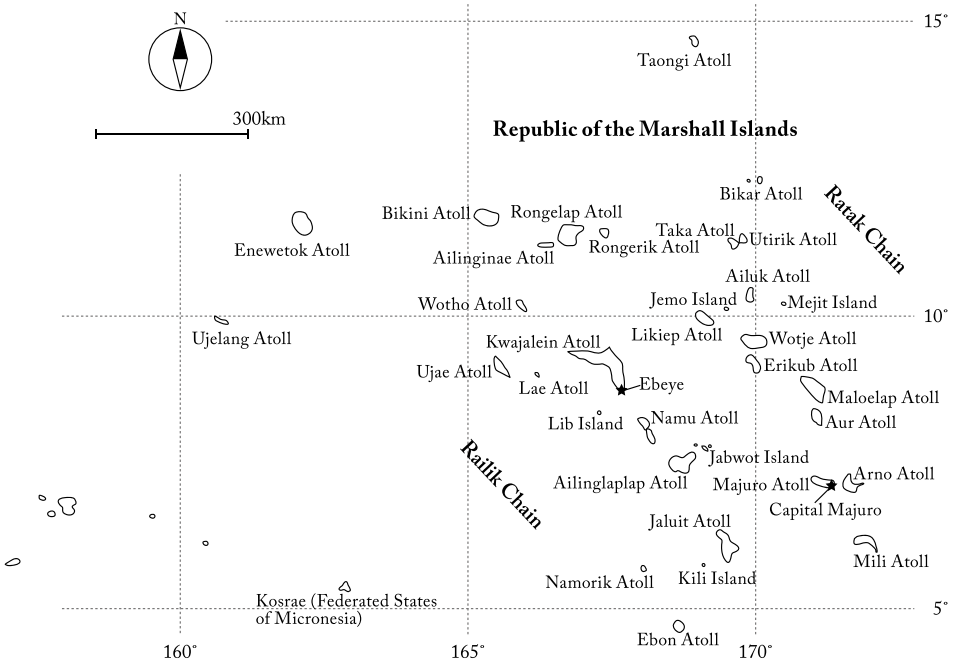


Fig. 1.1.2 The Marshall Islands

of illnesses and other problems, including thyroid disorders, cancers, miscarriage, stillbirths, and births of deformed children. Ultimately, the islanders decided on their own in 1985 to leave their native islands behind.

At Utirik Atoll about 500 kilometers to the east of the test site, 157 islanders were also exposed to radiation from the "death ashes." When the Republic of the Marshall Islands gained its independence, the U.S. government recognized the damage from the H-bomb tests and tried settling the dispute politically with 15 million dollars in compensation. However, damage was only acknowledged to the inhabitants of four atolls (Bikini, Enewetak, Rongelap and Utirik). Later, in official U.S. documents released after declassification it was revealed that the "death ashes" from the H-bomb test series had been scattered over such a wide region it could be considered global in scale. It was also noted that starting with 401 islanders living at Ailuk Atoll about 525 kilometers southeast of the test site, inhabitants throughout the entire Marshall Islands region had been exposed to radiation (Takemine, 2005; and also see Hiroko Takahashi, 2012, pp. 182-188; Takemine, 2015, pp. 113-154). The Ailuk Atoll islanders requested a proper investigation and compensation from the U.S. government, but the latter refused, maintain-

ing that the issue had already been resolved.

Exposure of Japanese Fishing Vessels to Radiation

The "Bravo" H-bomb test caused tremendous damage to marine vessels in the ocean nearby. The waters around Micronesia are good fishing grounds for tuna, so many of the affected craft were Japanese deep sea fishing vessels. According to internal documents of the Fisheries Agency dated November 30, 1954, that were released in 2015, at least 856 vessels were affected. The whole picture, though, on what appears to have been approximately 10,000 crew members exposed to radiation remains unclear. No follow-up surveys on the health of the crew members have been performed. Nevertheless, a study was conducted on the crew members of fishing vessels affected by the Bikini testing by a group called the "Hata Seminar" formed in 1983 by a high school teacher, Masatoshi Yamashita, and students from several high schools in Kochi Prefecture. They sought out testimonies from the affected that had been consigned to the shadows of history, recorded their findings and brought them to light (Yamashita, 2012).

One catastrophe of the Bikini H-bomb tests that was officially recognized by the U.S. and Japanese governments was the incident involving the Daigo Fukuryu-maru, a Japanese long-line tuna fishing boat. The boat was operating 160 kilometers east of the test site, and according to crew member Matashichi Oishi, early in the morning on March 1 a white powder fell so thickly on the deck their footprints were left in it. The same day, the crew were beset with dizziness, headaches, nausea, diarrhea and other symptoms (Oishi, 1991; 2003; 2007; 2011). Unable to leave the radioactively contaminated boat until they returned to Yaizu Port on March 14, the crew experienced inflamed eyes, discolored skin with burn blisters, bleeding, hair loss and other radiation symptoms. Taking only their external radiation exposure into account, the crew is estimated to have received on average 3.24 Sieverts, a high dose of radiation equivalent to those within 1 kilometer of ground zero of the Hiroshima A-bomb.

Furthermore, in May of that year, high concentrations of radioactive substances began to be detected in rain falling over the Japanese archipelago. Although the Marshall Islands inhabitants petitioned the United Nations to have the H-bomb testing halted, America asserted the legality of the testing, using Article 76 of the United Nations' Charter regarding international trusteeship "to contribute to international peace and safety" as an excuse. The continuation of the testing six times until May 13 was the cause of the radioactive rain in Japan. Radioactive contamination of fruits and vegetables at marketplaces was also confirmed at the end of May.

Leading figures in the U.S. government at that time attempted to calm the situation, saying that if the radioactive fallout fell into the sea, it would be diluted, limiting the ef-

fects of residual radiation (March 31, 1954 declaration by Lewis Strauss, then chairman of the Atomic Energy Commission Chairman, in Miyake, Hiyama & Kusano, 2014, pp. 21-24). Still, as the number of affected vessels continued increasing, radioactive tuna were caught, and radioactive rain was observed in Japan, it became clear that the impact of the H-bomb testing was reaching a scale and scope far beyond what had been expected.

No longer able to continue just looking on as a spectator, the Japanese government dispatched a Fisheries Agency research vessel, the Shunkotsu Maru, to the sea near the Bikini Atoll from May 15 to July 7 to investigate the effects of the H-bomb tests on marine ecosystems. From surveying fish, plankton, seawater and air over a voyage extending about 1,700 kilometers, they determined that radioactive contamination could be found in seawater and fish in areas removed by 1,000 kilometers or more from the Bikini Atoll, and that bioaccumulation of contaminants up the food chain played a role in the contamination of fish. The H-bomb tests had caused the worst case of radioactive contamination of the ocean in history. The survey disproved the view that radioactive fallout would be diluted by seawater and rendered harmless.

Meanwhile, the health condition of the 23 crew members of the Daigo Fukuryu Maru, who had been hospitalized, steadily worsened. Their bone marrow cells had declined to less than half the number in a healthy person. In poor health and having lost the ability to generate their own blood, they continued to receive antibiotics and blood transfusions. By and by many of the crew began to suffer liver function disorders. Chief radio operator Aikichi Kuboyama, in serious condition, died on September 23 of multiple organ failure resulting from his exposure to radiation.

Kuboyama's death made mass media headlines. It lent power to the Movement to Ban Nuclear Bombs that fed concerns over radioactivity and anger over nuclear testing, spreading them rapidly among Japan's citizens. The governments of America and Japan were driven to do something about it. Aiming for a political settlement of the Japanese fishing boat disaster, the U.S. government paid 2 million dollars (about 720 million yen at the exchange rate then) in compensation to the Japanese government on January 4, 1955.

The payment of this compensation, however, did not mean that the U.S. government was admitting the illegality of the H-bomb tests and apologizing to Japan. The compensation money Japan received was simply consolation with no account taken of America's legal culpability. Without revealing the entire situation of radiation exposures from H-bomb testing, the governments of both the U.S. and Japan tried to negotiate an amicable settlement and sweep the problem under the rug. Despite ongoing marine pollution, testing of fish for radioactivity was discontinued in December 1954. No attempt was made to clarify the degrees of exposure of crews of affected vessels other than the Daigo Fukuryu Maru, nor to investigate the impact on their health, nor to pay them any

compensation. The illegality of America's multiple H-bomb tests that produced so many victims was never recognized, and the testing continued at the Bikini and Enewetak atolls with not so much as a word of protest from Japan's government over the decision.

Nations possessing nuclear weapons have conducted a total of at least 2,050 nuclear tests from 1945 to 2013. The people victimized by radiation exposure live, like the Marshall Islands' inhabitants, on the fringes of superpower-centered civilized society (Daigo Fukuryu Maru Peace Association, 2014, pp. 96-103). Additionally, the repeated nuclear tests have scattered enormous amounts of radioactive substances throughout the environment, resulting in irremediable contamination globally. The 2000-plus nuclear tests to date have released an amount of iodine-131 estimated at about 3 million petabecquerels ("peta" meaning a quadrillion—that's a "one" followed by fifteen "zeros"). That is about 577 times the amount estimated to have been released by the Chernobyl disaster (about 5,200 petabecquerels). In 1991, International Physicians for Prevention of Nuclear War (IPPNW) announced its findings that the final number of fatalities from cancers attributable to the repeated atmospheric testing of nuclear weapons could be as high as 2.4 million people worldwide (IPPNW, 1991, pp. 39-40). The real degree of harm from nuclear testing to humanity, however, is not known with any certainty.

2. The History of Nuclear Power Generation in Japan

Post-war Nuclear Energy Research

Research in Japan to develop an atomic bomb was initiated in 1943, progressing in secrecy during the Asia-Pacific War. Called the "*Ni-Go* Project," it was conducted primarily by physicist Yoshio Nishina under guidance of the Imperial Japanese Army at the Institute of Physical and Chemical Research (now RIKEN). "F-Go Project" research began in 1944 at Kyoto Imperial University (now Kyoto University) under the direction of the navy. Neither project, however, ever managed to come anywhere near to developing a nuclear weapon in reality.

After the war ended, GHQ had the cyclotrons (equipment essential to the research) destroyed, and during the occupation Japan was forbidden to conduct any research in atomic nuclear physics. When the Treaty of San Francisco went into effect in April 1952, however, a group of physicists led by Seiji Kaya proposed advising the government on establishing an investigative body to consider the question of nuclear energy. Although research on nuclear physics resumed, many in academia opposed research on nuclear energy. During that period, the Korean War broke out (1950 to 1953), and Japan began remilitarizing with the establishment of the National Police Reserve. The academics felt strong concern because Japan-U.S. relations were drawing closer in national se-

curity matters, and if Japan began researching nuclear energy, it would get itself involved in America's military strategy (Yoshioka, 2011a, No. 2, Ch. 3).

In the 1950s, nuclear energy began to be used in ways aside from A-bombs. The Soviet Union brought the world's first nuclear power plant into operation in 1954. That was followed by a military-civilian dual use reactor (Calder Hall Nuclear Power Station) that started operating in Britain in 1956, producing plutonium for the military while providing electric power. America created the world's first nuclear powered submarine, the USS Nautilus, in 1954.

Dwight D. Eisenhower, who succeeded Truman as U.S. president in 1953, promoted development of the H-bomb. He also adopted a strategy of deploying nuclear weapons at U.S. military bases worldwide. The aim of this was to contain the Soviet Union, and it became the origin of the "nuclear deterrent" strategy in international security (Ohta, 2014). At the same time, American industrial circles starting getting involved in developing nuclear power, having been beaten to it by Britain. They began asking the government to cultivate a global market for it (Nakagawa, 2011).

"Atoms for Peace"

To avoid having America's nuclear strategy being seen as dangerous by international society under those conditions, President Eisenhower began seeking non-military uses for nuclear energy. The reasoning behind this was he thought that if people believed nuclear energy would bring about peace and prosperity, it would be easier to develop and deploy nuclear weapons (Yoshimi, 2012). At the United Nations General Assembly in December 1953, Eisenhower proposed the idea of "Atoms for Peace." This was America's national strategy to get people to think of atomic power as a non-destructive technology.

Soon after "Atoms for Peace" had been proposed, a budget for nuclear power was adopted by the plenary session of Japan's House of Representatives on March 4, 1954. After that, Japan's government began setting up a system for development and use of nuclear energy. Industrial circles saw it as the advent of a business opportunity in the field of nuclear energy. From then on, the political, ministerial and business worlds kept a cooperative pace with each other in promoting peaceful use of nuclear energy. It must be added that the nuclear energy budget was approved by the House of Representatives in the same month that the Daigo Fukuryu Maru incident occurred. Thus, this was when the Movement to Ban Nuclear Bombs was on an upsurge among Japan's citizens. A grassroots signature drive was burgeoning in opposition to nuclear weapons. It netted more than 30 million signatures. To suppress this growing movement, America held "Atoms for Peace" exhibitions in 10 Japanese cities, including Hiroshima, where memories of the atomic bombing were still fresh. In its attempt to wipe away the memories of

Hiroshima, Nagasaki, and now the Daigo Fukuryu Maru, it worked together with Japan's ruling elite to meticulously steer public opinion (Igawa, 2002).

In parallel with this, America under Eisenhower conceived of a plan for actual deployment of nuclear weapons in Japan. A nuclear-armed warship docked in Japan in 1953, and nuclear weapons were moved into a U.S. military base in Okinawa from the end of 1954 to 1955. At that very time, Japan was coming under America's nuclear umbrella. A new security treaty was concluded between Japan and America in 1960, and a campaign arose against the Japan-U.S. Security Treaty. That was also the year that Fukushima Prefecture declared its intention to attract nuclear power plants. Japan's involvement in America's nuclear strategy progressed at the same time as its nuclear power policy. "Atoms for Peace" and "for military use" were the two sides of America's nuclear strategy during the Cold War era.

Battle over the Pros and Cons of Nuclear Energy

During that time people were raising their voices in protest of "Atoms for Peace." Masao Tsuzuki, a physician who had led an investigation into damage from the atomic bombings and directly encountered the suffering of the atomic bombing victims, opposed the construction of nuclear power plants. He brought up examples of radiation damage resulting from nuclear power in the U.S. and Europe and warned, "When considering peaceful utilization of atomic power, at the same time, or better yet, before that, we must seriously consider prevention of damage from radioactivity" (Tsuzuki, 1954, p. 943). Theoretical physicist Seitaro Nakamura also stated that from the standpoint of moral duties of scientists, "Currently there is no suitable treatment for radiation injuries, so in view of public health shouldn't our position really be avoidance of all manmade radioactivity? … Until our ability to process the radioactive wastes from atomic power generation relying on nuclear fission has been perfected, it would be wrong to allow it as an industrial technology in a country with space as limited as Japan's" (Nakamura, 1954, p. 124).

Another theoretical physicist, Mitsuo Taketani, who had once advocated construction of nuclear reactors but had witnessed the terrible spectacle of the Daigo Fukuryu Maru incident, came to take a firm stand against the peaceful use of nuclear power. He said, "The various parties agitating for peaceful use are not just camouflaging, but concealing their motives with regard to the movement against nuclear weapons" (Taketani, 1955, p. 99).

The government, however, failed to take such warnings seriously (Jomaru, 2012, pp. 82-92).

The Japan-U.S. Atomic Agreement was concluded in November 1955, and three laws on atomic power were approved in December of that year (Atomic Energy Basic

Law, Law for Creation of the Japan Atomic Energy Commission, and Law for Partial Revision of the Cabinet Establishment Law).The organizing of atomic power development thus got underway. The Japan Atomic Energy Research Institute (JAERI), which would be the recipient of enriched uranium, based on the Atomic Agreement, and Nuclear Fuel Corp., which handled the development of uranium mines and nuclear fuel production technology, were established as special public corporations under the jurisdiction of the Science and Technology Agency. In 1956, industrial circles created the Japan Atomic Industrial Forum Inc., and the Japan Atomic Energy Commission (JAEC) was launched as a government institution to create and promote an atomic energy business plan for Japan.

Hideki Yukama, who had received the Nobel Prize in Physics and was in a position to represent Japanese academia at that time, was among the first members of the Japan Atomic Energy Commission. His opinion was that research and development (R&D) of atomic energy needed to be built up starting from the basics.[6] However, Matsutaro Shoriki, the commission's chairman, simply ignored the academics' cautious stance and laid out a course of importing atomic energy facilities rapidly from overseas. By 1955, America was already showing intentions of providing Japan a test reactor complete with enriched uranium. In 1956, Britain offered to sell Japan an improved Calder Hall-type reactor (graphite-moderated gas-cooled) and America offered a light-water reactor. The Japan Atomic Power Company purchased the former from Britain in 1958, and made the decision to build Japan's first commercial reactor in Tokai, Ibaraki Prefecture. The Tokai Power Station began operating in 1966.

The improved Calder Hall-type reactor was large and heavy, and the amount of electricity it could generate was small relative to the high cost of building it. In addition, it had safety issues. Thus from then on, Japan chose to propagate the U.S.-made light-water reactors instead, and from about 1970 it began building and starting up numerous nuclear power plants with light-water reactors. Since then, there have been continued mishaps and trouble at these nuclear power plants. As the citizens' concerns over pollution and other environmental problems grew, a controversy arose over the incompatibility of democracy with the secretiveness of atomic energy. The government and electric power companies, however, developed an extensive public relations and propaganda campaign to discourage opposition, and with time on their side, they continued making well-funded persistent moves to persuade local governments and citizens in suitable areas to let them have their way. Also, because this state-controlled program re-

[6] Hideki Yukawa told an Asahi Shimbun reporter in a private conversation, "I am not interested in atomic power generation. We must make people more aware of the frightful danger of radioactivity. They keep going on and on about peaceful use, but it is not such an easy thing." (Jomaru, 2012, p. 13).

ceived enormous support from policy makers, atomic energy continued to grow steadily. American manufacturers of atomic reactors began showing interest in teaming up with those in Japan in the 1980s, and joint Japanese-American production of light-water reactors has been promoted (Yoshioka, 2011a, Ch. 3 to 5).

Nuclear Fuel Recycling as a Goal (Yoshioka, 2011a, Ch.4-5)

One goal of Japan's nuclear energy development plans from the start has been to "recycle nuclear fuel." That entails reprocessing spent nuclear fuel to obtain plutonium, and using that as a fuel in fast-breeder reactors, generating power through nuclear fission. It is a grand plan to produce plutonium from uranium while generating electricity. Conventional nuclear power generation uses enriched uranium with light-water reactors and was viewed from the start as merely transitional.

For fuel cycle-related technology, Japan's government was particularly keen on developing reprocessing techniques and fast-breeder reactors, investing immense sums in their R&D. Development of reprocessing techniques got fully underway in the mid-1960s. Japan imported technology from France and built its first reprocessing plant at Tokai, Ibaraki Prefecture. Full-scale operation began in 1981. The Tokai Reprocessing Plant, however, has only a small capacity for reprocessing and is unable fully to handle the amount of spent nuclear fuel being produced, which has continued growing together with the amount of nuclear power generation. To expand Japan's reprocessing business, plans for building new facilities in Aomori Prefecture were announced in 1984, to consist of a large-scale reprocessing plant together with a uranium enrichment plant and a low-level radioactive waste landfill. Construction of the Rokkasho Nuclear Fuel Reprocessing Facility began in 1993, with operations scheduled to start in 1997. A series of problems of various sizes occurred, however, and completion of the facilities was delayed repeatedly. Commercial operations have yet to get underway. The cost of construction was expected to be about 760 billion yen, but has already swollen to about 2.2 trillion yen. The completion target of November 2015 has been postponed to early fiscal 2018.

Thus far, the Joyo experimental fast reactor and Monju fast-breeder reactor have been constructed in Oarai, Ibaraki Prefecture and Tsuruga, Fukui Prefecture, respectively, following the roadmap toward implementation.[7] Construction work on Monju began in 1985, and a successful criticality test was run in April 1994. In 1995, however, a fire

[7] In its long-term plan of 1967, the Atomic Energy Commission of Japan laid out a roadmap for promoting development of fast-breeder reactors in four stages: experimental, prototype, demonstration and, finally, commercial reactors. The Joyo reactor was an experimental one, lacking power generating equipment (thermal output of 140,000 kilowatts), while the Monju reactor is a prototype capable of generating electricity (maximum power output of 280,000 kilowatts).

broke out when liquid sodium coolant leaked. For 14 and a half years after that, they were unable to restart the reactor. When in 2009 they managed to restart the reactor, another accident occurred about three months later, even before any electricity could be generated, and they shut it down once more. There is currently no outlook for starting it back up again.

The initial plans put implementation of fast-breeder reactors in the latter half of the 1980s. Later plans, though, postponed the target for implementation: In 1982, the target was amended to 2010; and in 1994, it was delayed until 2030. France's Superphenix fast-breeder reactor suffered a continuing series of accidents during its time in operation and was closed permanently in 1997. That left Monju as the only fast-breeder reactor among the advanced nations.[8]

A total of 1.225 trillion yen was spent between 1980 and 2015 on the R&D budget for Monju. Even now, when the reactor cannot operate, it continues to run up costs estimated at about 55 million yen a day. A report submitted with the hopes of having the injunction against its operation lifted was found in February 2015 to contain numerous errors. Japan's Nuclear Regulation Authority (NRA), who had received it, said in November of that year that the Japan Atomic Energy Agency (JAEA) should not be relied on for operating Monju and recommended the Minister of Education, Culture, Sports, Science and Technology to specify a different managing entity to replace it.

The nuclear fuel cycle project was thus deemed nationally important, and even when it became clear that the technology was fraught with terrible dangers, with incessant delays in the schedule and costs prodigious enough to bankrupt the plan, the government still would not give it up.

Nuclear fuel cycle technology was originally developed for the purpose of producing atomic bombs. It has been called a "Sensitive Nuclear Technology (SNT)."[9] This is because even it if is used as a technology for generating electricity, changes in nations' policies can occur, and it could wind up being used to produce nuclear weapons at any time. Japan is the only non-nuclear power permitted by international society to engage in nuclear fuel cycle projects. While taking a cooperative attitude toward the International Atomic Energy Agency (IAEA)[10] and faithfully obeying America's nuclear non-prolifer-

[8] As of June 2016, Russia, India and China are continuing to go forward with their plans for fast-breeder reactors.

[9] This indicates technical systems requiring exceptional caution in the employment of the techniques or disclosure of the technical knowledge because it could lead directly to development of nuclear weapons. Uranium enrichment, reprocessing and fast-breeder reactors, which comprise the core of nuclear fuel cycle technology, all constitute sensitive nuclear technology that could be converted to military use.

[10] An international institution founded for the purposes of promoting peaceful use of atomic

ation policies, Japan has obtained all kinds of sensitive nuclear technology. It was allowed to build within its borders nuclear facilities that could be converted to military use.

America, the chief promoter of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)[11], is deeply cautious about allowing other countries to possess nuclear facilities capable of being converted to military use, such as reprocessing plants, or substances such as plutonium that are used in nuclear weapons. Japan has entrusted nuclear fuel reprocessing to private companies, and has taken the stance of limiting the use of the plutonium it has to civil affairs. America has made an exception in allowing this.

Nuclear Power Set-backs and Rallies (Yoshioka, 2011a, Ch. 5, 7)

From the 1970s to the early 1990s, nuclear power generation experienced steady growth in Japan. Indications of a decline in this growth, though, could be seen from around the mid-1990s. The primary cause of this was stagnation in Japan's economic growth. A second cause was concern that the wave of electricity deregulation sweeping the globe could also affect Japan. A third cause was that it was becoming harder to obtain land for siting power plants.

Electricity deregulation is a means of enabling free price competition by separating off the electricity transmission departments of the huge electric power companies that have monopolized power generation and transmission, and recognizing new participation from companies selling electricity. What made this necessary was that the electric power companies' management system, which had been exempted from price competition in the market due to their local monopolies on the power supply and use of the fully distributed cost method[12] of price setting, was causing electricity rates to rise. It was recognized that this was blunting the international competitiveness of Japan's manufacturing industry. Progress in electricity deregulation took the wind from the sails of nuclear power promotion, but in the first decade of the 21st century the powers promoting nuclear energy fought back, putting a swift brake on electricity deregulation and reduc-

energy and preventing its conversion to military use. U.S. President Eisenhower's speech to the UN General Assembly in 1953 on "Atoms for Peace" served as the impetus for its founding in 1957 as an independent UN-affiliated institution.

[11] An international treaty stipulating responsibility for negotiating nuclear disarmament among all parties to the treaty, and preventing proliferation of nuclear weapons among all nations except the five nuclear-weapons states (U.S., Russia, Britain, France and China). It prohibits non-nuclear-weapon states from using atomic energy for military purposes, while recognizing their right to peaceful use of atomic energy. The treaty entered into force on March 5, 1970. There were 191 signatory nations to the treaty as of February 2015. Japan signed it in February 1970, ratifying it in June 1976.

[12] A method of calculating rates so as to make the total income equal to the total cost of business, inclusive of business rewards. This method is used for determining charges for public utilities such as electricity, water and gas services, stable supplies of which are needed.

ing its momentum. Plans for the Rokkasho reprocessing plant are expected to entail enormous costs for construction and maintenance, so if electricity deregulation is realized, there is a high likelihood of them being cancelled or frozen.

Thus at the dawn of the 21st century, the prerequisites for expansion of nuclear power were lost. It looked like the basic track of Japan's nuclear power policies touting implementation of the nuclear fuel cycle and promotion of nuclear power might be forced to accept some revisions. The cabinet, however, adopted nuclear power policy principles sticking to the same old course in an October 2005 decision. The target date for development of fast-breeder reactor technology was revived. In 2007, expansion of the scope of electricity deregulation was completely halted.

In the first decade of the century, the use of nuclear power was recommended as a countermeasure against global warming since it releases no carbon dioxide during power generation. A "nuclear renaissance" was announced to the world. Until the Fukushima accident occurred, Japan was part of this movement, making plans to build multiple nuclear power plants at home and export them abroad. The situation changed completely, however, on March 11, 2011.

Nuclear Exports

Public opinion polls conducted by various organizations consistently show about 70% of Japan's people in favor of abandoning nuclear power[13], either at once or in stages. In Europe many people joined the movement to abandon nuclear power following the Chernobyl accident. The Fukushima accident served as a trigger for Germany to adopt legislation for abandoning nuclear energy completely by 2022 and devote effort to promoting wider use of renewable energy. At present, however, Japan's government is pushing for nuclear exports. It goes without saying that when 70% of its own people are opposed to nuclear power, to export nuclear power plants would be immoral. Nevertheless, the problem does not end there. Complicated factors are involved in exporting nuclear

[13] In Europe after the Chernobyl nuclear accident in April 1986, the movement that arose seeking abandonment of nuclear energy coined the term *"Ausstieg"* in German ("phase-out" in English). Jinzaburo Takagi proposed translating this into Japanese as *"datsu genpatsu"* ("breaking away from nuclear power"). This was later popularized throughout Japanese society through the media and local movements opposing nuclear power. The term used in the 1970s was *"han genpatsu"* ("anti-nuclear power"), which had strong connotations of being against idea of nuclear power and its use. As implied by the German term *Ausstieg* (which normally means to debark from a train or other transportation) implies, *datsu genpatsu* has nuances of embarking on a clear program of abolishing already widespread nuclear power. "In Europe, the term *'datsu genpatsu'* is becoming popular. The term *'datsu'* provides a sense of resistance in many people's minds, and they can understand the meaning well, as how specifically to embark on a program for abolishing nuclear power. In that respect, it probably spoke to them conceptually in a way decisively different from the slogan 'society without nukes.'" (Takagi, 1986).

power that go beyond technical prowess or capital strength.

Not only did new orders for nuclear power plants in America lapse after the Three Mile Island accident in 1979, cancellations of plans for which construction was already underway totaled 106 units by 1983. In the 30 years following the accident, new construction fell to zero. Therefore, while American nuclear power plant makers maintained their design capabilities, they lost their manufacturing ability.

The Bush Administration, which was inaugurated in 2001, took a clear position of promoting nuclear power. It advocated the "nuclear renaissance," embarking on a mission to save the moribund nuclear industry. The United States-Japan Joint Nuclear Energy Action Plan was concluded between the Bush Administration and the first Abe Administration in 2007. Japan would provide technical and financial assistance for rebuilding America's nuclear power industry, and America would work jointly with Japan on promoting nuclear exports. Then although legislation had previously been adopted not allowing the Japan Bank for International Cooperation (JBIC), one of the financial institutions supporting Japan's policies, to finance exports to advanced nations, the government issued a new cabinet order enabling investment finance to advanced nations in the case of business involving nuclear power generation. This made it possible for Japanese financial institutions to finance nuclear power projects in advanced countries, including America. The currently effective Japan-United States Atomic Agreement will expire in 2018. The Japanese government's attitude is thought to be based on a desire to create an equal footing between America and Japan now so it can maintain the right to possess reprocessed plutonium when the agreement is renewed.

Having obtained America's cooperation, Japan's government established a consortium, the International Nuclear Energy Development of Japan Co., Ltd. (JINED), and embarked on nuclear exports using national financing. To support exports to Vietnam and Turkey, they took measures using government money to cover the costs of preliminary surveys. Also, the company that took the orders for the feasibility study was the Japan Atomic Power Company (JAPC), a statutory company of Japan (Suzuki, 2014).

Nuclear exports involve difficult problems, including how the risk of accidents is to be borne, how spent fuel is to be handled, what means there are to prevent diversion to nuclear weapons, and how to prevent the local inhabitants from being harmed by radioactivity. The technical and political risks are huge, surpassing those of constructing nuclear facilities within one's own country. Moreover, because politicians are being used as sales representatives, the matter cannot be considered purely a business deal, but involves a high likelihood of getting ripped off by wily clients and leaving Japan's citizens to clean up the mess (Yoshioka, 2011b).

3. Catastrophes at Nuclear Power Plants and Related Facilities

The Three Mile Island Nuclear Accident

Nuclear power is said to be safe, but, in fact, many accidents have occurred at nuclear power plants. Here we will review some representative examples.

A loss of coolant in reactor number 2 (959 megawatt electric generating power) of the Three Mile Island Nuclear Generating Station (TMI-2), located on an island in the Susquehanna River in Pennsylvania, led to a terrible accident with a partial meltdown of the reactor core on March 28, 1979. TMI-2 was a pressurized water reactor. Pressurized water reactors are built with a primary coolant system, in which the water circulates within the pressurized reactor vessel and proceeds from there to a steam generator, and a secondary coolant system, where water circulates between the steam generator and a set of turbines. The heat from the primary coolant system causes the water in the secondary system to vaporize, and the resulting steam is used to run the turbines. The water in the secondary coolant system plays an important role in carrying heat away from that in the primary coolant system, thus indirectly acting as an important coolant for the reactor core. What triggered the accident was a pump failure in the secondary coolant system. The auxiliary pumps went into action right away automatically, but because the workers had forgotten to reopen the valves after conducting a maintenance check the day before the accident, circulation of water within the secondary coolant system stopped. Heat trapped within the primary coolant system had no way of escaping. This caused the temperature and pressure of water within the reactor core to climb steeply.

In order to prevent destruction of the reactor core when the pressure rises, a relief valve in the pressurizer opens automatically. That day, however, once the pressure was relieved, the valve failed to close again, so boiling water and steam continued to erupt from it. Nuclear power plants are equipped with an emergency core cooling system (ECCS) that injects water forcibly during emergencies involving loss of coolant water in the reactor core. Because water injection by the ECCS failed, though, the upper part of the reactor core lost its water entirely. The fuel rods melted—a major accident known as a "meltdown"—during which radioactive substances leaked into the environment.

The governor of Pennsylvania advised expectant mothers and young children to evacuate the area within eight kilometers of the reactor on March 30. Voluntary evacuation spread among citizens fearing an enormous catastrophe. An investigation conducted seven years after the event found that 70% of the fuel had melted, with about 20 tons of fuel falling to the floor of the pressurized reactor vessel. Miraculously, none of this huge amount of melted fuel penetrated the floor of the vessel, certainly a bit of good fortune amid misfortune.

There are various opinions on the amount of radioactive substances released into the environment during the accident, and no precise figures are known. According to a government committee formed to investigate the accident, the maximum exposure to people living in the vicinity of the plant was about 0.7 millisieverts (mSv), and not a large enough amount of radioactive substances was released to result in acute damage. However, a survey by the residents on health damage (the scientific basis for which is controversial) reported increases in the numbers of health problems and neonatal infant mortalities rising immediately after the accident. Deaths from various cancers, including leukemia, were also reported to have increased.

This accident was the result of a series of equipment failures and human errors. Even with multiple redundant safety measures in place at a nuclear plant, it is a mistake to buy into the idea that major accidents will not occur. With the Three Mile Island nuclear accident, the "nuclear safety myth" in America was crushed.

The Chernobyl Nuclear Accident

The No. 4 reactor at the Chernobyl Nuclear Power Plant (1,000 megawatt electric generating power) in the Ukrainian SSR of the former Soviet Union exploded on April 26, 1986, in what was then the worst nuclear accident in history. Unlike the Three Mile Island nuclear accident, the Chernobyl disaster resulted from a runaway fission reaction.

What triggered the accident was a turbine generator test conducted just prior to a scheduled inspection. It was being run with most of the safety equipment disengaged to maintain power. In the final stage of the test, conditions inside the reactor became unstable, and the operators inserted the control rods into the reactor core to shut down the reaction. This, however, had the opposite of the intended effect, with power surging by a factor of a hundred. This was a "runaway reaction," also known as a "special power excursion," which sounds innocuous, or a "nuclear burst," which doesn't. Within a few seconds of that at least two large explosions occurred, destroying the nuclear reactor and the building that housed it. It left the reactor core exposed. The Chernobyl Nuclear Power Plant was using graphite as a neutron moderator. This graphite ignited and sent smoke rising into the sky, carrying radioactive "ashes of death" up high and scattering them far and wide.

Initially, the radioactive substances were blown to the northwest. On April 27, they crossed the Baltic Sea, and high levels of radioactivity were detected in Sweden. By the 28th, the Soviet government had no choice but to admit to the accident. From the end of April into early May, nearly all of parts of the northern hemisphere, including Japan, were detecting radioactivity from Chernobyl. The entire world came to know just how serious an accident it had been.

The "ashes of death" continued to be released for about ten days as the graphite kept burning. Of the radionuclides within the reactor, about 50 to 60 percent of the iodine-131, and 30 to 50 percent of the cesium-137 are estimated to have been released. The northern and central parts of Ukraine incurred severe contamination, as did southeastern Belarus and European Russia west of the Ural Mountains. Even 300 kilometers or more from the nuclear power plant, areas highly contaminated by rain from radioactive clouds extended onward.

Radiation exposures resulting from the accident caused harm on a tremendous scale judging just from the cases in which the circumstances are clearly known. First, the people who received the most severe health damage were the nuclear power plant workers who happened to be present at the site during the accident, and the firefighters who rushed to the scene to extinguish the fires. They were bathed in intense radiation, and of the 134 people hospitalized with acute radiation damage, the UN officially acknowledges at least 28 fatalities. When the Soviet Communist Party's secret minutes were released in 1992, they revealed that more than 10,000 people living nearby had been hospitalized, receiving treatment for radiation damage and other illnesses (UNSCEAR, 2011, p. 58).

The second group of people exposed to high doses leading to health damage were the workers charged with cleaning up after the accident. Called the "liquidators,"[14] they were forced to clear up the scattered radioactive substances and contaminated debris in the vicinity of the nuclear reactors, build the concrete "sarcophagus" that enveloped the ruined reactor, and decontaminate the 30-kilometer zone, all of which exposed them to radiation. There are said to have been more than 800,000 liquidators, and various kinds of investigations have revealed that they suffer higher rates of leukemia and cancer than the general population. Many of the workers who suffered from various illnesses at that time as a result of their exposure to radiation are suffering from them even now (Alexievich, 1997).

In the areas that incurred severe contamination from the falling "ashes of death," the inhabitants lost their hometowns. Immediately after the accident, about 135,000 people living within 30 kilometers of the nuclear power plant had to evacuate. Three years after the accident, in 1989, details on the state of contamination were released. Learning of this, about 110,000 people living in the Byelorussian SSR (now Belarus) decided to move away from their homes. The Soviet government moved a large number of people away from the contaminated areas in 1991.

After the dissolution of the Soviet Union in 1991, the governments of Russia, Be-

[14] This term is derived from the Russian "likvidator," where it means "person who deals with the aftermath." The area within 30 kilometers of the nuclear power plant was ordered evacuated, and the term came to be applied to the people working within that area.

larus and Ukraine whose territories had been contaminated, took legal measures. Contaminated areas where cesium-137 had been measured at 37,000 to 185,000 becquerels per square meter (bq/m^2) were designated "radiation-controlled areas," and recognition of the right of inhabitants to transfer out of areas having 185,000 to 555,000 bq/m^2 was given. Moreover, the obligation to move people out of areas having 555,000 to 1.48 million bq/m^2 was fulfilled. Evacuation of the inhabitants from areas having more than 1.48 million bq/m^2 was also made mandatory. Obligations to transfer people out and mandatory evacuations were enforced over a total area of about 10,000 square kilometers. This is equivalent to not only the area of Fukui Prefecture, which hosts Japan's greatest concentration of nuclear power plants, but the adjacent Kyoto and Osaka Prefectures added as well, with their major cities. As of this time, the total number of mandatory evacuees, including people who evacuated voluntarily, is estimated at 400,000 to 500,000 people. These people can never return to their former homes.

The Tokai-mura JCO Criticality Accident

Japan's first criticality accident occurred on September 30, 1999 at 10:35 a.m. in Tokai-mura, Ibaraki Prefecture at the Tokai Plant of JCO. JCO was a nuclear fuel processing company, and its main area of work was "reconverting." That is a step in the process for manufacturing nuclear fuel rods for conventional nuclear reactors (light-water reactors), and includes chemical processing of uranium. That day, though, three workers were handling a uranyl nitrate solution containing 18.8% fissile uranium-235 wth the goal of producing materials for MOX fuel[15] to be used in the Joyo experimental fast reactor. This is a dangerous substance with a uranium concentration far exceeding that of the nuclear fuel used in conventional nuclear reactors (3 to 5 percent).

"Criticality" is a condition in which a nuclear fission chain reaction is sustained at a constant rate. It refers to the reaction occurring in a nuclear reactor during its operation. When an accumulation of fissile uranium-235 exceeds a certain amount, criticality can be achieved outside a nuclear reactor as well. Therefore to prevent accidental exposures due to criticality, plants handling uranium solutions establish rules on what containers can be used for processing these solutions, restricting their shape and capacity. That day, however, in violation of these rules, the uranium solution was poured into a settling tank, which had a large capacity. The amount of uranium in the tank reached critical mass, setting off a nuclear fission chain reaction in the uranium solution. This resulted in the sudden creation of an "uncovered nuclear reactor" at the plant, with no radiation shield-

[15] Nuclear fuel containing a mixture of uranium and plutonium oxides. The acronym is derived from "mixed oxides."

ing or control rods. Large quantities of radiation escaped into the vicinity.

At 10:36, right after the accident, neutron rays were detected at the Japan Atomic Energy Research Institute (JAERI) located 1.7 kilometers to the east of the JCO plant. At about 11:30, a high level of 0.84 mSv per hour of gamma radiation was detected at the site boundary. This level would result in the annual allowable radiation exposure limit for the public at large being reached in a little over an hour. The village of Tokai were informed about the accident and sent out a warning to its citizens at 12:30. At 3:00 that afternoon, the mayor, Tatsuya Murakami, issued evacuation orders to about 150 people living within 350 meters of the conversion building. At about 5:00 p.m., strong neutron rays of 4 mSv per hour were measured at the site boundary. The level of neutron radiation did not decline after that, and it was considered certain that criticality was continuing, so they needed to brace for the worst case scenario of the plant being destroyed and large amounts of radioactive substances being released. At 10:30 p.m., about 310,000 people living within 10 kilometers of the plant in Ibaraki Prefecture were requested to shelter indoors, the JR Joban Line that passes near the plant was stopped, and the Joban Expressway and national highways nearby were closed to traffic. Late that night, a request went out for Japan Ground Self Defense Force disaster relief troops.

The criticality did not cease until about 6:15 a.m. on October 1. Eighteen JCO employees received heavy doses of radiation as they took turns entering the accident site to release the cooling water from around the settling tank, which appeared to be causing the criticality to continue by reflecting back the neutron radiation. They also poured boric acid into the settling tank to absorb neutrons, and about 20 hours after it had started, the criticality was finally terminated. The evacuation advisory to residents within 10 kilometers was lifted that day at 4:30 p.m. The evacuation orders to those within 350 meters were lifted on October 2 at 6:30 p.m.

Japan's Science and Technology Agency announced that this accident rated a Level 4 on the International Nuclear Incident Evaluation Scale (INES). The worst nuclear power-related accident to have occurred in Japan as of that time had been a fire and explosion at a reprocessing plant run by the former Donen (PNC) in Tokai in March 1997, which was rated a Level 3. This was the first time such a large number of people living in the vicinity of a plant had been requested to shelter indoors in Japan on account of a nuclear accident.

The amount of uranium-235 that underwent nuclear fission was about 1/1000 of a gram, and many people were exposed to the radiation that was released. Three workers who had been assigned to operations at the accident site were penetrated by intense radiation at levels people had received near the hypocenter of the Hiroshima and Nagasaki atomic bombings. Hisashi Ouchi and Masato Shinohara, who were pouring uranium

solution into the settling tank, were exposed to radiation doses estimated at 16 to 20 grays and 6 to 10 grays, respectively. Those amount to 6,000 to 20,000 times the annual allowable exposure dose for the general public of 1 mSv. The third worker, Yutaka Yokogawa, who was working at a distance from the other two, received a somewhat lower exposure dose, but it was still 1 to 4.5 grays. The health status of Ouchi and Shinohara, who had been subjected to lethal doses, gradually worsened. Despite all-out efforts by their teams of doctors, Ouchi succumbed to multiple organ failures due to radiation exposure on December 21, 1999, followed by Shinohara in April the following year. There had been precedents overseas of fatalities from exposure resulting from criticality accidents at facilities handling nuclear materials, but this was the first time for Japan.

Residents living near the plant flocked to medical centers in Ibaraki Prefecture to be tested for exposure, with a final tally of about 75,000 people being tested. The Science and Technology Agency revealed that in addition to the two workers killed, a total of 666 people had been exposed. They comprised 172 workers at the Tokai plant, 207 residents living nearby, 59 disaster prevention workers and 228 other people who had entered the area ordered evacuated. The government explained that aside from the two fatalities and the third worker suffering from acute harm, there was no need for the others to fear health consequences because their exposure doses had been small. Some of the residents filed lawsuits, but no damages were awarded for late-onset health damage resulting from exposure.

Japan's Nuclear Regulation Agency (NRA) formed a committee to investigate the accident on October 7, issuing its final report at the end of December analyzing the causes of the accident. The direct cause was that the three workers had been seeking a more efficient way of mixing the uranyl nitrate solution to obtain a more even concentration—a dangerous process. They poured the solution into a settling tank, the shape and capacity of which did not conform to standards for preventing criticality, and the amount they poured into it exceeded the limit. The settling tank had not been designed originally for homogenizing uranium solutions, so its use was in gross violation of proper work standards.

The investigation into the accident revealed that the three workers lacked sufficient awareness of the danger of criticality and that their supervisor knew beforehand that using a settling tank for homogenizing uranium solutions was unlawful became clear later. These findings indicated insufficient safety training at JCO. A later investigation also determined that although the process of homogenizing uranium solutions had become a new special process upon receipt of a contract for producing MOX fuel materials, it had not been subject to a safety review by either the Science and Technology Agency or the NRA. In that sense, it could be noted that the criticality accident had resulted

from a defect in Japan's nuclear safety regulations. In either case, there were a number of overlapping structural factors leading to the accident. It could not be blamed on the three workers' carelessness.

For about 20 hours, a criticality continued that was not contained within a nuclear reactor at a power plant. This accident resulted in exposures of many people, and it demolished the impression that exposure catastrophes would never occur at Japan's nuclear facilities. It could never have been said to begin with that nuclear power safety is no more than a matter of safety at nuclear power plant facilities and nuclear reactors. The reason is that a society using nuclear energy/atomic power is circulating dangerous nuclear substances within that society. That circulation encompasses the whole process from mining the uranium to disposing of the spent nuclear fuel. This accident occurred not at a nuclear power plant, but at a nuclear fuel processing plant. Large-scale disasters involving exposures of people living nearby could happen any place where a large amount of nuclear materials are held, not just at nuclear power plants. The JCO criticality accident provided proof of that.

Another lesson from the accident that we must never forget is that to shut down a criticality in an "open-air nuclear reactor" with nothing to block the radiation, operations in the vicinity of that reactor are necessary. Such operations entail the risk of exposure to large amounts of radiation. Regulations established by the International Commission on Radiological Protection (ICRP)[16] limit "planned exposure doses" during operations expected to involve exposure to 100 mSv. Japan has decreed the same figure for "exposure doses during emergencies" such as accidents. To avoid radiation doses in excess of this figure, no more than a few minutes of work can be allowed to be performed. For that reason, 18 JCO employees wore alarm dosimeters and performed the work in turns. This still leaves the problem of choosing just who will perform the work in cases where large amounts of exposure are predicted.

Conditions may arise in which workers at the scene of an accident are exposed to mortal danger from large quantities of radiation in their efforts to avoid exacerbation of an already bad situation. Such a risk can accompany large accidents at nuclear facilities, and actually did occur with the Chernobyl nuclear accident, and once again with the Fukushima nuclear accident.

[16] The International X-ray and Radium Protection Committee (IXPRC) was an international scientific body founded in 1928 to guard against occupational diseases resulting from radiation exposure. In 1950, it was reorganized and restructured as the ICRP, centering around America's Atomic Energy Commission and other similar organizations. It provides advice on protecting against radiation. Many countries follow the standards on radiation exposure set out by the ICRP.

4. Workers' Exposures

Uranium Miners' Exposures

To produce nuclear fuel, first, large amounts of uranium ore must be mined and refined. America has a broad expanse of land with uranium veins extending across the southwestern region known as the Four Corners from the four states whose borders meet there (Utah, Colorado, New Mexico and Arizona). This region is inhabited by some of America's indigenous peoples. From the mid-1940s until the beginning of the 1980s, when large amounts of uranium were needed for nuclear weapons and power plants, many Navahos and Hopis were employed as uranium miners. The problem was that neither the government nor the mining companies informed them of the danger from exposure, and they worked with no protection against the radiation. As a result, many diseases including cancer started occurring among the native people exposed during their work in the mines. The damage to the uranium miners' health is a serious problem not only in America, but common to all uranium-mining countries.

Another problem was that in the process of mining and refining the uranium ore, components aside from uranium-235, which is needed for nuclear fuel, were discarded as tailings or slag. To produce the 30 tons of concentrated uranium consumed per year by a nuclear reactor with a 1,000 megawatt output, 130,000 tons of uranium ore must be mined. From that, 190 tons of natural uranium must be extracted and processed. The process generates 2.4 million tons of uranium tailings and 130,000 tons of slag (Koide, 2010, p.71). The amount of these radiation-releasing nuclear waste materials is equal to about 84,000 times that of the concentrated uranium used to fuel nuclear reactors.

Near uranium mines, the radioactive substances contained in the massive amounts of discarded tailings and slag disperse and contaminate the soil and water, threatening the health and lives of the people living in the area. For example, the tailings dam breach incident at Church Rock, New Mexico on July 16, 1979 allowed large amounts of radioactive solution impounded behind the dam to flow into the Puerco River, exposing people who lived downstream to radioactivity. The total amount of radioactive substances leaked exceeded that released at the time of the Three Mile Island nuclear accident, making it America's largest nuclear accident to date.

A 1993 report by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) blamed uranium mining for one quarter of radiation exposures to humans. These incidents receive little attention in contrast to their severity because the uranium mines in any uranium-producing country are located mostly in areas populated by indigenous peoples. At the World Uranium Hearing held in Saltzburg, Austria in 1992, it was pointed out that not only was this true for uranium mining, but

that siting of nuclear testing and nuclear waste disposal sites also continued to be in areas where indigenous communities were located. Indigenous communities have neither produced nuclear weaponry nor shared in the benefits of electricity from nuclear power at any time in history. The indigenous peoples gathered at the hearing termed this "nuclear racism" (Toyosaki, 2006, pp.80-81).

To run its nuclear power plants, Japan imports and consumes large amounts of uranium fuel. The material affluence of nuclear-dependent Japanese society thus has this other facet: the underpinning sacrifices of the radiation-exposed indigenous uranium mine workers and their nuclear-contaminated homelands.

Nuclear Power Workers' Exposures

A TV commercial for nuclear power was created a while back that showed a scene of operations personnel remotely controlling a reactor in a well-appointed central control room. The commercial conveyed an image of safe, clear power generating facilities supported by the latest technology. This intentionally hid the reality, though, that if it were not for the people undertaking dangerous work involving exposure to radiation, such nuclear power plants would be unable to operate at all.

Regular inspections are conducted about once a year at nuclear power plants. Unlike during normal times of operation, every few months during these regular inspections, more than a thousand workers per day per reactor work inside the electric generating facilities. Radiation exposures at levels with serious health impacts among people working at nuclear power plants occur not to the operators during times of normal operation, but to workers entering and working in areas within the facilities contaminated with radioactive substances during these regular inspections. They replace nuclear fuel, mop up contaminated water that has spilled on the floor, decontaminate the work area, clean out the reactor containment vessel and contaminated water tanks, inspect and repair measuring equipment and pipes, launder clothing soiled with radioactive substances, dispose of wastes, and so on. There are more than 300 operations they perform that involve exposure to high levels of radiation. Under current Japanese law, the annual allowable radiation exposure limit for the general public is 1 mSv. In contrast, the annual allowable limit for nuclear power plant workers is 50 mSv, or 100 mSv over a five-year period. In times of emergency such as responding to accidents, the limit was previously 100 mSv, but has recently been raised to 250 mSv.

That they are allowed to be exposed to 50 or more times the radiation dose than is permitted for the general public indicates exposures cannot be avoided in work at nuclear power plants. If the allowable radiation exposure limit for the general public and nuclear power plant workers were required to be the same, the nuclear power industry could

never have come into existence. This double standard for exposure doses shows the real nature of nuclear power, which is to accept workers' exposures.

Numerous problems have been indicated regarding the actual state of nuclear power plant worker exposure management (Higuchi, 1991; 2011). Workers wear special protective clothing with a direct vent system so that they do not get contamination directly on their skin or clothing, and to avoid breathing radioactive particles floating in the air, they were a face mask that covers the face and head entirely. They also wear an alarm meter that sounds a warning when the general level of radiation reaches a certain level. When necessary, they also wear oxygen tanks and/or radiation-protective vests. Under high-temperature, high-humidity conditions, however, the masks cloud up quickly, blocking vision. The masks can also obstruct breathing and make speaking difficult. To improve work efficiency and achieve the required quotas, a number of workers have removed their masks despite knowing the danger or ignored their alarm meters and continued working. Even if they keep their masks on and work carefully, protected against internal exposures from inhaling radioactive substances, their protective clothing does not shut out radiation entirely, so they cannot be protected against external exposures.

As a rule, it is the employer's responsibility to record the amount of radiation each worker is exposed to on the job, making entries in a radiation management notebook that is issued to each worker. Accurate dose entries are essential to exposure management, but there have been many cases in which smaller than actual values of radiation doses were recorded in the notebooks or people performed the work without even knowing about the existence of these notebooks.

There are no accurate figures on how many people have been exposed to radiation working at nuclear power plants in the years since Japan started up its first one. Since 1977, about 480,000 workers have received radiation management notebooks. Therefore, one could say that Japanese nuclear energy has been supported through its history by at least 500,000 or so exposed workers. A particular concern is the health damage these workers will suffer, exposed to large amounts of radiation that by far exceed the allowable doses for the general public.

If a worker becomes ill due to work involving radiation exposure, it is only natural that he or she have the right to receive compensation from the workers' accident compensation insurance scheme. There have been few cases, however, in which a causal relationship between exposures during work at a nuclear power plant and a later-occurring the illness was recognized and workers' compensation was granted. As on 2014, the number stood at 13 cases.

The types of diseases recognized under workers' compensation are limited to leukemia, malignant lymphoma and similar malignancies, and no compensation is provided for

certain diseases that are considered possibly caused by exposure to radiation. Except for acute damage resulting from exposure to large amounts of radiation, diseases resulting from exposure do not appear immediately but may manifest after many years. Thus for diseases that might have another cause besides exposure, any connection between the exposure and the disease might be concealed by the presence of other possible causes. For example, there are epidemiological studies showing workers formerly employed at nuclear power plants to have higher rates of cancer than the general public. The government argues, however, that these increased rates of cancer have other explanations (drinking, smoking), and does not recognize a causal relationship with exposure (Matsuzaki, 2013).

The fact is, nuclear power plant workers who perform work involving exposure are not full-time employees of the electric power companies, but part-time workers employed for short periods by subcontractors. This is a major factor in their inability to receive compensation commensurate to their risks from exposure. Taking the example of statistics of 2009 from the Japan Nuclear Safety Organization (JNES), a breakdown of the numbers of people working at Japan's nuclear power plants that fiscal year gave a total of about 9,000 electric power company employees versus about 74,000 people employed by subcontracting companies. The average annual level of radiation exposure among the electric power company employees was 0.3 mSv, compared to 1.1 mSv among subcontractor employees. Calculating from these numbers, the workers employed by the subcontractors received upwards of 99 percent of the total radiation exposure dose (Yoroi, 2012, p.100).

Workers put in the precarious position of temporary employment have great difficulty complaining about poor working conditions for fear of losing their jobs, even if they are made to work with little prior education on radiation exposure and insufficient exposure management. In cases where they are required to work without the radiation management notebook, they are unable to provide actual proof of exposure if they suffer health damage later. That makes it difficult for them to receive acknowledgement for workers' compensation. Almost none of the subcontracted part-time workers at nuclear power plants have joined labor unions. They are unorganized workers. Subcontracting is structured such that the workers are employed in isolation, not knowing where they might be assigned next, perhaps having kickbacks deducted from their wages, and unable to seek support from others. Even if they fall ill as a result of exposure, it is not easy for them to find people to consult with or provide support for trials seeking recognition for workers' compensation. These people are apt to feel forced to accept their fate quietly.

Chapter 2
The Fukushima Daiichi Nuclear Power Station Accident and Humanity

The history presented in the previous chapter weighs heavily on us. Yet we modern humans have all along accepted the government's word and power company publicity that major accidents like Three Mile Island and Chernobyl would never occur at a nuclear power plant (NPP) in Japan. We have let ourselves be lulled into thinking it is not our problem. We have ignored warnings from specialists who point out the enormous risks of using nuclear power and criticize the problems lurking in a social system that promotes nuclear power. The tragic earthquake and tsunami of March 11, 2011, however, burst through our childlike trust most shockingly. As the appalling details of the Fukushima accident gradually became clear, and as people learned about the circumstances the refugees had been forced to endure, an anti-nuclear movement arose and spread nationwide.

It wasn't two years, however, before the so-called "nuclear village" of government, bureaucracies, finance, academia and media began dismissing this citizens' movement. As calls grew louder for recovery of the Tohoku region in time for the Olympics, a movement to promote restarting of NPPs gained strength. That movement disregards the memory of the Fukushima accident, treating it as if it had already been dealt with completely and the situation restored to normal. The fact is, however, that many refugees are being forced to return because their assistance has been cut off. They are being deprived of other places to live, and many people whose lives have been turned upside down by the nuclear accident feel more and more strongly that they have been abandoned by their country. They also perceive that Tokyo Electric Power Co. (TEPCO) has been let off the hook. It is wrong to turn our backs on this reality.

1. The Fukushima Daiichi Nuclear Accident

At 2:46 p.m. on March 11, 2011, a tremendous earthquake occurred in the seabed 130 kilometers off the Oshika Peninsula of Miyagi Prefecture. It had a magnitude of 9.0,

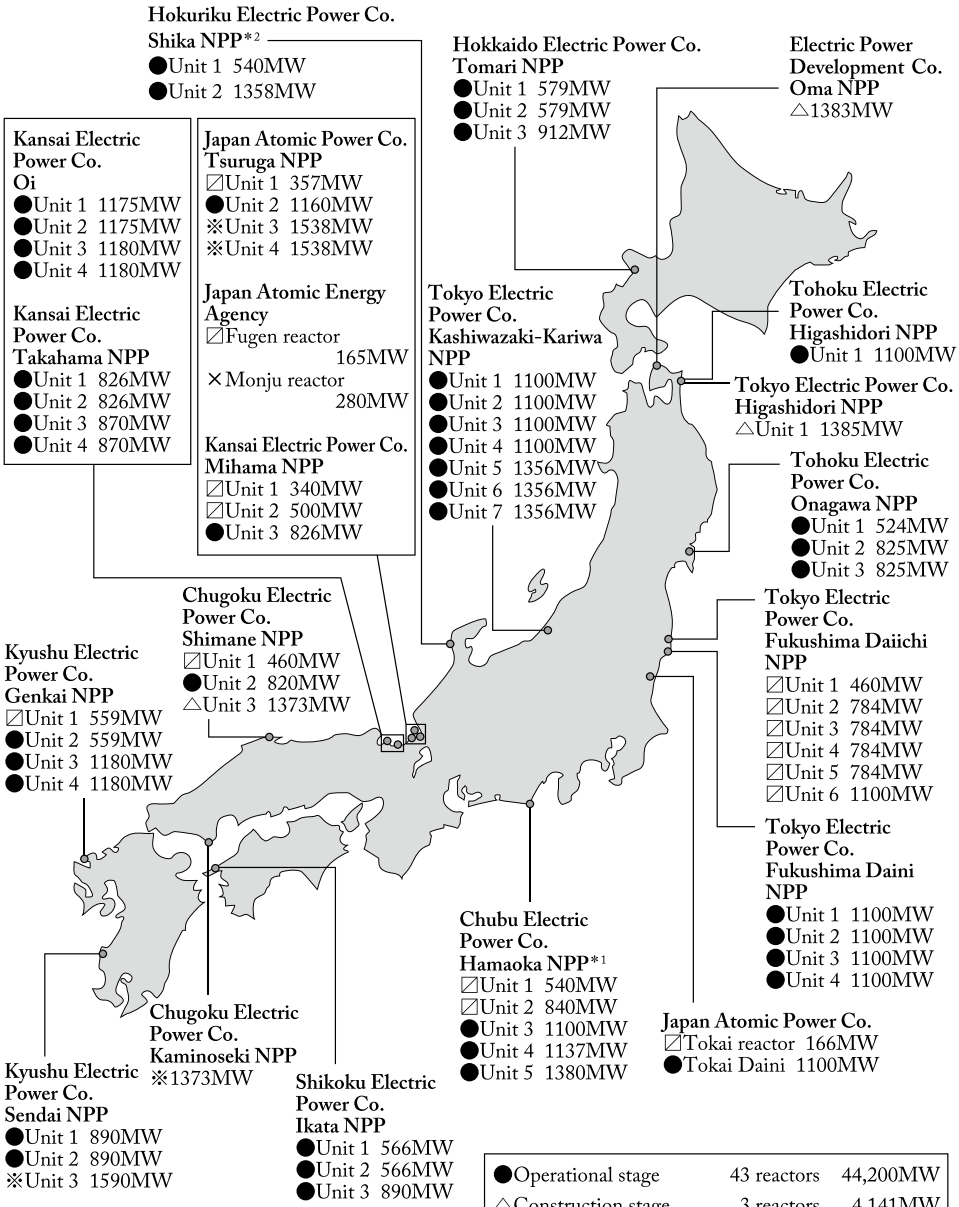
or a seismic intensity of 7—the strongest on the Japanese scale. It caused terrible damage in Japan's Tohoku and Kanto regions. These regions have the world's highest concentration of NPPs, located along the Pacific coast. The 15 reactors there include Tohoku Electric Power Co.'s Higashidori Unit 1 in Aomori Prefecture, and Onagawa Units 1 to 3 in Miyagi Prefecture; TEPCO's Fukushima Daiichi Units 1 to 6 and Fukushima Daini Units 1 to 4 in Fukushima Prefecture; and Japan Atomic Power Co.'s Tokai No. 2 Power Station in Ibaraki Prefecture (see Fig. 1.2.1). The Onagawa, Fukushima Daini and Tokai No. 2 NPPs were severely damaged by the earthquake and tsunami. Fortunately, they maintained electric power, so they avoided major problems.

At the Fukushima Daiichi Nuclear Power Station, the Unit 4 to 6 reactors had been shut down for periodic inspections, with only Units 1 to 3 operating. When the earthquake hit with a seismic intensity exceeding 6 and was detected, the three reactors shut down automatically. Unlike at conventional power plants, the nuclear fuel at NPPs continues to produce intense heat, even when they are shut down, so it must be kept cool by drenching it with water. That requires electric pumps to circulate the water. The electric power transmission system was knocked out at Fukushima Daiichi, cutting off the external power supply, so the diesel-powered emergency generators started up.

At 3:35 p.m., just when the workers were heaving a sigh of relief over having successfully shut down the reactors, a huge tsunami with a height of about 14 to 15 meters came roaring in to the plant. Under the assumption that no tsunami reaching Fukushima Daiichi would exceed 5.7 meters, TEPCO had chosen to situate the buildings that housed the reactors no higher than 10 meters above sea level. Officials at both TEPCO and the Nuclear and Industrial Safety Agency knew that this NPP was the most vulnerable one in Japan to tsunamis. They wanted to rein in construction costs, however, and made the economic-based decision to raise the rate of operation. In this, they put too much confidence in the low probability of a tsunami occurring that would be big enough to flood the buildings. They also postponed measures against tsunamis[17]. As a result, the emergency diesel generators and their power distribution equipment (switchboards, etc.)—the lifeline for reactor core cooling—were inundated by this tsunami and disabled. Aside from the generator for the Unit 6 reactor, all means of supplying electric power to the plant were lost. This is what is known as a "station black out" (SBO).

As a means of buying time until power can be restored in the event of an SBO, each nuclear reactor is equipped with emergency cooling devices. These are located within the reactor and operate with high temperature and pressure water and steam. The cooling

[17] See Soeda (2014) for details on the course of events leading TEPCO and the government to neglect tsunami countermeasures.



●Operational stage	43 reactors	44,200MW
△Construction stage	3 reactors	4,141MW
×Test operation discontinued	1 reactor	280MW
※Safety testing stage	4 reactors	6,039MW
⊘Decommissioned	15 reactors	8,623MW

*1 Hamaoka Units 3 to 5 are idled until completion of tsunami walls and other countermeasures.
*2 Shika Unit 2 has made a temporary change in output, but its original value is shown here.

Fig. 1.2.1 An overview of Japan's NPPs.
(Citizens' Nuclear Information Center, 2015, p. 72, partially revised)

device for the Unit 1 reactor, however, hardly worked at all. The severely damaged electric power transmission system could not be restored in a short time, and attempts to provide power using mobile emergency power generators went poorly. The cooling equipment of the Unit 3 reactor stopped running on the 13th, and that of the Unit 2 reactor on the 14th. That left all three of the Unit 1 to 3 reactors incapable of keeping their nuclear fuel cool.

When all of the water in a nuclear reactor evaporates due to the tremendous heat released by the nuclear fuel, leaving the pressure vessel exposed, the zirconium alloy shielding of the fuel rods reacts with the steam, producing large volumes of hydrogen gas. The nuclear fuel gradually reaches its melting point of about 2,850 degrees Celsius and begins dropping down to the bottom of the pressure vessels (a meltdown). In the case of Fukushima, part of it is thought to have penetrated the bottom of the vessel (a melt-through). The simultaneous occurrence of multiple meltdowns and melt-throughs made it the biggest accident to have been experienced thus far by mankind. The accident at Unit 1, where the cooling equipment had failed to function, progressed most quickly. Its reactor core began melting down on the evening of March 11, and experts were aware that a meltdown was occurring. This fact, though, was kept secret from the public. There was no official acknowledgement of the meltdowns until mid-May, two months after the accident.

The hydrogen leaked from the pressure vessel, proceeded through the containment vessel and penetrated into the reactor buildings at Units 1 to 3. Then it exploded, blowing the roofs off these buildings. At the site of the accident, venting valves in the containment vessels, which are normally kept closed, were opened to release high-pressure gases and avoid destruction of these vessels. This is because the containment vessels play the most important role in keeping the "ashes of death" contained within the reactor. Workers continued striving any way they could to supply water to the reactor cores using fire truck pumps.

It was the Unit 2 reactor that faced the most dire circumstances. Operations to open the vents and release the gases went poorly, and water flow was blocked from reaching the reactor core. The containment vessel faced imminent destruction. Then, on the evening of March 14, it happened. A later investigation revealed that an attempt to vent the reactor at that time apparently failed. In the pre-dawn hours of the 15th, part of the containment vessel broke. Fortunately, the containment vessel did not suffer serious damage. It was then, though, that the largest release of radioactive materials during the accident occurred, escaping through the damaged portion. This major release on the 15th resulted in radioactive contamination over a broad swath of eastern Japan. It reached as far north as Aomori Prefecture and as far south as Shizuoka Prefecture.

Another sudden explosion occurred on the 15th in the Unit 4 reactor building,

which had not been operating at the time of the earthquake. The explosion appears to have been caused by hydrogen that had flowed in via ducts from the Unit 3 reactor. Although the nuclear fuel in the Unit 4 reactor had been removed for a periodic inspection, 1,535 fuel rods were being kept in the spent nuclear fuel pool inside the building.

Electric power was not restored, and the temperatures and pressures of the reactors were not stabilized until late in March. Large amounts of the "ashes of death" from within the reactors had been scattered due to the simultaneous destruction of multiple nuclear reactors. The worst case scenario in which people could do nothing to stop further destruction had been averted for the time. They had to keep spraying the reactors with water, though, because they had to cool down the nuclear fuel that had melted, fallen and escaped from the vessels. Vast volumes of radioactive water have been generated day by day at the accident site, and the workers have struggled to deal with this.

When a serious accident occurs at an NPP, unlike with conventional power generating systems, people are forced into a battle against radioactive substances over long periods of time. TEPCO and the government have drafted a schedule for decommissioning the reactors, with the goal of completing the work in 30 to 40 years. These figures, of course, are based on wishful thinking. Unfortunately, no one knows precisely how long it will take to restore the situation to normal. Humanity has never before experienced a horrendous accident quite like this.

2. Pain and Misery—the Social and Psychological Damage from Nuclear Disasters[18]

Lives Deprived of Everything

The first thing to be noted about nuclear disasters is that the victims are deprived of everything in their lives. The livelihoods they had cultivated, working in places they had grown used to over the years, are suddenly gone one day. Irreplaceable human relationships, occupations, assets, schools, home towns, familiar landscapes, rich nature, fruits of the land, memories and evidence of ancestral lifestyles and cultures, the foundations of self-realization, purpose in life and life plans—all of life's workings lock, stock and barrel—are lost. Worse yet, people experience shock when ordinary things in their lives, whose safety they had been continually assured of, suddenly turn out to be dangerous. They face fear and anxiety. Needed information or assistance does not arrive. They feel plainly betrayed by the government and TEPCO, whose information they had once trusted and to whom they had entrusted decision-making for many years.

[18] More on this below. Yamashita, Ichimura & Sato, 2013; Kwansei Gakuin University Institute of Disaster Area Revitalization, Regrowth and Governance, JCN & SAFLAN, 2015.

Not only that, the disaster victims are exposed to radiation. In the Fukushima accident, Units 1 to 3 underwent reactor core meltdowns, and the buildings that housed Units 1, 3 and 4 had their roofs blown off by hydrogen explosions. On March 15, a plume (drifting smoke) containing radioactive substances was carried by a southeasterly wind into Namie, Iitate and other towns and villages northwest of the plant, and then by an easterly wind into the cities of Fukushima, Nihonmatsu, Motomiya, Koriyama and other inland municipalities, rendering them heavily contaminated. Large-scale radioactive fallout occurred in a number of areas on March 15 and 21, polluting soil, rivers and the sea. Radioactive substances were detected subsequently in water supplies and agricultural, livestock and marine products.

During that time, the area within three kilometers of the plant was ordered evacuated on March 11 at 9:23 p.m. The orders were subsequently changed to "shelter in place" for the area within 10 kilometers of the plant at 5:44 a.m. the next morning. Then an expanded evacuation directive was issued on March 12 at 6:25 p.m. for the area within 20 kilometers of the plant. An additional "shelter in place" directive was added on March 15 for the area between 20 and 30 and kilometers from the plant. Then, on April 21 and 22, the area within 20 kilometers of the Fukushima Daiichi Nuclear Power Station was designated a "restricted area"; Katsurao, Namie, Iitate, part of Kawamata, and part of Minamisoma were designated "deliberate evacuation areas"; and Hirono, Naraha, Kawauchi, Tamura and part of Minamisoma were designated "evacuation prepared areas in case of emergency." The evacuated areas grew larger and larger. The residents could not obtain accurate information. Meanwhile, they were forced to tolerate long hours of relocation in fear and anxiety. Worst of all, during this time, many of them were exposed to radiation together with psychological distress from threats to life and limb.

As a result, about 100,000 residents of Futaba, Okuma, Tomioka, Naraha, Namie, Minamisoma, Iitate, Kawamata and other municipalities were evacuated. From April 1, 2012, the government reorganized the restricted area and deliberate evacuation areas into three categories: "areas to which evacuation orders are ready to be lifted," "areas in which residents are not permitted to live" and "areas where it is expected that residents will face difficulties in returning for a long time." Nearly all of Futaba and Okuma (95%) were designated "areas where it is expected that residents will face difficulties in returning for a long time." If interim storage facilities for radioactive waste and contaminated soil are built in those areas in the future, it is possible that the residents will not be able to return to their hometowns for 30 years or more. Among Fukushima Prefecture's citizens, originally, 150,000 evacuated[19]. That number has decreased since then, but as of

[19] Evacuations by government directives, etc.: 70,817 living within Fukushima Prefecture, and

2016, about 90,000 of them were still living away from their original residences (according to a Fukushima Prefecture Disaster Preparedness Council release). There are already many people who have decided to make their residence elsewhere rather than continue to live as evacuees.

Disaster Victims' Hardships

People who had no choice but to evacuate fled not only to destinations within the prefecture but drifted about to all parts of Japan. In the course of that, they have suffered through squalid conditions, and have been forced to tolerate tight living quarters with food shortages, no privacy and lack of sanitation. Since they were not provided appropriate information about the diffusion of radioactive substances, many of them fled to places with even higher levels of radioactivity or were forced to evacuate needlessly. Even now, five years after the accident, many people continue to spend their lives inconveniently in temporary housing. Long-term evacuation has forced them to endure changes in residence, employment, schooling and medical or nursing care. It has broken up families and communities. Unable to rebuild their lives, their isolation has deepened. As a result their physical and mental health has suffered, multiplying the damage.

Certain politicians have claimed that conditions arising from accidents at NPPs do not result in fatalities, but in fact, many people have lost their lives. More than 3,000 disaster-related deaths caused by loss of strength and energy due to relocation and changes in the living environment that accompany evacuation have been recognized in three prefectures of the Tohoku region (3,407 fatalities as of the end of September 2015, according to a Reconstruction Agency release). In Fukushima Prefecture, there were 2,028 disaster-related fatalities, of which 1,368 (67%) were of evacuees from the nuclear accident or otherwise nuclear-related fatalities (*Tokyo Shimbun*, March 6, 2016). For these people, the nuclear accident was a life-threatening issue. They couldn't access medical or welfare services. The communities that had supported their lives were shattered. Rebuilding their communities and lives was difficult. Their future held no hope because they didn't know if they could ever resume their former lives. Even if they could return home, no assistance was being offered to redesign their shattered lives. Their long-term exposure to low-level radiation created anxiety. These are just some of the various kinds of suffering the nuclear accident brought them. Living with too deep a sense of loss, with no hope in sight, more and more of these people have been taking their own lives.

29,693 living elsewhere, for a total of 100,510. Voluntary evacuations: 23,551 living within Fukushima Prefecture, 26,776 living elsewhere, for a total of 50,327. Total: 94,368 living within Fukushima Prefecture, 56,469 living elsewhere for a grand total of 150,837 (as of September 22, 2011. MEXT, Dispute Reconciliation Committee for Nuclear Damage Compensation , 2011).

In addition, the nuclear disaster ruined industries and the economy in the contaminated areas. It annihilated communities and their culture. People who can no longer engage in farming, forestry and other industries that relied on Fukushima's famed natural abundance are the most obvious example, but many other people working at companies or on their own lost their jobs or had no choice but to change careers. Farmers and dairymen were deprived of the joy of working to produce life-sustaining foods. They now live with hardship and troubles. The disaster has also caused tourist numbers to dwindle. The disintegration of communities has also resulted in the collapse of families and individuals. The suicides of an organic vegetable farmer (in Sukagawa, March 24, 2011) and a dairy farmer, who left the message, "If it weren't for the nukes" (in Soma, June 11, 2011) were covered in the news.

In addition, local citizens who comprised about 80% of the workers undertaking dangerous duties at the Fukushima Daiichi and Daini NPPs bore the brunt doubly, responsible for work under severe conditions dealing with the nuclear accident while being victims of the accident themselves. Not only are nuclear workers engaged in dangerous work, they are also forced to deal with multiple subcontracting schemes, contract fraud, organized crime involvement and other forms of exploitation or inferior treatment. There are many cases of infringement of their rights as workers. In addition, various forms of labor in areas with radioactive contamination, not limited to decontamination work, but also including road improvement, construction, cleaning and work at refuse disposal stations all entail exposure to radiation.

Fragmentation and Psychological Burdens

Life as an evacuee involves suddenly being thrust into unsatisfactory environments, the anxiety of an unclear future, the psychological suffering and sense of loss over deprivation of one's hometown. These all cause various kinds of conflict and fragmentation among people. Both adults and children are hurt when their relationships with people close to them are torn asunder. Ruptures spread between people who have voluntarily evacuated and those they left behind, between people who stayed in the prefecture and those who relocated elsewhere, between people living in temporary housing and those renting a place to live, and between the evacuees themselves and the people accepting them into their communities. These are aggravated by lines drawn after the accident. Areas are delineated that will receive compensation, or differing amounts compensation, or support for health maintenance and so on. The lines drawn by TEPCO and the government in their evacuation directives were at the same time lines determining who would be an evacuee and who wouldn't. In other words, they discriminated among the victims, whose harm was trivialized in discussions of compensation. Communities were

further fragmented by differences in amounts of compensation that could be received.

Under conditions in which interests among multiple diverging parties could not be balanced, dubious choices were made, and minority views were drowned out. This resulted in deep divisions among the victims and produced conditions in which the problems of nuclear power became a taboo topic they could not openly discuss. People suffer in their own individual ways, so the inability to understand each other's feelings caused everyone more suffering. Even in temporary housing, which appears to be a uniform environment at first glance, it is not unusual for people under stress to come into conflict with each other. These kinds of rifts spread, affecting relationships between the evacuees and people in cities appealing against nuclear power, and between the people of Fukushima and other citizens. The risks of exposure can be passed along to the future in the form of discrimination, as occurred before in Hiroshima and Nagasaki.

The stress produced by changes in environment accompanying life as an evacuee can have a serious impact on family life, as well. People experience health concerns from exposure to radiation differently, and conflicting views on various everyday challenges, such as children's commutation to school, finding work, or caring for the elderly can strain relationships between spouses, parents and children or siblings. When the environment for bearing, raising and educating children—which is extremely important in human life—breaks down, the distress is especially severe in families with children. Parents are caught in a dilemma between the costs of evacuation and the risks of exposure. In many families that opted for voluntary evacuation the mother and children evacuated, but in many cases, the children were separated from their friends and had a hard time because they could not make good friends in the places where they had relocated. The elderly also had trouble adapting to life in temporary housing or other living spaces located in areas to which they were unaccustomed. Their everyday lifestyle such as tending vegetable fields fell apart, they tended to become inactive, with their health suffering the consequences. Many of these families have fallen apart, with separations and divorces occurring as the families fail to function as before.

One's hometown community is made up of the natural environment, economy, culture and other elements. The people live together there as a part of the society and natural environment. They live as humans, and grow and attain self-actualization, inheriting and creating culture. A nuclear disaster, however, deprives people of this over a broad area. In some places, the productive population decreases, manufacturing industries leave, and the industrial structure collapses due to difficulties people have with switching occupations. Damage that cannot be dealt with by the local government on its own impoverishes every one of the citizens. The support that is really needed is supposed to include the reconstruction of livelihoods and restoration of scattered communities

through recovery of adequate levels of welfare, education and medical services, but the budget for recovery focuses mainly on decontamination and rebuilding infrastructure.

On the other hand, the evacuees agonize over the choice of whether or not to return. The national and prefectural governments are apt to forge ahead with coarse discussions of compensation, saying that the problem is solved because cleaning up the contamination and providing compensation to the victims constitutes "reconstruction." In fact, by imposing repatriation policies unilaterally without considering the victims' wishes, they give the evacuees a straight choice between two alternatives, returning now or not returning. The responsibility for safety is pushed onto the victims as their own decision. The victims are being forced to repatriate to "a place I want to return to, but cannot live there," or "a place that is dangerous but is said to be safe," and this is causing them enormous suffering. People who were suddenly and unconditionally chased out of their original community are now being forced to make this unreasonable choice.

Radiation Exposure and Health Concerns

Unlike earthquake or tsunami victims, the victims of nuclear accidents live not only with anxiety and concern over their present condition, but also face risks in the future. They are concerned whether low-level radiation exposure might cause illness in the future, whether they will face discrimination because of their exposure, whether they will be able to marry, and whether they will be able to bear healthy children. What is spurring these concerns is that the standard the Japanese government formerly declared, specified and upheld for exposure to the general public, which was an effective dose of 1 millisievert per year (mSv/y)[20], was revised after the accident at the Fukushima Daiichi Nuclear Power Station to 20 mSv/y by the government itself. They have also heard Fukushima Prefecture's radiation health risk control advisor declare that no health damage would occur even at exposure levels of 100 mSv/y. Such claims are being used to try to get ordinary citizens to return to regions where the air dose rate is as high as 20 mSv/y.

Particularly controversial was the radiation dose standard for schoolyards. Originally, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) chose an annual dose of 20 mSv as a guide, following the ICRP's post-accident recovery

[20] The regulations enforced under the Act on Prevention of Radiation Damage Caused by Radioactive Isotopes etc. make it clear that the limit for exposure doses to the general public, aside from people who perform work with radiation, is "1 mSv/y of effective dose starting from April 1 each year" (Article 14, Item 4). This is based on the ICRP's recommendations published in 1990, so countries around the globe are observing it. Regarding the "controlled areas" of business operators whose projects involve handling radiation, Article 4 of the Regulation on Preventing Ionizing Radiation Disorders (Ministry of Labor ordinance No. 41, September 30, 1972) states that exposure over any three-month period is not to exceed a total of 1.3 mSv. That is equivalent to about 5 mSv/y.

phase reference level for the public, and set a radiation dose standard for schoolyards at kindergartens and elementary and junior high schools in Fukushima Prefecture of 3.8 mSv/y.[21] The children's guardians put up an extremely strong resistance to this, so MEXT retracted this on August 26, 2012, and indicated a new policy of aiming for 1 mSv/y. Even so, there are still many places radiation doses are being measured exceeding the standard for normal times (1 mSv/y). There are hotspots even in the Nakadori area, which is located away from the coast and contains the cities of Fukushima, Koriyama and others forming the prefecture's political and economic heart, where radiation dose levels are so high that if the standards following the Chernobyl accident were applied, they would give the residents the right to relocate or even make relocation obligatory. It would be ridiculous to say that the citizens' mental suffering over risks to their health, especially the risk of late-onset conditions occurring has been resolved.[22]

Japan's government declared in December 2011 that the Fukushima Daiichi Nuclear Power Station was in a state of cold shutdown, but it was actually in as unstable a condition as ever. It is unclear whether the heavily damaged facilities and temporary cooling systems will be able to withstand future earthquakes and typhoons. Contaminated water continues flowing into the sea. Decommissioning the Fukushima Daiichi reactors is also expected to take several decades, so if the evacuees return, they will have to face the risk of another nuclear accident the rest of their lives and continue bearing with their destinies as "disaster victims" (Tsutsui, 2015).

There are limits to how much decontamination is possible using the various methods being promoted currently, so it is difficult to gain the evacuees' trust. Decontamination using high-pressure washing scatters the radioactive substances, which are washed away in the water. Decontamination by stripping off the surface layer of soil in agricultural fields and forests poses risks of landslides due to loss of topsoil, and the area needing decontamination is too large. Also, the "flexible container bags," which are a simple way of storing the radioactive substances in the wastes that are placed into them can be seen

[21] The ICRP recommended an evacuation reference level immediately after occurrence of an accident of 20 to 100 mSv/y, so 20 mSv/y was adopted as the lowest value among that, but for the next stage (up to five years after an accident), the highest value was adopted from the recommended range of 1 to 20 mSv/y. The discrepancies in reasoning have created confusion.

[22] The standards used in Chernobyl were as follows: (1) 5 mSv/y or greater was an "eviction zone" (obligatory resettlement zone). (2) 1 to 5 mSv/y was a "non-obligatory eviction zone" (areas where residents have the right to relocate). (3) 0.5 to 1 mSv/y was a "zone of residence" with preferential socioeconomic status (careful monitoring obligatory). This law, "Legal Treatment of Areas Contaminated Radioactively by the Chernobyl Accident," was adopted on February 27, 1991, five years after the accident by the Supreme Soviet of the Ukrainian SSR and enforced from July 1, 1991. After dissolution of the USSR, it became a law under the Ukrainian parliament (Verkhovna Rada) and was revised and amended by order of the Ukrainian Council of Ministers on December 26, 1992.

stacked up all over the place in the disaster-affected region. Meanwhile, obtaining land for holding them temporarily and for building interim storage facilities and final disposal sites is proving difficult.

What's more, decontamination involves enormous costs. The government estimates that decontamination will cost 2 trillion yen, but the National Institute of Advanced Industrial Science and Technology estimates it will take as much as 5.1 trillion yen. Ninety percent of Fukushima's "Reconstruction and Revitalization" project budget, which is more than 700 billion yen, is being spent on decontamination. The latter is becoming a gargantuan public works project (Ieda, 2014, pp.212-216).

The People's Exhaustion

The people have been thrust into a situation with many negative aspects. These include no target date set for recovery from the nuclear accident, lack of clarity as to whether decontamination can guarantee the evacuees' safe return, no outlook for the interim storage facilities construction dates, and no progress toward satisfactory compensation from TEPCO. The people are tired of hearing talk about nuclear power. They don't want to see the problems. They are apt to succumb to the desire to forget about it all and turn away from things that provoke anxiety.

To prepare for holding the 2020 Tokyo Olympics, the government has been promoting a boost in mood, with "repatriation" becoming "revival," "earlier lifting of evacuation orders" becoming "community revival," and "compensation" becoming "rebuilding lives." They have embarked on a course of quickly rescinding the forced evacuation and attempting to abrogate responsibility for compensation and reparations. The government and TEPCO take the stance that those who evacuated voluntarily were not real evacuees in the first place, so they have no responsibility to those people. Their attitude toward compensation was no better. On top of being required to submit tiresome paperwork in the midst of chaotic evacuee life, the victims had the value of their compensation assessed based on criteria determined by the government's Dispute Reconciliation Committee for Nuclear Damage Compensation and TEPCO, in other words, the perpetrators of the disaster. Their assessment could in no way be considered to reflect the real state of damage the victims had suffered. A number of discrepancies in the amounts awarded caused divisions among the victims. To the victims, it was preposterous that TEPCO and the government, the ones whose actions had deprived them of their livelihoods to begin with, now held the power of life and death over them. It felt as if the responsibility for causing harm through the accident was being circumvented.

There has also been stress from pressure to conform to cliquish expectations arising from the close ties among people in these communities. Rather than expressing dissatis-

faction or criticism, they have a tendency to suffer silently at home, not raising waves. As time passes, apathy tends to increase on its own as memories fade, like sharp features weathering away. While they are like other victims in many ways, disaster victims suffer more than others from having to live their lives hidden away. It is arguable whether anything should be done to address this injustice. People would rather forget the accident, or they may have decided they would like to live as though they had recovered already and had restored stability to their lives, so to speak.

There may also be people who suffer from conflict as a result of work being carried out related to nuclear power. It seems that because the Catholic Church is calling for abandoning nuclear power, such people feel that they've lost their place in the Church and they leave. The Church does not want to persecute people for supporting their livelihood through nuclear power. Within the Church, people must not deny each others' individuality over differences in standpoints. However, the presence of a social mechanism in support of nuclear power causing divisions among people of the same faith, we have no choice but to notice problems. For that reason, we must continue to think about how we can reconcile our fragmented communities. We must seek a path of dialog for restoring relationships.

3. Grief and Anger—the Structural Inhumanity of Nuclear Power

Collapse of the Safety Myth

Many people are, of course, angry and resentful over the insufficiency and lack of transparency of the national, prefectural and local government's measures to help the disaster victims. There are many reasons they feel dissatisfaction and anger. These include various policies on radiation risk assessment; the dearth and bias of investigations of radiation; the lack of supportive measures for relocation and evacuation; concerns about food safety countermeasures; the repeated changes in standards for zoning, inspections and items subject to shipping restriction with regard to agricultural and fisheries products; the paltry aid and compensation for contamination; the difficulty and complexity of procedures to request compensation; and more. At the heart of it all, there is anger about being misled by the "safety myth" propounded continuously by TEPCO and the government, and the lack of willingness by the very people who misled them to take responsibility for the consequences.

The accident had barely occurred when the troubles started. They were unable to provide accurate evacuation orders. Perhaps many people had already lost their trust in the government and TEPCO by then. The reason they lost trust was they saw that the people living nearby had been assured by the safety myth for all those years by TEPCO

and the government, only to suddenly see it crumble. It takes time for people to accept the fact that they have been deceived by lies about purported safety, and it is a painful process for the people involved.

Nuclear power has always been a high-risk business for electric power companies. Because there are many stakeholders, huge sums of money are needed even for siting the facilities, and if an accident occurs, the losses and damages may be inestimably high. Furthermore, it may be impossible to get an accurate assessment of the back-end costs[23], so even from the planning stages it involves high business risks. It was the Japanese government that forcibly brought this situation about. By shouldering the electric power companies' damage compensation risks as collateral for cooperation with national policy, the government cast its destiny with that of the electric power companies. Nuclear power was promoted by this "privatized national policy," so to speak. The government and electric power companies invested further enormous sums manipulating public opinion with the "safety myth." Playing a big role in this was Japan's so-called "nuclear village," a tight-knit collaboration among scholars, technicians, bureaucrats, politicians, the electric power industry, financial circles and media (see Komori, 2016).

The "nuclear village" created an environment in which open debate was impossible. The electric power companies and government are suspected of having constantly concealed, fabricated or manipulated information about nuclear power itself, which they monopolized. The citizens who sustained the damage were not given sufficient information by the government, just assured emphatically that it was safe. Their "right to know" about things pertaining to their own health, which is a basic human right, was infringed.

Even in the process of dealing with the Fukushima Daiichi accident and its aftermath, TEPCO and the government, including the former Nuclear and Industrial Safety Agency, released only information that was favorable to themselves, hiding anything unfavorable. As a result, it has been indicated that many people were exposed to radiation from the Fukushima nuclear accident needlessly (Hizumi & Kino, 2012; Kino, 2013). In particular, there were data available predicting the diffusion risks of radioactive substances from the most up-to-date facilities, called SPEEDI (System for Prediction of Emergency Dose Information), but they were not released to Japan's citizens. Indeed, they were provided to none less than the U.S. military. Also, in Iitate, the radiation dose spiked on the evening of March 15 (reaching an hourly maximum of 44.7 microsieverts). Although the U.S. Department of Energy suggested on March 22 that there might be notable contamination in the vicinity of Iitate, it was not until April 22 that Japan's

[23] This indicates the costs incurred in processing uranium fuel after it has been expended at an NPP. It includes reprocessing of spent nuclear fuel, production of MOX fuel and also the costs of dismantling plants and disposing of the waste materials.

government designated Iitate as a "deliberate evacuation area."

Moreover, although the government had not conducted a thorough examination of the causes of the nuclear accident, it issued a declaration of containment (December 16, 2011). Then, to make Japan look like a suitable candidate for the Olympics, Prime Minister Shinzo Abe declared in front of international society that the contaminated water from the Fukushima Daichi NPP was "under control" (September 7, 2013). It must be said that the persons responsible for the political scheming to restart Japan's nuclear reactors and export nuclear technology based on this kind of false advertising are ignoring the unforgiving nature of nuclear accidents.

Coerced "Allowable Limits"

Experts on the health risks of radiation have also played a role in coming up with scientific information along national policy lines, obedient to interests promoting nuclear power while under direct control of the government (Takagi, 2000; Shimazono, 2013). The Radiation Effects Research Foundation (RERF)[24] conducted research on the delayed effects of radiation that has had a big impact on determining allowable exposure doses. RERF is a research institute that gives nuclear power promoters control over information on radiation damage, and dispatches its members to international institutions such as the ICRP and UNSCEAR[25]. The U.S. government also contributes to this organization, though, and in concert with the Japanese government, they have tended to lowball estimations of the damage from the atomic bombs.

Even Fukushima Prefecture, which should be taking thorough measures to prevent health damage from exposure, has not listened to concerns from parents who are particularly worried about their children's health. By underestimating the health risk, they

[24] This is the research institute that performed health surveys of the atomic bomb victims and the pathological testing and research on radiation exposure. It was established and operated by the Japanese and American governments (a public interest incorporated foundation). In 1975, the Atomic Bomb Casualty Commission and the Ministry of Health and Welfare's National Institute of Health (NIH) were reorganized, and the Radiation Effects Research Foundation was founded as a foundation jointly funded and managed by Japan and the U.S.

[25] The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). It was established to evaluated and report on the degree of exposure to ionizing radiation and its effects. UNSCEAR's report was also used as basic data for the International Commission on Radiological Protection (ICRP). The ICRP is criticized for considering political, economic and other social conditions when issuing its all-embracing recommendations. The National Institute of Radiological Sciences, which collaborates with the IAEA, is an organization that was created intentionally to bring together investigative reports from a purely scientific point of view, unlike UNSCEAR and the ICRP. From an independent and scientifically objective point of view, it claims UNSCEAR's reports are highly appraised. On the other hand, the European Committee on Radiation Risk (ECRR) points out that there is overlap in personnel among the IAEA, ICRP and UNSCEAR.

mislead the prefecture's citizens. "Risk communication" originally had the following meaning: "A process of mutually exchanging information and views among individuals, groups and organizations. This includes all kinds of messages about the nature of the risks; concerns, expressions of opinion and risk messages; reactions to legal or systematic decisions for risk-control, and so on" (NRC, 1989, p. 365). In Fukushima, however, the government stubbornly defended the theoretical model of "safety and reassurance," made light of the citizens' and residents' risk assessments, and had a "proper" assessment conducted by specialists for publicity. As a result, unilateral explanations and education from the government became "risk communication." The doctors involved with this were criticized for failing to recognize differing opinions and trying to suppress them. Their assigned duties were to alleviate concerns of the prefecture's citizens and avoid causing confusion in society.

The "accident containment" declaration by Prime Minister Yoshihiko Noda on December 16, 2011 marked the turning point when the government started urging evacuees to return to areas where the air dose rate was 20 millisieverts per year (mSv/y) or less. It was the government's policy to start repatriating people to areas where decontamination had reduced the dose rates. To make this more explicit, they reorganized the areas under evacuation orders in March 2013. These areas were divided into places evacuees could return to soon (20 mSv/y or less), places they could return to after a few years (20 to 50 mSv/y), and places they could not return to for five years or more (50 mSv/r or more). Repatriation was deemed possible everywhere else (where the contamination was not at levels necessitating evacuation). The government would determine when the evacuation orders for each area would be lifted and terminate compensation when they were lifted. With this they began the process of having the issue brought to a conclusion. This reorganization of zones and lifting of evacuation orders would end aid to the victims and begin drawing the curtain on the nuclear accident. It would divest the evacuees of their "victim status," and consign what had transpired to oblivion. In fact, the government chose a policy in a June 2015 cabinet decision of rescinding the evacuation orders for "areas in which residents are not permitted to live" and "areas to which evacuation orders are ready to be lifted" in March 2017. Following that, Fukushima Prefecture announced that as of March 2017 it too would terminate its offer of compensation to "voluntary evacuees." These were people who had evacuated without receiving evacuation orders from the government, and numbered approximately 9,000 households with 25,000 people (as of December 2014, according to Fukushima Pref.) by providing free housing in the location to which they had evacuated. With no input to the discussion from the citizens affected, they made the extremely grave decision to repatriate them. This separates the disaster victims into individual people or households and forces them to take individ-

ual responsibility for the remaining choices on issues and risks (Hino, 2016).

The government insists obstinately that changing the conventional radiation exposure dose regulation standard of 1 mSv/y to 20 mSv/y, designating evacuation zones or spots and then repatriating ordinary citizens to zones with those radiation doses are in accordance the "ALARA" principle[26]. In other words, for the time being, it would be hard to keep air dose rates below 1 mSv/y (the former public exposure limit for normal times) in the disaster-affected areas of the highly populated Nakadori region of Fukushima Prefecture, where major cities like Fukushima and Koriyama are located. If they were to apply the same 1 mSv/y standard as elsewhere, millions of people would need to evacuate, which would bring on a panic, requiring gigantic amounts of compensation and other expenses to be paid. If the choices of "considering the risks to citizens' health, applying the 1 mSv/y standard, and recommending evacuation" or "avoidance of costs and chaos arising from evacuation" are weighed and the latter is given precedence, it means abandoning the former standards may be inevitable. To the government, 20 mSv/y is a "safe" standard. It is the condition for lifting evacuation orders, and it is also seen as an index for determining whether or not to evacuate. In other words, it forces acceptance of the assertion that anything at or under 20 mSv/y will not be considered harmful, and everyone should bear with it.[27]

The government's decision to raise the standard for evacuation areas and spots to 20 mSv/y was based on ICRP recommendations (ICRP,2009). The ICRP itself, however, recommends keeping exposure doses as low as possible regarding health risks, as no "threshold (borderline) value" exists (the LNT model)[28] in the sense of no health effects occurring from radiation exposures below that value.

From data on the atomic bombing victims of Hiroshima and Nagasaki, an internationally recognized risk assessment is that radiation exposures equivalent to 100 mSv/y cause a definite increase in death rates from cancer. We have been told that nobody knows what happens when the exposure dose is less than 100 mSv/y. In the latter half of

[26] The radiation prevention principle advocated by the ICRP. Under the ALARA (as low as reasonably achievable) principle, application of standards for radiation exposure that cannot be reasonably attained may have to be abandoned. If this principle were followed, it would not necessarily be considered improper to relax radiation dose standards for the public or occupationally exposed people if it was inevitable under emergency circumstances. For background on this principle's advocacy, see Nakagawa, 2011, pp.145-146.

[27] A total 11,600 square kilometers of contaminated areas exist in Fukushima Prefecture with readings above 1 mSv/y, equivalent to the entire area of Akita Prefecture. It is said that the areas with readings above 20 mSv/y total 1,600 square kilometers (Shirai, Fukushima Nuclear Disaster Plaintiffs Group & Defense Counsel, 2015, p.13).

[28] The "linear no-threshold assumption" is the idea that no threshold value exists for health risks from radiation exposure, and a threat to health from low-dose radiation exposure cannot be denied.

the 1980s, however, the Central Research Institute of the Electric Power Industry (CRIEPI) and National Institute of Radiological Sciences (NIRS) began advancing theories denying the LNT model. Currently, the view is circulating that the ICRP has said that the highest value of annual dose range of 1 to 20 mSv that is the "emergency reference level for protection of the public," i.e., 20 mSv/y, is safe, so to speak. The Japanese government has taken this point of view from the ICRP and UNSCEAR, who have also said that not enough research exists on doses below 20 mSv/y, so nothing is known, but it holds stubbornly to the view that no increased health risks have been recognized with the 20 mSv/y standard. It must be noted, however, that saying this dose is safe and requiring people who had evacuated to return is an inhumane policy that overlooks the health concerns of the disaster-affected citizens.

Prefectural Citizens' Health Management Survey

The Fukushima Prefecture Citizens' Health Management Survey conducted in 2011 has been dogged by doubts from many local citizens. It lacked sincerity with no transparency in its countermeasures to health concerns. This was due to the process Fukushima Prefecture and Fukushima Medical University used to set policies, the extremely short duration, the way assistants were shut out of the examinations, and the reluctance to disclose information, as seen from its inability to provide answers readily to questions about the results. It is also criticized for not building a relationship of trust between the test administrators and the medical examinees. The prefecture insists that the objective of the survey was to estimate radiation dose values and confirm whether they were safe or not, and thereby alleviate anxiety over exposure. This, however, means taking a stance of assuming "no harm," with the objective of "dispelling anxiety." What is important to the citizens of Fukushima Prefecture is the truth. Disaster victims have always decided for themselves whether or not to forget their own concerns. The role expected to be played by the review committee should be to conduct appropriate investigations for the citizens and to study and evaluate the health effects that can be found from the data in a fair manner. By giving "alleviation of anxiety" as the purpose of the survey, however, they instead lose the citizens' trust in the specialists and scientists involved in studying the health effects of radiation. The response rate to the survey was low, and it is feared that the people's trust in future surveys will also be low.[29]

The thyroid testing of the children is a particular issue. The tests uncovered quite a number of cases or suspected cases of thyroid cancer.[30] The Fukushima Medical Univer-

[29] The "basic survey" of the prefectural citizens' health survey targeted 2,055,383 citizens, but as of October 31, 2014, only 553,418 had responded, giving it a response rate of no more than 26.9%.

[30] Thyroid testing began from October 2011 and covered about 370,000 citizens 18 years and

sity, however, denied any causal relationship between these results and the nuclear accident. Moreover, they have deemed the cases to be thyroid cancer only, and concluded that "no future increases in infertility, effects on fetuses, cardiovascular diseases, cataracts or other deterministic effects of radiation (tissue reactions) are expected." This is because since the Chernobyl accident, the IAEA and other international institutions have taken a stance of saying that health damage from low-level radiation is limited to pediatric thyroid cancer, and not recognizing any other damage from internal radiation. It was in the fourth year after the Chernobyl accident that the fact of increased thyroid cancer became clear. However, they had not conducted a comprehensive survey of the exposed region prior to that time. Regarding a causal relationship between low-level exposure doses and disease occurrences, the Fukushima Medical University's stance in determining that "there are no effects" based on the fact "there are many things we do not understand" was robust. The occurrence of abnormalities, though, is not limited to the early period within a few years of the accident, but can span several decades. Therefore, rather than deciding from the start that there is "no relationship," they should proceed cautiously from the point of view that there might be a connection and conduct surveys extensively and repeatedly. That they conducted this survey without taking such measures, with the conclusion already given that even if they found thyroid abnormalities, exposure from the Fukushima Daiichi NPP accident had no effect simply invites the citizens' mistrust (Hino, 2013).

Child Victim Support Law

Problems have also been pointed out in the government's handling of the Assistance for Children and Nuclear Disaster Victims Act, which was promulgated on June 27, 2012. This law was originally based on the principle in the Chernobyl standards that respected the thoughts and choices of individual disaster victims. The gist of it was to provide equal support to the disaster victims in the area targeted for support regardless of their choice to evacuate, stay behind or repatriate. It was needed because prior to then, people who had voluntarily evacuated were receiving exceedingly small amounts of compensation.[31] No action was taken to enforce this law, however, for more than a year. On

younger. The second round of testing added children born during the year after the accident, bringing the total to about 385,000. The Fukushima Prefecture Citizens' Health Survey Review Committee reported in June 2016 that it had diagnosed a total of 173 cases of thyroid cancer or suspected thyroid cancer.

[31] The governmental Dispute Reconciliation Committee for Nuclear Damage Compensation decided on December 6, 2011 to pay compensation to a certain range of voluntary evacuees (23 municipalities including Fukushima City, Koriyama, Iwaki and others). TEPCO, however, paid no more than a uniform rate of 80,000 yen per person (except for children of 18 and under and expectant mothers, who received 400,000 yen). This wouldn't even cover the costs of moving or transport.

October 11, 2013, after the Liberal Democratic Party (LDP) prevailed in the House of Councillors election, a cabinet decision was finally made to enforce it. As a result, the original principles of the Support Law that were supposed to guarantee the right to evacuate were eviscerated. The actual use of the law became to funnel support for rebuilding livelihoods exclusively into early repatriation, based on the government's intentions to rescind the evacuation orders and encourage evacuee repatriation (Morikawa & Yamakawa, 2015)[32].

Three levels of exposure dose standards were stipulated under the Chernobyl standards, but the Japanese government never provided any new standards lower than the 20 mSv/y, and only three new policies were adopted to aid voluntary refugees. What these people wanted most was to be accepted in temporary emergency housing outside of Fukushima Prefecture, but that was never adopted. At the root of this was the reorganization of the evacuation zones (into "areas where it is expected that residents will face difficulties in returning for a long time," "areas in which residents are not permitted to live" and "areas to which evacuation orders are ready to be lifted") following Prime Minister Noda's aforementioned declaration of containment (December 2011), and the related policy of lifting evacuation orders in areas with less than 20 mSv/y and encouraging the residents to return to them.

Regarding the health risks of low-level radiation, the national and prefectural governments do not recognize standards aside from those of the IAEA and WHO, and they keep insisting that there are no direct health effects arising from exposure. They unilaterally push their view that there will be no further contamination exceeding what has happened, and there will be no more NPP explosions so safety is assured. However, if they were taking the disaster victims' point of view, who are really stuck with the health risks from low-level exposure, the government would adopt policies for protecting the health of the disaster victims from the standpoint of the Precautionary Principle, under which the risk of cancer would be assumed to exist in light of differing opinions among experts about the health risks of low-dose radiation (Hino, 2014).

Right to evacuate

The Japan Federation of Bar Associations maintains there are rational reasons at least for children and pregnant women living in areas where the annual radiation dose exceeds 5.2 mSv to evacuate. The reason is that under the Ordinance on Prevention of

[32] The law spoke of principles, but the rights of disaster victim citizens were never decreed. As a result, policies were subject to governmental discretion. The persons administering it were Reconstruction Agency bureaucrats and Counselor Yasuhisa Mizuno, who made inappropriate remarks more than 600 times on Twitter, among other improprieties.

Ionizing Radiation Hazards, places where exposure exceeds 1.3 mSv for any three-month period (= 5.2 mSv/y = 0.6 mSv/month) are designated controlled areas, and nobody but necessary personnel are allowed to enter (Ordinance on Prevention of Ionizing Radiation Hazards, Article 3, Items 1-1 and 4). Moreover, persons under 18 years in age are not allowed to work in controlled areas (Ordinance on Labor Standards for Minors, Article 8, Item 35). A causal relationship is recognized for leukemia resulting from exposure doses exceeding 5 mSv/y in occupational accidents (Director-General of Labor Standards Bureau, Ministry of Labor, 1976). A report by Anand Grover, Special Rapporteur to the UN Human Rights Council, also pointed out that the people who should be receiving support under the Assistance for Children and Nuclear Disaster Victims Act were those living in any region contaminated at levels exceeding 1 mSv/y at the time of the accident. He also called on the Japanese government to provide all the people who lived in, evacuated from or returned to areas exceeding 1 mSv/y the support necessary for their relocation, housing, employment training and other necessary expenses.

Now, five years after the nuclear accident, the people who have continued "voluntary evacuation" to protect their children's health from the effects of radiation are being abandoned by the government, TEPCO and the municipalities where they previously were living. Their isolation and hardships are intensifying. The national and prefectural governments will cut off their provision of rental housing at the end of March 2017 on the basis of their "accelerated reconstruction" policy. Because of this, the people continuing their voluntary evacuation are being forced to make a painful choice between repatriation or proceeding somehow with their voluntary evacuation. These people are placed in a difficult situation again, losing their right to avoid exposure and the life they had managed to build during five years in their new communities (Yoshida, 2016).

Japan's Distortions and Nuclear Power

Nuclear power is said to be "national policy." As we have moved from the 20th century into the 21st, the battle among nations has switched fields from military expansion to economic competition. In the midst of this, Japan has chosen nuclear power as one means of maintaining an advantage for itself in international relations. Nuclear power has been adopted as a focal point for handling this country's diverse challenges, such as obtaining resources, solving environmental problems, competing economically and cultivating international relationships. At the same time, nuclear power has created an enormous vested-interest structure. In fact, nuclear power has eaten its way deeply and broadly into Japan's industrial structure. People in all sorts of industries profit from nuclear power, not only the original civil engineering, construction and machine industries, but also spanning a spectrum from banks to local shops.

However, while the profits from this are great, it is an extremely risky business. It may be true that Japan as a nation has bet on this enterprise while aware of the risks. In an archipelago beset by frequent earthquakes, however, the gamble of spending enormous amounts of money to build 54 NPPs resulted in the fiasco of the Fukushima accident. Not only that, but from that festering wound all sorts of previously hidden inconsistencies came spewing forth.

The people who should be bearing responsibility for this fiasco, however, refuse to recognize their failure. All of the consequences of their failure are being foisted onto the disaster victims. The victims are being led to accept this as natural. On the other hand, the people responsible for the accident have started out again in different places, acting quickly before anyone can notice. They are hoping to put this nightmare behind them and making the same gamble as before by restarting nuclear reactors and exporting the technology. Once again they suggest to a new group of vulnerable people that having jobs would be preferable to safety, and they repeat their gamble, putting these people's lives, history and culture at risk of destruction.

Nuclear power stands at the center of an undemocratic structure. From the start it could only be built with the collusion of enormous authority and vested interests. Ordinary citizens who are not experts on nuclear power are coerced into becoming part of the arrangement by the government and specialists wielding great authority. It is a common rule that aggressive measures are taken to divide the local community in order to entice nuclear power plant facilities, but municipalities troubled by underpopulation can flourish economically for a while from subsidies, such as through the Three Power Source Development Laws[33], so it is hard for them to resist this temptation. Conflicts that never existed before between those in favor and those opposed are introduced into the local community, with the profits to be obtained dividing the citizens, leaving these communities deeply wounded. Taking a longer view, though, the community's dependence on subsidies, like narcotics, can be said to impede the healthy independence of the locality. We must admit that NPPs as a "national policy" in this way corrupt local communities and the way the people in them make their living.

Philosopher Tetsuya Takahashi called post-war Japan's distorted structure a "system of victimization" (Takahashi, 2012). That also fits the circumstances of the recent

[33] The "Three Power Source Development Laws" is a term encompassing the Law for Adjustment of Areas Adjacent to Power Generating Facilities, the Electric Power Development Promotion Tax Law and the Special Account Law for Electric Power Promotion. They were established in 1974 by Prime Minister Kakuei Tanaka's cabinet to promote the siting of NPPs. These laws set up a mechanism for supplying subsidies to areas providing sites for electric power plants from a "promotion of power resources development tax" that the electric power companies levied on top of their electricity rates.

nuclear accident. The interests of the people causing others to sacrifice are supported by the sacrifices their victims make. Furthermore, this victimization is normally glorified and justified by the community (nation, citizenry, society, corporations, etc.) as "noble sacrifices." However, as seen in Japan's defeat, and now the nuclear accident, when defeat becomes so clear that it can no longer be concealed, the people who are victimizing others abandon their own responsibility and disappear, leaving only their victims to bear the consequences. The regions that took on the duty of creating "energy for a bright future" with nuclear power were depopulated areas, and they were sacrificed when the accident occurred. If problems occur, the truth is concealed, organizations with political authority and economic power are protected, and the rest are cast away. Rural, peripheral and outlying regions are sacrificed and the center benefits—isn't that just like the system of colonial rule? American military bases are concentrated in Okinawa, and the same mechanism may underlie the continued political trampling on the rights of citizens opposed to that. The nuclear disaster that started on March 2011 may be a big setback for part of the "rich country" policy of aiming for competitive growth of gargantuan enterprises under governmental leadership. In that way, it is comparable to a second defeat following upon the first one in 1945 of the "strong army" part of the "rich country, strong army" slogan pursued since the Meiji Era. In the revitalization and reconstruction from this historical catastrophe, to both Japan and the world, would it not be better this time to overcome this system of victimization and work toward realizing the opposite kind of society, where individual human beings matter?

4. Rights and Relief—the Pathway[34] to 'Restoring Humanity'[35]

From the Standpoint of Human Rights

From a broader perspective, the radioactive disaster that brought tremendous suffering to the disaster victims can be said to have infringed broadly on the "right to live with dignity." This is a basic human right guaranteed by Japan's constitution. The nuclear accident and the way Japan's government and TEPCO handled it posed a substantial threat to the lives and health of the disaster victims. As the responsible party, the government is in the position to design policies to prevent recurrences based on thorough

[34] See below. Kawasaki et al., 2012; Ie, 2012; Assistance for Children and Nuclear Disaster Victims Act (promulgated on June 27, 2012).

[35] This was originally a principle propounded by economist Tokuzo Fukuda who had experienced the Great Kanto Earthquake of 1923. It means reconstruction that gives priority to the rebuilding of livelihoods, not the restoration of roads, buildings and other destroyed assets, but meeting the needs of each individual person. While underlining that definition here, we will analyze this term from a Christian standpoint.

investigations of the damage from the accident. It should also provide appropriate compensation to the victims by legal means, especially constitutional law. In that sense, what the government is supposed to do is restore one by one the human rights that have been usurped, carrying out reconstruction and revitalization in a real sense.

Anand Grover was sent by the UN Human Rights Commission following the Fukushima nuclear accident to report on human rights conditions in Japan. He raised the following points in his recommendations to the Japanese government in a report he submitted on May 27, 2013 (A/HRC/23/41/Add.3; Human Rights Now, 2014).

(1) Creating and enforcing the following polices for early response to nuclear accidents: releasing to the public information on the line of command for emergency response directives, areas to be evacuated and places to proceed to, and guidelines for assisting vulnerable persons.

(2) Health monitoring for the people affected by nuclear accidents. Conducting health impact monitoring of workers at NPPs and people residing in areas with exposure of 1 mSv/y or more. Continual monitoring of health impacts from radioactivity using comprehensive well-rounded monitoring methods applied over the long term and, where necessary, providing appropriate procedures or treatment. Children's health monitoring should not be limited to thyroid tests, but should consider all health effects and include blood and urine tests, internal radiation tests, and psychological care. Also, information on the test results should be made easily accessible to the children and their parents.

(3) Formulating plans as a nation for evacuation zones and public exposure limits on the basis of human rights rather from the standpoint of economic benefits versus risks. Basing these plans on scientific evidence, and reducing public exposure to 1 mSv/y or less. Providing accurate information in school textbooks and other resources regarding the danger of radiation and the fact that children are particularly vulnerable to radiation exposure.

(4) For decontamination, reducing radiation dose levels to 1 mSv/y or less. Deciding where and how to establish interim and final disposal facilities through discussions, with citizens' participation.

(5) For ensuring transparency and the responsibility for explanations within the regulatory framework, upholding internationally recognized standards and guidelines in nuclear regulatory administration and NPP management. Having members of the Nuclear Regulation Authority and the nuclear energy industry release information to the public. Ensuring that monitoring is independent, that TEPCO takes responsibility, and that the taxpayers are not stuck with the legal responsibility for the compensation and reconstruction and forced to foot the bill.

(6) Regarding compensation and remedial action, providing aid for reconstruction,

the rebuilding of people's livelihoods and health examinations and treatment free of charge, in line with the basic plan of the Nuclear Accident Child Victims' Support Law. Having indemnity claims against TEPCO settled without delay.

(7) Letting citizens, especially disadvantaged groups, participate in decision making processes, as they should.

The above points have properly indicated the health risks from the effects of radioactive substances released during the nuclear accident. Many people who were residing in the vicinity of the accident, especially pregnant women, children and the younger generation are suffering because they must continue living in areas with high levels of radioactivity on the basis of the evacuation standard of 20 mSv/y set by the government and because neither economic assistance for their relocation and refuge nor sufficient health countermeasures are being devised. Moreover, the government has specified and implemented measures for restoration that do not fully reflect the citizens' views.

The Grover Report makes the extremely important recommendation of limiting the public's exposure to 1 mSv/y or less, based on widely recognized research showing undeniable health impacts from low-level radiation. It recommends that only when the annual exposure dose is at 1 mSv or below should the evacuees be urged to repatriate.[36] It also calls for provision of accurate education and information on the risks of this low-level exposure. This same report shows that since the Fukushima nuclear accident, the Japanese government has been seen as taking remarkably insufficient countermeasures compared to the policies of the USSR to protect its citizens in the wake of the Chernobyl accident. It bears saying that the Japanese government's and TEPCO's nuclear accident response is devoid of any perspective from the viewpoint of the human rights of the people who have been harmed.

Providing Aid from the Standpoint of the People Most Affected

The Grover Report goes on to point out that plans with regard to exposure levels should be formulated on the basis of human rights rather from the standpoint of economic benefits versus risks, and in particular, that they must adopt the perspective of the most vulnerable people, such as pregnant women and children. This is an important thing to point out. A nuclear disaster deprives people of their right to life and health, so compensation and restoration must incorporate the viewpoint of facilitating the protec-

[36] A March 2013 report by the International Physicians for the Prevention of Nuclear War (IPPNW) stated that the urging repatriation to areas where the additional annual exposure dose is expected to exceed 20 mSv cannot be allowed. The Nobel Peace Prize-winning Physicians for Social Responsibility (PSR) with a membership of 50,000 across America also disputes it, saying that it is common knowledge in academic circles that no safe level of radiation exists.

tion of human rights in the health and welfare of the disaster victims. It is by facilitating flexible preservation and protection of these human rights that the victims can feel at ease and recovery from the various wounds inflicted by the disaster becomes easier. The Council of Europe also asserts in "Ethical principles relating to disaster risk reduction and contributing to people's resilience"[37] (Prieur, 2012) that to protect human rights in disaster management, (1) prohibition of discrimination, (2) impartiality and (3) high standards of information and participation must be ensured.

The United Nations Committee on Economic, Social and Cultural Rights expressed concern that the needs of people in disadvantageous or vulnerable positions (the elderly, disabled, women, children, etc.) were not being fully met in the evacuations resulting from the Great East Japan Earthquake and Fukushima nuclear accident along with the efforts toward reconstruction and restoration. To include economic, social and cultural rights in disaster prevention plans, they also recommend improving disaster response by basing it on human rights, and ensuring transparency and rapid sharing of information on preventive measures and the safety and potential dangers of NPPs (June 10, 2013, E/C.12/JPN/CO/3. From a Japanese translation by the Liaison Conference for the International Covenant on Economic, Social and Cultural Rights NGO Report (tentative English translation)).

The United Nations Human Rights Committee expressed concerns as well about the high limits for public exposure being allowed in Fukushima and, with the lifting of evacuation orders for several areas, the people being given no choice but to return to areas contaminated with high radioactivity. They said that all necessary measures should be taken to protect the lives of people affected by the Fukushima nuclear accident and that the designations of evacuation zones should not be rescinded unless the radiation levels there pose no risks to the inhabitants. They recommended monitoring radiation levels and providing information about this to the people affected by the nuclear accident as the opportunity arises (Recommendations, July 23, 2014, p.24. CCPR/C/SR.3091, CCPR/C/SR.3092).

The same committee regards the situation the victims of the Fukushima nuclear accident have been placed in to be not fully protective of their right to life, as guaranteed under Articles 6 and 12 of the Covenant on Civil and Political Rights; nor of citizens' right of access to information, as guaranteed under Section 19 of the Covenant. The Nuclear Accident Child Victims' Support Law enacted in 2012 recognized that the health effects of low-level radiation were unclear and instituted equal support for choices by the

[37] "Resilience" is the ability to recover flexibly from large environmental disturbances after being temporarily rendered non-functional.

disaster victims to remain in the evacuation zones, remain evacuated or be repatriated. Despite this, the government has clearly been promoting policies for their repatriation. These kinds of government policies violate the rights of citizens to life and health and their right of access to information that are recognized by international society.

The Right to Live in Peace

Nuclear energy has been pursued aggressively by successive administrations. The potential danger and horrendous degree of damage from nuclear accidents are still being pointed out as before. It is possible to say that Japan's government bears legal responsibility for the nuclear accident. National policies brainwashing the citizenry with myths of nuclear safety, and using the power of subsidies to push these dangerous facilities on depopulated regions can be indicated as incompatible with Japan's constitution. The legal basis for seeking governmental responsibility and pursuing the rights of the exposure victims may be found in the "right to live in peace" which is enshrined in the Preamble to Japan's Constitution. Reflecting on this principle brings renewed awareness that nuclear energy is in conflict with the Constitution's human rights provisions in a number of ways.

The preamble to the Constitution of Japan states, "All peoples of the world have the right to live in peace, free from fear and want." If the wind direction had been different at the time of the reactor building explosions during the Fukushima nuclear accident, eastern Japan could have been annihilated. This demonstrates the immense unavoidable potential risks of nuclear energy. The "right to live in peace" as stated in Japan's Constitution speaks not only of the right of the Japanese people to exist, but extends this right to "all peoples of the world." Attempting to profit and ensure national security through this unholy, intractable thing called the "atom" for the sake of life- and peace-loving Japanese and international society, on the contrary, threatens the peaceful existence of "all the peoples of the world."

This is confirmed in Article 13 of the Constitution of Japan, which specifies "the right to pursue happiness" ("All of the people shall be respected as individuals. Their right to life, liberty, and the pursuit of happiness shall, to the extent that it does not interfere with the public welfare, be the supreme consideration in legislation and in other governmental affairs") and Article 25, which specifies "the right to life" ("All people shall have the right to maintain the minimum standards of wholesome and cultured living.")

There were also other human rights that were damaged by the nuclear accident that are supposed to be guaranteed, as specified in Article 17,"Every person may sue for redress as provided by law from the State or a public entity, in case he has suffered damage through illegal act of any public official"; Article 22, "Every person shall have freedom to choose and change his residence and to choose his occupation to the extent that it does

not interfere with the public welfare"; Article 26, "All people shall have the right to receive an equal education correspondent to their ability, as provided by law"; Article 27, "All people shall have the right and obligation to work"; and Article 29, "The right to own or to hold property is inviolable."

The Goal of 'Restoring Humanity'

If revitalization and restoration of the victims of nuclear accidents were enshrined in the Constitution, the goal would be "restoring humanity" in conformance with the right to life, particularly the dignity of humans and the right to pursue happiness. The compensation for damage from nuclear accidents inflicted unilaterally upon people through no fault of their own was from the beginning supposed to be about helping the victims recover their jobs and lifestyles that they would not have lost if it hadn't been for the nuclear accident. In addition, it is supposed to provide full recovery of their rights as humans that were violated.

What "restoration" seems to mean to the government and TEPCO, however, is to proceed with public works projects such as decontamination, restoration of infrastructure (waterworks, sewers, roads), and reconstruction of public facilities such as schools and hospitals. The foremost goal of this is to help the economy recover through projects into which gigantic sums are invested as grants, to bring the population back and to increase employment. Helping the disaster-stricken region recover from the point of view of that sort of "restoration" is the source of pressure from the government that is urging early repatriation of the disaster victims. That, however, shows poor consideration of the disaster victims' pressing requirement to know if they can possibly rebuild their lives, and is likely to result in a "recovery without people," losing sight of flesh-and-blood humans. Here once again, the relationship is seen between the dominating government and the regions dominated through the use of subsidies. The hopes of the disaster victims who are living a temporary lifestyle as evacuees are to return to their former everyday lives, but for that, they must have their "humanity" restored, that was lost as the result of the nuclear accident. Here, "humanity" means their rights and dignity as humans in communities and societies built by layer upon layer of human relationships. It also needs to include reconstruction of the commensurate social mechanisms.

The reparations and compensation would therefore be insufficient, because they try to resolve by means of economic ethics the mental suffering of difficult evacuation life and the loss of individual assets. The reality of the damage needs to be made clear and the qualities of the "humanity" was that was lost need to be deeply considered. What a real "solution" to the Fukushima nuclear accident would be is to reconsider the nuclear accident from the standpoint of the disaster victims and rebuild society by making the most

of those reflections. That would also include the task of fundamentally rethinking the kind of system we have that operates NPPs while having all of the authority and wealth monopolized by a privileged few, but exposing humanity to structural violence. The disaster victims together with other citizens, researchers, specialists and politicians, and also religious people and churches need to examine more deeply the connections between restoration and humanity, support and humanity, and science/technology/nations/governance and humanity, provide information and form networks. The path to restoring for the sake of humanity that which was destroyed by the nuclear accident and putting humanity at the heart of society will take community resources and ingenuity and will be painful, but we must embark on this road to abundance. This task is in deep accord with the views of "Integral Ecology," raised in Pope Francis' *"Laudato Si"* encyclical, which is discussed in Part 3 of this book.

Particularly in modern Japan, with its growing disparities, many people in the younger generation are finding it hard in a variety of senses to live, and it is becoming a society that sometimes leads people to think they are about to become "refugees." That feeling was certainly strong in the regions affected by the nuclear accident. Shouldn't we be seeking a "restoration of humanity" starting from the disaster-stricken region, through which people support each other in mind and body, and in which we share life goals in facing the future together?

Seeking Responsibility

To initiate a "restoration of humanity" that brings about a revival of well-being for the disaster victims and disaster-stricken region, first the actual state and total amount of damage must be elucidated and the main constituents responsible for causing the damage must be identified. Then, based on that, compensation and relief mechanisms must be devised that give top precedence to rebuilding the livelihoods of individuals and families. This relief must include fair treatment of residents who elect not to be repatriated. The possibility of various options, not merely two alternatives, must be recognized so that the rights of long-term evacuees are guaranteed.

Many of the victims who were plaintiffs in suits over the Fukushima nuclear accident are pursuing the responsibility of the state for errors in nuclear administration that caused tremendous damage to the people of Fukushima, arguing that they are eligible under the Constitution to seek rights and remedies. As a general rule rights and remedies apply under the Constitution when state authority infringes upon the rights of individuals. Because of that, it could be argued that it would be difficult to judge whether rights and remedies are possible under the Constitution with regard to damage triggered by a natural disaster that was not directly caused by the state. In addition, even if the govern-

ment had a hand in licensing a private enterprise that subsequently caused damage to citizens, they may say the government is not obligated to bear responsibility for it. It goes without saying, though, that the victims seeking relief may request an investigation into the uncertainties about responsibility arising from the dual structure of the government-TEPCO alignment.

It is a fact that the Fukushima Daiichi Nuclear Power Station caused the accident and failed to ensure safety. We also seriously need to face the fact that the government and TEPCO covered up hazards by claiming everything was safe, and that the accident response measures they had professed beforehand were flawed. If accidents are possible in the worst cases, it can be said that imposing NPPs on the citizens was wrong from the beginning. There are no perpetrators in the case of earthquakes and tsunamis, but in the case of nuclear disasters, there are. The government and TEPCO are the perpetrators. The burden of the accident resulting from that human disaster is being fobbed off onto the people who were living nearby. If the responsibility for this can only be resolved in a neglectful manner, there is no choice but to say that the future society of Japan and, moreover, our children's future will be impacted by serious inconsistencies and obstacles. There are concerns, however, among electric power companies and other businesses about "liability without fault" under the Act on Compensation for Nuclear Damage, which laid out the system of compensation in the case of accidents. These are leading to uncertainty about the place of "liability with fault" for the accident. Because of this, the perpetrators are afraid to take a straightforward apologetic stance toward the victims, and they promote a "recovery without people" rather than compensating the disaster victims. Moreover, with the responsibility still unclear, they promote a pretty fiction, ending the evacuation and drawing the curtain on the accident. We must not allow the government's early lifting of the evacuation orders and urging people to repatriate to give rise to a new safety myth that, after all, "the Fukushima Daiichi nuclear accident wasn't such a bad accident and the evacuees can head back home and live happily forever after."

Inconsistencies in the Act on Compensation for Nuclear Damage

The Act on Compensation for Nuclear Damage is said to have two goals, (1) protecting the victims and (2) promoting nuclear energy business. Looking at the course of events from the time the Fukushima nuclear accident occurred, however, shows that clashing interests between these two goals were a problem from the outset. That is, because of this clash, the responsibilities of the business that caused this accident were obfuscated, and protection of the victims is being obstructed.

Section 3 of the law states the following: "Where nuclear damage is caused as a result of reactor operation etc. during such operation, the nuclear operator who is en-

gaged in the reactor operations etc. on this occasion shall be liable for the damage, except in the case where the damage is caused by a grave natural disaster of an exceptional character or by an insurrection." When an accident occurs, the nuclear energy company involved is subject to "liability without fault" with no need for substantiating intention or error. This, it is said, protects the victims by expediting trials.

Section 16 establishes that when the nuclear energy company is unable to cover compensation for an accident, the state will provide the needed assistance. Though the Fukushima nuclear accident was the first such case, all at once conditions "nearly beyond imagination" became the reality. Section 16 was not invoked, but supportive measures from the state toward the company were invoked that were substantially equivalent in effect.

To actualize compensation for the Fukushima accident, the Act on the Nuclear Damage Liability Facilitation Fund (currently, the Nuclear Damage Compensation Facilitation Corporation Act) was enacted on August 3, 2011. This act, however, was focused on financial support and relief for the company involved, TEPCO, from the government. TEPCO was for all practical purposes relieved of its share of the burden. Moreover, with the government itself able to hide behind the Nuclear Damage Liability Facilitation Fund, it was a deliberately ambiguous solution relying on dual responsibility. On the face of it, the idea was to make TEPCO responsible as the direct perpetrator for bearing the financial burden, but in substance, it let TEPCO off the hook by allowing it to collect the financial resources to pay the compensation from the citizens through electricity rates and taxes. This was done deliberately to make the issue of responsibility ambiguous and rescue the perpetrator by hitting citizens in the wallet. Moreover, according to Section 4 of the Act on Compensation for Nuclear Damage, responsible parties aside from the nuclear energy companies, such as the manufacturers who produced the biggest hazards—the nuclear reactors themselves—bear absolutely no responsibility for paying compensation. In the past, the shareholders, bondholders, manufacturers, banks and others connected with the electric power companies have assumed the risk of responsibility for compensation in return for earning their gigantic profits, but are being exempted from their share of the burden of compensation for the accident this time. It is, after all, a trick for exempting the government and companies from responsibility when major nuclear accidents occur and getting the citizens to bear the burden instead. It is a way of admitting, "If a nuclear accident happens, the damage will be too great, so we cannot take responsibility, and therefore, we won't." In this way, a situation is evolving in which the electric power companies as private companies enjoy economic benefits from nuclear energy, while foisting the tremendous damage it causes onto the citizens.

Pollution issues in postwar Japan, such as Minamata disease from mercury pollution, show the importance of clarifying corporate and government responsibility for

causing damage and, based on that, requesting the parties involved to bear the costs. The Nuclear Damage Compensation Facilitation Corporation Act, however, ignores these lessons. Even in the trial in August 2011 in which a golf course in Nihonmatsu requested TEPCO to provide decontamination, the golf course lost the case. The reasoning was that the radioactive materials scattered from the NPP were not TEPCO's property but by the logic of "the idea that they are ownerless by nature conforms to reality," TEPCO was deemed to bear no responsibility for decontamination.

In this way, the second goal of the Act on Compensation for Nuclear Damage, "promoting nuclear energy business," is achieved, but the first goal, "protecting the victims," could be said to be hindered for the sake of the second goal. There have been many cases in which the victims found the compensation they were awarded to be unacceptable.

The conditions behind for poor treatment of the nuclear accident victims have been explained above. It would be a mistake, however, to relegate the problems with compensation for damages this time in the past and move on. To achieve the above-mentioned "restoration of humanity," it will be necessary to re-examine conventional nuclear energy policies that ignore victims' rights, and to have a national debate on how Japan can become a country that cherishes humanity (Citizens' Commission on Nuclear Energy, 2014). For that, first, we must look into the precise causes of the accident. From there, we must clarify the responsibility of the government and other parties involved who contributed to the decisions on nuclear energy policy, and then dismantle the distorted societal structure.

There is also talk that it has become more difficult to obtain new sites for reactors due to the recent accident, and it is self-evident under Japan's energy situation that whatever efforts are put into extending the lives of this country's superannuated NPPs, sooner or later Japan must abandon nuclear energy. Throughout the world, renewable energy is outstripping other forms in terms of the amount of electric power generated, and nuclear energy is already falling behind the times[38]. In Japan as well, to encourage the development of small-scale renewable energy in each area, first the regional monopolies of the electric power companies with exclusive source rights should be dismantled and electric transmission, with its high utility, should be operated separately from the electric power companies.

Verification through the Judiciary

One method needed by victims for changing unfair conditions is verification

[38] According to estimates for 2013, fossil fuels accounted for 78.3% of the world share of final energy consumption, followed by renewable energy with 19.1% and for nuclear energy with 2.6% (REN21, 2015, p.22).

through the judiciary. To clarify the facts of the accident and try to obtain atonement for crimes and apologies from the perpetrators for what they did, compensation for damages and recovery livelihoods and occupations; to provide detailed health examinations that give the victims a chance to learn the truth, ensure health care for the future safety of the victims, implement measures to reduce exposure levels and achieve recognition of the victims' "right to evacuate"; and to create a system that helps the victims' children recuperate, trials are particularly important.

Recently, a trial following the Fukushima nuclear accident resulted in a decison with significance as a turning point in the former trends in nuclear energy litigation in recognizing the danger of NPPs. It was handed down on May 21, 2014 by the Fukui District Court in a suit requesting an injunction against the operation of Units 3 and 4 of Kansai Electric Power Company's (KEPCO's) Oi NPP. This decision directed KEPCO to suspend operation of the Oi NPP's Unit 3 and Unit 4 nuclear reactors on the basis of the "personal rights" of people residing within a 250 kilometer radius of the Oi NPP.

This decision went way beyond prior decisions in administrative and civil litigation over NPPs in that the judiciary had until then ratified the claims of government agencies and companies, and repeatedly insisted on excessive substantiation of deficient safety as the responsibility of the communities in these suits. The reason the communities were continually defeated by the NPP-supporters in nuclear energy trials prior to then was that the government and companies controlled all of the technical information, while the plaintiffs, who had the burden of substantiation, could not easily acquire that information. The Fukushima nuclear accident, however, was an event that exposed the truth that the safety standards that had been previously made the judgement standard in legal evaluations were erroneous. After that the old judicial ruling framework of primarily deferring to the government's safety examination results collapsed, obligating the courts to make their own judgements based on the danger of the technology and scale of damage that were revealed by the Fukushima nuclear accident. In addition, not only did doubts remain over the infallibility of the safety technology and facilities at the Oi NPP, but the injunction against operating them was recognized because of vulnerabilities that had been created by an overly optimistic outlook. What formed the basis this time for the direction of the decision was the viewpoint based on Articles 13 and 25 of the Constitution, which place the highest value on personal rights, meaning that the citizens should be protected from the dangers of radioactive substances. In this sense, it can be considered a ground-breaking decision.

The judgement paper stated, "Under our country's legal system, no other value can be found that surpasses" personal rights. In contrast, it said, the electric power industry that NPPs support has a socially important function, but constitutes an economic activ-

ity, which should be given a lower priority than personal rights, which are the core value under the Constitution. NPPs, like major disasters and wars, deprive people over an extremely broad region of their fundamental personal rights and bear the risk of the worst form of environmental pollution. Therefore the injunction against their operation was only right. From then on, arguments such as that operation of NPPs would provide a stable electric supply and reduce the costs, or that it would reduce carbon emissions could not compare to the rights of an extremely large number of people to exist, and have been waved aside.[39]

'Restoring Humanity' and a 'Culture of Life'

The future course of the victims of the Fukushima nuclear accident must also be supported on the basis of policies upholding these personal rights. Nuclear energy, as described above, has been supported by a societal structure with many distortions, lacking fairness. How does God view a society lacking ethics, in which no one takes responsibility, where a few of the people put their own immediate economic benefits of ahead of the citizens' health and safety, monopolizing national policy, invoking the power of the law to maintain their privileges, and trampling on rationality and democracy? There is no choice but to call the structure of a technological society that does not treat humanity as important, or that brings on extreme destruction a "culture of death" such as that Pope John Paul II spoke of ("Evangelium Vitae" encyclical).

According to the "Evangelium Vitae" encyclical, the current threat to the sacred value of human life is symbolized by the Biblical passage, "The voice of your brother's blood is crying to Me from the ground" (Genesis 4:10). Humans, who were created in God's image and blessed with the richness of life (Genesis 3:5) committed the original

[39] Decisions in subsequent NPP trials, however, have gone every which way, failing to touch upon personal rights. The decision handed down by the Fukui District Court on April 14, 2015 in a suit for injunctions against the operation of the Oi Units 3 and 4 and Takahama Units 3 and 4 idled the Takahama NPP. This provisional decision, however, was rescinded in January 2016, and Takahama Unit 3 was restarted on January 29, followed by Unit 4 on February 26, 2016. The provisional injunction against the Oi NPP was also rejected on December 24, 2015. A suit requesting a provisional injunction against Kyushu Electric Power Company's operation of the Sendai Unit 1 and 2 reactors was rejected by the Miyazaki branch of the Fukuoka High Court on April 22, 2015. Subsequently, Sendai Units 1 and 2 were restarted in August and October, respectively, of that year. Nevertheless, in a provisional disposition suit by citizens of Shiga Prefecture seeking an injunction against reactor restarts because their safety was not guaranteed, the Otsu District Court in Shiga Prefecture handed down a temporary ruling on March 9, 2016, ordering the operation to be halted, saying that KEPCO had failed to support its claims sufficiently about its severe accident response measures, tsunami countermeasures and evacuation plans. As a result, with the Takahama Unit 3 and 4 reactors, for the first time in history, a reactor in operation was halted by a ruling (operation of the Unit 4 reactor had already been halted on February 29 due to trouble).

sin by violating God's commandment. The first outcome of that was fratricide (Cain killing his younger brother Abel). From then until this day, humans have continued repeating the outcome of this sin, and they live in the midst of a structure of mutual harm. This is the "culture of death" that deprives humans of their dignity and solidarity.

Symbolizing the healing of the resulting state of sin, and bringing forth of renewed life and reconciliation from the schisms and fragmentation, are the words of Jesus Christ in the New Testament, "I have come that they may have life" (John 10:10). Loving humanity and all of God's creation, and protecting, guarding and fostering them are the righteous path of people who follow Jesus Christ. We, from the viewpoint of the Christian Church regarding basic humanity and society, the world and the environment, must reconstruct a post-nuclear-disaster society based on the ethics of extending trust for mutual understanding of differences and recognition of others' standpoints, a society that guards human rights over economic ones, and protects the citizens. In other words, we need a society that hosts a "culture of life." This challenge will be revisited in Part 3.

Appendices to Part 1

The Birth of Radiation Physics and Nuclear Physics

Humanity's utilization of nuclear energy had its origins around the end of the 19th century, with the birth of radiation physics. At that time, there were still many scientists who doubted the physical existence of molecules and atoms, considering them nothing more than a hypothetical concept for explaining observed physical phenomena. We will begin the chronology with the discovery of radiation.

1895 Wilhelm Roentgen discovers X-rays.

1896 Henri Becquerel discovers radiation emanating from uranium

1897 J.J. Thompson discovers electron beams in what were known then as "cathode rays"

1898 Madame Curie discovers radium, a radioactive element

1899 Ernest Rutherford discovers alpha rays, beta rays and gamma rays

Following these discoveries, it was learned that beta rays were identical to electron beams, or cathode rays, and that alpha rays were identical to the nuclei of helium atoms and carried a positive charge. In the midst of these kinds of consecutive discoveries, it was Rutherford, who in 1911, based on scattering experiments, proposed an atomic structure consisting of a positively charged nucleus and, whirling around that, a number of negatively charged electrons.

While these experimental results were being obtained on the one hand, the advent of quantum mechanics got underway on the other, providing the theoretical basis for nuclear physics, which made nuclear technology possible, and set off the 20th century physics revolution. Let's trace the chronology of that journey.

1900 Max Planck proposes quantum theory (the theory that the energy of blackbody radiation occurs in discrete amounts, in other words, has a particle-like nature)

1905 Albert Einstein proposes the light quantum hypothesis (the theory that light = particles of electromagnetic waves)

1913 Niels Bohr proposes his model of the atom (in which there are stable orbits with discrete energy levels at which electrons revolve around the nucleus)

1925 – 1926 Werner Heisenberg and Erwin Schroedinger bring quantum mechanics to perfection

While quantum mechanics was in the process of being developed in 1919, Rutherford discovered protons (hydrogen nuclei). After protons were discovered and quantum mechanics was fully understood, the scientists turned their attention to elucidating the internal structure of atomic nuclei.

1932 James Chadwick discovers the neutron (clarifying that atomic nuclei are composed of protons and neutrons)

1933 Enrico Fermi proposes the beta decay theory

1934 Hideki Yukawa proposes the meson theory

The result of liberating these nuclear forces is nuclear energy.

The Jewish physicist Leo Szilard, who was born in Hungary, knew about Chadwick's discovery of the neutron. In 1933, when the Nazis rose to power in Germany, he predicted that since neutrons lacked a charge, they could approach and hit atomic nuclei. He conceived the idea that it would be possible to initiate a fission chain reaction by bombarding atomic nuclei with neutrons. As the fascism of Nazi Germany and Mussolini's Italy spread its influence across the European continent, many distinguished physicists defected to America and Britain. Einstein fled from Germany, Szilard from Hungary and Fermi from Italy, each going to America; while Bohr fled Denmark for Britain.

It was in the midst of this global situation that German scientists Otto Hahn and Fritz Strassmann conducted an experiment in December 1938 in which they bombarded uranium with neutrons. Investigating the results, they found that from uranium (atomic no. 92) they had obtained a lighter element, barium (no. 56). Hearing of this result in Sweden, Lise Meitner, a colleague of Hahn's, who had fled there, concluded that it had been generated by the nuclear fission of uranium.

Thus it was that in an era dominated by fear of the Nazi regime, nuclear physics, born from efforts to understand how nature worked, began a transformation. Inclinations toward producing an atomic bomb began manifesting.

Peaceful Use of Atomic Energy for Forgetting the Tragedy of the Atomic Bomb

To achieve peaceful use of atomic energy in Japan, the tragedy of the atomic bomb was exploited. While the memories of Hiroshima and Nagasaki were still vivid, Commissioner Thomas E. Murray of the American Atomic Energy Commission (AEC) spoke of building nuclear power plants (NPPs) in Japan as an effective way of distancing the people of Japan and America from the memories of the bloodshed inflicted on those two cities (*Asahi Shimbun*, September 22, 1954). Hidenori Shibata, confidant of media mogul Matsutaro Shoriki, who played a big role in introducing NPPs to Japan, also spoke in 1954, saying, "Atomic energy is a double-edged sword. The peaceful use of

atomic energy is touted extensively to crush opposition to atomic bombs, so there is no choice but to go along with it and provide hope for a grand industrial revolution in the near future" (Shibata, 1985, p. 301; Jomaru, 2012, pp.94-95). Murray went as far as saying that Hiroshima would be the best candidate for confirming explicitly the effectiveness of the peaceful use of nuclear power, as it has horrible memories and strong fears about atomic and hydrogen bombs. Agreeing with Murray's ideas, Mayor Shinzo Hamai of Hiroshima spoke in January 1955, saying, "Building the first facilities for peaceful use of atomic energy in the first city victimized by atomic energy would bring comfort to the spirits of the victims. I think the citizens of Hiroshima would agree with using the energy of the atom, used initially for 'death,' to bring 'life' instead" (Yoshimi, 2012, p. 31). In March of that year, after embarking on a career in national politics and being elected to the Diet, Matsutaro Shoriki said, "We call on all nations to make practical use of atomic energy in peaceful industries, and will strive to dispel anxieties lingering from the terrible war" (*Asahi Shimbun*, Toyama Edition, March 1, 1955; Jomaru, 2012, p.100).

Technological Potential of NPPs for Producing Nuclear Weapons

Japan decided to purchase an improved version of the Calder Hall Nuclear Power Station from Britain in 1958, and constructed its first commercial reactor. The context behind Japan's purchase of a British nuclear reactor despite indications of safety issues included political intentions for improved relations with Britain following the war and issues concerning the reprocessing of spent nuclear fuel. America would not allow Japan to extract plutonium through reprocessing of spent fuel, but required Japan to return the spent fuel to America. Also, although the improved version of the Calder Hall plant produced less electricity than a light water reactor, it was suitable for producing high purity plutonium-239 from uranium-235. Thus, by concluding a nuclear power pact with Britain recognizing Japan's right to reprocess the spent fuel, Japan is said to have been aiming to obtain similar permission from America. Japan had set its sights on the possibility of possessing plutonium in the future (Arima, 2012, Ch. 2).

Despite not possessing nuclear weapons, Japan has managed to obtain the full set of technologies needed for manufacturing them (nuclear reactors, reprocessing, uranium enrichment). Influential post war Japanese politicians occasionally mention Japan's ability to arm itself with nuclear weapons. For example, Nobusuke Kishi, who served as Prime Minister during the dawning of Japan's nuclear energy development (1957 to 1960), spoke before the House of Councillors' Committee on the Cabinet on May 7, 1957 about "nuclear armaments constitutionality theory." An interview with Liberal Democratic Party (LDP) Policy Research Council chairman Shigeru Ishiba featured in

a magazine after the Fukushima nuclear accident quoted him as remarking, "It's important to maintain our commercial reactors because it would allow us to produce a nuclear warhead in a short amount of time…It's a tacit nuclear deterrent" (SAPIO, October 5, 2011). We wonder if such remarks are being made because they support a system of technology that has both military and peaceful applications, with NPPs constituting the civil use of a nuclear technology that enables atomic bombs to be produced.

Nobusuke Kishi made the following remarks about the utilization of nuclear energy for peaceful purposes (NPPs) being possible to change to military use (weapons) through mere policy changes in his memoirs.

"It is intrinsically possible for nuclear energy technology in itself to have both peaceful uses and uses as a weapon. Policy is what determines which way it will be used, and that is a matter of national will. Japan's national will and the will of her citizens has determined that nuclear energy will not be used as a weapon, so Japan will not deviate from peaceful use. But even given peaceful use, as the technology advances, the possibility of its use in weapons automatically increases. Japan does not possess nuclear weapons, but its potential ability for that is growing stronger. This gives us the ability to increase our say on the international scene regarding issues of disarmament and nuclear test bans" (Kishi, 1983, pp.395-396).

Such views are not limited to Kishi alone. In the 1960s, prior to Japan's Three Non-Nuclear Principles resolution (1971) and ratification in 1976 of the Nuclear Non-Proliferation Treaty (NPT), Japan's political leaders were investigating the technical possibility of nuclear armament and the effect it would have on international politics if it did so. What is worth noting among them is an internal document written by a foreign policy planning committee at the Ministry of Foreign Affairs (MOFA), titled "Our Country's Foreign Policy Outline" (1969). In it one can find the words, "economic and technical potential for nuclear weapons production."

"Regarding nuclear weapons, regardless of whether we ratify the NPT or not, we will adopt a policy of not possessing nuclear weapons for the time being, but we will always maintain the economic and technical potential (ability) for nuclear weapons production and take care not to accept any restraints on it. Furthermore, our policy on nuclear weapons in general will take care to avoid pointless domestic turmoil when bringing in tactical nuclear weapons, in the event that this ever occurs in the future, educating the citizens to the effect that our policy is based on calculations of international political and economic interests" (MOFA Foreign Policy Planning Committee, 1969, pp. 67-68).

Having the ability to manufacture nuclear weapons in preparation for national emergencies itself reflects recognition of the basis of Japan's national security policies. Japan's political leaders, who made peaceful use of nuclear energy their principle, have

tried to develop technology that enables nuclear weapons to be produced on the basis of nuclear energy promotion policy, and have created a national system with the capacity for nuclear armament at any time. In this way, the government's intention, seen as the "technical potential" for nuclear armament, is thought to be one factor hindering the movement for a society without nukes in Japan, although it has experienced a serious nuclear accident.

The Quest for the Nuclear Fuel Cycle

The Japanese Atomic Energy Commission (JAEC) began considering reprocessing of spent nuclear fuel in 1956, creating policies to implement reprocessing projects. The Power Reactor and Nuclear Fuel Development Corp. (PNC) was established in 1967 with the objective of developing fast breeder reactors that could use plutonium as fuel. Construction of the Joyo fast breeder test reactor began in 1970, and it first reached criticality in 1977. The PNC also undertook development of nuclear fuel reprocessing and uranium enrichment technology. It started constructing the Tokai Reprocessing Plant in 1971. JAEC organized an international conference on enrichment schemes in 1971, and the electric power industry also launched a uranium enrichment investigation committee in 1972. Japan tried then to participate in a joint international project for uranium enrichment, but ultimately wound up advancing with development of uranium enrichment technology on its own.

In May 1974, India conducted a nuclear test, and since then, the movement for sensible nuclear technology regulations geared toward nuclear non-proliferation has strengthened. Having started developing uranium enrichment technology just prior to that, Japan had the Tokai Reprocessing Plant facilities construction completed in October 1974, just after India's nuclear test. The next year, when it reached the stage at which it was about to start test extraction of plutonium from spent nuclear fuel, America intervened, strengthening the international system for nuclear non-proliferation in response to India's nuclear test.

In response, if America was going to put pressure on Japan over its uranium enrichment and reprocessing plans, Japan would resist by showing that it was prepared not to ratify the NPT. In fact, from the 1960s to the early 1970s, there was talk among concerned parties of opposing the NPT. This treaty unilaterally favored countries already possessing nuclear arms and was unfair to others. It would put heavy restrictions on Japan's civil use of nuclear energy—at least this was the public argument of those opposed to it. But it is also said that the government officials involved did not want to abandon their prospects for nuclear armament that loomed in the background. This opposition to

the NPT resulted in considerable delay between Japan's signing of the treaty in February 1970 and its ratification by the Diet in June 1976.

The Democratic Carter administration inaugurated in January 1977 announced strict nuclear non-proliferation policies, including indefinite postponement of plutonium recycling. It also sought restrictions on Japan's civil use of plutonium. After negotiation, America agreed to the operation of the Tokai Reprocessing Plant, but made it a temporary measure until technology for co-processing of spent nuclear fuel could be readied, thus limiting its operation. Meanwhile, Japan's electric power companies decided to entrust reprocessing of their spent nuclear fuel to Britain from 1978. Perhaps America acquiesced to Japan's and European countries' promotion of plans for civil use of plutonium, though it was loath to.

America's nuclear non-proliferation policies, however, had become an impediment even before Japan began promoting the nuclear fuel cycle. For that reason, the nuclear fuel recycling project went forward during this time under private entrustment. It was thought that entrusting reprocessing to private concerns in Japan would make it less vulnerable to American interference than entrusting it to Britain or France.

In the 1970s, the Science and Technology Agency had the PNC proceed with construction of the Tokai Reprocessing Plant. It also aimed for realization of plans to construct a privately managed commercial reprocessing plant. The electric power industry, the implementing entity for the project, was reluctant for a while to take on this private entrustment scheme. Finally, however, with the establishment of the Japan Atomic Fuel Service Co. in 1980, the nuclear fuel reprocessing project could be entrusted to a private company, so that was done. After that, Japan's nuclear fuel industry began taking part in uranium enrichment as well. Following the beginning of full-scale operation of the Tokai Reprocessing Plant in 1981, plans emerged in 1984 for siting a set of nuclear fuel cycle facilities in Rokkasho-mura, in the northerly prefecture of Aomori.

The Republican Reagan administration, inaugurated in 1981, was more tolerant of Japan's nuclear energy plans. At that juncture, nuclear energy-related concerns in Japan began aiming for revision of the Japan-United States Atomic Agreement, favoring comprehensive agreement on international transference of nuclear materials rather than item-by-item agreement, as had been the case until then. If they could succeed in achieving this, they could get the plutonium that had been extracted from spent nuclear fuel from Japan's NPPs sent back to Japan periodically from the reprocessing plants in Britain and France without the U.S. government interfering. Despite opposition to such a revision of this nuclear agreement, it was approved in 1988.

Construction began in 1993 of the Rokkasho-mura nuclear fuel cycle facilities. However, the Democratic Clinton administration, inaugurated in 1993, reasserted nu-

clear non-proliferation and began advocating a treaty banning the production of fissile materials that could be used in weapons production. Japan's government would be forced by this to commit itself internationally not to store surplus plutonium. In return for this, the Clinton administration agreed to refrain from interfering with Japan's plans to use plutonium.

The fast breeder reactor "Monju" achieved criticality in 1994, but the very next year an accident occurred in which sodium leaked from the secondary coolant system. In response to this accident, the PNC took inappropriate actions and then intentionally concealed them in a fabricated accident report. Then in 1997, an accident occurred at the PNC's Tokai Reprocessing Plant with a fire and explosion. This accident revealed the PNC's insufficient safety measures.

After the Monju accident, the nuclear fuel cycle was put on hold, but in January 1997 a cabinet decision supporting plans for plutonium-thermal reactors, which use light water reactors to burn MOX fuel, was arrived at with adjustments by the Ministry of International Trade and Industry (MITI). Since then, the government has implemented these so-called "plu-thermal" plans as they are, making no attempt to build a consensus on the nuclear fuel cycle. Plu-thermal has a number of drawbacks, including nuclear proliferation and national security issues arising from the use of plutonium, the high costs entailed in manufacturing MOX fuel, greater damage from radiation when accidents occur, difficulty of controlling the reactors, and difficulty of disposing spent MOX fuel. Despite these issues, the government went full speed ahead with it. Their aim was consumption of the plutonium extracted through nuclear fuel reprocessing. The purpose of plu-thermal was to create an excuse for operating the Rokkasho reprocessing plant.

No discussion has been allowed on the development of fast breeder reactors or the related nuclear fuel cycle technology, but it is allowed to proceed. Of course, the previous policy of making fast breeder reactors "the main nuclear power source of the future" has been retracted, and any specific time frame for their practical implementation has been withdrawn. However, the nuclear fuel cycle plans proposed in 1998 by the Japan Nuclear Cycle Development Institute (JNC) that was founded to replace the PNC are still being pursued. Also, after the Science and Technology Agency was dismantled in 2001 and Monju came under the joint management of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Economy, Trade and Industry (METI); the Nuclear and Industrial Safety Agency was organized under METI. This reorganization put METI in charge of both promoting the nuclear power industry and overseeing its safety regulation. METI has come to wield enormous power over the nuclear energy administration.

The Nuclear Fuel Cycle Facilities Suite at Rokkasho-mura

Why is a set of nuclear fuel cycle facilities being located at Rokkasho-mura? The first reason is that the problem of property rights disposition has already been solved at this prospective siting location. The second is that the Mutsu-Ogawara comprehensive development zone on the Shimokita Peninsula was desperate to attract businesses, having failed to attract an industrial complex as planned and being saddled with enormous debts, and the parties with a stake in it were trying to recover their losses. The third is that Aomori Prefecture already had a high concentration of developed or prospective nuclear power facilities, so it had become easy to enlist the cooperation of local municipalities, including the prefectural authorities.

In disputes over NPP siting in America and Europe, safety issues are the main point of contention, but in Japan, monetary issues have even greater significance over that. At Rokkasho-mura, a spacious site and the resolution of fishery compensation issues had already been ensured by a third-sector company of Aomori Prefecture (Mutsu-Ogawa Development Inc.). Cases of nuclear power-related facilities being invited by depopulated regions experiencing economic hardships are not limited to Rokkasho-mura. The fact must not be overlooked that in Japan, an earthquake-prone country, siting decisions for the nuclear industry have been based on monetary issues, not safety. Also, if the nuclear fuel cycle facilities at Rokkasho-mura are operated, they will discharge far more radioactive substances than an NPP would. And we must not forget that the damage from imaginable accidents could be far greater.

Ruiko Muto's Speech at 'Goodbye to Nuclear Power Plants' Rally of 50,000

(September 19, 2011, Meiji Park, Tokyo)

Today, I arrived with many busloads of companions from Fukushima Prefecture and from the places to which we evacuated. This is the first time many of us have participated in a rally or demonstration, but we will try to convey the grief caused by the accident at the Fukushima nuclear plant. We called out to each other, invited each other to raise our voices together, and came here to say, we do not need nuclear reactors!

First, there are a few things I would like to say. To each of you who have been making serious efforts day after day to protect life under difficult circumstances since March 11, you have my deepest respect. I would also like to express my appreciation to everyone who has warmly extended a helping hand to the people of Fukushima Prefecture, connecting with us and providing support in various ways. Thank you all. Then, to all the children and young people who have been left bearing a heavy burden from this accident, on behalf of the generation that brought about such a situation, I apologize from my heart. I am truly sorry.

Ladies and gentlemen, boys and girls, Fukushima is a very beautiful place. Eastward, the coastal Hamadori region looks out over the deep blue Pacific. The inland plains and hills of the Nakadori region are a treasure-house for peaches, pears, apples and other fruits. Westward, golden rice stalks droop their heads on the Aizu Plain, around Lake Inawashiro and Mount Bandai. The far west is framed by deep mountain ranges. This is our homeland, with its blue mountains and clear water.

The nuclear accident of March 11 was a turning point. Radiation, invisible to the eye, poured down upon this landscape, and we became radioactive fallout victims.

In the midst of widespread confusion, various things happened to us. Our people were caught up in a rapidly deployed "safety campaign," and in the blindness of alarm, the connections between us were torn apart. Who can say how many people worried and grieved in our localities, our workplaces, our schools, our homes? Day after day, many inescapable decisions were forced upon us. To flee, or not to flee? To eat, or not to eat? To make our children wear masks, or not to make them? To hang the laundry outside, or not to hang it outside? To work our fields, or not to work them? To speak out about things, or to stay silent? We faced various agonizing decisions.

Now, looking back at the past half year, certain things have gradually become clear—the true situation is being hidden. The country is not protecting its citizens. The

accident is still not over. The citizens of Fukushima Prefecture are being made the subjects of a nuclear experiment. A huge volume of radioactive waste remains. Despite the enormous price that we have already paid, there are powers intent on driving nuclear power forward. We have been abandoned.

We heave deep sighs of exhaustion and overwhelming sadness. But the words that spill from our mouths are "Don't you dare treat us like fools!" "Don't rob us of our lives!"

In the midst of our anger and grief, we, the citizens of Fukushima Prefecture, are quietly rising up. Mothers and fathers, grandmothers and grandfathers, wanting to protect their children; the young generation, fighting to stop their future from being stolen; workers trying to help those cleaning up the stricken nuclear plant, exposed to huge doses of radiation in the process; farmers in despair at the contamination of their land; people with disabilities, determined that the radiation not give rise to yet new forms of discrimination and separation: One by one, each citizen is asking questions about the state's, and TEPCO's, responsibility. We are raising our voices to say, "No more nuclear reactors!"

Quietly burning with fury, we have become the ogres of Tohoku. We, the people of Fukushima, want to share our sense of distress, responsibility and hope, and to support each other as we proceed with our lives, whether we have left our hometowns or have stayed on in Fukushima. Please join with us. Please note the actions that we are undertaking. We are learning about negotiations with the government, evacuation rulings, temporary evacuation, health preservation, decontamination, radiation measurement, nuclear reactors and radioactivity. And we are going everywhere to tell people about Fukushima. Today, companions of ours are giving a speech in New York. We are working on this in every way we can think of. Please help us. Please don't forget Fukushima.

There is one more thing that I want to talk about. That is our lifestyle, how we each live our lives. We need to imagine the world on the other side of that socket into which we plug our things so casually. We need to be aware that convenience and development come at the price of discrimination and victimization of people. Nuclear power plants are on the other side of that socket.

Humanity is no more than one species among the living creatures on Earth. Is there any other species that usurps its own future? I want to live as an honest being, in harmony with our beautiful planet Earth. Although it may be a humble effort, I want to treat energy as a precious resource, and weave an ingenious, rich, creative life. How can we build a new world that is the polar opposite of one reliant on nuclear reactors? Nobody has a clear answer to that. What I think we can do is for each of us as individuals to think really, really seriously with our own minds, keep our eyes wide open, decide what we can do, and then act on it, rather than merely following someone else's decisions. Let us remember that each and every one of us has that power. All of us have the

courage to change. Let us reclaim the confidence that was stolen from us. Then, let us connect with each other.

If the forces that even now aim to advance nuclear plants seem like a vertical wall looming over us, our power extends horizontally, without limits, through our ongoing connections.

Just now, try reaching out and gently holding the hand of the person next to you. Take a look at each other, and listen to each other's hardships. Let's accept each other's anger and tears. Let's spread the warmth of these hands we're holding now throughout Japan, throughout the world. No matter how overwhelmingly heavy the burden each one of us has to bear, no matter how rough the road we have to travel may be, let us not turn away from our goal, but support each other going forward, and let us survive these times with free spirits and good cheer. Thank you very much.

Part 2

Scientific and Technical Characteristics of Nuclear Energy

Part 2 presents basic information on radiation, nuclear energy, nuclear power plants and the nuclear fuel cycle. The grave dangers of nuclear energy and many problems connected with its use are also explained from a scientific and technological standpoint.

Prior to the accident at the Fukushima Daiichi Nuclear Power Station, the average Japanese citizen had a poor understanding of the various issues with using nuclear energy to generate electric power. They also failed to grasp the terrible potential risks involved in nuclear power, that are on an entirely different level from those of technologies using other forms of energy. The government, industries, scholars and technicians promoting nuclear power had declared that Japan's nuclear power would not be involved in major accidents like that at the Chernobyl Nuclear Power Plant. They created what is known as the "nuclear safety myth." Despite knowing about the unallowable dangers of a large accident at a nuclear power plant, the diverse people promoting nuclear power were taken in by the safety myth they themselves had created, thinking that people could control nuclear energy. That they were remiss about making sufficient preparations against accidents is not unrelated to our own failure to get a sufficient grasp of the problems with nuclear energy. We put our faith in the safety myth.

(The material Chapter 1 of Part 2 in the Japanese edition of this book can be read in books on nuclear power generating technology, so we have omitted it here. For that reason, there is a gap in the footnotes from No. 40 to No. 50.)

Chapter 2
Problems with Nuclear Power

As we saw in the preceding chapter, nuclear power is a technology that attempts to control enormous amounts of energy. The scale of that energy is several orders larger than those produced by ordinary energy sources, some of which are burned for power, and others that we need to maintain life. Moreover, by utilizing that energy, we create a large variety of unstable atomic nuclei with poor balances between protons and neutrons. Humankind does not possess the technical ability to stabilize unstable atomic nuclei. Additionally, the use of nuclear technology necessitates the exposure of many people to radiation. If a major accident occurs at an NPP, manpower is required immediately from the company or government, with the awareness that people's lives are on the line. If nobody steps forward to do this, the whole country or even several countries may face ruin. In these ways, nuclear power is beset with huge problems. Our society, however, is constantly hearing that it is necessary nonetheless. Is it really necessary, though? In this chapter, we will consider this issue.

1. Characteristics of Nuclear Power Plants

Heat-generating Systems of Nuclear Reactors

Nuclear power plants (NPPs) comprise systems that use the energy from nuclear fission in the nuclear reactor to heat water and generate steam. The steam is used to turn the turbines for producing electricity, and then recycled back through the system again. What distinguishes them from thermal power plants, which produce steam by burning petroleum, coal, LNG or other fuels, is that in place of a boiler, there is a nuclear reactor. Whereas the heat generating principle of the boiler is a chemical reaction combining hydrocarbons with oxygen (combustion),that of the nuclear reactor is nuclear fission of uranium 235. Comparing the density of heat generated per unit volume of the heat generating equipment, that of a boiler for thermoelectric power (pulverized-coal-burning, water-cooled) is 0.5 MW/m^3, while that of a boiling water reactor (BWR) is on the order of 50 MW/m^3 and that of a pressurized water reactor (PWR) is on the order of about 100 MW/m^3. In other words, a nuclear reactor has a heat generation density two or three

orders (100 to 1000 times) greater. Because of that, the mechanical design of PWRs is more complicated. Also, since the temperature changes with great speed during start-up and shutdown, the people operating it need to possess a strong ability to judge situations quickly. Once control of a nuclear reactor is lost, it is nearly impossible to regain it. If an accident occurs in which radioactive substances spill out into the environment, severe radiation results that makes it impossible for people to approach and lend a helping hand.

The speed of heat generation in combustion reactions is familiar to humans. We have acquired a feeling for it over the millennia. In the case of nuclear fission, however, the moment one realizes criticality has been achieved, enormous amounts of heat are already being generated. If anything goes wrong with the mechanism for inserting and withdrawing the control rods, a nuclear burst can occur in a flash. For example, if several control rods were to fall out while the reactor is not operating, it could result in an unintended criticality.[51] If an earthquake were to occur during operation, with the control rods becoming bent or damaged, even if attempts are made to insert them and shut down operation, the control rods could get stuck. As a result, it would become impossible to halt high-temperature heat generation, the coolant would boil away and be lost, and a meltdown might occur.[52] In the Fukushima Daiichi nuclear accident, a total station blackout resulted in fuel melting down. The result was the biggest nuclear accident since Chernobyl. In that sense, nuclear reactors have inherent difficulties that differ substantially from methods of operating typical heat-generating systems that people have become familiar with over the ages.

Neutron Irradiation Embrittlement

As if that were not enough, reactor vessels also suffer from a phenomenon called "neutron irradiation embrittlement," which does not occur at plants relying on conventional chemical reactions. This causes deterioration of the pressure vessels. The neutron rays affect the structure of the steel from which pressure vessels are made. As a result, they become more brittle and easily cracked. Steel is generally characterized by brittleness at low temperatures. When steel is exposed to neutron rays for many years, however, the temperature at which it becomes brittle gradually rises. The temperature inside a

[51] Accidents in which control rods fell out have occurred at nuclear power plants in various places. For example, in 1971, five control rods fell out at the Fukushima Daiichi Unit 3 reactor, resulting in a criticality (covered up until 2007). In 1991, three control rods fell out at the Shiga NPP Unit 1 reactor, with a criticality (also covered up until 2007).

[52] In 2008, it was found that one of the control rods at the Kashiwa Kariha Unit 6 reactor had become detached from the drive unit. The inability to insert them is suspected to have been due to an earthquake that had occurred the previous year.

pressure vessel of a reactor in operation is about 300 degrees Celsius. However, if the emergency reactor core cooling equipment is used, spraying water over the core, the temperature of the internal surface of the pressure vessel is reduced to 100 degrees or less while the internal pressure stays the same. Under those conditions, a once-strong pressure vessel may suddenly become brittle and crack. Currently, Japan has aging reactors at which the temperature this phenomenon could occur at has risen to as high as 98 degrees Celsius (for example, the embrittlement monitoring test piece at the Genkai Unit 1 reactor[53]; Koiwa, 2012).

Crude Technology

As was noted earlier, it is not possible to develop nuclear power technology on a trial and error basis. In any technical system, mishaps occur at all stages from designing to operation. Then the lessons learned from these accidents and mistakes are put to use, improvements are made and progress toward safety and economic practicality goes forward. In other words, in the cases of petroleum plants or electronics, for example, the experience gained from accidents and mistakes is shared. From that, a sort of "literacy" develops and spreads regarding maximum limits for avoiding accidents and what is within a permissible range. In the case of nuclear energy, though, public relations from government leaders always supersede concerns from the bottom of society, not to mention empathy and a concrete sense of what conveniences are desired. Expositions and the mass media cheerlead for it while the average person is not allowed even to tour the inside of nuclear power facilities. Those are insulated from impressions that can be gained from the five senses. One reason for that is the danger from radiation, and another is to guard nuclear technology secrets. In conventional industries, for example in the case of Toyota's *"kaizen"* initiative, suggestions for improvements spanning the entire manufacturing process are welcomed even from average technicians involved. They are implemented swiftly to improve the company's manufacturing technology. In the case of nuclear technology, however, it was U.S. military-related companies that were developing it when it was initially adopted. Therefore, the Japanese could not take the initiative to improve it, because changing the designs and tinkering around with trial and error were not permitted. Furthermore, response measures to severe accidents exceeding design standards were never considered, because such severe accidents were not supposed to happen. Estimations of possible earthquakes and tsunamis were also insufficient. Only after the Fukushima accident did testing with severe accident scenarios begin to be im-

[53] A plate made of alloy having the same composition as the reactor pressure vessel. It is placed inside the pressure vessel together with the reactor to investigate the state of deterioration. It is removed at regular intervals and tested to determine its strength.

plemented in regulatory standard inspections.

NPPs also have the typical problem of being difficult to retrofit. When one structural component of conventional industrial facilities becomes outdated, it frequently undergoes radical renovation or is replaced. But because reactor pressure vessels are irradiated, it is difficult for workers to approach or come in contact with them. Nuclear power concerns have attempted to modify parts aside from the pressure vessels or introduce digitalization without interrupting operations. Every time they make modifications, though, they have to obtain approval, so they do not occur as frequently as with thermal generation, and more costs pile up. As a result they continue to be operated for decades with the same old original designs.

Why Nuclear Power was Widely Adopted

As a military technology, nuclear reactors were developed for producing plutonium for atomic bombs. Nuclear power, though, is used as a means of obtaining large amounts of energy. The fact that such facilities produce huge amounts of heat serves as a reason to adapt them for electrical power generation. Releasing information on this technology to society at large and providing access to technical details to all relevant persons down to each engineer is another matter. Such measures have been denied. The advancement of nuclear energy was not accomplished by showing proof of its superiority over technology already on the market and taking steps to promote it gradually. Instead, it was hastily introduced by politicians and bureaucrats seeking to possess nuclear technology and enhance their own political power. They prevented their own country's scientists and technicians from testing and verifying the basic designs and had the plants built. Generally, commercial contracts treat the supplier and purchaser as equals, and neither side is given more authority than the other in negotiating for adjustments to suit their economic interests. The negotiations for nuclear power, however, have involved unequal relationships between the U.S. and Japan on the one hand, and the Japanese government and the electric power companies on the other. Purchasing agreements have been concluded that are clearly not on equal terms. From an economics standpoint, the power companies enjoy a monopoly over regional markets, and support is given to the region through the three Power Source Siting Laws. The limited amounts of compensation these laws require them to pay out for accidents are so small they are practically meaningless. Thus the reactors have been purchased and built under conditions quite far removed from market principles. Moreover, there has been extremely little openness about the technology, citing secrecy for national security, or to avoid danger from terrorists if given access to those secrets. Furthermore, quite an effort has been made to keep information on accidents under wraps, under the pretext of "to prevent the masses from panicking." During

the Fukushima accident, the authorities refused to reveal the actual status of the meltdowns or the release and spread of radioactive substances, saying, "we must prevent troublemakers from causing confusion." Currently there are no realistic evacuation plans for areas around reactors set to be restarted. Even where decent evacuation routes exist, traffic engineering experts have pointed out that it would be impossible for people living nearby to evacuate prior to the venting of containment vessels (Kamioka, 2014). In this way, just to plunge ahead and promote a crude technology like this, the authorities exercise the power to block critics who point out dangers. Thus the chance for nuclear power to be developed into a mature civil technology is lost.

2. Characteristics of Severe Accidents

Human Factors in Severe Accidents

Prior to the Fukushima accident, no consideration was given to inspection procedures in nuclear energy regulations. They were deemed unnecessary, since the rate of severe accidents at such facilities was low. For example, when the Chernobyl accident occurred in 1986, propaganda was spread that such a nuclear accident would never occur in Japan. After the Fukushima accident, though, the government abolished the former Nuclear Safety Commission along with the former Nuclear and Industrial Safety Agency, which had been organized as part of the Ministry of Economy, Trade and Industry (METI). In their places, the Nuclear Regulation Authority/Nuclear Regulatory Agency (NRA) was established in September 2012 as a regulatory organization independent from government agencies supporting nuclear energy. The first thing the NRA turned its attention to was creating new regulatory standards. These new standards were enacted in July 2013. Under the new system, permission for restarting reactors would be granted to all reactors that underwent inspection and met the new regulatory standards. Newly introduced targets of inspection included measures against severe accidents. As of July 2015, nuclear reactors whose modifications have been approved include Units 1 and 2 of Kyushu Electric Power Company's Sendai NPP, Units 3 and 4 of Kansai Electric Power Company's Takahama NPP and Unit 3 of Shikoku Electric Power Company's Ikata NPP. In each case, severe accident countermeasures accounted for more than half of the content of the inspection documents for approval of modifications, numbering over 400 pages each. Specifically, more than 20 severe accident scenarios were postulated. The response measures proposed for each scenario to cool overheating fuel or prevent containment vessel breakage were evaluated.

However, compared with standard measures for dealing with accidents that normally occur at conventional industrial facilities, in two senses, it would be difficult to

implement these severe accident countermeasures. For instance, in the case of a fire breaking out at a petroleum plant, first, attempts are quickly implemented to extinguish the fire. If that fails, and further efforts are futile, those efforts are discontinued, and the fire is allowed to burn itself out. One example of this occurred after the earthquake on March 11, 2011, when 17 spherical tanks holding LPG gas at the Cosmo Oil Co. refinery in Chiba were engulfed in flames. It took 10 days for all of the combustible materials to be consumed, during which the fire was simply allowed to burn. In the case of NPPs, however, if loss of coolant occurs, aggressive measures need to be taken to cool the reactor, or else the temperature will rise and an explosion will occur, scattering the nuclear materials inside the reactor over the surrounding area. That renders large land areas uninhabitable. For that reason, when severe accidents occur at NPPs, the electric power companies propose scenarios with workers in a huge circle fighting to ensure sufficient cooling. The NRA accepts this.

Let's look at one example of a serious accident simulation in the inspection documents for design change approval at the Sendai NPP. A loss of coolant accident (LOCA) was simulated together with a total station blackout (loss of both the emergency core cooling system (ECCS) and the containment vessel spraying system) to see if a molten core-concrete interaction (MCCI), in which the molten fuel in a meltdown reacts with concrete in the reactor, could be prevented. (This simulation was identical to ones performed at the Takahama and Ikata NPPs; Kyushu Electric Power Co., 2013a). The documents show that in if electric power cannot be restored quickly, the plan is first to bring in mobile high-capacity electric generators, install, connect and start running them. This would take more than 30 minutes. Then, they would start running the electric power injection pumps that are part of the permanent plant facilities, and start spraying the reactor vessel. Amazingly, this was accepted. Another team would drive in with mobile high-capacity pump cars, install and connect them, and start pumping sea water into the reactor vessel recirculation unit. The plan is to commence spraying of the reactor vessel about 49 minutes after failure of reactor core cooling, creating a pool of water about 1.3 meters deep at the bottom of the reactor vessel about 1.5 hours into the emergency. The idea is this would achieve cooling because it would enable the molten core, which would begin dropping down at about 1.5 hours following loss of coolant, to fall into water (NRA, 2014; see Figs. 2.2.1 and 2.2.2).

The problem with simulations, however, is that they ignore limitations of human abilities and the work environment at a plant during an accident. It also bears noting that they make optimistic assumptions. The lessons of the Fukushima accident tell us that getting a grasp of the situation itself is no easy task. In fact, time simply went by at Fukushima with no one able to ascertain what was happening. The "Yoshida Testimony"

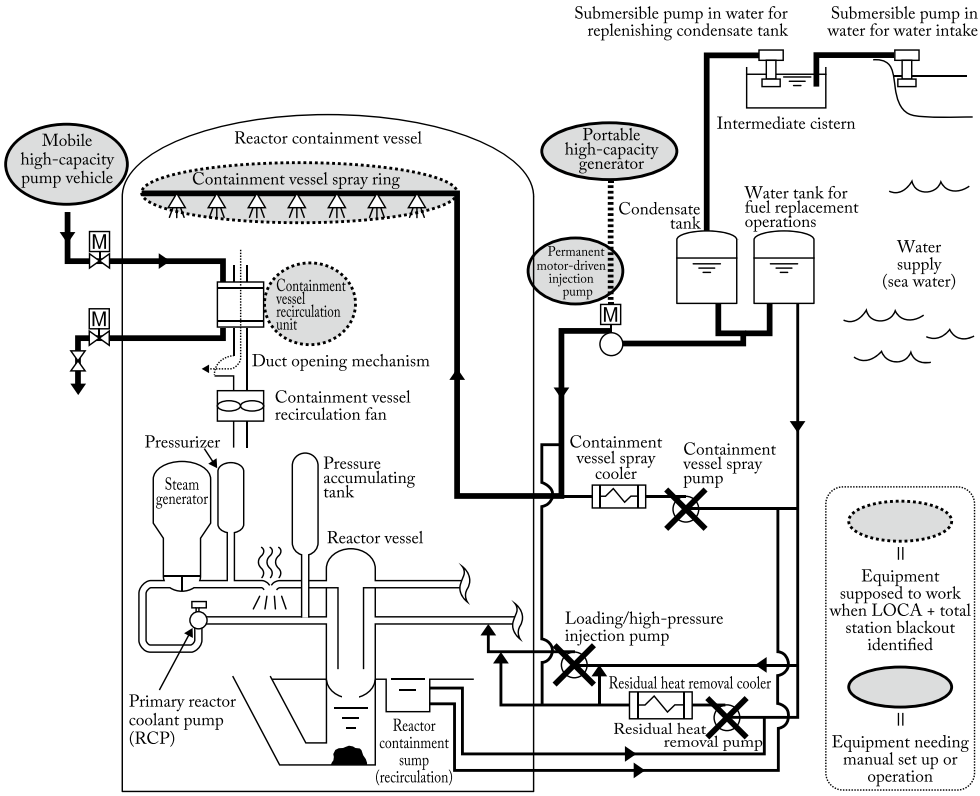


Fig. 2.2.1 Equipment needing to be set up and run in the event of a LOCA with total station blackout (reproduced from Kyushu Electric Power Co., 2013a, 11-2, with revisions).

from the governmental hearings on the accident revealed that plant manager Masao Yoshida could not tell what was going on inside the nuclear reactors for nearly three days. It is also known that during the severe accidents are Three Mile Island and Chernobyl, the people operating the reactors could not grasp the phenomena that were taking place right in front of them. In other words, it is possible for phenomena to occur that are beyond people's ability to recognize. Even assuming they recognize what is happening, time is still required to verify it. Once confirmation is obtained, another 30 minutes elapse before that can be translated into action. The conditions for transporting mobile high-capacity generators and pump cars to the scene will be more severe than at normal times. Mobile equipment for dealing with major accidents is required to be stored at a necessary distance (e.g., 100 meters or further) from the plant. If a major accident occurs in conjunction with a natural disaster such as an earthquake, tsunami or volcanic erup-

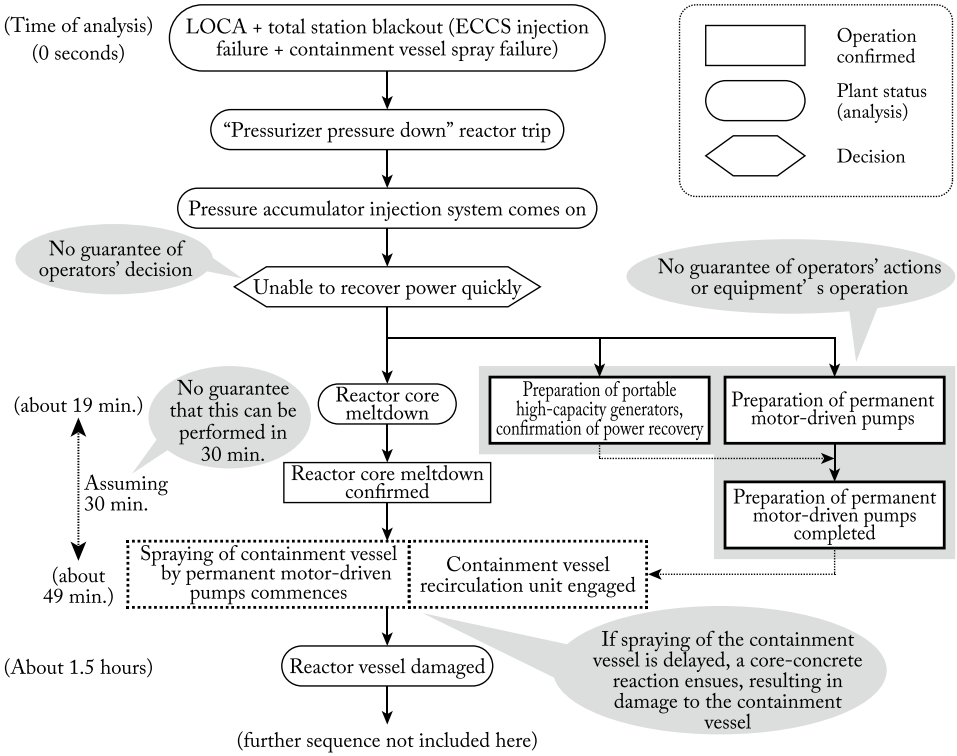


Fig. 2.2.2 LOCA with total station blackout scenario
(reproduced from Kyushu Electric Power Co., 2013b, 13-2, with revisions; and see Ino & Takitani, 2014, p.334)

tion, the roads may be blocked by scattered debris or be damaged themselves, necessitating more time to navigate them. Therefore the scenarios for major accidents currently listed in the inspection reports must be considered wildly optimistic, with no consideration of human limitations (Ino & Takitani, 2014).

Clean-up Work after Accidents

So, what happens if these strenuous efforts fail, the reactor vessel breaks and a plume[54] containing radioactive gas and dust is released into the atmosphere? In that case, too, the new regulatory standards require that equipment needed for controlling the

[54] "Plume" (from "feather") is defined as "a trailing cloud of smoke arising from a fire." When air pollution became a concern, it came to be used as a term for an air stream carrying and spreading pollutants. The present book uses it to mean "an air stream carrying radioactive materials."

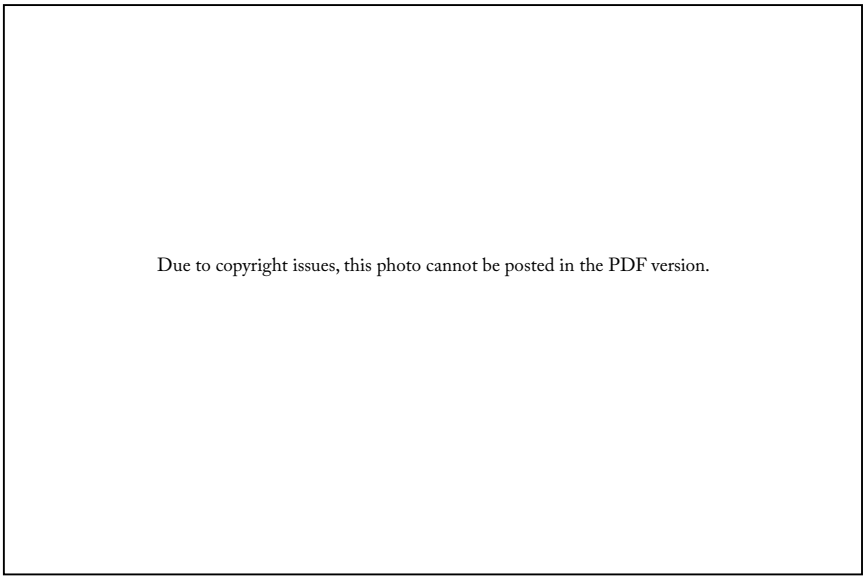


Fig. 2.2.3 Firefighting equipment deployed on high ground at the Shimane Nuclear Power Station. Water cannons in the foreground. The trucks behind them are the high-capacity pump vehicles.

spread of radioactive substances outside the plant must be installed (Article 55 of the Ordinance Prescribing Standards for the Location, Structure and Equipment of Commercial Power Reactors and their Auxiliary Facilities). Below, we will examine the measures taken to meet this requirement at Units 3 and 4 of the Takahama NPP. According to the Kansai Electric Power Co. in "Measures to Prevent Release of Radioactive Materials," which is found in the documentation titled "On the Amendment to the Application for Approval of Modifications to Nuclear Reactor Facilities," to control plumes emitted from the cracks in a fractured containment vessel, they plan to connect high-capacity pumps to gigantic water cannons to catch the radioactive substances in the plume and wash them away (Kansai Electric Power Co., 2014). These water cannons lack engines of their own for transport, so they need to be towed by some sort of vehicle to the place they will be used. Then, once they have reached the determined position and been fixed in place, it will be necessary to attach 300 millimeter diameter hoses at that location. After that, the angle of spray is adjusted by turning a wheel by hand, a tool that relies on extraordinary human strength.

Nothing good can be expected from this strategy, which amounts to nothing more than using gigantic water cannons and spray hoses. Three reasons can be cited right off.

First, there are huge quantities of noble gases[55] released during a major accident that cannot be captured by water. Second, assuming the ashes generated and released by an explosion of the fuel in a meltdown are captured by the water, the ratio of ashes captured is expected to be extremely small. If the accident occurs at night, the plume may not even be visible. Third, the task would require work under conditions of high radiation, in violation of legal contracts (Labor Safety & Health Law, Article 25, Director of the Labor Standards Bureau, Ministry of Labor, 1972; Tsutsui, 2013).

The electric power companies submitted applications for approval of modifications to their facilities that were replete with these sorts of ideas. That the NRA examined and approved them indicates the actual state of regulatory review procedures in Japan. Absurdities like trying to catch sparks from an open fire using water cannons connected by hoses to the water supply have no hope of functioning in reality. Both the people submitting these and those examining them have no reason to be unaware of that. They go as far as assuming performance of motions that exceed human physical limits under severe accident scenarios. This can therefore be considered a forced approval of plans on paper for the sake of appearances only.

Since the Fukushima accident, the NRA has enforced the new regulatory standards requiring companies to submit scenarios on how they can prevent containment vessel breakage when dealing with severe accidents. Also, assuming ultimately that the containment vessel did break, they are required to submit a scenario for stopping the release of radioactive substances. The companies are not going to admit that it is "impossible" in their response. If they did, who would want to be involved? Who knows if such fools exist, so rather than admitting they have these issues, they have no choice but to submit responses claiming these measures to be successful. The regulatory agencies examining these must ultimately let them pass, so they pretend to be deceived by this charade. This sort of complicity has to continue as far as is needed to obtain approval for the existing NPPs, pretending they conform to the new standards. Evidence of this is seen in the approvals of applications for modifications to facilities of the Sendai, Takahama and Ikata NPPs. The kinds of examination procedures being followed currently by the NRA constitute empty formalities between the petitioners and the regulators (Tsutsui, 2015).

[55] "Noble gas" is the generic term for the six elements occupying the rightmost column of the periodic chart (18th column): helium, neon, argon, krypton, xenon and radon. They are all chemically inert, meaning they form no chemical compounds.

3. Catastrophes and Their Prevention

Countermeasures to Natural Disasters

The 1970s and 80s, when many NPPs were being built in Japan, were a period of minimal seismicity in this country. Thus, for example, the seismic standards in force when Kyushu Electric Power Co. had the Sendai NPP built were 270 Gal for Unit 1 and 372 Gal for Unit 2.[56] The seismic motion generated by the earthquake that caused the accidents at the Kashiwazaki-Kariwa and Fukushima Daiichi NPPs exceeded the limits of their design ground motion. After that lesson, applications for approval of modifications to facilities that were approved on September 10, 2014, nearly doubled the design ground motion to 620 Gal. In addition, the length of time seismic motion was theorized to continue had been quite short—less than a minute—when the plants were built. However, the plate boundary earthquake that led to the Fukushima accident continued for more than three minutes. The basic structure of foundational ground and building frameworks cannot be easily changed, so we cannot assume a sufficient margin of safety.

There are also doubts that the adopted value of the standard seismic motion itself as given above is enough. Seismology is a young science, with the theory of plate tectonics being first discussed in 1968. There are a mere 100 years worth of accumulated modern seismographic data. Meanwhile, the storage of energy for earthquakes occurs on the scale of millennia. Therefore, it is impossible to arrive at maximum values based on estimations and what we know currently from the data on faults.

Seismic expert Katsuhiko Ishibashi hypothesizes that for Japan's NPPs, the maximum acceleration for seismic standards should be at least the previously found maximum of 1700 Gal (see Ishibashi, 2014a, p.875; 2014b). The current regulatory standard is the previously found maximum value with a little leeway added, based on scientific measurements. Thus the authorities call it a "scientific standard." The "K-NET/KiK-net" strong earthquake measurement networks, however, have been gathering data for no more than 20 years. It is impossible on the basis of such limited data to calculate the magnitude of an earthquake that occurs once every 10,000 years or 100,000 years, as is required for NPPs. The standards must be based on the Precautionary Principle and include plenty of leeway. For that, the persons responsible for risk assessment must be identified and decisions made with the agreement of the citizens.

Japan is a country with many volcanos, so testing with regard to volcanic eruptions is also essential. The examination documents for granting approval for modifications to

[56] A Gal is a unit of acceleration: 1 cm/s^2.

facilities at the Sendai NPP claim that "the possibility of an eruption measuring VEI7[57] or greater is sufficiently low," but that "monitoring will be carried out during the operating period." In two meetings held with volcanologists, however, all of the experts attending agreed that "At the current state of the science, we cannot say that the possibility of volcanic activity is sufficiently low. Moreover, monitoring cannot provide effective foreknowledge of risks." This is a phenomenon that even Japan's academicians cannot guarantee to be predictable no matter how they try, so a system that gives only Kyushu Electric Power Co. responsibility for foreseeing eruptions is unrealistic. The NRA's *Assessment Guide of Volcanic Effects to the Nuclear Power Plant* declares that the possibility of "unmanageable volcanic phenomena during the operating period is sufficiently small," and says that what will be done is to "conduct monitoring of volcanic activity and create instructions for handling the situation if signs of activity become evident." The premises for the former assertion have collapsed and the latter course is impossible to implement.

4. Nuclear Waste Treatment

High Level Radioactive Waste

When NPPs are running, "spent nuclear fuel" is generated, containing many nuclear fission products together with plutonium and other elements. In Japan, the spent fuel removed from nuclear reactors is stored for a while in spent fuel pools that have been built within the reactor buildings. Once the radioactivity has decreased to a certain extent, they are taken away to the reprocessing plant in Rokkasho-mura, Aomori Prefecture, where they are kept in other pools that have been built there (those are nearly full, though, as of this writing). Spent nuclear fuel contains high levels of radioactive substances and releases extremely high levels of radiation. It also contains large amounts of radionuclides with long half-lives. For example, plutonium has a half-life of 24,000 years and would take an estimated 100,000 years to reach a potential toxicity on par with naturally occurring uranium. When that is disposed of, it needs to be kept isolated from the sphere of human activity for that immense length of time. Thus far, methods considered for disposing of high-level radioactive waste (HLW) have included deep sea disposal, burial at the base of glaciers, space disposal using rockets to send it up beyond the atmosphere and release it outside the solar system's gravity field or use the sun's gravitational field to pull it inward, direct injection into the earth, and so on. In the meantime, various countries have conducted ocean disposal, but concerns about oceanic pollution led that

[57] VEI (Volcanic Explosivity Index) is a measure of the power of a volcanic eruption, ranging in steps from VEI 0 (small) to VEI 8 (large). VEI 7 eruptions occur at a rate of five to ten times worldwide per 10,000 years.

practice to be banned under international treaty (the London Convention) in 1975, with the ban extended to all nuclear waste matter in 1993. Direct injection into the earth has also been attempted, but concerns about environmental pollution have stymied that as well currently. Space disposal has been considered too, but the cost and possibility of rocket failure among other factors have kept that from being adopted. Currently, deep earth burial is being considered as a final disposal method. Meanwhile, because there is no way to dispose of it, the waste is being stored in above-ground facilities, and the idea of making that the long-term storage method has strong backing. These difficulties with disposing of HLW are a fatal flaw that future generations will be forced to endure. They were one factor that led Germany's Ethics Commission to decide to abolish that country's NPPs (Ethics Commission on Safe Energy Supply, 2011, p.153).

There are two general ways to handle spent nuclear fuel, reprocessing and directly disposing of it without reprocessing it (once-through). Japan's policy is to reprocess all spent nuclear fuel. When removing the uranium that is left after refining out the plutonium in the spent fuel, great quantities of liquid waste are produced containing lots of radionuclides.

Large amounts of this waste containing high-level radioactive substances are added to glass and solidified, loaded into stainless steel canisters, and called "vitrified waste." The "high-level radioactive waste" specified under Japan's "Law on final disposal of specified radioactive waste" refers to this vitrified waste. The liquid waste resulting from reprocessing has extremely high radioactivity, and is said to be instantly fatal to anyone approaching it. Newly produced vitrified waste also emits strong radiation, making remote operations necessary. While waiting for the radioactivity of this vitrified waste to decrease to some degree, it must be stored above-ground for 30 to 50 years before final disposal. As of December 2011, Japan had 1,780 vitrified waste canisters. If all of the spent nuclear fuel in Japan were reprocessed and turned into vitrified waste, it would come to around 27,000 canisters. Even in international cases where spent fuel is disposed of directly without reprocessing, the metallic containers into which it is loaded are categorized as HLW.

Choosing Sites for Geological Disposal

The Onkalo spent nuclear fuel repository in Finland, whose policy is direct disposal of spent nuclear fuel, consists of a tunnel dug at a depth of 520 meters underground with side tunnels spreading out, where radioactive waste is to be brought during a period of 100 years. When one tunnel is full, it is filled with earth and completely sealed off. The stability of that geological formation (ground layer) is considered quite high from a scientific standpoint. Still, the plan to store it there for the unimaginably long period of

100,000 years, far exceeding human history as it is known to us, raises questions beyond the scope of science to answer.

Unlike Finland, Japan has volcanos and fault lines, and there is constant danger of these faults slipping. The Nuclear Waste Management Organization (NUMO) was established as a company for carrying out disposal under Japan's conventional policy framework, based on the "Act for Final Disposal of Specified Radioactive Waste." Since 2002, it has solicited candidate disposal sites in municipalities throughout Japan in pursuit of locations for geological disposal (burial deep underground). Japan's governmental research institutes have put forward the view that stable geologic formations would be found within Japan. There are many experts, though, who point out the uncertainty and difficulty of such a prediction, so opinions are divided on this. Even assuming a place is found where the ground will not shift over long periods of time, if there is much water underground, geological disposal will not be possible there. Therefore, no place such as that they claim is possible has been found yet in Japan.

Japan's policy is to reprocess all spent nuclear fuel, but the Rokkasho-mura reprocessing plant is not operating in real terms. Also, the Monju fast breeder reactor, which would use the plutonium as fuel is essentially bankrupt. In the future, if nuclear power plants continue operating, the Rokkasho-mura reprocessing plant would lack the capacity to reprocess all of the spent nuclear fuel produced by them, even if it were fully operational. Furthermore, even if the spent fuel were to be reprocessed and the plutonium separated, it would be used only by the plutonium-thermal (pluthermal) NPPs at most, which would not have the capacity to consume all of it.

Regardless of whether or not the NPPs operate in the future, Japan will have to consider direct disposal of its spent fuel. The current interim spent fuel storage methods will also need to be reconsidered. The spent nuclear fuel awaiting reprocessing is currently being stored in pools, but this storage method requires consideration of radioactive contamination of the cooling water due to damaged coatings on the fuel rods, and the risk of the cooling water boiling off during power outages. To deal with these issues, air-cooling of HLW in dry storage has been proposed while direct disposal is considered. Frank von Hippel and the International Panel on Fissile Materials (IPFM) have issued a report recommending dry-cask storage. This would entail cooling the spent nuclear fuel for a certain period in water until the heat of decay subsides sufficiently, then transferring it to sealed metal containers called "dry casks" and storing these above ground or in shallow underground facilities, circulating air through to cool them. In America, dry-cask storage is already being conducted on-site at NPPs, and it would be rational for Japan to adopt this method as well (von Hippel & IPFM, 2011). But what would happen if an earthquake destroyed the facilities housing them and the air stopped circulating? The risk

of a major accident necessitates ways to prevent that.

'Responses' and 'Recommendations' by the SCJ

Regardless of whether nuclear power is continued or discontinued, the problem of HLW disposal needs to be addressed quickly. Postponing action would be unforgivable from the standpoint of our responsibility to future generations. Thus the Atomic Energy Commission of Japan (JAEC) asked the Science Council of Japan (SCJ) to discuss initiatives for HLW disposal. The SCJ responded in September 2012. Its response included the following six recommendations for interim storage, limiting the total amount, sharing the burden fairly, etc. (SCJ, 2012; 2014; Sadamatsu, 2014; JAEC, 2014, p. 118).

(1) Radically reviewing policies regarding HLW disposal.

(2) Recognizing limits to scientific and technological capabilities and ensuring scientific independence.

(3) Rebuilding a policy framework based on temporary storage, and limiting the total volume.

(4) Recognizing the necessity of policy-making procedures that help persuade people to share burdens fairly.

(5) Recognizing the necessity of multi-step consensus forming procedures with creation of discussion venues.

(6) Recognizing the necessity of persistent long-term efforts to resolve issues.

Later, in April 2015, the SCJ submitted "Policy Recommendations on the Disposal of High-level Radioactive Waste—Concerning Temporary Storage for Building a National Consensus (Proposal)" (Science Council of Japan, 2015). In their "responses" and "recommendations," the SCJ spelled out its idea for what they termed "temporary storage" of HLW. This differs from both interim disposal and final disposal in that the idea is to find ways to ensure time for gaining citizens' understanding, researching geological disposal and forming a consensus, while keeping the waste cool to prepare it for geological disposal. Technically, what is being proposed is temporary storage that adopts dry-cask storage methods, allowing about 30 years for forming a consensus on geological disposal methods and places, and then another 20 years for building the final disposal facilities.

What kinds of methods should be used for achieving the required consensus within the temporary storage time frame? The conventional policy has been to provide large subsidies to financially strapped rural communities to buy their acquiescence. The SCJ's "responses" and "recommendations," however, were a radical revision of that method, advocating creation of policies that share burdens fairly, taking time to reach a consensus through a multiple-step process. Therefore, it calls for construction of temporary storage facilities in each electric power region from the standpoint of facilitating these discus-

sions, arousing interest and sharing burdens fairly. These facilities are built in the meantime, but the final disposal facilities will not be constructed right away. The SCJ also seeks to establish an upper limit on the total amount of HLW and limit the amount by which the total amount increases.[58]

Based on discussions by JAEC and others, Japan established the "Law Concerning Final Disposal of Specified Radioactive Waste" in 2000. It has promoted plans for geological disposal, but more than 10 years have passed without even an initial survey of literature being accomplished. On the other hand, pursuing the Holy Grail of the nuclear fuel cycle, they restart the reactors. Reprocessing and fast breeder reactors are effectively defunct. It would be absolutely impossible anyway to reprocess the entire amount of spent nuclear fuel. Because of that, the direct disposal of spent fuel has to come into consideration. However, when reprocessing was not possible in the past at Rokkasho-mura in Aomori Prefecture, the NPPs that had generated spent fuel were requested to accept it back. Building provisional storage facilities on existing NPP premises to handle such requests would be the most natural choice from the point of view of keeping radioactive substances under control. In this regard, however, questions arise about whether this would just force the NPPs to receive further concentrated HLW and whether the NPP sites had a high risk of major earthquakes. Thus it necessitates consensus-based planning.

The SCJ's "responses and recommendations provide no realistic solutions. They point out the NPPs' "original sin," however, of posing a stupendous challenge immeasurable in terms of a human lifetime, exceeding the very existence of humanity itself.

Low Level Radioactive Waste

Low level radioactive waste (LLRW) can be divided into two broad categories: wastes from NPPs, reprocessing plants and other nuclear facilities; and wastes generated by the Fukushima accident and subsequent decontamination efforts. Current policies address their disposal, and are supposed to be enforced on the basis of the "three principles of minimization," i.e., minimizing environmental contamination, exposure and burden to Japan's citizens. When nuclear facilities are decommissioned, the same principles should be observed keeping the wastes in isolation across quite long spans of time.

It is now an urgent task to establish methods of handling LLRW from the Fukushima accident. Lots of waste is being generated in connection with containing the accident. Likewise, gargantuan amounts are arising from decontamination of the surrounding region and accumulating in heaps in areas where people engage in their daily

[58] Regardng criticisms of the many remaining uncertainties in the SCJ's "recommendations" and "responses," see Yoshioka & Nawa, 2015, p.102.

activities, such as residential areas and agricultural fields. The government has previously requested prefectures throughout Japan to accept contaminated debris, spreading the burden around. Spreading contaminated material around, though, violates the principles of concentrating and isolating the contaminants. Moreover, while a standard limit of 100 becquerels/ kilogram (Bq/kg) for effluents applies during normal operations of NPPs, this limit has been relaxed to 8,000 Bq/kg for earthquake disaster debris (Kumamoto, 2014, p.126). With the goal of reducing the volume of contaminated waste, the Ministry of the Environment (MOE) is currently having a number of incinerators built in Fukushima Prefecture. The standard for those effluents will be the same 8,000 Bq/kg as above. Moreover, as a means of preventing dispersal of incinerator ash, bag filters[59] will be installed. Bag filters have problems such as catching a low ratio of particles 10 microns or less in diameter and rupturing if poorly supervised, scattering highly concentrated soot. This may lead to radioactive atmospheric pollution in the vicinity, motivating people living nearby to oppose them actively. Also, what is currently becoming the biggest issue for society right now is the establishment of interim storage facilities, mostly for contaminated rubbish, and final disposal facilities for designated wastes. The MOE is asking that each prefecture in the vicinity establish one final disposal site for burial of contaminated wastes. Wherever you go in these prefectures, however, people are opposed to the placement of such facilities nearby. From the perspective of the basic principles of handling radioactive materials, "concentrating and isolating" them on NPP premises or close by would make rational sense for solving this problem. This, however, would inevitably increase the burden on the already overburdened victims of the nuclear accident, so it will be necessary to proceed carefully, forming a consensus.

Even if no accident occurs, as long as nuclear reactors are operating, LLRW will continue to be generated. First, to manufacture enriched uranium, large amounts of depleted uranium, containing uranium-238 will be discarded. Then, discarded equipment used at NPPs and other facilities that has been radioactively contaminated is finally taken to the LLRW disposal facilities in Rokkasho-mura, where it is disposed of in landfills. A certain amount already has. The future course of disposal, though, has been unclear since the Fukushima nuclear accident and with the outlook for the nuclear fuel cycle uncertain. In the future, reactors will be decommissioned and we must consider disposal facilities for dismantled nuclear reactors.

The Basic Energy Plan of 2014

It has been thought that given the Fukushima nuclear accident, there would be

[59] A high-capacity cloth filter in the shape of a large bag used for filtering soot from exhaust gas.

many changes in Japan's Basic Energy Plan regarding governmental energy policies and nuclear power governance. However, this plan, put forward by METI in April 2014, shows no big changes from before the nuclear accident. Even though the nuclear cycle is currently discredited, there was no change in priorities among nuclear power projects from the early days when nuclear power was first introduced. In other words, the nuclear fuel cycle remains every bit as much the goal as from the start in Japan's nuclear energy policy. The Basic Energy Plan declares, "The basic policy of Japan is to promote a nuclear fuel cycle that reprocesses spent fuels and effectively utilizes the plutonium retrieved, from the viewpoint of effective utilization of resources and reduction of the volume and harmfulness of high-level radioactive waste." Even regarding the troubles that have arisen at Monju and the delays in completing the Rokkasho reprocessing plant, it displays a clear determination to place importance on "taking this situation seriously and solving the problems, including technical challenges that we face, one by one" in the nuclear fuel cycle.

It is important that Japan show international society that it possesses no plutonium for which it has no use, for the sake of nuclear non-proliferation. For that reason, the development of "pluthermal" and fast breeder reactors (FBRs) is essential. Even if nuclear transformation can be done in a laboratory using FBRs and accelerators, it is no exaggeration to say that the dream technology for "reduction of the volume and harmfulness of high-level radioactive waste" is virtually impossible to achieve in any practical sense. They would like to call it "a technology that uses plutonium for peaceful purposes," but using an ambiguous expression like "nuclear non-proliferation-related technology" is simply scheming to support the failed Monju FBR (METI, 2014, p.46).

What stands out in this Basic Energy Plan is that the key word of "FBR" has disappeared, only to be replaced by "pluthermal" which has been assigned a big role. The city of Hakodate, which lies across the strait from the planned site and would be directly impacted by an accident, is opposed to it. It has filed a suit, but the fact remains that a full-MOX NPP (light water reactor using only MOX fuel) is under construction in Oma, Aomori Prefecture. If the government calls off its plans for nuclear fuel reprocessing, it will mean that all the spent nuclear fuel being stored at the nuclear fuel cycle facilities in Rokkasho-mura will no longer be considered a resource, but rather junk. If that's the case, Aomori Prefecture has vowed to return it all to the senders, i.e., each of the NPPs that shipped it there in the first place. Therefore, the government has no choice by to keep saying it supports plans for reprocessing to extract plutonium as a resource.[60] If the government cancels its FBR plans, the plutonium extracted through re-

[60] If full-scale operation of the nuclear fuel reprocessing plant at Rokkasho-mura does not begin

processing will lose its destination aside from use for military objectives. As a result, although the "FBR" key word has vanished, its development is still very much underway.

Even if "pluthermal" technology is implemented, FBRs will still be necessary for consuming the plutonium produced by reprocessing. Also, for reasons of ensuring the nation's security, there are people who want to support reprocessing and maintain the ability to produce plutonium bombs if the need arises. To ostensibly deny such intentions, though, they need to be able to use plutonium to generate electricity. If that is not possible, they have no excuses to tell international society, which supports nuclear non-proliferation. This is another reason they cannot give up on developing FBRs, which are defunct in any realistic sense.

5. The Cost of Nuclear Energy

Not Cheap At All—Nuclear Energy's Back-end Costs

We are often told that nuclear energy is cheap. Let's examine that idea. Conventionally, the costs of generating electricity using nuclear energy that have been compiled by the Federation of Electric Power Companies and published by the government are calculated on the basis of an ideal case of 80% operating rate over 40 years of smooth operation. The list of expenses also includes "private costs" generated within the electric power companies, which are the total of capital costs, fuel costs, maintenance costs, etc. (Oshima, 2011, p.98).

In the case of NPPs, however, in addition to the operators' private costs, there are also major costs borne by the government. These are "R&D costs" spent by government-affiliated institutions and "siting measure costs" paid to local governments. Taken together, these two items are called "policy costs." Kenichi Oshima, an environmental economics professor, calculated these from data found in the electric power companies' published annual securities reports (Table 2.2.1, Oshima, 2011, p.112). What this shows is that even without adding in the "back-end costs" such as insurance against accidents, nuclear energy is a more costly way of producing electricity than thermoelectric or hydroelectric power.

The "back-end costs" are the expenses incurred in reprocessing spent nuclear fuel generated by NPPs, processing MOX fuels, dismantling old plants and disposing of wastes. In the case of the Fukushima accident, it still cannot be predicted how much the costs of compensation and settlements will ultimately reach, but as of March 2014, the amount paid out was about 11 trillion yen (Oshima & Yokemoto, 2014). Several meth-

soon, the pools holding these companies' spent nuclear fuel will fill up in short order, and they will be forced to halt operations.

(units: yen, kWh)

	Direct Costs of Electricity	Policy Costs		Total
		R&D Costs	Siting Measure Costs	
Nuclear Power	8.53	1.46	0.26	10.25
Thermoelectric Power	9.87	0.01	0.03	9.91
Hydroelectric Power	7.09	0.08	0.02	7.19
Conventional Hydraulic Power	3.86	0.04	0.01	3.91
Pumping-up	52.04	0.86	0.16	53.07

Table 2.2.1 The real costs of electric power generation (annual averages, 1970-2010).

ods have been proposed for calculating amounts of compensation for severe accidents. Using environmental economics professor Seung-Joon Park's formula, the maximum amount would be 279 trillion yen, while using that of the Insurance Forum Leipzig, it would 6.9 trillion euros (at an exchange rate of 115 yen/euro, that is about 700 trillion yen)(Ban, 2011). If the costs of insurance to cover that amount were added to electricity rates, nuclear power could not be called a cheap way to produce electricity. Even Norman Rasmussen in his "The Reactor Safety Study" (WASH-1400), which considered this at the time nuclear power was just being adopted as an electric power generation system, was already aware of this fact. That TEPCO's insurance contract was for only 120 billion yen demonstrates that NPPs have never been financially sound industrial facilities.

Other factors raising concerns about future cost increases are the costs of reprocessing and final disposal of the spent fuel and decommissioning old reactors after NPPs close. Figures published by the government have been calculated on the basis of the current cost of the Rokkasho reprocessing plant, but those facilities can handle only half the amount of spent fuel expected to be generated by the time these plants are decommissioned. In addition, the cost of decommissioning the NPPs is expected to be on the order of 50 billion yen per unit. The electric power companies, however, have not set aside enough to cover that (Ono, 2013). In this regard it must be said that estimations have fallen short.

Policy Costs of Nuclear Energy

Let's take a detailed look at what constitutes the "policy costs" of NPPs. Nuclear

energy has been fostered as a privately run, over-protected extension of national policy (Yoshioka et al., 2015, p.11). NPPs are an extremely costly item supported by the government.

First, support is provided for siting. Under the three Power Source Siting Laws, subsidies of 150 billion yen per unit are paid out to the municipality hosting a reactor and the neighboring municipalities between the time of its construction and decommissioning. This serves to support the local economy and produces a relationship of dependency, with the local communities seeking the addition of more and more nuclear reactors as if it were a narcotic for them.

Second, research and development (R&D) is supported. Every year, more than 100 billion yen in grants is allocated to Japan's nuclear power R&D institution (the JAEA). In other words, enormous financial support for nuclear power R&D is provided by the government.

Third, the government bears the regulatory costs. The electric power companies in Japan avoid paying the costs of safety regulations, but that is understandable as a way to ensure regulatory independence. This is true not only for nuclear power, but also for other energy sources as well. Unlike other energy sources, however, the regulatory costs of nuclear power are considered rather high. Furthermore, there has been insufficient consideration of these costs.

Fourth, compensation is paid. Generally, industrial facilities bear responsibility for unlimited compensation. Therefore, they make decisions based on an economic balance between investment in plant safety and the costs of insurance. Under the Act on Compensation for Nuclear Damage, however, only 120 billion yen per plant is covered. If anything above that amount is needed, the government covers the costs of compensation. In the case of the recent Fukushima accident, the amount of support the government provided to TEPCO through the Nuclear Damage Compensation and Decommissioning Facilitation Corporation has already exceeded 10 trillion yen. Many times more than that are expected to be added in the future. In other words, the amount of insurance coverage noted above does not even amount to one percent of what is needed.

Fifth, even since it became clear that the nuclear fuel cycle is technically and economically defunct, the policy of reprocessing is still very much alive. Support is being provided to reprocessing facilities and the Monju reactor. Because of this, spent nuclear fuel is allowed to be considered a resource with value as an asset. Also, by authorizing the Nuclear Waste Management Organization (NUMO) the government is promoting a system in which the government itself accepts ultimate responsibility for the final disposal of vitrified waste containing high-level radioactive waste.

In response to these policies, the Democratic Party of Japan established the Energy

and Environment Council in 2012, soon after the Fukushima nuclear accident. Employing the methods of listening to views, holding public hearings, and conducting discussion-style opinion surveys, it gathered data and wrote up "Innovative Strategy for Energy and the Environment." Therein it said it would marshal all the policy-making resources it could to ensure "Zero Nukes" to be achieved by 2030.

Shortly thereafter, however, the Shinzo Abe administration was inaugurated under the Liberal Democratic Party. The new energy plan proposed by METI was adopted by his cabinet in April 2014. That plan failed to draw any lessons from the Fukushima accident, but maintained the NPP-promoting policies from prior to the accident. Even the Nuclear Regulation Authority (NRA) that had been established during the Democratic Party administration created new regulatory standards to facilitate qualification of all previously constructed NPPs. The chairman, Shunichi Tanaka himself promoted procedures for restarting reactors, while admitting, "Even if they meet the standards, there is no guarantee of their safety."

Chapter 3
The Fukushima Daiichi Nuclear Accident —a Mind-boggling Disaster

In the preceding Chapter we saw what kinds of issues nuclear power plants (NPPs) have. The present chapter will give an additional overview of specifically what happened during the Fukushima Daiichi nuclear accident. The accident set in with a tense situation, as if war had broken out. To avoid a catastrophe for Japan, in fact, many people put their own lives on the line responding to the accident. Nevertheless, severe environmental contamination resulted. As of August 2011, government calculations estimate the amount of radioactive cesium released to have been about 169 times that released by the Hiroshima atomic bomb (Nuclear and Industrial Safety Agency, 2011). The fission products that fell widely over eastern Japan caused radiation exposures to people and radioactive contamination of the soil. The resulting oceanic pollution has also been severe. Most of the radioactive substances released by the accident fell over the Pacific Ocean. A substantial amount of contaminated water has also been released into the sea. It is the worst case of radioactive oceanic pollution in history, and it is still ongoing.

Even so, it can be said that an even worse "worst case scenario" was avoided due to a number of overlapping serendipitous factors. The nuclear fuel had been removed from the Unit 4 reactor, which happened to be shut down. The spent fuel pool in the same building, though, was holding 1,535 fuel rod assemblies, containing fission products estimated at several thousand times those of the Hiroshima atomic bomb. If a major aftershock had caused the pool to rupture, the nuclear fuel would have been scattered, releasing strong radiation and heat. Radioactive gases would have been released. There were concerns the Fukushima Daiichi Nuclear Power Station (below, Fukushima Daiichi NPP) could be rendered a danger zone into which workers could not enter. Due to many lucky coincidences, that situation was averted. Also, different weather conditions could have resulted in a larger degree of radioactive contamination. When thinking about restarting the NPPs, we must not forget the possibility that far larger amounts of radioactive contamination might occur the next time a nuclear accident occurs on the same scale.

1. What Happened at the Fukushima Daiichi NPP?

Conditions at the Time of the Accident

At the time of the accident at the Fukushima Daiichi NPP, then-Prime Minister Naoto Kan requested work to be performed that entailed a risk of death to a small number of workers in order to save many lives. Here, we note that NPPs have the characteristic of inevitably requiring labor that puts the lives ordinary industrial workers at risk. This work exceeds the limits of their labor contracts and deprives them of their human rights. The accident opportunely revealed to us in Japan for the first time the military-like nature of their operation.

The stricken NPP suffered a total station blackout due to the earthquake and tsunami, and it became impossible to cool the fuel within the reactor pressure vessels. (Units 1 and 2 had total station blackouts in which even DC current, i.e., batteries, was unavailable.) The necessity of opening vents if this condition continued was not made clear by the experts to the politicians until 9:00 p.m. on March 11th (Kimura, 2012, p. 45). Masao Yoshida, manager of the Fukushima Daiichi NPP, ordered Unit 1 to be vented at 12:06 a.m. on March 12th. The pressure within the containment vessel may have greatly exceeded the design pressure of 427 kPa. At this point in time, the TEPCO Head Office and key politicians were aware that venting would be conducted at about 3:00 a.m. Yet it wasn't until nearly 4:30 that it was reported to the politicians that the area around Unit 1, where venting was needed, would be off limits to workers due to high levels of radiation (Kimura, 2012, p. 84). After 7:00 a.m., Prime Minister Kan boarded a helicopter for Fukushima, saying "Do (vent) it soon!" Plant manager Yoshida replied, "We'll vent it. We'll have the suicide squad handle it."

Three teams of two people each were organized at the scene to open the valve by hand. The first team went out at 9:04 a.m., opened the valve 25% of the way, as planned, and returned. When the second team was heading out to the site, their dosimeters sounded the alarm, showing readings of over 90 millisieverts/hour (mSv/h), so they turned back. The third team refused even to try to go to the scene (Kimura, 2012, pp. 97-98). In other words, TEPCO's employees had never before even considered weighing the value of preventing an explosion at the NPP against the value of their own lives. That can be considered normal for employees at a private-sector corporation.

It was 3:36 p.m. on the 12th when the explosion occurred at the Unit 1 reactor building. The Unit 3 reactor building exploded at about 11 a.m. on the 14th. A radiation manager returning home from the site that day at 2:36 p.m. reported that radiation levels near the Unit 3 reactor reversible valve pit (the most important source of cooling water at a nuclear reactor) were from 400 to 500 mSv/h. Hearing this, plant manager Yoshida

cried out in disbelief (*Fukushima Genpatsu Kiroku Chiimu* (Fukushima Nuclear Accident Documentation Team), 2013, p. 304). TEPCO and the Nuclear and Industrial Safety Agency (NISA) had just raised the individual cumulative radiation dose during emergencies from 100 mSv to 250 mSv barely 30 minutes prior to that. Even with that revision, a worker in that environment at those radiations levels would reach the new limit in a mere 30 minutes. In addition, the Unit 2 reactor faced danger too that evening when it could not be vented to reduce pressure. At TEPCO, people were debating withdrawing, and they tried having a request sent by TEPCO President Shimizu to cabinet members. The first attempt was made at about 7:00 p.m. on the 14th, when President Shimizu tried reaching Banri Kaieda, Minister of Economy, Trade and Industry, by mobile phone. The second time was later that day, near midnight, when the water level inside the Unit 2 reactor fell, and the pressure within the containment vessel exceeded its design limits. That was around that time that attempts to operate the valve failed there too (Kimura, 2012, p. 213).

To the first evacuation request, Minister Kaieda responded with "I would like you to stay there." In response to the second request, cabinet members Kaieda, Edano and Hosono each refused to grant permission to evacuate, and finally Prime Minister Kan refused it, saying "Running away would be unthinkable." The cabinet members were unanimous in their opinion that, "To keep them from fleeing there is no choice but send them help" (about 3:00 a.m. on the 15th).

Meanwhile, at the scene, there had been more than 6,000 people present at the time of the earthquake, and on the night of the 14th there were still as many as 720, but of them 650 people were evacuated to the Fukushima Daini Nuclear Power Station a good distance south, leaving only 70 workers. There is no way that 70 people could handle six nuclear reactors in the maelstrom of an accident. TEPCO had given up on responding to the accident and was abandoning the NPP. At such times, how should each employee make his or her decisions? The Industrial Safety and Health Act stipulates the following.

> Article 25: When there is imminent danger from an occupational accident, the business operator must cease operations immediately, and take whatever measures are needed to evacuate the workers from the workplace.

At such times, when workers become aware of emergency conditions, is it really okay for them to evacuate based on their own judgement? An official notice from the Labor Standards Bureau states the following:

> This article stipulates that the business operator is obligated to allow workers to evacuate in times of emergency during a disaster, but when an occupational disaster is perceptibly imminent, it is natural that the propriety of workers departing from the workplace for emergency evacuation based on their own judgement, not lingering to take measures, should not have to be spelled out by the law. (Ministry of Labor, Labor Standards Bureau, 1972)

In other words, if the conditions early in the morning of March 15 fit this description, regardless of what plant manager Yoshida told them, those 650 workers could make the decision to evacuate to the Fukushima Daini NPP because conditions were too dangerous at the Fukushima Daiichi NPP site, and no one had the right to stop them. If plant manager Yoshida had realized that and had ordered the workers to stay at the Daiichi NPP, he would have been breaking the law.

The regulatory standard proposals for NPPs that were implemented in July 2013 are taken to be nothing more than standards for facilities. What should have top priority, though, is establishing rules regarding dangerous work and the rights of working people to life and health. These days, the Japanese Electrical, Electronic and Information Union, whose members operate the NPPs, has requested subcontracting of any work involving exposure to high amounts of radiation to help its members avoid exposure. At this time, in dealing with the aftermath of the Fukushima Daiichi nuclear accident, highly skilled pipe fitters and crane operators have already been exposed to radiation up to the allowable limit, so workers without experience are required to proceed with the work (Goto, Sayama & Aoki, 2013; Tsutsui, 2013). In other words, skilled workers are not being employed, but in a deteriorating work environment, new people must constantly be introduced to perform the work dealing with the aftermath at what to society are the most dangerous facilities. The result is complete abandonment of the necessary skill standards for safe management. When that happens, work at NPPs is not possible without the precondition of accepting danger and being prepared to face accidents and fatalities.

To obtain the electric power that provides us our peaceful civil life, shouldn't we radically rethink whether we really want this contradiction? These electric power facilities pose a risk to life similar to military facilities and standing armies. Do we really need that kind of electric power?

Externalizing Environmental Burdens

Meltdowns occurred at Units 1, 2 and 3 at the Fukushima Daiichi NPP, and hydrogen explosions destroyed the reactor buildings of Units 1, 3 and 4. By several instances of sheer good luck, however, containment vessel destruction was avoided, together

with loss of cooling water in the spent fuel pools. If either had occurred, the result would have been much greater releases of radioactive substances and total abandonment of the NPP by the workers. If a situation had developed in which abandoning the NPP became unavoidable, all of eastern Japan would have been rendered severely contaminated. An estimated 50 million people would have needed to evacuate.

Immediately after the accident, large amounts of radioactive materials were released into the atmosphere. About 90% of them were carried out over the Pacific Ocean by the seasonal winds, and about 10% were scattered over land. According to TEPCO's calculations, the amount of radioactive substances released came to about 900 petabecquerels (PBq, 10^{15} becquerels) in terms of conversion to iodine (the INES system: the international yardstick for evaluating nuclear power incidents), which breaks down to 500 PBq of iodine, and 10 PBq of cesium-137. This is about one sixth as much as the amount INES estimated was released by the Chernobyl nuclear accident, which came to 5,200 PBq (TEPCO, 2012). Also, the amount of iodine-131 released by the Fukushima nuclear accident was about 10 times, and the amount of cesium-137 released, about 100 times, the respective amounts released by the Hiroshima atomic bomb. A number of other organizations in addition to TEPCO published estimations of the amounts of radioactive substances released into the atmosphere by this accident.

There have also been various estimations of the amounts released into the sea. Regarding cesium-137, some people think that the amount that flowed into the sea was one quarter to one fifth the amount that was released into the atmosphere (Aoyama, 2014, p.859).

What had a direct impact on the living environment were radioactive substances in the plumes spread by the wind. Much was deposited in areas that encountered rain fall, resulting in soil contamination. When people were being evacuated following the accident, the district of Iitate, which is located 30 kilometers to the northwest of the plant, received highly concentrated fallout, and the people who evacuated in that direction from near the plant received serious radiation exposure. This problem arose because data from a monitoring system the government had prepared beforehand, called SPEEDI, was concealed by the Fukushima prefectural government. In addition, hotspots are distributed over a wide region, even quite far from the plant, as the result of wind direction and weather factors at that time. For example, rice straw in Tome, Miyagi Prefecture had high concentrations of radioactive substances. Farmers in Fukushima Prefecture who used that straw as cattle feed were forbidden to ship their cattle. Tea was reportedly contaminated in Shizuoka Prefecture, and rice in Niigata Prefecture, both hundreds of kilometers away. Arnold Gundersen spent five days in Tokyo in February 2012, where he collected five samples from paved environments to investigate contamination of the

Tokyo living area. He reported that all five samples were found to have such high levels of radioactive contamination that they exceeded the American standard of 7,000 Bq per milligram for being declared radioactive waste (Gundersen, 2015, p. 152). This information was not reported to the general public, but the contamination covered a large region.

Environmental contamination is not the kind of thing that is resolved quickly. What is most notable is the flow of contaminated water, which still shows no prospects for being resolved. For that reason, even more than five years after the accident, Fukushima's coastal fishery cannot operate. On the other hand, we sometimes hear reports that radioactive substances are being dispersed to surrounding areas through the transference of debris removed to facilitate work at the Fukushima NPP. The main cause of the contaminated water, the presence of water flowing into the plant underground, is common to many NPPs in Japan. The problem of dust scattered from explosions of reactor buildings is also shared by NPPs after serious accidents. Below, we provide a timeline of water contamination problems over the last five years at the Fukushima Daiichi NPP (Kino, 2014; Soramoto, 2014).

In a speech Prime Minister Abe gave in Rio de Janeiro on September 7, 2013, appealing for Japan's hosting of the Olympics, he said, "Regarding fears about Fukushima, we give our assurance. The situation is under control." These days, however, what is actually happening is one mistake after another in work dealing with water contamination. A series of hitches has occurred with the SARRY and ALPS water treatment systems brought in to deal with the situation, and space is running out for tanks to hold all the contaminated water until it can be treated.

It has been recognized since right after the accident that an underground wall would be needed to shut out the water and prevent it from flowing in underground (Mabuchi, 2013). TEPCO has delayed such measures, though, for economic reasons. Since then, about 400 tons of highly concentrated contaminated water has been generated in cooling the molten reactor core debris, and the area the tanks are in has developed remarkably high levels of radioactivity due to incidents such as leaks from the tanks. At the beginning of 2013, the government established a council to discuss what to do about the contaminated water, and as a result decided to order a joint venture between TEPCO and Kajima Corp. to construct an "ice wall" (impermeable frozen soil wall) to stretch around the reactor buildings of Units 1 to 4. They reason they chose this frozen soil method was that to spend their development budget from METI they had to find an unproven technology that needed to be developed. In late March 2016, they began trying to freeze part of the ice wall, but it did not solidify as planned, and they were unable to shut out the underground water with it (as of June 2016).

Organizational and systemic factors play a big role in these delayed responses.

TEPCO was in such a bad financial situation that essentially it should have undertaken bankruptcy procedures. The reality, though, is that the government is sinking funds into TEPCO through the Nuclear Damage Compensation and Decommissioning Facilitation Corporation, and a "decommissioning promotion company" has been established within TEPCO and is charged with handling remedial measures for the Fukushima Daiichi NPP. This company's stinginess toward the countermeasures it was created to handle is the biggest factor impeding measures against environmental contamination.

2. What Could Have Happened at the Fukushima Daiichi Nuclear Power Station?

The Many Happenstances and the Major Disaster that Could Have Happened

The Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) released part of its records of hearings with people involved with the accident on September 11, 2014. Among them, the "Yoshida Testimony" provided by plant manager Masao Yoshida conveyed the tense situation during the accident. It had become impossible to inject water into the Unit 2 reactor on the evening of March 14, and he directed workers to evacuate the plant. The following are his recollections of the situation:

> "We had come to a situation where fuel was really exposed, but we could not lower pressure or pump in water, so really, this is the hardest part for me to remember. I thought then, though not for the first time, that we were going to die. I thought we were really going to die. With no water coming in, the Unit 2 reactor was going to melt. All the fuel was going to really override pressure in the containment vessel and escape outside. That would have been a worst-case accident with corresponding amounts of radioactive substances all spewed outside. That would no longer be a Chernobyl class–maybe not a "China Syndrome," but something like that. If that were to happen, we would have had to stop pumping water into the Unit 1 and Unit 3 reactors… I thought that the people who were there—I mean, people staying near the quake-proof control center building—would be the first to have their lives at risk…I think I [said] that workers at the site should take shelter, except for minimum staff…That was because I thought the radioactive substances would all come spewing out and eastern Japan would be finished." (From a hearing on August 9, 2011.)

In fact, the pressure inside the Unit 2 reactor decreased on its own in the early hours of the 15th, and the danger of an explosion passed. It is still unclear why that hap-

pened, but it is thought that a crack may have formed in the bottom of the containment vessel, allowing the gases to leak out and reducing the pressure. It is a large container made of welded steel plates 30 millimeters thick, but a crack formed locally and prevented the whole thing from exploding.

There were other situations that reached a dangerous stage too. The Unit 4 spent fuel pool happened to be holding a large amount of nuclear fuel for the duration of a regular inspection. Perhaps due to the explosion of the Unit 4 reactor building, a partition between the reactor well above the pressure vessel, which just happened to be full of water, and the spent fuel pool was displaced. Water flowed from the reactor well into the pool and kept the fuel rods cool. Moreover, that well was originally scheduled to be emptied, but construction work the day before resulted in that being delayed so by coincidence, it had been left full.

The building housing the Unit 4 spent fuel pool suffered a hydrogen explosion due to hydrogen gas flowing in from Unit 3 via vent lines. This weakened the pool's side walls and bottom, and there was the risk of losing the water if an aftershock occurred. If that had happened, it was thought the nuclear fuel in this pool would have melted, producing so much radiation it would have prevented people from approaching the site, and the other reactors would all have been seriously damaged from lack of service. Subsequently people would have been forced to abandon the Fukushima Daini NPP site, as well, which has four nuclear reactors, so that would have meant that 10 nuclear reactors and their spent fuel pools would all have been abandoned and seriously damaged. The result would have been devastation of all of eastern Japan. Experts in America and Europe feared this case most of all.

The nuclear reactor pressure vessels of Units 1, 2 and 3 were breached when the nuclear fuel within the containment vessels melted to one extent or another. As the pressure within each containment vessel rose to about twice the design pressure, they developed local ruptures that automatically lowered the pressure, thus avoiding explosions that would have destroyed them entirely. That was extremely fortunate. There was every possibility that the containment vessels could have exploded entirely. In addition to the above rise in pressure due to the inability to cool the reactors, steam explosions or hydrogen explosions could have destroyed them.

Two weeks after the accident, on March 25, Shunsuke Kondo, then-chairman of the Japan Atomic Energy Commission (JAEC) outlined the accident in a PowerPoint presentation, which is publicly available (Kondo, 2011). It gives a rough estimation at the one-week point, when the nightmarish dangers of the first week or so after the accident occurred ended, of how much radioactivity might have been released if a hydrogen

Unit	Nuclear Reactor		Spent Fuel Pool	
	No. of Fuel Assemblies	Total Radioactivity (Bq)	No. of Fuel Assemblies	Total Radioactivity (Bq)
Unit 1	400	2.90E+20	392	1.60E+18
Unit 2	548	5.00E+20	615	5.50E+18
Unit 3	548	5.00E+20	566	4.80E+18
Unit 4	*(548)	**(1.7E+19)	1,535	2.10E+19
Unit 5	548	1.60E+19	994	9.20E+18
Unit 6	764	1.00E+19	940	2.70E+18
Shared Pool		—	6,375	1.40E+19

* Rated Value for Unit 4

** Value assuming fuel had been present in the reactor.

(Regarding "E": 4.5E+19 indicates 4.5 x 10^{19}, for example)

Table 2.3.1 Numbers of fuel assemblies in the nuclear reactors and spent fuel pools and their total radioactivity (NAIIC, 2012, p.141).

explosion had occurred in the pressure vessel or containment vessel of the Fukushima Daiichi Unit 1 reactor, followed by loss of control over the other reactors due to complete evacuation of workers, and loss of ability to cool the reactors and the spent nuclear fuel pools. His figures showed that if the amount of radioactivity contained in two reactor cores had been released, the region that would needed to have been evacuated due to soil contamination at levels requiring mandatory evacuation in the case of Chernobyl (1,480 kBq/m^2) would have had a radius of 170 kilometers. The region required to allow voluntary evacuation (555 kBq/m^2) if Chernobyl standards were applied would have had a radius of 250 km (this assumes that the Fukushima Daini NPP reactors remained under control). Subsequently, it would have required ten years or more for the radiation levels in this region to subside to 1 mSv/y.

The maximal possible radioactivity release would have occurred if the pressure vessels and containment vessels had exploded one by one, the cooling water had evaporated from the spent fuel pools and all of the radioactive substances had been cast out and scattered in the environment. Table 2.3.1 shows the total amounts of radioactivity contained in the reactors and the spent fuel pools. The total amount released would have been one order of magnitude higher than Kondo's figures. It would be no exaggeration to say that under Kondo's estimations eastern Japan would have become uninhabitable and in the worst case, the entire Japanese archipelago would have been rendered unfit to live in.

The Nuclear Accident and Weather Conditions

(Nakajima, Ohara, Uematsu & Onda, 2014, Ch. 3)

The direction in which radioactive substances from a nuclear accident travel and the areas where they wind up contaminating the soil depend to a large degree on weather conditions. The Fukushima nuclear accident demonstrated clearly that contaminants do not spread in a neat, concentric fashion from the scene of the accident, with severity depending on distance. In fact, the region to the northwest of the Fukushima NPP suffered particularly severe widespread contamination.

Large releases of radioactive substances from the accident were occurring over periods ranging from hours to days. Thus, how far, in what direction and what amounts of the contaminants were transported and into which areas they settled were influenced greatly by the weather conditions at the time of and subsequent to their release. The direction and speed of the wind and occurrence of rainfall or snowfall were particularly important factors. The effect of the wind direction and speed itself means that how high the radioactive substances were blown during the explosions was a factor as well. The reason is that wind speed and direction differ depending on altitude. In the case of the Fukushima nuclear accident, it is thought that the radioactive substances were sent no higher than 1 kilometer above the plant. In the case of the Chernobyl accident, the explosion was quite powerful and fires raged afterwards, sending radioactivity from within the reactor up in black smoke. This resulted in radioactive substances reaching higher altitudes. The winds at the altitude they reach carry them away. Then they fall back to the ground again together with rain or snow.

The largest release of radioactive substances from the Fukushima Daiichi NPP occurred from the night of March 14 until the morning of the 16th. It is thought they were released to a height of up to 30 meters. The radioactive substances remaining at this low altitude were carried by northerly to northeasterly winds through the morning of the 15th.Thus they were blown south along the coast of Fukushima Prefecture into Ibaraki and Tochigi prefectures. There was no rain or snow at this time, so most of the radioactive substances did not fall to the ground there, but were carried inland to the northern Kanto Plain, just north of Tokyo. On the afternoon of the 15th, the wind shifted clockwise to southeasterly. Most of the radioactive substances then were carried to the northwest of the NPP toward Iitate. Rain and snow, falling in Fukushima Prefecture and the northern Kanto mountains at that time, washed the contaminants to the ground. This resulted in the creation of hotspots in Iitate, and also deposition of radioactive substances in the northern Kanto mountains. On the morning of the 16th, strong northwesterly seasonal winds were blowing, so almost all of the large amounts of radioactive substances released then were carried out over the Pacific Ocean. In addition, part of the radio-

active substances that initially stayed at low altitudes were carried by rising air currents to the stratosphere. From there they are thought to have ridden the westerly jet stream to North America and beyond there to Europe. It was during March 21 to 23 that northeasterly winds blew radioactive substances released by the Fukushima Daiichi NPP, carrying then into the Kanto Plain, where Tokyo and its neighboring cities are located, and distributing them widely there. Worse, there was continuous rainfall at this time, resulting in hotspots in Kashiwa in Chiba Prefecture and other places nearby.

If the wind on the 15th had been blowing like it was on the 21st, contamination of the Kanto Plain would have predictably been much more serious. Also, March 2011 was characterized by a stronger-than-normal cold air mass over Japan. If the synopsis had been more typical of the average year, it is said that the contamination of the Sendai Plain north of Fukushima, and the Abukuma Mountains stretching along the coast of Fukushima Prefecture would have been serious. If the Fukushima accident had occurred during summer, when southerly seasonal winds prevail, the result would have been severe contamination of inland parts of Fukushima Prefecture and the Sendai Plain. The areas contaminated and scale of contamination would also have differed in yet other ways for the rainy season or autumn rains, or if there had been a typhoon.

Preparations underway currently to restart Japan's NPPs are advancing steadily. If an accident of the same scale were to occur at one of these NPPs somewhere, we must estimate the increased severity and wider distribution of radioactive contaminants that would result from different meteorological conditions, including rainy seasons and typhoons. When that kind of accident occurs, we can no longer say that such kinds of weather conditions are beyond expectations.

Appendices to Part 2

From the Birth of Neutrino Science to Detection of Neutrino Oscillations

The phenomenon of an atom transforming into the next higher element in the periodic table while emitting a high-energy electron ray, called a beta ray, has been known about since the beginning of the 20th century. Observations back then also revealed that the law of energy conservation was apparently not obeyed in these instances. Physicist Niels Bohr first suspected that the law of energy conservation did not hold in the realm of the atom. In 1930, however, Wolfgang Pauli proposed a hypothesis that upheld the law of energy conservation, introducing a "ghost particle" that had not been detected before. That electrically neutral hypothetical particle was later dubbed "the neutrino." Subsequently, the neutron was discovered, and the atomic nucleus was found to consist of protons and neutrons. In 1933, Italian physicist Enrico Fermi proposed a theory that included the neutrino to explain the phenomenon of beta decay as a neutron transforming into a proton. With Bohr also working on this, Fermi won the Nobel Prize in 1938. He used the money from the prize to escape Mussolini's fascist dictatorship and defect to America. In America, Fermi participated in the Manhattan Project, helped build the world's first nuclear reactor in Chicago, and after that, cooperated in the construction of the Hanford nuclear reactor for plutonium production. It was through the Hanford reactor that the plutonium was produced for the atomic bomb that was dropped on Nagasaki. An experiment was conducted using the Hanford reactor in 1953 to see if neutrinos emitted during the fission reaction could be observed, but it failed to detect any. In 1956, however, neutrinos emitted in the Savannah River reactor were successfully detected. This marked the first experimental observation of the neutrino. Thus mankind's first glimpse of the neutrino occurred at a nuclear reactor in operation.

Incidentally, within stars, various kinds of fusion and decay reactions take place involving atomic nuclei. In some large stars, though, when the number of atomic nuclei capable of undergoing fusion falls too low, the star is crushed by its own weight, resulting in a supernova explosion. When that happens, even greater energy is induced, fusion and decay occur, and atomic nuclei with as many protons as uranium are generated. Masatoshi Koshiba (who won the 2002 Nobel Prize in Physics) constructed a neutrino detector, the "Kamiokande," with which he succeeded at observing neutrinos produced by a supernova explosion in 1987.

In modern physics, the smallest unit of matter is called an "elementary particle." Electrons and neutrinos are elementary particles with small masses. In contrast, protons and neutrons are not elementary particles, but are themselves composed of multiple particles, containing three quarks each. A quark is an elementary particle with a heavy mass. Also, for all elementary particles that make up matter, particles of an equal mass exist with opposite electrical charges.

In 1973, Makoto Kobayashi and Toshihide Masukawa (who shared the 2008 Nobel Prize in Physics) proposed the idea that quarks comprised three generations, with two types of each, making a total of six types (or "flavors") of quarks (the Kobayashi-Masukawa Theory). Mixtures of quarks of differing generations form, according to this theory, and this can explain the physical phenomenon called "CP violation." At that time, only three flavors of quarks had been discovered, two flavors of first generation quarks ("up quarks" and "down quarks") and another flavor ("strange quarks") comprising the structures of protons and neutrons. By 1995, however, all six flavors of quarks had been observed. Corresponding to the three generations of quarks are lightweight elementary (including electrons) particles (first generation), muons (second generation) and tauons (third generation). In addition, there are three corresponding generations of neutrinos, electronic, muonic and tauonic. For a long time, according this Standard Model of particle physics, neutrinos hypothetically had zero mass.

Incidentally, when cosmic rays strike the atmosphere, electronic neutrinos and muonic neutrinos are generated. From these observations of neutrinos in the atmosphere, Takaaki Kajita obtained experimental evidence in 1998 that different types of neutrinos mix and their ratios change over time (oscillating). This provided evidence that each of the different generations of neutrinos (electronic, muonic and tauonic) exists in a quantum-mechanically superimposed state with three neutrino types with different non-zero masses (the same three generations, electronic, muonic and tauonic, with a phase shift). These results earned Kajita the 2015 Nobel Prize in Physics.

As fusion occurs inside the sun, beta decay occurs simultaneously, with protons transformed into neutrons (beta plus decay, or electron capture), and an electronic neutrino is released. Arthur B. McDonald of Canada observed that as these electronic neutrinos fly from the sun to the Earth, they transform into other generations of neutrinos. For this discovery, he shared the 2015 Nobel Prize in Physics with Kajita.

Despite their extremely high penetrating power, neutrinos have barely been observed. They are a sign of beta decay among unstable atomic nuclei in supernova explosions or within the sun, and beta decay of atomic nuclei in the atmosphere when it is struck by strong cosmic radiation. Neutrinos are signals from enormous releases of energy in space that do not reach the Earth directly.

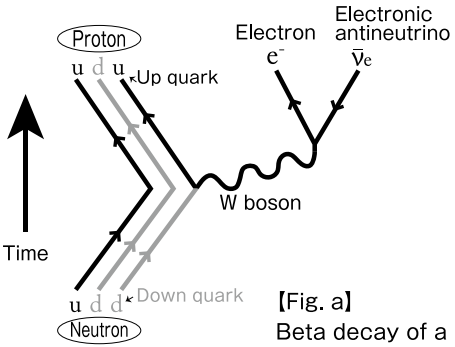
Beta Decay and Mesonic Theory from the Perspective of Modern Physics

Currently, we are attempting to use the muons generated in the atmosphere by cosmic rays as a sort of "fluoroscope" to see the condition of the nuclear fuel inside the reactors or containment vessels involved in the meltdowns or melt-throughs at the Fukushima Daiichi NPP. Muons are lightweight, second generation elementary particles, and like electrons, which are first-generation elementary particles, they are connected with beta decay. Also, just as neutrinos corresponding to electrons (electronic neutrinos) exist, so do those corresponding to muons (muonic neutrinos). Furthermore, muons have so much penetrating power they can pass through a kilometer of solid rock.

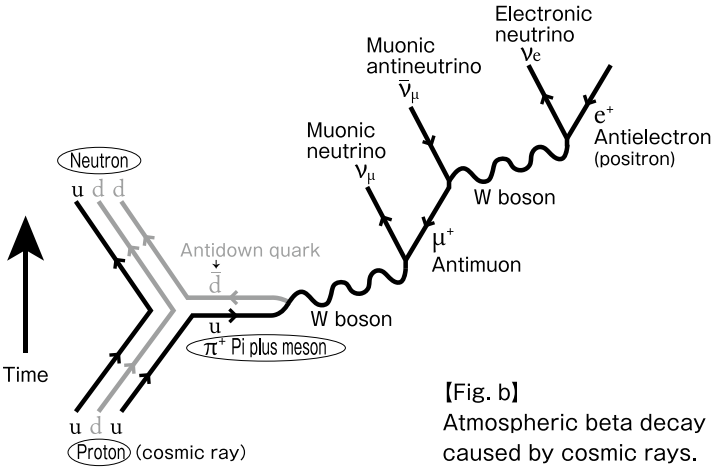
Muons were first observed in cosmic rays in 1937 (secondarily), but initially, they were thought possibly to be pi mesons that had been predicted to explain nuclear forces in 1934 by Hideki Yukawa (who won the 1949 Nobel Prize in Physics). In fact, this was a case of mistaken identity, and pi mesons were observed in 1947. It happened that after Fermi's theory on beta decay was published in 1933, some physicists tried using his theory to explain nuclear force, but this effort failed. Yukawa took hints from the beta decay theory, but showed through the mesonic theory that nuclear force arose from a different kind of force from that which was causing beta decay. In this theory, protons, which carry a positive charge, could be bound to each other while taking in neutrons, which have no charge, through the mediation of certain particles he hypothetically introduced, called "mesons." The nuclear force, according to Yukawa, is the force generated by the acceptance of mesons by protons or neutrons.

It was noted above that muons are generated in the atmosphere by cosmic rays, but a more precise explanation is as follows. Protons pouring down from space produce pi mesons (pi plus mesons) in the atmosphere while turning into neutrons. The pi mesons undergo beta decay, becoming muons (or more accurately, anti-muons) and muonic neutrinos. Then those muons undergo beta decay, becoming muonic neutrinos (or more accurately, muonic antineutrinos), simultaneously producing positrons (antielectrons) and electronic neutrinos. In this way, the muons that were mistaken for pi mesons are among the particles deeply involved in mediating beta decay. What is termed exposure to cosmic radiation is actually exposure to radiation produced in the atmosphere, as described above, and protons reaching us directly from space.

According to the modern Standard Model of particle physics, protons and neutrons are composite particles composed of three quarks each (protons consisting of two up quarks and a down quark, and neutrons, of one up quark and two down quarks). Also the meson is not an elementary particle, but a composite one, consisting of two quarks



【Fig. a】
Beta decay of a radioactive nucleus.



【Fig. b】
Atmospheric beta decay caused by cosmic rays.

The arrows representing actions of the particles in the figures indicate a time direction from past to future, but for the antiparticles (anti (positive) electrons, antidown quarks, antimuons, antineutrinos), the arrows indicate the opposite: from future to past. This is because the motion of antiparticles from the past into the future is equal to the motion of particles from the future into the past. The circled particles are composites, and the rest are elementary particles.

(or more accurately, a quark and an antiquark, e.g., a pi plus meson is an up quark and an antidown quark). In contrast, quarks with heavy mass and quarks with light mass, muons, neutrinos, etc., are elementary particles, incapable of being divided further.

Also, based on the quantum electrodynamical concept of force arising from acceptance of particles that form and disappear over a short time (quantum field theory), beta decay is the force arising from acceptance of a particle called a W boson. By accepting a

W boson, a quark is transformed into another quark of the same generation (one of the down quarks that are part of a neutron turns into an up quark that is part of a proton), thus turning a neutron into a proton; a meson composed of a quark and an antiquark forms and disappears; a neutrino, which is a lightweight elementary particle, turns into an electron or muon of the same generation; and a pair of particles consisting of one particle and one antiparticle forms and disappears. For example, through the W boson that is released when a neutron becomes a proton, an electronic and antielectronic neutrino form as a pair and disappear (see Fig. a). Also, pi plus mesons formed by protonic cosmic rays (composed of an up quark and an antidown quark) in the atmosphere disappear, and through the W boson, an antimuon and antimuonic neutrino form as a pair. Furthermore, through the W boson released as this antimuon turns into an antimuonic neutrino, a positron (antielectron) and electronic neutrino form as a pair (see Fig. b). This is the essence of beta decay. Note that as a particle that mediates force, the W boson was originally thought to have no mass, but in fact it has mass. When this originally massless particle takes in a Higgs boson and acquires mass, a Higgs particle is released. Yoichiro Nambu (who won the 2008 Nobel Prize in Physics) contributed greatly to the idea of "spontaneous breaking of symmetry" that explains this system.

Regarding the forces that produce beta decay, a source of radiation from the products of nuclear fission, the nuclear force used in atomic bombs and NPPs is not one of the fundamental forces in physics. The force that builds neutrons and protons by binding three quarks together is a fundamental force (or interaction). This is a different force from the fundamental force that causes beta decay, a fundamental force that is far stronger. The nuclear force that builds atomic nuclei by binding together neutrons and protons, by contrast, arises from a leakage of the fundamental force binding the three quarks together (by mutually receiving mesons), so it is a secondary force, so to speak.

Nuclear Reactors Not Using Uranium or Plutonium Fuel—Thorium or Fusion Reactors

In response to an appeal from the U.S. Department of Energy in 2001, the Generation IV International Forum (GIF) on the fourth generation of nuclear energy systems was inaugurated. Thirteen countries currently participate, including Japan. They are conducting research on various new types of nuclear reactors. The nuclear reactors to be developed that would be permissible for use in the future must not be prone to severe accidents and must not generate long-lived nuclear waste products. Sad to say, not one such reactor is foreseen (Citizens' Commission on Nuclear Energy, 2014). Apart from these, there are fusion reactors, whose realization as nuclear reactors is a far away. Here we provide a simple explanation of two types of nuclear reactors we often hear about.

Unlike light water reactors that produce fission in enriched uranium, thorium molten salt reactors use thorium-232, a radioactive isomer of thorium (atomic number 90), which is bombarded with neutrons, causing two beta decays, transforming it into uranium-233, which is used as the nuclear fuel in this reactor. Research on NPPs using thorium, however, is barely advancing at all. At this time, only Norway and China have declared R&D policies in favor of it. Thorium reactor proponents point out advantages such as using liquid fuel, eliminating the risk of a meltdown, higher safety than at uranium reactors that use solid fuel rods, more efficient electric power generation, reduced volume of radioactive wastes, and little plutonium generated, making it difficult for diversion to nuclear weapons. Just like conventional nuclear reactors, however, they would still utilize nuclear fission, and though producing a smaller volume of wastes than uranium reactors, the volumes of high-level radioactive wastes they produce that pose disposal problems would still be massive. Also, what level of safety they can guarantee remains completely unknown. At the present stage, they amount to nothing more than a dream technology for nuclear engineers.

Fusion reactors attempt to use the energy released when deuterium and tritium, both heavy hydrogen isotopes, are fused, creating helium and a neutron. Controlling fusion by man-made means is technically next to impossible. To initiate nuclear fusion, the deuterium and tritium must be heated into a plasma with a temperature of about 100 million degrees. No materials exist for nuclear reactors to start with that could withstand such high temperatures. Use of a powerful magnetic field to enclose the plasma is being considered, but it appears the road to its technical realization is extremely long.

Assuming nuclear fusion reactors were realized, they would not produce the radioactive isotopes of iodine, cesium, strontium and other fission products that conventional nuclear reactors do. They would, however, produce large amounts of tritium, a radioactive isotope of hydrogen, instead. Tritium has the same chemical properties as regular hydrogen, so if it escaped into the environment, it would form water and other compounds by combining with oxygen and other diverse elements in the environment, and would be impossible to clean up. The neutron rays emitted during fusion are also extremely powerful and abundant. They would render the entire structure radioactive in a short time. It is thus thought that frequent replacement of the principal equipment would be necessary. Several hundreds of kilowatts would be needed to run a fusion reactor, so they would never be commercially viable. Gigantic sums of money will be needed just to build a test reactor, so R&D is proceeding on the basis of international cooperation, with the International Thermonuclear Experimental Reactor (ITER) to be built in France. Yet the first trial runs with it, scheduled for 2019, are expected to be greatly delayed.

Depleted Uranium Ammunition

When uranium is enriched to concentrate uranium-235 for atomic bombs and nuclear fuel for NPPs, massive quantities of depleted uranium are generated. Depleted uranium contains large amounts of uranium-238, which emits alpha rays. Originally, it was considered radioactive waste. Uranium, however, has high specific gravity and is very heavy and hard, so when it is used to manufacture shells, the results have extremely high penetrating power. This is depleted uranium ammunition. When these shells hit their target, high-temperature uranium is atomized into nanoscale particles. From there it is carried and scattered by the wind. When fine particles of uranium, a radioactive heavy metal, enter the body, they bring the risk of health problems. Depleted uranium ammunition was used in large quantities in the 1991 Gulf War. It was subsequently also used in 1995 when NATO (North Atlantic Treaty Organization) intervened in the Kosovo War. It is a known fact that the U.S. military keeps depleted uranium ammunition at Kadena Air Base in Okinawa, which has led to suspicions that it was used in the Iraq War in 2004. Health problems have arisen among residents living near where depleted uranium shells fell and military personnel deployed there. Cases of depleted uranium being detected in their bodies have also been reported. Scientists and NGOs assert a causal relationship between depleted uranium and health problems, but governments and almost all public institutions deny any connection between fine uranium particles in the body and these health problems.

Part 3

Christianity and the Abolition of Nuclear Power

In this third part, we will consider from the point of view of Christianity and modern thought the increasingly obvious ethical problems that arise from the use of nuclear energy.

Our considerations will focus upon whether a lifestyle that depends upon nuclear energy is compatible with responsibly building a civilization that does not damage the global ecosystem beyond repair. Christians believe that people can live happily and at peace through forming harmonious relationships with their own selves, with others and larger communities, with the earth as environment and with God. However, the use of nuclear power destabilizes and destroys all these relationships.

Modern thinkers have sounded an alarm about the destructive influence of exploiting nuclear energy. In line with that thinking, Pope Francis in his encyclical letter *Laudato Si'* insists upon a unification of humanity's "responsibility to God," "responsibility to society" and "responsibility to the created world."

Abandoning a lifestyle that considers it a sign of a rich cultural life to use huge amounts of energy for mass production and mass consumption while causing great waste and pollution, and focusing instead on human spiritual resources, other living things and future generations while choosing methods of energy production and its use that do not damage the sustainability of either society or the natural environment constitute the modern form of "spiritual poverty." Moreover, taking steps to build a society aimed at "human recovery" in order to overcome nuclear power plant disasters restores humanity as "the image of God."

Chapter 1
Ethics of the Use of Nuclear Energy

In this chapter, we will consider nuclear technology and nuclear power from the point of view of Christian social and environmental ethics. The technology that has such a big influence on modern society is based upon the West's technological revolution that was born of the scientific revolution and the industrial revolution that flowed from it. We can also say that the roots of today's environmental problems are also found there. It is also true that the deepest roots of Western culture are in Christianity. And so, it has been said that the origins of our present environmental crisis are to be found in Christian and Biblical thought.

First we will consider our environmental problems based upon the Biblical and Catholic views of the relationship between humanity and God's creation. According to the Bible, God created all things to be good and beautiful. However, at the same time, the Bible shows a strong conviction that human pride has given rise to sin that spreads disruption throughout the world. Therefore, reconciliation between humanity and God and one between humanity and other creatures are a major Biblical theme. Based upon that, the Catholic tradition has used the concepts of the common good and justice to think about a harmonious human society and well-ordered relations with nature. Even so, there has as yet been little reference in Church teaching to the problem of nuclear energy.

On the other hand, present-day thinkers warn that nuclear energy differs greatly from the environment and life. It leads to strong controls within society that limit freedom. Those thinkers advocate a new concept of "ethical responsibility to future generations" and "environmental justice." We will survey the ethical implications of modern environmental ethics and the use of nuclear energy.

In May 2015, Pope Francis issued his encyclical *Laudato Si'* concerning environmental problems. In his encyclical, the pope refers only slightly to the use of nuclear energy, and he says nothing about problems related to nuclear power. However, the encyclical contains many hints for considering the use of nuclear energy. We will review encyclical letters on social ethics and environmental ethics by previous popes, using *Laudato Si'* as a foundation for a synthesis of them in considering nuclear energy and nuclear power.

1. The Biblical basis for environmental ethics

Creation and humanity

The starting point for Christian reflection upon environmental ethics is the Biblical understanding of humanity's status and role in relation to God and creatures as they are presented in the Book of Genesis (Chapters 1-3, and on through Chapter 11).

In the creation accounts that form the beginning of Genesis (1:1-2:4a), the seven days of God's creating are presented as a process in which chaos and darkness are prepared for life. All creation is a free gift from God. God looked upon all that he created and declared it "good" (Gen. 1-4, 10, 12, 18, 21, 25) and "very good" (Gen. 1:31). God moved the world from chaos to cosmos, to a thing with meaning and value. The Bible repeatedly speaks of the beauty and goodness of God's creation and praises God for it.[61]The Psalms especially and in many ways sing the people's praise of God's creation. "Let them praise the name of the Lord, for he commanded and they were created. He established them forever and ever; he fixed their bounds, which cannot be passed. Praise the Lord from the earth, you sea monsters and all deeps, fire and hail, snow and frost, stormy wind fulfilling his command!" (Psalm 148:5-8).

In creating, God blesses "living things" (cf. Gen. 1:20, 21, 24, 28, 30). The earthly world has been made as a "home for life" in which various creatures live by the "power of life," the spirit of God. Having a close relationship with nature blessed by God, humanity finds healing, peace and rest (cf. Wisdom 13:3-5; Sirach 39:16, 33; 43:1, 9).

Incidentally, the Creation Narrative in Genesis was written in the midst of the disastrous "Babylonian Captivity" when the southern Kingdom of Judah was destroyed by Babylonia and its leading citizens were taken into exile. The Bible tells the creation story to bring hope for life to people who live in fear and despair, showing them that God creates a "home for life" in a world of death, darkness and confusion.

In creation, humanity is given the role of "image of God," "likeness of God." "Then God said, 'Let us make humankind in our image, according to our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the wild animals of the earth, and over every creeping thing that creeps upon the earth.' So God created humankind in his image, in the image of God he created them; male and female he created them. God blessed them, and God said to them, 'Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth'" (Gen. 1:26-28). Humanity, made in the image and likeness of God, lives in com-

[61] Cf. John Paul II, 1990 World Day of Peace Message, 14.

munion with other people based upon the relationship of male and female, and through being entrusted with the care of creation has strong bonds with other living creatures.[62] Thus, the Creation Narrative stresses that humanity exists in relationship with God the Creator, with other people, with other living beings and with the earth. These relationships are the indispensable condition for humanity to find the meaning of its existence and to live well.[63] Care to protect and nurture living creatures with respect and love is a duty entrusted to humanity by God. "The Lord God took the man and put him in the Garden of Eden to till it and keep it" (Gen. 2:15). In the history of salvation, humanity participates in God's creative work through its own labor and activity.

With the birth of modern science, humanity began to think that through knowledge acquired by experiment and observation we could govern nature. Thus, the words "have dominion" in the Bible were understood to mean that humanity was allowed to exercise exploitative rule over nature. This has given rise to the misunderstanding that the Bible and Christianity have caused our environmental problems.

However, if we pay attention to the wording in Genesis, we see that the words preceding "have dominion" are not "ordered them," but "blessed them and said." Biblical scholars interpret this order to exercise dominion as an invitation to make real the blessing of God, the order that God desires. Moreover, the Church's teaching authorities have emphasized that the dominion exercised by human beings as the image of God is to care for living beings, a duty for humans to fulfill a role of service.[64] The purpose of creation is, through cooperation with God by humanity, the image of God, to make the world a "home for life."

Therefore, through the expression "have dominion," humanity realizes that we have been blessed by God with a place to live on the earth and receive what we need to maintain life. Humanity is not allowed unrestricted rule, exploiting and making self-centered changes to other living things and the natural environment. The modern rationalism that says that nature is "an empty space given by God to be ruled over by humankind" has no connection with the original Biblical thought.

Humanity must obey the conditions that God sets, and in doing so fulfill its role as ruler over other creatures. "And the Lord God commanded the man, 'You may freely eat of every tree in the garden; but of the tree of the knowledge of good and evil you shall not eat, for in the day that you eat of it you shall die'" (Gen. 2:16-17). God promises that

[62] Cf. Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 451; John Paul II, encyclical *Sollicitudo Rei Socialis* (On Social Concern), 29; Pope John Paul II, encyclical *Evangelium Vitae* (The Gospel of Life), 42.

[63] Cf. Francis, encyclical *Laudato Si': On Care for Our Common Home*, 66.

[64] John Paul II, General Audience, January 17, 2001, 3.

humanity will become the image of God, but at the same time shows the limits of human rule over nature (cf. Wisdom 2:23). "O God of my ancestors and Lord of mercy … by your wisdom [you have] formed humankind to have dominion over the creatures you have made, and rule the world in holiness and righteousness" (Wisdom 9:1, 2-3).

Humanity (adam) is merely dust of the earth (adamah) (Gen. 2:7), and humanity's status in nature is defined by God who said, "The land is mine; with me you are but aliens and tenants" (Lev. 25:23). Therefore, the use of nature by humanity is regulated to provide a fair distribution of the blessings of the earth (cf. Lev. 19:9-10, 25:8-17), to give rest to the land and animals (cf. Lev. 25:1-8) and to show that the blessings of the earth come from God (cf. Deut. 26:1-11).

In this, the command to cultivate and care for the earth is shown to have an ethical orientation. God's creation existed before humanity, and bears evidence of the Creator (cf. Rom. 1:20). Human oversight of creation means protecting the life and dignity of all creatures under the rule of God.

Sin as the rupture of relationship

If the commandment "have dominion" is God's blessing and word of invitation, God's first word of warning is, "but of the tree of the knowledge of good and evil you shall not eat" (Gen. 2:17). Humanity may not decide for itself what is good or evil.

If humanity forgets this warning and tries to act like the Creator, nature will turn against it and human dominion over nature will turn into terrible suffering (cf. Gen. 3:17-19). It will be a case of humanity marring its own image of God.[65] This first sin brings about alienation within people and with others, resulting in fratricide, the Deluge and the confusion of languages at the Tower of Babel (cf. Gen.4-11). The whole of creation has been subjected to futility and, groaning, waits to be set free (cf. Hosea 4:3; Rom. 8:20-21). This sin is called "original sin," and has weighed upon successive generations. The arms race, regional disputes, chauvinism, injustice in nations, disrespect toward nature and the unlimited exploitation of natural resources can all be linked to this sin.[66] Creation, which is originally a story of blessing, is always threatened by the power of death.

The root of such evil is human pride, that is, unfaithfulness to the Creator's intention. It is a form of idolatry. Basically, it is surrender to the temptation, "when you eat of it [the forbidden fruit] your eyes will be opened, and you will be like God" (Gen. 3:5). It transgresses God's rule and denies the transcendence of God.[67]

[65] Cf. John Paul II, encyclical *Sollicitudo Rei Socialis* (On Social Concern), 30.

[66] John Paul II, 1990 World Day of Peace Message, cf. Introduction, 2, 3, 5.

[67] Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 464; John Paul II, encyclical *Centesimus Annus* (On the 100th Anniversary of Rerum Novarum), 38;

Vatican II (1962-65), an ecumenical council at which the Catholic Church took a new look at itself and spoke of its view of the future, said, "For without the Creator the creature would disappear. … But when God is forgotten, however, the creature itself grows unintelligible."[68] In other words, if humanity fails to see God it does not understand itself as the image of God with a transcendent character and will fail in its responsibility to care for creation with compassion and with reverence for its divine source. And so, the bonds that unite God and the world are broken, as are human life and dignity. The heart of the tragedy experienced by people today lies in the fundamental discrepancy that arises between a "culture of life" and a "culture of death."

Reconciliation between God, humanity and creation

But the Bible also speaks of "a new creation" in which the harmony between humanity and creation that has been wounded by sin will be restored. "I am about to create new heavens and a new earth" (Isaiah 65:17; cf. 32:15-18).

According to the New Testament, these "new heavens and new earth" are brought about through salvation by Jesus Christ. Jesus lives in complete acceptance of God's loving care for humanity, plants and animals. The Gospel of the Kingdom of God (the Reign of God) of which Jesus spoke reaches out in love through humanity to all creatures. In Jesus' work of forgiving and healing God embraces humanity, and humanity is freed from the reign of sin and the sickness of death. Thus the wounds of humanity's torn relationships within individuals, with others and with the world are healed and restored. This is the fulfillment of God's creation and salvation: "So if anyone is in Christ, there is a new creation: everything old has passed away; see, everything has become new!" (2 Cor. 5:17). We are told, "For in him all the fullness of God was pleased to dwell, and through him God was pleased to reconcile to himself all things, whether on earth or in heaven, by making peace through the blood of his cross" (Col. 1:19-20). The cross and resurrection of the Son of God, then, bring the place "where righteousness is at home" in the world (2 Pet. 3:13; cf. Isa. 66:22, Rev. 21:1) and the relations among God and humanity and all creatures reach fulfillment.[69] By caring for God's "home of life" humanity fulfills its vocation to be the "image of God."

encyclical *Evangelium Vitae* (The Gospel of Life), cf. 21, 22.

[68] Vatican II, *Gaudium et Spes*, 36.

[69] Cf. Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 453, 454; John Paul II, 1990 World Day of Peace Message, 4; encyclical *Sollicitudo Rei Socialis* (On Social Concern), 31.

2. Humanity and creation in the Christian tradition

Living as an image of God

In the Biblical tradition, humanity experiences awe when standing before the power of nature over which we have no control. In that context, while developing culture and technology, humanity discovers a living ecological community with God's creation. Humanity, created from the dust of the earth, develops culture while responsibly cultivating and protecting the earth.

This image of humanity was further developed in the religious and cultural traditions of Christianity in the late Classical Period and the Middle Ages.

For example, from the sixth century on, the Benedictine monastic tradition founded by St. Benedict of Nursia (c.480-547) developed the wilderness of Western Europe in the spirit of Ora et Labora (pray and work). The focus of monastic life was the Mass and Divine Office, but that led to an attitude of gratitude and respect toward labor in the fields, manual labor and caring for livestock. This life marked by beautiful liturgies and loving care for the earth takes on the character of a sacrament, a visible sign of God's blessings. To the monk, then, to mistreat God's gift of the earth is a form of blasphemy. The relationship with God, the earth and all creatures practiced in Benedictine monasteries has been an expression in history of the ideal of Eden.

In the Middle Ages, the Franciscan followers of St. Francis of Assisi (1182-1226) praised all creatures as "brothers." Above all, they esteemed "poverty" that does not become a burden to this world and results in a life marked by peace. For Francis and his followers, nature is not measured by its usefulness, but should be received with joy, gratitude and praise as a gift because it is a mirror showing the presence of God. As such, the creation is the source of life, healing, reconciliation and creativity.

The medieval mystic Hildegard of Bingen (1098-1179) who left us her experiences in her writings and art was considered a prophetess. She was an expert in herbal medicine and botany, and a composer of liturgical music as well. At the core of her varied talents are life and healing, and with them a deep love and care for the green earth. Hildegard taught her unique sense that nature and humanity share a richly intimate relationship.

The theology of divinization *(theosis)*

This "image of God" based on the Bible is illuminated by a theology based on the relationship between grace and nature in the created world.

The Church Fathers in the early stages of Christianity, including Irenaeus (c.130-202) and Athanasius (298-373), thought that humanity was "divinized" through the mystery of Jesus Christ's incarnation, that the whole cosmos is sanctified in God's *oi-*

konomia (saving activity).[70] Divinized humanity is given a role of priestly mediation through which all of creation is drawn into communion with God and becomes the locus of sanctification.

The Church Fathers and the Eastern Churches even today are characterized by the fundamental thought, "Christ was made human that we might be made God."[71] Rather than concentrating upon the rupture between God and humanity that resulted from original sin, their starting point is the creation of humanity as the image of God and the perfection of that image in the incarnation of Christ. It is a positive viewpoint stressing that humanity shares the essence of God (cf. 2 Pet. 1:4) and singing the praises of God who so fully affirms humanity.

In this understanding, the *oikonomia* that is the history of God's cosmic salvific work began with the Father's creating. The incarnation of the Son showed its objective. And, moved by the Holy Spirit all creation engages in the Trinitarian "divine liturgy." Salvation history and the history of the Church that is part of it are a process of education for humanity to restore and perfect the image of God, that is, *theosis* (divinization). In this vision, through the working of the Holy Spirit, humanity regains the image of God, and through this sanctification the universe is also sanctified and raised to God. Thus, humanity and the rest of creation deepen their connection with each other through being united with God. In that case, there is no way that humanity might rule over nature in an exploitative way.

A synthesis of nature and grace

In the Middle Ages, Thomas Aquinas (1225-1274) synthesized the theology of the Catholic Church. He made use of the philosophy of Aristotle that viewed nature scientifically, as well as the *theosis* tradition of Eastern theology that taught that humanity is capable of becoming divine. Aquinas tried to look upon the world, humanity and history from the viewpoint of God, in other words, viewing everything in relationship with God. His statement, "Grace does not destroy nature, but perfects it," summarizes Aquinas's view.[72] Created nature will be raised by grace to a new nature, in other words, a super nature bearing new power. Creation has a supernatural destiny, communion with God. Humanity, the spirit-endowed creature, has the vocation of being the agent of that des-

[70] This is the core theological concept of the Eastern Church Fathers. It means, "the history of God's saving activity in the cosmos." The word comes from the Greek oikos (house) and nomos (system, law). Thus, it literally means "household management." It is the root of the words "economics" and "ecology."

[71] Cf. Athanasius, *On the Incarnation*, 54.

[72] Cf. *Summa Theologica*, Part 1, Question 1, Article 8.

tiny. When humanity participates in the life of God, nature also achieves its destiny.

Grace helps humanity to realize the love of God. That love attracts them, fills them, develops their love for God and enables the friends of God to grow in likeness to God. For Aquinas, that is *theosis*. And when humanity as friend of God grows to resemble God in love, goodness and elegance, then humanity's relationship with nature becomes one of service as image of God for the earth, as is written in Genesis.

For Aquinas, the activity of all natural things is, at the deepest level, the work of God. God continuously bestows existence upon creation and remains present to it. As humanity develops its biological, social, psychological and spiritual dimensions, it becomes free to engage the world around it and share in God's creative work. Aquinas's thought gives no support to an idea that humanity can separate itself from nature and exercise control as it wishes over nature. Rather, when all of nature, including humanity, is revered as God's creation, then God's plan for creation, harmony based upon the common good and justice, is realized. Each person must transcend his or her private good for the sake of the common good, living by the maxim that one must respect others. This means mutually recognizing and protecting the fundamental freedom of each person as the image of God. Therefore, Aquinas says, in the first place, justice urges people to seek the common good and to act accordingly. This is juridical justice (iustitia legalis). Second, the common good must be shared with each member of society according to their condition. This is distributive justice (iustitia distributiva). The third form, commutative justice (iustitia commutativa), aims at the construction of a peaceful and harmonious society in which all people can live together by correcting imbalances in the distribution of societal goods. This point of view also has implications for the ethics of modern environmental problems.

Loss of the medieval synthesis

In the second half of the Middle Ages, the relationship between nature and grace lost the Thomistic balance. Franciscan theologians like Duns Scotus (c.1266-1308) and William of Occam (c.1285-1347) emphasized the absoluteness of God's love and a religious commitment to complete dependence upon the will of almighty God. This differed from Aquinas's view that grace works in humanity to make it a new creation, changing instead to the idea of "encounter" and "relationship" based upon the "will" of persons. This position, called "nominalism," introduced a rupture between the natural and the supernatural. In time, this brought about a dualism between God and humanity, faith and reason, religion and science, flesh and spirit. In the anthropocentrism of the Renaissance and the modern Enlightenment, religion came to be considered a kind of emotional phenomenon separated from natural order. God and nature were thought to be unre-

lated, and thus humanity can take ownership of and rule over nature.

With the birth of modern science, the view of the relationship between humanity and nature, the concept of nature, the shape of society and ethics have all changed greatly. The concept of humanity as the "image of God" serving and governing the created world has been forgotten. Instead, humanity is considered to exist separately from nature. Using the power of technology, humanity goes beyond any limits, seeking absolute power. With that comes the loss of any concept of the common good among individuals, in society, and with nature.

The birth of modern science and the forgetting of the common good

With the birth of modern science in the 16th century, the medieval Scholastic philosophy represented by Thomas Aquinas was rejected. Francis Bacon (1561-1626) considered knowledge acquired through experiment to be the only true knowledge, knowledge that would enable humanity to govern nature. It was Bacon who coined the famous phrase, "Knowledge is power." René Descartes (1596-1650) also rejected Scholasticism, declaring that the clear and distinct contents of mathematical concepts are a better model of natural reality as created by God. The next step was to consider all of nature apart from the human spirit as a mathematically structured mechanism.

Thinkers like Galileo Galilei (1564-1642) and Isaac Newton (1642-1727) gave birth to modern science based upon the emphasis on empirical research of those like Bacon and the Cartesian view that natural reality is structured mathematically.

Thomas Hobbes (1588-1679) understood society mechanistically, just as Descartes understood nature mechanistically. For Hobbes, the basis of society is the fact that humanity in its natural state consists of "war of all against all." For Hobbes, political community is based upon a "social contract" among competing individuals, and justice consists in observing this contract.

For Immanuel Kant (1724-1804), pure reason (theoretical reason) can only involve phenomena presented to sensibility (sensation). Natural science develops from the application of intellect to phenomena. On the other hand, the only way to distinguish between the free subject and phenomena is through practical reason. Thus, Kant laid the theoretical foundation of modern science. From this period on, natural philosophy and ethics or metaphysics, reason and faith, natural science and religion followed separate paths.

With the progress of such modern scientific thought, the Biblical view that humanity exists in relation to the rest of creation, participating with it in developing the common good in accord with the intention of God, gradually faded. The Catholic worldview of humanity as the "image of God" disappeared.

3. Humanity and nuclear energy

Human-introduced nuclear fission

The modern Scientific Revolution of the 16th and 17th centuries triggered the Industrial Revolution of the mid-18th and 19th centuries in Europe. The steam engine was developed, and subsequently the generator. Physicists took the view that there was something common to heat, electricity and mechanical work, something they called "energy." Humanity had used the energy found in nature, by burning wood and utilizing the flow of streams, but with the invention of the steam engine and the generator more energy sources had to be acquired. People began to use coal and oil—the fruits of eons of interaction between soil, water, air and living things —as new sources of energy for motive power and the generation of electricity. These fossil fuels are consumed at a rate that vastly exceeds that at which they were produced. Today, the impact of this human activity on the earth has become enormous, and nature's delicate balance between earth, water, the atmosphere and living things is collapsing. In the 20th century, humanity learned to use the tremendous energy hidden in the nucleus of the atom, first for weapons and later for power generation.

Nuclear energy and the energy that gives rise to beta decay are the forms of energy that generated the cosmos. Outside the earth's environment, as nuclei are newly formed or change, powerful energy is emitted, including light and various other forms of radiation. In that situation, the nuclei are unstable and pervasive strong radiation makes life impossible. In the earth's environment, however, atomic nuclei are stable. As the planet's atmosphere and magnetic fields formed, most cosmic radiation was blocked from the earth's surface. Meanwhile, radioactive nuclides on the earth's surface weakened and radioactivity from subterranean rock was also attenuated as it rose to the surface. Thus, life could flourish and evolution could produce a multitude of life forms.

However, in the 20th century humanity introduced into the earthly milieu radioactive materials that are hardly to be found in natural state of that environment such as radioactive cesium and plutonium with its half-life of 24,000 years, bringing into danger the natural environment of the earth and life processes. Hannah Arendt (1906-1975), political theorist of the contemporary era, called this crisis situation in which humanity has been alienated from the natural environment of the earth "earth alienation" (Arendt, *The Human Condition*, 1958, Chapter 6).

The use of nuclear energy and the crisis of humanity

Where did the contemporary technological thinking that lead to the use of nuclear energy go wrong? The relationship between human beings and nature cannot be consid-

ered apart from the problem of relations among people nor, even more, from social systems. Unless they build mutual relationships that are free of discrimination and oppression, human beings will surely continue to be destructive of nature. By the same token, unless human beings build a relationship with nature that does not harm it, society will never be free of discrimination and oppression.

The methods that were used for the introduction of nuclear power were not based upon rational choices. Because of the massive quantity of nuclear energy involved, nuclear reactors cannot be built through a learning process based on trial and error. Further, although the development of safer reactors was a possibility, electric power companies built plants that used uranium as fuel. That was because the hugely expensive necessary infrastructure such as uranium enrichment facilities were already available for use thanks to the military establishments in nuclear-armed nations. In other words, what lay at the origins of nuclear power was not a rational cost-benefit analysis, but the interests of state supported by military power. In addition, open discussion of the risks of nuclear power generation was suppressed. (Radkau, *Nature and Power*, appendix to the Japanese translation, 2012, pp. 464-6). From the process and methods by which it was introduced, it is understandable that nuclear power carries with it the risk of the suppression of human freedom.

The use of nuclear power has the potential to strengthen social control by those with power in society. Contemporary thinker Robert Jungk (1913-1994) emphasized that the dream that the misuse of nuclear energy can be avoided and domestic safety in its use can be perfectly protected is an illusion, and that its use will lead to the loss of freedom and human nature, humanity's greatest treasures. Jungk, who, like Arendt, was a Jewish intellectual, was sensitive to the danger that a society can turn totalitarian. He warned that nations that promote nuclear power industry can turn into "nuclear empires", turning the whole nation into a sort of concentration camp. (Robert Jungk, *Der Atom-Staat — Vom Fortschritt in die Unmenschlichkeit*, 1977 Vorwort p.XII).

The Japanese scientist and critic of the nuclear power industry Jinzaburo Takagi (1938-2000) used the term "society under nuclear based control" for this kind of controlled society (Takagi, 1983, p. 215). Nuclear energy is many orders of magnitude greater than any of the other sources of energy that sustain daily life and life functions. That enormity increases the risk of creating society under nuclear based control. Nuclear energy comes to dominate all life and the human spirit, and people who try to use it yield to a distorted temptation to exploit this dominance. Humanity has aimed at acquiring the capacity to freely manipulate nuclear power, but we must be attentive to the fact that such control can only be acquired through strengthening control over people. (Takagi, 1983, p. 215).

A nuclear based social control has a big influence on not only social relations, but also affects human psychology, leading to a lack of concern for life and a high valuation of power. Since it has the potential to destroy all of humanity and even all of life, under the nuclear strategy that dominates the world today, the lives of individual human being and every other living thing on the earth has come to be something of little importance. Thus, in the carrying out of atomic weapons tests, harm to soldiers and civilians were considered an unavoidable price.

Even in the case of the so-called "peaceful use" of nuclear power, the situation is similar. Workers in the nuclear industry and others who are exposed to radiation from nuclear accidents are not treated as concrete and individual lives, but merely as statistics of mortality rates and occurrence probabilities (Takagi, 1996, p. 85). Such lack of concern for lives has linked itself with an economic system that emphasizes utility above all in all fields of production and living, and has strengthened the faith that is placed in size, power and material prosperity. As a result, the desire for material consumption continuously becomes ever more inflated, and the true meaning of human freedom has been lost from sight. In such circumstances is a spiritual life even possible?

Developing an ethics for the abolition of nuclear power generation is, therefore, closely related to the issue of regaining the original freedom that has been usurped by nuclear based social control. So, the movement to abolish nuclear energy is not simply aimed at appealing to those countries and industries that promote nuclear power to protect both health and the environment; it is also aimed at restoring freedom. In other words, it must be understood that it is a movement that aims to protect and preserve human relationships based not on mistrust but on trust and solidarity (Jungk, 1997, p.3, in the preface to the Japanese edition,). This will entail placing limits upon the continuously inflating desires of individuals and society.

Within the natural environment of the earth where life forms can survive, the nuclei of atoms are fundamentally stable. However, human use of nuclear energy has produced unstable atomic nuclei, and this has meant the introduction into the earth's system of a level of energy characteristic of the extraterrestrial cosmos that is too strong for living beings. We must not forget that the system that allows life on earth is grounded on a very subtle balance that is far from common in the cosmos. If we turn a blind eye to these facts and, in seeking control over nature and people, destabilize atomic nuclei, this will become a real crisis.

4. Contemporary environmental ethics

Ethical thought on environment

As mentioned above, the traditional Western understanding of nature has changed greatly since the scientific revolution that began in the 16th century. Nature has been isolated from any relationship with God and a mechanistic view of nature dominates. Following that, with the industrial revolution, the human ability to technologically manipulate nature expanded vastly. However, since the middle of the 20th century, many people, alarmed about the future of humanity because of the development of weapons of unprecedented destructive power and the prominence of environmental destruction, have begun to feel uneasy. This unease has led to the birth of environmental ethics in multiple forms. We will present an overview of the main points of view.

Environmental ethics addresses morally normative values for the relatedness of people and nature. The earth is a place where the various flora and fauna nurture each other's life and where the energies that make the survival of life possible interflow. All living organisms, including humanity, as a whole form a single community. From around 1950, thinking—a "land ethic"—was put forth that argued that this is only possible within an overall system of soil, water and air (Aldo Leopold, *A Sand County Almanac*, 1949, pp. 315-51). The American biologist Rachel Carson (1907-1964) sounded an alarm in her 1962 book *Silent Spring*, issuing an appeal warning of the dangers of the excessive use of chemicals destroying nature and damaging the human body, and raising the alarm that science and technology focused only on human interests are, in terms of both capacity and rate, overwhelming nature's original self-cleansing and self-healing ability.

This way of thinking took shape in the 1970s, when global environmental deteriorations had been emerging with heightened ethical awareness regarding the environment, especially in the United States, philosophical and ethical underpinnings for the environmental movement were sought. Discussions emerged with eco-philosophical perspectives, such as "Deep Ecology", which raised critical and ontological questions about how the rights of nature should be understood, human consciousness toward nature, and the very nature of modern society.

In 1992, the United Nations Conference on Environment and Development (UNCED, commonly called the Rio Summit or Earth Summit) was held in Rio de Janeiro, Brazil, with the theme of sustainable development. The "Rio Declaration" adopted as one of the outcome documents of the Summit is well known as an attempt to reflect the principles of "intergenerational ethics" in environmental policy. "Sustainable development" was understood as the idea that economic development must remain within a

range that can be sustained by the Earth's ecosystem, which involves ensuring that the present generation does not deplete resources that future generations will need (intergenerational justice) and seeking to eliminate the imbalance in resource use between the Global North and South, the gap between poverty and wealth (intragenerational justice). These concepts have become central ideas of subsequent international conferences and have become widely accepted (United Nations World Commission on Environment and Development, 1987; Tanaka, 2003, pp. 12-21).

Responsibility to future generations

In contemporary environmental ethical thought, the idea of "responsibility to future generations" (intergenerational ethics) is also important. Here, we will focus on Germany, where criticism of nuclear power resulted in policy changes.

In the period following the Second Vatican Council, in the latter half of the 1960s and early 1970s, in what was then West Germany there arose among Catholic and Protestant theologians a *Theology of Hope* (Jürgen Moltmann, 1964) and a *Theology of the World* (Johann Baptist Metz, 1968). These attracted much attention by their declaration that humanity is making progress toward the completion of the world. That view was popular for a while as well in Christian circles in Japan. These views were clearly influenced by the self-described atheist philosopher Ernst Bloch (1885-1977) in his books *The Spirit of Utopia* (1918; English edition, 2000) and *The Principle of Hope* (3 volumes, 1938-47; English edition, 1986). These books strongly appeal to the Marxist prophetic and utopian orientation, claiming that a socialist revolution will bring about human liberation and progress. In line with these challenges, progressive theologians took on board this historical thinking that considered it self-evident that history is trending toward a future completion. There was no mention of the dangers of nuclear power, just as Bloch had considered nuclear power a wonder energy that would contribute to human liberation and progress. The theology of hope and the theology of the world hardly made any use at all of the Catholic tradition that saw humanity as existing within nature. Rather, they inherited the modern Western tradition in which humanity objectifies and stands in confrontation with nature.

However, in the late 1970s, the idea of "responsibility to future generations" that criticized such progressivism arose. Its advocates were Hans Jonas (1903-1993), like Bloch a German Jew, and the Catholic philosopher Robert Spaemann (1927-).

Jonas's book *The Imperative of Responsibility* criticizes the progressive view of history that, since Francis Bacon's day, has held no doubt about the relationship between the progress of technology and humanity and emphasizes "responsibility to future generations." (Jonas, 1979; English edition, 1984). This means the responsibility for the present

generation to adopt a lifestyle that does not inflict damage on future generations. It can be expressed as the following obligation: "Act so that the effects of your action are compatible with the permanence of genuine human life." (p. 11) In this, it is particularly important to act keeping in mind the absolute worst that can happen in the future. Jonas' thought denies any dualism that sees "spirit and nature" in confrontation, but rather develops a metaphysics that sees humans as "members of nature," a view that has affinity with the Catholic view of nature (Jonas, *The Phenomenon of Life*, 1966). Thus, it restores the concept of the good that had been lost in modern ethics, setting it as the basis for his understanding of nature. What emerges from that is an ethics of responsibility for future generations.

Jonas warns that when introducing new technology it is essential to exercise extreme caution. Once a technology is introduced, it tends to "take hold," making it difficult for society to abandon it, even when better technologies appear. And, as has been the case of atomic weapons and nuclear power, the whole structure of society winds up being shaped in accord with the science and technology.

While the idea of a responsibility to future generations is a critique of the modern Enlightenment attitude that has expected unlimited progress in science and technology, it also presents guidelines for responsible action so that we who live in the present do not impose burdens on future generations. It greatly influenced both governing and opposition parties in the former West Germany. Of course, the fact that environmental deterioration and global warming had emerged as political and social issues was also part of the background for this. However, a movement in West Germany opposing nuclear power plant construction that began in the mid-1970s was another big factor. Although Jonas himself did not take any clear position regarding the problem of nuclear power, his theory of ethics and technology have had a big impact upon thinking about the issue. And it coincided with the beginning of the anti-nuclear movement in West Germany.

At the end of the 1970s as the anti-nuclear movement began in West Germany, the conservatively inclined Catholic philosopher Robert Spaemann declared that the use of nuclear power as an energy source cannot be ethically justified because, in the absence of a sure means of disposing of nuclear waste, nuclear power forcibly imposes a burden upon future generations. Instead, he urged the desirability of conversion to renewable energy sources. His position had a great influence upon the Catholic Church and Catholic intellectuals. Like Jonas, Spaemann criticized the modern view of humanity's domination over nature, considering ethics and ontology inseparable. He also criticized nuclear power from the point of view of an ecological metaphysics that sees humanity as a part of nature, and from that of responsibility ethics, and maintained a stance of opposi-

tion to the "peaceful use of atomic power".

Spaemann's pioneering anti-nuclear stance came from a different perspective from that of the progressive and left-wing elements of society and strongly influenced the German bishops. In 1980, the Catholic Bishops' Conference of Germany expressed a skeptical stance toward nuclear power. In 1998, the CBCG called for the abolition of nuclear power, and in 2000 again expressed their opposition to it.

Even more than Jonas and Spaemann, the sociologist Ulrich Beck (1944-2015) influenced German public opinion by calling for awareness of a "risk society ethics" that deeply involves responsibility for future generations (Beck, *Risk Society*, 1986; English edition, 1992).[73] Beck posits that the present era is the beginning of an era of "reflexive modernity" that must seriously consider the increased risks resulting from the environmental destruction that has come as a side effect of industrialization. Such risks as nuclear power plant accidents and climate change are created by humanity itself, and those catastrophes spread damage with no societal, geographical or temporal boundaries to their spread. The emergence of these new kinds of dangers is connected to the fact that in the process of modernization human decision making has become something that generates risks. The human victory over nature that has resulted from modernization has created results over which we have no control. Most institutions in society usually do not take into account the possibility of such large-scale disasters as nuclear accidents. So, once such a situation has occurred, no one takes responsibility for it, and society degenerates into institutionalized irresponsibility (Beck, interview in Asahi Shinbun, May 13, 2011). These risks extend to people of yet-unborn generations, and so a new ethics to prepare for them is essential.

Environmental justice

Alongside a responsibility to future generations, we must also take into account what is known in contemporary environmental ethics as "environmental justice." This concept emphasizes that while the wealthy can live in a good quality environment, socially vulnerable people such as minorities and the poor easily become the ones who bear the brunt of environmental damage. It first came to be discussed in North America in the 1980's as a protest against the "environmental racism" in which hazardous waste disposal facilities are concentrated in areas where poor people and African-Americans live, concomitant with a social movement aimed at correcting the unfairness in which minorities tend to become the victims of environmental destruction. It has become a serious

[73] Following the Fukushima nuclear power plant disaster, Beck was a leading member of the commission set up by the government of Angela Merkel that decided to end nuclear power generation in Germany in favor of safer generation methods.

topic of discussion since 1991, when the United Church of Christ Commission for Racial Justice sponsored a National People of Color Environmental Leadership Summit that adopted 17 principles on "environmental justice" (Kito, 2002).

Among these are (1) "affirming the sacredness of Mother Earth, ecological unity and interdependence of all species, and the right to be free from ecological destruction"; (2) a demand "that public policy be based upon mutual respect and justice for all peoples, free of any form of discrimination or bias"; (3) "protection from nuclear testing … and disposal of toxic/hazardous wastes"; (4) universal protection from nuclear testing that threatens the fundamental right to clean air, land, water, and food; (5) affirming "the right of all workers to a safe and healthy work environment without being forced to choose between an unsafe livelihood and unemployment"; (6) full compensation for all victims of environmental injustice and reparations for damage; and (7) quality health care. Though it was issued in the United States more than 20 years ago, given the current situation in Japan following the nuclear accident in Fukushima, the declaration deserves rereading here.

With the 1992 Earth Summit held in Rio de Janeiro, environmental justice came to be considered on a global scale. Since then, environmental justice has been described as being characterized by the "combined achievement of environmental conservation and social equity." There should be no circumstance where environmental protection is carried out for some wealthy people while on the other hand creating unemployed poor people in the name of protecting the environment.

In Japan following the Fukushima Nuclear Power Plant accident, the relationship of this rationale of environmental justice to human rights protection, particularly the Constitution's Article 25 dealing with the right to live and Article 29 concerning property rights, becomes particularly concrete. The question is how to distribute risk and support fairly and equitably. For example, children in Fukushima Prefecture are disadvantaged compared with children in other areas who are not threatened by radioactive contamination, forced to transfer to different schools or restricted from playing outdoors.

In addition, the situation of people who are working desperately at the nuclear power plant accident site to protect the welfare of Fukushima citizens and the whole nation must be considered from the viewpoint of environmental justice. In many cases these workers are employed by subcontractors, and close attention should be paid to whether they are being paid in accordance to the sacrifice they are making.

In connection with environmental justice theory, the word "sustainable" has become something of a buzzword. However, care must be exercised when using this term because it can become a sort of panacea, conveying the impression that unlimited economic

growth is possible in an age of environmental concern. Sustainability means protecting biodiversity, using natural resources and disposing of pollutants within the limits of nature's capacity to regenerate and purify, all on the premise of socioeconomic fairness. However, this term should be taken as a keyword of environmental justice, calling us to reconsider what we should seek in our relationships with God, people and other creatures.

5. *Laudato Si'*

The popes speak

Based upon what has been discussed regarding the Christian view of the environment and modern environmental ethics, where does the Catholic Church stand regarding nuclear energy and nuclear power?

Pope Francis issued his encyclical *Laudato Si'* in May, 2015. Though the encyclical deals with environmental issues, it does not mention the problem of nuclear power directly. However, there are many useful suggestions in it for looking at the problems presented by nuclear power, suggestions we will examine below.

We will begin by summarizing the basic view of the Catholic Church on environmental issues that popes have presented in the recent past and which form the background for *Laudato Si'*.[74]

The Second Vatican Council spoke of humanity's use of the earth and creation, and the progress of science and technology in the following way: "For man, created in God's image, received a mandate to subject to himself the earth and all that it contains, and to govern the world with justice and holiness; a mandate to relate himself and the totality of things to Him who was to be acknowledged as the Lord and Creator of all. Thus, by the subjection of all things to man, the name of God would be wonderful in all the earth."[75] The Council teaches that for believers, the fact that, through the activities of individuals and organizations, humanity has made tremendous efforts to improve their living conditions is clearly consistent with God's will. Humans are seen as stewards of nature, protecting and nourishing it, enjoying its fruits with the aid of advances in science and technology to cultivate and serve it in accord with God's will (Genesis 2:15).

Since the Industrial Revolution, there has been significant progress in various fields such as science, technology and the social sciences. This progress has, of course, been of great benefit to humanity. However, it has had a downside in the destruction of nature. When humans try to order the world for their own convenience, the "justice" between

[74] Cf. Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 456; John Paul II, encyclical Sollicitudo Rei Socialis, 34, 37.

[75] Vatican II, *Gaudium et Spes*, 34.

humanity and nature that Thomas Aquinas spoke of is destroyed. The result is a society in which greed, excessive lust for power and mistakes go unrecognized, and problems caused by some are blamed on others. In other words, human decisions that do not follow the true and the good give rise to "structures of sin" in the world. John Paul II called this "an anthropological error" because though everything that exists does so as God's gift even prior to human existence, humanity has forgotten that human power is based upon the grace of God.[76] To discover a just way for humanity to relate to the natural environment, steps will be required that are fully cognizant of the ever-expanding cravings of human beings.

Therefore, the teachings of the Bible and the magisterium of the Church indicate basic ethical standards regarding the relationship between humans and the environment. Popes repeatedly state that environmental problems are fundamentally matters of ethics and morals.[77] The environmental crisis leads to social crises, and the various crises that the world currently faces are fundamentally crises of morality and in that way they are all linked. Therefore our approach to the environment must be one that opens consciences to the ethical dimension.

Regarding those ethical standards, recent popes have raised various points.

The first principle is "reverence for life." Particularly, reverence for human dignity must be the foundation of any economic, industrial, scientific or technological plans that touch on the environment. If in the pursuit of productivity and profit workers' human rights are ignored or various forms of environmental pollution are caused, an attitude that respects life is clearly lacking. As industrialization proceeds in an unplanned manner, the result is increased pollution of the environment and adverse effects on people's health. Any development of the environment that is directed solely toward productivity goes against nature and will disturb the delicate balance of the ecosystem, disregard humanness, and ultimately destroy what is good for the whole of humanity.

Therefore, the second principle is awareness that the environment is the common property and a common good of all human beings, and care for it is a universal obligation of humanity. The environment must be appropriately used as a "cosmos" that has its own order and relationships.[78] We should not intervene in any ecosystem without considering nature as an integrated whole and paying sufficient attention to any impact on other ar-

[76] Cf. John Paul II, encyclical *Centesimus Annus*, 37.

[77] Cf. Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 459; John Paul II, encyclical *Sollicitudo Rei Socialis*, 34, World Day of Peace Message, 1990, 4, 5.

[78] Cf. Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 456; John Paul II, encyclical *Sollicitudo Rei Socialis*, 34.

eas and the safety of future generations.

Third, we must face the fact that natural resources are limited, and some of them are not renewable. We have a duty to not devastate the earth, but to hand it on to future generations. If we think of natural resources as being infinite and use them carelessly, we sin not only against the present, but also against people of future generations. The natural environment is the common heritage of humanity and is a gift from God to all. In using it, we take on a responsibility to those whose circumstances make them vulnerable, to future generations and to all humanity.[79] As mentioned earlier, this kind of awareness has become an essential theme in contemporary ethical thinking, as "intergenerational ethics" (responsibility for future generations).

The fourth principle is that in the protection and conservation of global environments, the issue of energy must be given serious consideration.[80] Energy resources are dominated by nations and companies and the disparity in and exploitation of those resources are the cause of many conflicts. Wars and conflicts force extra sacrifices upon poor countries that suffer death and destruction as well as stagnation and the decline of development as a result. Therefore, it is urgent that poor countries participate when the international community develops regulations for the management of exhaustible resources. This would be truly "global" in the sense that our globe as all creation would be involved.

This is also linked to the problem of peace. How much natural resources are wasted in war? Peace within and among ethnic and national groups would greatly help the conservation of nature. Peaceful agreements on resources and their use would constitute protection and welfare for the environment.

Finally, the popes appeal for a shift to a "human ecology."[81] That is, they preach that protection of the natural environment requires "protection of the environment for humans" and "protection of the environment for society." If we hope for peace, humanity must be more conscious of the relationship between respect for nature and respect for the human environment. An attitude that does not respect the natural environment also impairs human beings and their social coexistence. Conversely, if we do not respect human beings, we will inevitably damage the natural environment. Peace with creation and peace among people are two sides of the same coin. So, protecting humanity from self-destruc-

[79] Cf. John Paul II, encyclical *Evangelium Vitae* (The Gospel of Life), 48; Pontifical Council for Justice and Peace, *Compendium of the Social Doctrine of the Church*, 467; Paul VI, encyclical *Populorum Progressio* (On the Development of Peoples), 17, apostolic letter *Octogesima Adveniens* (The Eightieth Anniversary), 21; Benedict XVI, World Day of Peace Message, 2010, 8.

[80] Cf. Benedict XVI, encyclical *Caritas in Veritate* (Love in Truth), 49, 50.

[81] Cf. John Paul II, encyclical *Centesimus Annus*, 36, 38; Benedict XVI, encyclical *Caritas in Veritate*, 51; World Day of Peace Message, 2007, 8.

tion requires, as a responsibility to creation, exploring new ways of living symbiotically with the ecosystem of the planet that is now in crisis. That is human ecology.

Human ecology refers to human beings respecting every dimension of their own existence and integrally developing themselves in the social relations such as relations with the ecosystem and with life, sexuality, marriage, family, law, economy, politics, culture, etc. Education and law are necessary to foster such human ecology. It is also connected to a "social ecology" that includes urban planning that takes into consideration how people live, and issues of gender and labor as well.[82] This perspective is taken up by Pope Francis, who further deepens it using the concept of "integral ecology."

The composition of *Laudato Si'*

In his encyclical *Laudato Si'*, Pope Francis recapitulates the teaching of the previous popes on the environment and presents a new outlook. The title is taken from a phrase in St. Francis of Assisi's *Canticle of the Sun*, "*Laudato si', mi Signore*," (Praise be to You, my Lord), which praises God through all creatures. In his encyclical, the pope calls for an "ecological conversion" that heeds the cry of the Earth, and leads us to redirect our efforts toward responsibly protecting the beauty of what is our common home. The word "ecology" comes from the Greek word *oikos* meaning "house / dwelling." Therefore, the Pope speaks of "the earth, our home" (21).

The encyclical consists of a foreword and six chapters.

Chapter 1, "What is Happening to Our Common Home," is based on the latest results of scientific research on environmental problems, and refers to climate change, water problems and biodiversity, pointing out as well the ecological debt that the residents of the Northern Hemisphere owe to those of the Southern Hemisphere.

Chapter 2, "The Gospel of Creation," considers human responsibility toward nature, the intimate relationships among all creatures and the environment as the common asset of everyone, from the viewpoint of the Biblical Judeo-Christian tradition.

Chapter 3, "The Human Roots of the Ecological Crisis," analyzes the causes of the current environmental crisis in dialogue with philosophy and the human sciences. The encyclical finds the root causes to lie in the dominance of the technocratic paradigm and an extreme anthropocentrism. The document sounds an alarm over this kind of practical relativism that diminishes the dignity of personhood through such things as the dehumanization of labor and genetic manipulation.

Chapter 4, "Integral Ecology," proposes an "integral ecology" that comprehensively considers the place of humanity in this world and the realities that surround them. The

[82] Cf. John Paul II, encyclical *Centesimus Annus*, 38.

natural environment is closely related to the various spheres —economy, politics, culture, daily life— that make up people's lives. Therefore, the pope points out that environmental problems and social and human problems are inseparably related.

Chapter 5, "Lines of Approach and Action," states that sincere and transparent dialogue is necessary at every level of society, economy and politics.

Chapter 6, "Ecological Education and Spirituality," emphasizes the importance of education and training to create, maintain and develop good habits as a means to ecological conversion. The roots of the cultural crisis run deep, so it is not easy to change habits. Therefore, steps that involve all educational conditions are important. The encyclical argues that a new lifestyle will have a healthy influence on politics, economy and society and invites us to aim for an integral ecology that in small daily attitudes and a simple life shows responsibility for the world and consideration for the weak. In that context, the pope emphasizes the importance of an ecological spirituality that can be found in the spiritual traditions of the Church.

Humanity should praise God

By using the words of St. Francis of Assisi's praise of the Creator, *Laudato Si'*, as the title of his encyclical, Pope Francis shows that for him the starting point for thinking about ecology is the fact that the universe has been created with a God-given goal, and that the whole of creation and every existence within it has nobility and goodness. Thus, he quotes the Catechism of the Catholic Church: "Each creature possesses its own particular goodness and perfection. … Each of the various creatures, willed in its own being, reflects in its own way a ray of God's infinite wisdom and goodness. Man must therefore respect the particular goodness of every creature, to avoid any disordered use of things" (LS 69).

Regarding humanity's position in the created world, the encyclical follows earlier positions of the magisterium. However, the pope acknowledges that in the history of Christianity the relationship of humans toward nature has been viewed as a Promethean mastery (116). For the pope, the source of the world's current environmental problems is that humanity has lost sight of its place in creation, "presuming to take the place of God and refusing to acknowledge our creaturely limitations" (66) and distorting the command to "have dominion" over the earth (Gen. 1:28) and the mission to "till and keep it" (Gen. 2:15). In this, the originally harmonious relationship between humans and nature has changed to a confrontational one (LS 66, cf. Gen. 3:17-19).

Therefore, in seeking the roots of the environmental crisis, the encyclical looks at the present state of humanity. The necessary starting point is the perception that humanity must exercise responsible stewardship toward creation. Science and the technology that has

been derived from it cannot be denied, and should, in fact, be praised as a fruit of human progress. However, now "humanity has entered a new era in which our technical prowess has brought us to a crossroads" (102). The Pope points out that science and technology "have given those with the knowledge, and especially the economic resources to use them, an impressive dominance over the whole of humanity and the entire world" (104).

In this context, the pope shows concern about the power that technology has given to humanity. "Never has humanity had such power over itself, yet nothing ensures that it will be used wisely, particularly when we consider how it is currently being used. We need but think of the nuclear bombs dropped in the middle of the twentieth century, or the array of technology which Nazism, Communism and other totalitarian regimes have employed to kill millions of people, to say nothing of the increasingly deadly arsenal of weapons available for modern warfare. In whose hands does all this power lie, or will it eventually end up? It is extremely risky for a small part of humanity to have it" (104).

The basis of this concern is recognition that the development of technology has become self-propelling without having been accompanied by a development of prudence and moral consistency that could direct it. As the encyclical points out, "our immense technological development has not been accompanied by a development in human responsibility, values and conscience" (105), and appeals that, "A fragile world, entrusted by God to human care, challenges us to devise intelligent ways of directing, developing and limiting our power" (78). It quotes an address of Pope Paul VI: "the most extraordinary scientific advances, the most amazing technical abilities, the most astonishing economic growth, unless they are accompanied by authentic social and moral progress, will definitively turn against man" (4)

The pope finds problems not only in the self-propelling nature of technological development, but also in the kind of thinking that led to this situation. In the process of developing and applying technology, human beings become the subjects, and that which is studied, nature or specific beings therein, become objects that stand apart from humanity. In that process, humans unthinkingly forget that they themselves are inseparably a part of the nature that is the object of their studies and activities. For Francis, this indicates a difference between modern technology and more traditional human activity. "Men and women have constantly intervened in nature, but for a long time this meant being in tune with and respecting the possibilities offered by the things themselves. It was a matter of receiving what nature itself allowed, as if from its own hand. Now, by contrast, we are the ones to lay our hands on things, attempting to extract everything possible from them while frequently ignoring or forgetting the reality in front of us" (106).

And the Pope makes a further point regarding technology. "We have to accept that technological products are not neutral, for they create a framework which ends up con-

ditioning lifestyles and shaping social possibilities along the lines dictated by the interests of certain powerful groups. Decisions which may seem purely instrumental are in reality decisions about the kind of society we want to build" (107). The technology produced by human beings will inevitably come back and rain down on humanity itself. "We stand naked and exposed in the face of our ever-increasing power, lacking the wherewithal to control it. We have certain superficial mechanisms, but we cannot claim to have a sound ethics, a culture and spirituality genuinely capable of setting limits and teaching clear-minded self-restraint" (105).

Ecological Conversion

For people living in a modern technological society, what would constitute an appropriate relationship with nature? The pope points out, "If the simple fact of being human moves people to care for the environment of which they are a part, Christians in their turn realize that their responsibility within creation, and their duty towards nature and the Creator, are an essential part of their faith" (64).

Humanity must be sensitive to the various relationships in nature. "Responsibility for God's earth means that human beings, endowed with intelligence, must respect the laws of nature and the delicate equilibria existing between the creatures of this world" (68). The encyclical also strongly emphasizes the interconnectedness of relationships with the natural environment and relations among human beings and within society. "The creation accounts in the book of Genesis contain, in their own symbolic and narrative language, profound teachings about human existence and its historical reality. They suggest that human life is grounded in three fundamental and closely intertwined relationships: with God, with our neighbor and with the earth itself" (66). Francis further quotes from Pope Benedict XVI: "He observed that the world cannot be analyzed by isolating only one of its aspects, since "the book of nature is one and indivisible", and includes the environment, life, sexuality, the family, social relations, and so forth" (6).

In that sense, the encyclical strongly appeals for an "integral ecology." "This will help to provide an approach to ecology which respects our unique place as human beings in this world and our relationship to our surroundings" (15). To seek a good relationship with nature, we must seek good human relations and good social relationship at the same time. "A sense of deep communion with the rest of nature cannot be real if our hearts lack tenderness, compassion and concern for our fellow human beings. It is clearly inconsistent to combat trafficking in endangered species while remaining completely indifferent to human trafficking, unconcerned about the poor, or undertaking to destroy another human being deemed unwanted. …. Concern for the environment thus needs to be joined to a sincere love for our fellow human beings and an unwavering commitment

to resolving the problems of society" (91).

The reverse is also true. "It follows that our indifference or cruelty towards fellow creatures of this world sooner or later affects the treatment we mete out to other human beings. We have only one heart, and the same wretchedness which leads us to mistreat an animal will not be long in showing itself in our relationships with other people" (92). The pope especially emphasizes the situation of the poor and the socially disadvantaged. "Every ecological approach needs to incorporate a social perspective which takes into account the fundamental rights of the poor and the underprivileged. The principle of the subordination of private property to the universal destination of goods, and thus the right of everyone to their use, is a golden rule of social conduct and 'the first principle of the whole ethical and social order'. The Christian tradition has never recognized the right to private property as absolute or inviolable" (93). Instead, according to Francis, "The natural environment is a collective good, the patrimony of all humanity and the responsibility of everyone. If we make something our own, it is only to administer it for the good of all. If we do not, we burden our consciences with the weight of having denied the existence of others" (95).

Public dialogue

Therefore, the encyclical proposes a sincere and transparent dialogue at all social, economic and political levels. No projects can be effective without the involvement of a responsible conscience. Regarding the response to environmental problems, Francis says, "It is remarkable how weak international political responses have been. The failure of global summits on the environment make it plain that our politics are subject to technology and finance. There are too many special interests, and economic interests easily end up trumping the common good and manipulating information so that their own plans will not be affected. …. The alliance between the economy and technology ends up sidelining anything unrelated to its immediate interests" (54). The pope, noting that the such interests are reaching ever more deeply into contemporary processes, speaks of the importance of a broad collaboration and calls for a "new dialogue" at a global level., "We need a conversation which includes everyone, since the environmental challenge we are undergoing, and its human roots, concern and affect us all" (14). He calls for change not only at the level of abstract theory but also in our actual living.

6. Christian ethics and nuclear power

***Laudato Si'* and nuclear power**

Here, we will again examine what *Laudato Si'* suggests about nuclear energy and

nuclear power.

The following issues repeatedly appearing in *Laudato Si'* [83] can be said, in a sense, all to apply to the nuclear power problem:

- the intimate relationship between the poor and the fragility of the planet;
- the conviction that everything in the world is connected;
- the critique of new paradigms and forms of power derived from technology;
- the call to seek other ways of understanding the economy and progress;
- the value proper to each creature;
- the human meaning of ecology;
- the need for forthright and honest debate;
- the serious responsibility of international and local policy;
- a new lifestyle challenging the throwaway culture.

As we have affirmed thus far, nuclear energy and nuclear power bring various distortions to the way humanity and the world are viewed. The anthropocentric technocratic paradigm can lead to seeing neighbors, society and nature merely as means for the achievement of selfish purposes, producing consumerism and a throwaway mentality, as well as division and inequality in which the weak are dominated. People lose sight of the social sense of solidarity for the good of others deeply engraved in human nature, and come to accept individualism and selfishness, and even violence and exploitation. Dialogue in public society must not forget this point.

Chapter 3 of *Laudato Si'*, titled "The Human Roots of the Ecological Crisis," looks at technology in relation to this. The problems of modern technology analyzed in this chapter also apply to nuclear power. The encyclical, having expressed gratitude that technological advancements have improved people's standard of living (102-103), goes on to argue that, "they have given those with the knowledge, and especially the economic resources to use them, an impressive dominance over the whole of humanity and the entire world" (104). Further, "the technocratic paradigm also tends to dominate economic and political life" (109). This logic of domination destroys nature and exploits the weakest individuals and peoples.

The encyclical further points out that today's excessive anthropocentrism creates another logic, a "throwaway" mentality. Excessive anthropocentrism is the attitude that humanity no longer needs to accept its own legitimate position in the world, an attitude that overestimates its own abilities, and concentrates only on itself and its power. It regards everything, even the environment and human beings, simply as objects that can justifiably be disposed of, and produces countless forms of domination (123). Among

[83] Cf. Francis, encyclical *Laudato Si'*, 16.

these forms are such activities as the destruction of the natural environment, human trafficking, organ trafficking, discrimination and exclusion of children and the elderly, drug trafficking and fur trading of endangered species. All of these are born from human arrogance and a dominance-oriented logic. Labor issues are also involved in the throw-away logic. Francis declares, "Any approach to an integral ecology, which by definition does not exclude human beings, needs to take account of the value of labor" (124) and, "To stop investing in people in order to gain greater short-term financial gain is bad business for society" (128). This logic is at the center of the situation of nuclear power plant workers exposed to radiation.

Chapter 5 of the encyclical, "Lines of Approach and Action," points out the necessity not just of analysis, but of "dialogue and action which would involve each of us as individuals, and also affect international policy" (15). It is obvious that dealing with this situation cannot be merely an ideological, superficial or business idea that "is reduced to a series of marketing and image-enhancing measures." Rather, the encyclical emphasizes that deepening dialogue is indispensable to this action. "There are certain environmental issues where it is not easy to achieve a broad consensus. Here I would state once more that the Church does not presume to settle scientific questions or to replace politics. But I am concerned to encourage an honest and open debate so that particular interests or ideologies will not prejudice the common good" (188). The encyclical calls for an honest and fair development process in order to contribute to real "integral human development" in politics and business. This honest and fair dialogue will especially be a problem in dealing with nuclear power issues.

Universal reconciliation with every creature

We must admit that humanity's use of nuclear energy is a deviation from the God-given position of humans in nature. The vast power of nuclear energy and the large amount of unstable nuclei that it produces are incompatible with life, raising the serious risk of destroying the ordered community of living things. If we continue to ignore such dangers and to pursue illusions of wealth, our selfishness may lead to catastrophe for humanity and the global ecosystem. The various nuclear power plant accidents may already mark the arrival of the fruit of those desires.

In contrast, the salvation that Christianity aims at is expressed by the word "reconciliation." This reconciliation is "universal reconciliation with every creature" and includes "harmony between the Creator, humanity and creation as a whole" as mentioned in *Laudato Si'* (66). This must also be the starting point of our thinking about the problem of how the development of science and technology is to relate to human society. If science and technology cause destruction, division, exclusion, disparity, concentration of

wealth and power, and so on, they will become a hindrance to "universal reconciliation with every creature," neither will they contribute to true development for humanity. Therefore, from the viewpoint of "universal reconciliation with every creature," it is indispensable to consider the influence of the development of science and technology on human society and the natural environment.

In its efforts to practically address environmental issues, environmental ethics asks that the relationship between people and nature be understood and contextualized in relation to issues of social justice, the relationships among people. From the point of view of environmental ethics, Christians who have been reconciled to God through redemption by Jesus Christ must also be reconciled with other creatures. In that sense, with faith in God as Creator we have a duty to create a correct relationship with the created world (Jesuit Social Center Tokyo, 2012). In a true sense, we must build a society that can participate in God's work of creation. Therefore, we must consider energy usage that is suitable for human self-reliance and solidarity, and that while bringing abundance in each region and encouraging the distribution of wealth and economic activity, does not spoil what sustains life.

Integral ecology and the nuclear problem

We who live in modern times must actively pioneer a path beyond nuclear energy and nuclear power. What would such a process look like? Once again, we consider guidelines based upon the recommendations of *Laudato Si'*.

The core of the problem which runs through the whole of *Laudato Si'* is summarized in the following questions which can be called the keynote of this whole encyclical.

> What kind of world do we want to leave to those who come after us, to children who are now growing up? This question not only concerns the environment in isolation; the issue cannot be approached piecemeal. …. But if these issues are courageously faced, we are led inexorably to ask other pointed questions: What is the purpose of our life in this world? Why are we here? What is the goal of our work and all our efforts? What need does the earth have of us? (160)

The encyclical does not deal with the environmental problem as an isolated theme. Rather, it concerns itself with the entire globe in both space and time, looking at future generations as well as the planet. Furthermore, it says that it is important for us to think about our *raison d'etre* itself, in other words, the value underlying social life.

Therefore, throughout the entire document, *Laudato Si'* appeals for considering

things "integrally." The key to that is "integral ecology" as a new way of thinking of justice. It is "an approach to ecology which respects our unique place as human beings in this world and our relationship to our surroundings" (15). "Nature cannot be regarded as something separate from ourselves or as a mere setting in which we live" (139). Likewise, "the analysis of environmental problems cannot be separated from the analysis of human, family, work-related and urban contexts, nor from how individuals relate to themselves" (141). It is also connected with the various aspects of our lives —economy, politics, culture, our daily life— as well as our encounter with ourselves. And so, integral ecology is a way of life that takes into account all the dimensions of the existence of creation as well as us human beings.

The term "integral ecology" emphasizes the link between environmental problems and social-human problems. "We are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental" (139). Therefore, "An integral ecology is inseparable from the notion of the common good" (156).

"The common good" is the sum of various conditions of social life for individuals belonging to the community in order that they may more richly and easily live a fulfilled life. It is the reason and purpose for which human beings lead a social life. The Catholic Church teaches that public communities like nations and political power exist to promote the common good.[84]

Practically speaking, *Laudato Si'* states that the principle of the common good requires us to make a preferential option for the poor. For in contemporary societies "injustices abound and growing numbers of people are deprived of basic human rights and considered expendable" (158). The encyclical says that opting to value the common good by being in solidarity with such people and the next generations as well is the basis for sustainable development in the world.

Quoting Benedict XVI's *Message for the 2010 World Day of Peace*, Francis says, "in addition to a fairer sense of intergenerational solidarity there is also an urgent moral need for a renewed sense of intragenerational solidarity" (162). "Solidarity" is the resolution to work together for the common good, dedicating ourselves for others. In other words, it is putting into practice love of neighbor. *Laudato Si'* aims at the establishment of a world culture in which integral human development becomes possible through solidarity that does good for one's neighbor.

How do nuclear energy and nuclear power fit into such a picture?

Laudato Si' emphasizes giving priority to the weak in society for the sake of the

[84] Cf. John XXIII, encyclical *Pacem in Terris* (Peace on Earth), 48.

common good. However, nuclear power and nuclear weapons increase those socially vulnerable groups. Politicians, bureaucrats, nuclear power companies, nuclear power experts and the media influenced by money interests form a bloc with great political, economic and social influence. The vast majority of citizens who do not belong to that bloc do not have the capacity to receive accurate information and are driven into positions of vulnerability where they must submit to rule from above. Furthermore, nuclear power production leaves waste to future generations who have not yet been born, a vulnerable existence in that sense, and imposes on them a very troublesome and dangerous burden.

The political community exists to realize the common good by improving human dignity. But nuclear energy and nuclear power contradict this. A nuclear accident mentally as well as physically destroys the families that are the basis of human life. It distorts politics and economics through the rule of power. As the Catholic Church teaches, the chief purpose of human beings with all of creation together is to create a world suitable for human beings as the image of God, where they fulfill God's will by realizing their connection with God. Politics and economics should be valuable means of making society suitable for human beings. However, nuclear weapons completely destroy the conditions for people to achieve any self-actualization proper to humanity. Even though nuclear power creates economic wealth, at the same time it ultimately denies the cultural, moral, and transcendent values that are the goal of the common good.

Pope John XXXIII in his *Pacem in Terris*, emphasized repeatedly that the most basic values that human beings must pursue in social life are "truth," "freedom," "justice" and "love." It is important to see through social realities involved with nuclear energy and nuclear power from the perspective of these basic social values.

Truth —Does the information reported by the media accurately convey the truth? By hiding and distorting facts are the media supporting those interested in profit rather than the common good?

Freedom —Are people's freedom of action and speech against unfairness and the immorality of the nuclear industry, as well as against government and local administration, restricted or suppressed?

Justice —Simply put, justice means restoring to people that which they rightly deserve. But how can justice be realized for users of nuclear energy, nuclear related industries, governments and residents in plant development zones or accident victims?

Love —Are we aware of love not only at an individual level, but also of social and political love? How do we practice acts of love that improve the lives of our neighbors or aim for a society that can eliminate social factors that underlie poverty and injustice?

Chapter 2
Other Churches and Religions Wrestle with the Problem

The problem of nuclear power cannot be solved by one country alone. Besides Japan, Catholic bishops' conferences and their organizations in various countries are addressing this issue. We can learn a lot from their statements.

Moreover, many religious groups in addition to Catholic ones favor abandoning nuclear power generation. The messages opposing nuclear power of those other organizations are not only helpful for us, but also open the possibility of collaboration.

In Germany, both Catholics and Protestants have been involved with the government in the decision-making process of decommissioning nuclear power plants. Also in Europe, Austria has already abolished nuclear power. And in Asia, the Korean bishops' conference has deepened its concern with this problem. We will now look at the activities of various national bishops' conferences forcefully opposing nuclear power. We will also look at the situation in Japan among non-Catholic religious groups and believers.

1. Countries moving toward nuclear phase-out

Germany

Germany is the country that reacted most sensitively to the Fukushima nuclear power plant accident. The government immediately stopped the operation of old-style nuclear power plants and reexamined the safety of all nuclear power plants. Chancellor Angela Merkel convened an Ethics Commission on a Safe Energy Supply that published a report on the necessity of closing down nuclear power plants and energy conversion. In July 2011, the Bundestag (parliament) decided to phase out all 17 domestic nuclear power plants by 2022.

There are two factors that enabled Germany to make a decision on nuclear power before other countries. One is that, under the Social Democratic Party (SPD) administration in 2002, the country had already decided to abolish nuclear power by the 2020s. The abolition of nuclear power had become the established route of German energy

policy, even while the Merkel administration, mainly the Christian Democratic Union (CDU), in 2010 extended the period of nuclear power plant operation. Another factor is the result of an anti-nuclear power movement active since the 1970s. Citizens have repeatedly discussed the pros and cons of nuclear power, and the Green Party, which raises environmental issues as a policy priority, has also grown into a powerful political party. Public opinion against nuclear power generation especially increased after the 1986 Chernobyl nuclear power plant accident caused radioactive contamination. The government also set out measures to develop renewable energy.

Sixty percent of the German population belongs to one or another Christian church, and the churches are an integral part of German society. They play a moral leadership role in society. Remarks by church leaders are expected regarding problems that require consideration from an ethical and ideological point of view. That was why the Merkel administration invited three church leaders (two Catholics and one Protestant) to join the Ethics Commission on a Safe Energy Supply.

Why Christian churches appeal for nuclear phase-out

The German Catholic and Protestant churches all view the huge risks of nuclear power as a problem of human lifestyle and evaluate the right and wrong of its use from an ethical point of view. The basis of the churches' evaluation is the principle of "responsibility" deriving from God's commission to humanity in the Bible "to till the earth and keep it" (Gen. 2:15). The order of the natural world created by God as "very good" (Gen. 1:31) is the basic condition for all lives to grow healthily. To protect this, human beings have a responsibility to organize their lives so that future generations will not face dangers to survival due to environmental pollution and climate change and so forth. If humans relinquish this responsibility and continue a way of life that caters to their desires without limit, they will destroy the ecosystem beyond recovery. This will bring injury and suffering not only to other living creatures but also to humanity itself, which is part of the natural world.

The German churches have tackled with theological inquiries of whether or not the use of nuclear power with insoluble difficulties therein can be compatible with a life based on faith in God. A question of right or wrong regarding the use of nuclear power has been taken as a question touching on the essence of faith.

The German government and its Ethics Commission

Public opinion more than anything else has driven the Bundestag's decision to phase out nuclear power in Germany, but the Ethics Commission on a Safe Energy Supply also played a large role.

The report summarizing the discussions of the Ethics Commission told the German people of the necessity of phasing out nuclear reactors and the need for energy conversion. The document does not call for the abolition of nuclear power in other countries. However, in the chapter discussing the ethics of people making use of nuclear energy, it considers the question of whether human beings can responsibly use it. It takes an in-depth look from a philosophic point of view at the problems of the lifestyle of people and societies using nuclear power, and raises various questions. Related to this point, Japanese society can learn two things from the Ethics Commission report.

First, it is important to note that the Ethics Commission was composed not of nuclear experts, but of 17 academic, industrial and Christian intellectuals. The role of the Ethics Commission was not to propose measures for securing nuclear reactor safety from the viewpoint of engineering technology, but to consider the pros and cons of using nuclear power from an ethical point of view, and to rethink the way of life and society that is appropriate to human beings.

The ethical assessment of the use of nuclear power must be based on a proper evaluation of the risks involved. The fact is that regardless of how careful the safety measures, nuclear power cannot escape the risk of huge accidents. Unlike accidents involving fossil fuel powered automobiles and aircraft, a nuclear power plant accident can endanger society to the point of making survival impossible. At the time of the Fukushima nuclear power plant disaster, the head of the Atomic Energy Commission assumed that in "the worst-case scenario" tens of millions of residents would have to evacuate. Masao Yoshida, who was the Fukushima Daiichi nuclear power plant manager at that time, and who bore the heavy responsibility for damage control at the site, told investigators that when the accident occurred he imagined "the annihilation of East Japan."

Even without causing a huge accident, the risks of nuclear power extend to many areas of society. These include exposure of workers to radiation; the danger of the spread and military diversion of plutonium; environmental contamination caused by radioactive leakage from nuclear power and reprocessing plants; the huge costs and hazards associated with the storage, transportation and disposal of spent nuclear fuel; the imposition of nuclear waste management on future generations; the stress on local residents caused by uncertainty about the possibility of accidents and reinforced by evacuation drills. All these risks only appear when nuclear power plants operate. Evaluating such risks overall requires not only expertise in nuclear power, but also that of specialists in various fields. This was the role of the Ethics Commission.

In Japan on the other hand, most members of the government council discussing nuclear energy policy are known to be nuclear power plant promoters. Consequently, inconvenient objections to the conclusions desired by bureaucrats are suppressed and at

the stage of selecting members for the council the direction of policy has already been determined. In such a policy-making mechanism those who foresaw the occurrence of a huge accident were not effectively involved in Japan's risk assessment of nuclear power plants. So, it is a lesson never to be forgotten that a group of people who closed their ears to objections monopolized nuclear risk assessment and that led to the Fukushima nuclear power plant accident.

The second important point is that the Ethics Commission in Germany made clear the principles of ethical evaluation concerning the pros and cons of nuclear power. The report of the committee considers whether or not to use nuclear power based on the principles of "sustainability" and "responsibility."

The principle of sustainability involves the protection of the natural environment and the realization of a fair society. The commission says, "Germany's safe future rests on three pillars of sustainability: an intact environment, social justice and a healthy and powerful economy." (Ethics Commission on a Safe Energy Supply, *Germany's Energy Turnaround – A Collective Effort for the Future*, 2011, p. 8). Energy supply adapted to these principles maintains economic competitiveness and employment while sustaining the standard of living and the peace of society.

Another principle of responsibility is ecological, which is also mandated by the German constitution.[85] As the Ethics Commission puts it, "The ecological responsibility of human beings for nature sets out to preserve the environment and protect it, and not destroy it for selfish purposes, but to increase its usefulness and preserve the chances for securing future living conditions." (Ethics Commission on a Safe Energy Supply, *Germany's Energy Turnaround – A Collective Effort for the Future*, 2011, p. 11).

Based upon these two principles, the Ethics Commission concluded that a nuclear power phase-out and energy conversion are necessary. Renewable energy with less risk is expected to spread in Germany, and technological developments for energy efficiency are progressing, while German civil society recognizes the necessity of energy saving. Such a society recognizes that it is no longer justifiable to use nuclear power that involves the risk of huge accidents that endanger sustainability and force upon future generations the permanent burden of nuclear waste management.

The important thing to note here is that ethics that consider the sustainability of society and take responsibility for the natural environment and the survival of future generations are the value base supporting German civil society. Regardless of differences

[85] "Mindful also of its responsibility toward future generations, the state shall protect the natural foundations of life and animals by legislation and, in accordance with law and justice, by executive and judicial action, all within the framework of the constitutional order." Basic Law (constitution), Article 20a.

in their political positions, people widely accept this. Proposals from the Ethics Commission do not set forth a unique viewpoint, but rather inherit the arguments for environmental protection and the anti-nuclear power movement championed by German citizens for years. The significant history of discussions over the pros and cons of nuclear power generation in German civil society, including in universities and churches, supports the contents of the report.

Unfortunately, compared with Germany, citizens in Japan lack a way of thinking that considers the right or wrong of nuclear power as a problem of human living. Once the peaceful use of atomic energy became national policy, it became an obvious premise that nuclear power "contributes to the welfare of human society and the improvement of the living standard of citizens" (Article 1, The Atomic Energy Basic Law). Citizens who doubted this were a minority. However, since Japanese society has experienced the worst nuclear accident in history, would it not be appropriate that discussion among Japanese citizens regarding the phasing out of nuclear power should go beyond even that of the German Ethics Commission? In this sense, the report of the Ethics Commission is a good reference, suggesting future tasks for Japanese citizens who desire a nuclear power phase-out.

A letter issued by Archbishop Robert Zollitsch, then president of the Catholic Bishops' Conference of Germany, on the first anniversary of "3/11," summarized the position of the German Church:

> Of course, when questions about the safety of nuclear energy arise, specialists in this field should give the first response. However, Christian faith regarding Creation imposes an obligation and responsibility to protect the earth given by God as 'a home of life' where all creatures can safely live in the future.
>
> Sustainable action seeks solidarity not only in the present, but with future generations as well. It is not directed solely at human beings, but requires behavior and conversion toward creation based on environmental justice. Energy problems have long been discussed: limited resources, threatening consequences caused by climate change, and the fact that quite a few people cannot obtain energy from public sources at a reasonable price urgently necessitate a shift in energy policy.
>
> It must start with reducing energy use, improving the efficiency of that use and finding the best sources of alternative energy. Therefore, I would like to thank everyone who supports the new energy policies.
>
> In thinking about Japan one year after the catastrophe, the important

> thing is not to treat the energy problem as just one of energy, but to propose a different way or complementary way forward. This catastrophe has taught us that we must take a new look at creation. We will do our best to fulfill this responsibility. (https://www.dbk.de/presse/aktuelles/meldung/erzbischof-dr-robert-zollitsch-zum-1-jahrestag-der-katastrophe-von-fukushima/detail/)

Austria's Constitution and the Church's stance on it

A referendum was held in Austria in 1978, prompted by a movement against the construction of the Zwentendorf nuclear power plant along the Danube River. This resulted in a law that prohibits the use of nuclear energy for electricity production in Austria. Thus, the country turned from being one of the last developed countries not yet having nuclear power generation to the first developed country without nuclear power generation. And in 1999, Austria unconditionally banned the manufacture, experimentation and use of nuclear power generation and nuclear weapons under the Constitution. Reasons cited for opposing nuclear power include threat to health caused by emission of radioactive materials, unresolved problems of management and disposal of nuclear waste, the military connection, insufficiency of emergency measures in case of disaster and the fact that gigantic earthquakes had occurred in the areas surrounding nuclear power plants. Furthermore, Austria prohibits the import of electricity produced by nuclear power.

The Austrian bishops have expressed their support for these positions. On April 26, 1996, the 10th anniversary of the Chernobyl nuclear accident, the official publication of the bishops' conference noted that both within the Church and outside it there are people who warn about the dangers of nuclear power. The bishops affirmed that "we support and thank these people."

On March 17, 2011, a statement by Bishop Elmar Fischer was posted on the website of the Austrian Bishops' Conference. The statement said, "There is no choice other than the rapid abolition of nuclear power plants," and insisted that the management of nuclear power generation is beyond human ability. It called for a switch to renewable energy and a lifestyle with less energy consumption.

The Austrian Church commemorates Hiroshima Day on August 6 each year. On Hiroshima Day 2011, shortly after the Fukushima nuclear power plant accident had occurred, Cardinal Christoph Schönborn said that the Fukushima accident showed that the peaceful use of nuclear energy is ultimately uncontrollable. Numerous other bishops also called for the realization of a world without nuclear power.

2. Other bishops' conferences tackle nuclear power problem

The Catholic Bishops' Conference of Korea and nuclear power generation

Korea has long relied on nuclear power for a considerable part of its power consumption. However, the country received a big shock from the Great East Japan Earthquake and the Fukushima nuclear power plant disaster. The Catholic Church of Korea recognized that the threats and issues of nuclear power require serious consideration, and published a document that, grounded in faith, explored the problem in detail.

There had already been campaigns against nuclear power in Korea before 3/11. When transmission towers were needed in connection with the construction of a new nuclear reactor at the Kori Nuclear Power Plant in the Busan suburbs, citizens of the local village, especially the elderly, opposed the construction. The Federation of Korean Catholic Church Women Religious decided to care for these *halmeoni* (grandmothers) with all their might. And so, the movement against the construction of the towers became the focal point of the Korean Catholic Church's movement for phasing out nuclear power.

In addition, Catholics continued their resistance movement in Samcheok to the planned construction of a nuclear power plant in that city in northeastern Gangwon-do. The movement was successful, and in June 2014, a mayor was elected who opposes nuclear power generation. The halt of nuclear power plant construction is opening up.

The Catholic Bishops' Conference of Korea, which maintains close relations with its Japanese counterpart, issued "Nuclear Technology and the Teachings of the Church – Episcopal Reflections on Nuclear Power Generation" in October 2013.[86]

This document is a reflection on the nuclear power problem and the kind of attitude that should be taken based on the situation of Korean society. At the same time, it has pioneering significance in that the Korean Catholic Church has led the way in calling for a worldwide abolition of nuclear power beyond the boundaries between countries or peoples. Pope Francis' encyclical *Laudato Si'* did not mention abandoning nuclear power generation. The Korean bishops have taken the message of the encyclical one step further and have provided a model for dealing with the issue.

"Nuclear Technology and the Teachings of the Church," starting from treatment of nuclear power safety issues, considers various problems related to nuclear technology, such as the environment, economics, society, peace and alternatives to nuclear power generation. The document not only presents arguments against nuclear power, but in-

[86] A 9-week course titled "Catholic School for Nuclear Power Phase-out" opened in Seoul on September 17, 2014. The Subcommittee for Environment under the Bishops' Conference Committee for Justice and Peace prepared this course to educate Catholics in the teachings of the Catholic Church on nuclear technology and issues.

cludes arguments in favor of it so that readers might understand the problem and make informed judgments. It is based upon the social teachings of the Catholic Church, and tries to think about the nuclear power problem from the point of view of fundamental principles, such as human dignity and the common good.

The basic idea is that the nuclear power problem will not be solved by political compromises over interests or by sacrifices coerced upon the vulnerable, but by all citizens' serious considerations for future generations. This includes an awareness that solutions entailing moderation and sacrifice will be found only through people's own decisions.

At the same time, "Nuclear Technology and the Teachings of the Church" encourages government authorities responsible for the present and future of the state to make efforts to establish an active anti-nuclear policy and to protect human dignity and life, bringing about truly sustainable development based on individual reflection and decision.

Countries where bishops have been silent on the nuclear power problem

There are places where bishops' conferences have not issued statements on nuclear power and others where there are not yet clear and unified views, even though there are nuclear power plants in their areas, as for example, in Finland, France, India, Slovakia, South Africa, Spain, Sweden and the United Kingdom.

France has the world's largest proportion of nuclear power generation to total power generation.[87] Since the Fukushima disaster, the Justice and Peace Committee of the Bishops' Conference of France and individual bishops have raised questions regarding the purpose and necessity of nuclear weapons and nuclear energy. However there are also bishops who are in tune with those who advocate nuclear power. Since 1905, France has had a policy of separation of politics and religion *(laïcité)* that has led to a deeply rooted sense in civil society that religion is a private matter. As a result, there is opposition to any religious influence in public matters. Even if the bishops' conference were to come to some unified position and issue statements about the national policy on nuclear power, it is obscure whether such statements would have social impact.

Bishops' conferences that are speaking on the nuclear power problem

The following bishops' conferences have not made formal declarations on nuclear power, but have made certain observations because there are nuclear power plants in their areas, or there are concerns that their country will suffer harm from nuclear power plants in neighboring countries, or their countries are exporting uranium.

[87] According to the Japan Industrial Forum, as of August 1, 2014, France had 58 reactors on-line, producing 78 percent of the nation's electric power.

(1) Ireland

There are no nuclear power plants in Ireland. But on the coast of England near the Irish Sea, there is the nuclear facility called Sellafield (formerly named Windscale) that caused the worst nuclear accident in UK history.[88] This facility consists, among other things, of a nuclear reactor and a nuclear fuel reprocessing plant. The reprocessing plant has caused serious marine pollution not only in the Irish Sea but the whole surrounding sea area of due to many accidents.

The Catholic Bishops' Conference of Ireland *per se* has not announced any official statement regarding nuclear power generation, but many bishops oppose such generation. In 1978 when the construction of a nuclear power plant in Ireland was proposed, Auxiliary Bishop James Kavanagh of Dublin participated in a symposium in which administrative officials, academics and labor unionists who opposed the construction gathered, and he cooperated in issuing a statement. On November 11, 2012, then Archbishop Dermot Clifford of Cashel, in response to plans announced by the UK to build 10 nuclear power plants including Sellafield, announced that the Irish Bishops' Conference "oppose emphatically" such construction. Archbishop Clifford said that the bishops' conference and 95 percent of the bishops opposed nuclear power generation. He pointed out the dangers to the western United Kingdom and the eastern part of Ireland and called for switching to renewable energy.

(2) Australia

There are no nuclear power plants in Australia, but the country has the largest confirmed uranium reserves in the world, 31 percent of the world's supply. Australia is an exporter of uranium and 12 percent of uranium traded on international markets in 2012 was from Australia. In connection with changes of governments, proposals to build nuclear power plants in Australia have frequently been floated and the possibility cannot be ruled out in the future.

The Catholic Church's justice and peace committee has strongly opposed uranium mining. Many of the mines are located on Aboriginal land, and the committee points out the infringement of their rights, the contamination of the surrounding environment due to mining, and concern about military use.

Catholic Social Services Victoria and the Melbourne Catholic Commission for Justice, Development and Peace with ecumenical collaboration fostered by the Social

[88] The Windscale reactor was a British military plutonium production furnace. On October 10, 1957, a fire occurred in the nuclear reactor of Unit 1. Part of the fuel melted, and a large amount of radioactive material was released into the environment, a serious accident. Regarding the background of the accident, see Nishio, 2015, 18-20. Windscale was renamed Sellafield in 1981.

Questions Commission of the Victorian Council of Churches set up a research project and summarized the results. In 2007, a booklet titled *Nuclear Power: Cure or Curse?* was issued. This was based on the recognition that considering the pros and cons of nuclear power was an unavoidable task for uranium exporter Australia. Bishop Christopher Toohey, chairman of the Bishops Commission for Social Justice – Mission and Service (now Bishops' Commission for Justice, Ecology and Development), wrote its preface. This booklet, billed as "A Discussion Paper," stresses various points.

- **Uncertainty of Acceptable Radiation Levels on Human Body.** Differing from claims made by nuclear power promoters, there exists some scientific research suggesting that safe-dose threshold cannot be found and even a very small amount of radiation can cause harms.
- **Doubts about the effectiveness of nuclear power as a measure against global warming.** Even though nuclear power does not emit greenhouse gases during power generation, considering the emission of greenhouse gases from the mining of resources to the disposal of waste, it is ultimately not very different from fossil fuel emissions, and so it is not an efficient substitute power generation plan.
- **The danger of accidents.** There have been accidents in Chernobyl, Three Mile Island and Tokai village. Especially in Japan, accidents frequently occur. Considering the accident at the Kashiwazaki-Kariwa Nuclear Power Plant caused by the Niigata Chuetsu-oki Earthquake in 2007, there is concern about the earthquake-resistant strength of nuclear power plants in Japan. (N.B. This report predates the 2011 Fukushima disaster.)
- **Low economic efficiency.** Nuclear power generation always depends upon government subsidies. Above all, cost overruns in power plant construction are normal.
- **Potential connection to nuclear weapons.** In terms of technology, nuclear plant development will enable the development of nuclear weapons. There is no effective mechanism to prevent the diversion of such technology to nuclear weapons.
- **Nuclear waste.** The problem of nuclear waste has not been solved yet.

(3) Switzerland

In 1978 the Swiss Bishops' Conference issued a pastoral letter titled "Energy and Lifestyle." Although it does not address the issue of nuclear power in detail, it shows concern about the danger and points out that there is as yet no answer to such concern.

In 1982, the bishops of Basel (Switzerland), Strasburg (France) and Freiburg (Germany), all of them in an area where many nuclear power plants had been built, issued a cross-border joint statement on nuclear power. Rather than an analysis of nuclear power itself, it deals with the relationship between technological development and the ethics,

the limits of human capability to manage the dangers of nuclear plants and the necessity of consideration for future generations.

In 2000, the Swiss Justice and Peace Commission issued a pamphlet called *Ethics and Energy Policy* that also covered nuclear power. The pamphlet points out that the two biggest problems with nuclear power are the danger presented by the plants themselves and the fact that waste from those plants remains hazardous for tens of thousands of years. Overcoming the dichotomy of an either-or choice between nuclear power generation and fossil fuel power generation that contributes to global warming, the commission calls for a new way of thinking that promotes the development of renewable energy sources and a lifestyle that reduces energy consumption.

(4) United States

In 1981, the Committee on Social Development and World Peace of the United States Conference of Catholic Bishops released a statement in response to the experience of the oil crisis of the 1970s titled *Reflections on the Energy Crisis* that also looked at nuclear power generation. The problems listed were the danger of nuclear power generation itself, waste problems and the connection to nuclear weapons. This statement does not completely condemn the use of nuclear power, but points out that the safety proved "beyond reasonable doubt" is a necessary condition. It also points out that the right to participate in the process of policy decisions on nuclear power should be given to everyone affected.

3. The Holy See's position regarding the nuclear power problem

As an environmental and energy problem

While a number of bishops' conferences, as mentioned above, favor a nuclear power reactor phase-out, the Holy See has yet not spoken clearly on the issue.

Before the encyclical *Laudato Si'*, popes had spoken frequently about human control capabilities and the environmental crisis. For example, Pope John Paul II in *Redemptor Hominis* (1979) said:

> This state of menace for man from what he produces shows itself in various directions and various degrees of intensity. We seem to be increasingly aware of the fact that the exploitation of the earth, the planet on which we are living, demands rational and honest planning. At the same time, exploitation of the earth not only for industrial but also for military purposes and the uncontrolled development of technology outside the framework of a long-

> range authentically humanistic plan often bring with them a threat to man's natural environment, alienate him in his relations with nature and remove him from nature. Man often seems to see no other meaning in his natural environment than what serves for immediate use and consumption. Yet it was the Creator's will that man should communicate with nature as an intelligent and noble "master" and "guardian," and not as a heedless "exploiter" and "destroyer." (15)

In addition Benedict XVI in his *Caritas in Veritate* (2009) also states:

> *The Church has a responsibility towards creation* and she must assert this responsibility in the public sphere. In so doing, she must defend not only earth, water and air as gifts of creation that belong to everyone. She must above all protect mankind from self-destruction. There is need for what might be called a human ecology, correctly understood. The deterioration of nature is in fact closely connected to the culture that shapes human coexistence: *when "human ecology" is respected within society, environmental ecology also benefits.* Just as human virtues are interrelated, such that the weakening of one places others at risk, so the ecological system is based on respect for a plan that affects both the health of society and its good relationship with nature. (51)

Change in the attitude of the papacy to the nuclear issue

Remarks on environmental problems by the Holy See were mainly focused on climate change, energy, and ecological consciousness. References to nuclear power are extremely rare. Article 470 of *The Compendium of the Social Doctrine of the Church* states, "it will also be necessary to … increase the security levels of nuclear energy." It is, however, perhaps the only mention among official Church documents.

It appears that before 2011 the Holy See did not have major doubts about nuclear power. So long as the highest safety standards for humans and the environment were put in place and the use of nuclear power for weapons were prohibited, no problem was seen with the peaceful use of nuclear power. In fact, the Vatican has been a member of the International Atomic Energy Agency (IAEA) since its inception. Pope Benedict XVI, commemorating the 50th anniversary in 2007 of the establishment of the IAEA, stated, "The Holy See, fully approving the goals of this Organization, is a member of it since its founding and continues to support its activity," while seeking "to promote a progressive and agreed upon nuclear disarmament and to support the use of peaceful and safe nucle-

ar technology for authentic development."[89]

It is necessary to understand that there are two backgrounds to the Holy See's position on matters such as this. One is its role as the leader of the Catholic Church, clarifying the teachings of the Church. The other is that of a sovereign nation participating in a diplomatic exchange in the international community. Remarks on the IAEA by the Holy See, of course, belong to the latter category.

The Vatican joined the IAEA because it was understood that this organization contributed to the peaceful use of atomic power which should succeed nuclear military use.[90] Therefore, the themes that dominate declarations of the Holy See to the IAEA are the promotion of peace and economic development for peace. During the oil crisis of the 1970s, nuclear power was considered the most stable and low-cost energy supply for developing countries and also as providing relatively clean energy. For that reason, the Holy See took a position promoting nuclear power.[91] Nuclear energy was thought to help fight poverty and disease by encouraging economic development in poor areas and contributing to the peaceful settlement of the serious problems facing humanity.

The Holy See's position promoting nuclear energy remained unchanged through the autumn of 2010.[92] However, nuances in subsequent declarations show subtle changes. Declarations in support of nuclear power disappeared. Instead, calls for nuclear nonproliferation, the abolition of nuclear weapons, the prevention of diversion of nuclear power to nuclear weapons, the safety of nuclear technology, the problem of waste management and other uses of nuclear technology (medicine; agriculture; seawater desalination), etc., became the focal point of the Holy See's remarks, along with appeals for a system that guarantees poor nations to make access to such technologies.[93]

Especially since the Great East Japan Earthquake and the Fukushima power plant disaster, and given that the Catholic Bishops' Conference of Japan issued in November 2011 a statement calling for an end to nuclear power generation, the Holy See's view of the use of atomic power has shown changes.

On June 9, 2011, just before an Italian referendum asking whether to resume nu-

[89] Benedict XVI, Angelus, July 29, 2007.

[90] Prof. Hermann J. ABS, Statement at the 19th Session of the General Assembly of the IAEA, Vienna, September 24, 1975.

[91] Prof. Hermann J. ABS, Statement at the 18th Session of the General Assembly of the IAEA, Vienna, September 17, 1974.

[92] At the General Assembly of IAEA held in Vienna on September 22, 2010, the Vatican's special representative Monsignor Ettore Balestrero declared that for the sake of peace and human development the Vatican would "continue to support" IAEA efforts on behalf of the safe and reliable use of nuclear energy.

[93] Pontifical Council for Justice and Peace, *Energy, Justice, and Peace*, Chapter 2, IV, 5, Paulist Press (2016), pp. 46-48.

clear power generation, Pope Benedict XVI, speaking to newly-accredited ambassadors to the Holy See, said, "One of our political and economic priorities must be to adopt in every way a manner of life that respects the environment and supports the research in and use of forms of energy that preserve the patrimony of creation and are that safe for human beings." In the referendum (conducted June 12-13, 2011), over 90 percent of voters were opposed, and thus nuclear power generation was not resumed in Italy. Benedict mentioned Japan's nuclear power plant disaster in his January 9, 2012, New Year greeting to the ambassadors to the Holy See, "We cannot disregard … ecological disasters like that of the Fukushima nuclear plant in Japan," and he stressed the importance of protecting the environment and the ecosystem. Pope Francis at the time of the Japanese Bishops' ad limina visit in March 2015 compared contemporary civilization represented by the nuclear power plant accident to the Tower of Babel and he warned that human conceit might cause the destruction of civilization.

In the encyclical *Laudato Si'* the attitude toward nuclear power is still cautious. However, the encyclical does mention "the effects of nuclear energy use" among numerous "risks to the environment" (184). Also, regarding the tremendous abilities that have been given by modern technologies including nuclear technology, it says, "More precisely, they have given those with the knowledge, and especially the economic resources to use them, an impressive dominance over the whole of humanity and the entire world." It points out that there is no guarantee that knowledge will be wisely used, and that it is "extremely risky" for a small part of humanity to grasp it (104).

In a sense, then, it can be said that the pope has various strong concerns about nuclear power generation. But he has not clearly condemned it nor has he called for its abandonment or phase-out.

There are certainly some people in the Holy See who aggressively promote nuclear power.[94] Of course, there are others who take a cautious stand against it. Among those opposed to nuclear power generation, some call upon the Holy See to withdraw from the IAEA. In that case, however, voices in the IAEA calling for peace and nuclear nonproliferation, the abolition of nuclear weapons, environmental protection, etc. would be reduced. For that reason, it may be difficult for the Holy See to take a stance against nuclear power.

4. Nuclear phase-out calls from other Christian communities and other religions

Following the Fukushima Nuclear Power Plant accident and the difficult situation

[94] A prominent example is Cardinal Renato Martino who was the Vatican's ambassador to the United Nations from 1986 to 2002 and later became president of the Pontifical Council for Justice and Peace responsible for issuing the *Compendium of the Social Doctrine of the Church*.

of the victims afterwards, Japanese religious organizations have expressed various attitudes towards phasing out nuclear power.

Protestant Churches

Since soon after the Fukushima accident, Japanese Christian organizations have expressed deep concern over the serious damage, and have called for phasing out of nuclear power generation in Japan. The National Christian Council in Japan (NCCJ), which is comprised of Protestant Churches and the Anglican Episcopal Church in Japan (NSKK), issued a statement on April 11, 2011, a month after the disaster, calling for the immediate and total abolition of nuclear power generation. In addition, the Japan Baptist Convention (November 11, 2011), the Christian Network for a Nuke-Free Earth (December 25, 2011), the United Church of Christ in Japan (March 27, 2012, March 11, 2013), the Japan Evangelical Lutheran Church (May 4, 2012) and NSKK (May 23, 2012) have issued similar statements.

The 10th Assembly of the World Council of Churches (WCC) was held in Busan, South Korea, in October and November 2013. At this conference of the world's largest organization of Protestants and other Churches, participants from Japan, South Korea and New Zealand strongly appealed for ending nuclear power generation. In response to this international movement, the WCC Central Committee adopted a "Statement towards a Nuclear-free World" in July 2014.[95]

Among the Statement's specific recommendations are:

(1) To sustain and deepen ethical and theological discussions about civilian and military uses of nuclear energy, discerning what purposes they serve, how much they actually cost, whose interests they serve, what rights they violate, their impact on health and the environment, and whether there is actually evidence of the effectiveness of using nuclear power or in accepting protection from nuclear arms;

(2) To develop and practice an ecologically sensitive spirituality to guide transformative changes in individual and community lifestyles; to make positive changes in energy consumption, efficiency, conservation and the use of energy from renewable sources; and to build on the experience of environmentally conscious churches in the WCC;

(3) To practice and promote divestment from businesses and financial institutions involved in the production of nuclear weapons or nuclear power and related exports, and to advocate for the reallocation of government spending from nu-

[95] Statement towards a Nuclear-free World, July 7, 2014 (The World Council of Churches Central Committee, Geneva, Switzerland, July 2-8, 2014).

clear weapons and nuclear power to the development of renewable energy and the redevelopment of communities where nuclear industries are closing;

(4) To support rehabilitation, pastoral accompaniment, legal action and compensation for losses for the victims of nuclear accidents and nuclear tests including survivors of the Fukushima disaster in Japan and victims of nuclear tests in the Pacific; similarly, to support the lawsuit filed by the Marshall Islands against the nuclear-armed states at the International Court of Justice.

The statement of the WCC, which is said to represent 500 million Protestant and other Christians in the world, followed extensive lobbying efforts by Japanese Christians.

Religious and interreligious activities and declarations

The Japan Committee of the World Conference of Religions for Peace (WCRP) held its 39th Study Meeting of Religious for Peace in January 2013 with the theme "Nuclear Energy and Contemporary Society - Responsibility for the Future." Anglican Bishop Makoto Uematsu of the WCRP Japan Committee board and the primate of NSKK explained the purpose of the gathering:[96]

> The accident at the TEPCO Fukushima Daiichi Nuclear Power Plant in the Great East Japan Earthquake scattered radioactive materials not only in the immediate area but also over a wide range, threatening people's lives. We have realized that nuclear power generation itself is extremely dangerous. Even without accidents, the use of nuclear power itself, from the fuel mining stage to the waste disposal process, imposes sacrifices upon the weak. We have learned from this great earthquake that it threatens the life that has been given by the Divinity.

Behind these movements following the nuclear accident, there are the efforts of religious people who have worked for years on the nuclear power problem. There is an organization called "Association of Religious People Rethinking the Nuclear Power Governance" formed in 1993.[97] This group consists of religious people with various backgrounds, mainly Buddhist and Christian. Many of the members are religious people who have dealt with the nuclear power problem for a long time. The sustained efforts by this

[96] WCRP Religions for Peace Japan, "39th Religious Studies Meeting for Peace: Nuclear Energy and Contemporary Society - Responsibility for the Future," 2014.

[97] For details of the establishment of the organization, see http://mukakumuhei.com/. Members' messages are summarized in『原発　総被曝の危機―いのちを守りたい』(*The crisis of total exposure to nuclear generation – We want to protect life*), Tokyo, Yugakusha. (in Japanese).

association of religious and interreligious groups and individuals has shaped the basis for questioning nuclear power by religious people since the accident at Fukushima. "Religious People Call for Abolishing Nuclear Power Plants," a document by dozens of religious believers from various traditions including Shinto, was published on July 13, 2012.

Declarations by Japanese Buddhist organizations

In September 2011, the Rinzai Zen Myoshinji School issued "Declaration: Achieving a Society Not Dependent on Nuclear Power Generation." The Shinshu Otani sect adopted a "Resolution to Seek the Realization of a Society Free of Nuclear Power Generation through Stopping All Nuclear Power Plants and Decommissioning Reactors" in February 2012. In June 2012, the Rissho Kosei-kai issued a public statement, "Toward a Truly Prosperous Society: Beyond Nuclear Power."

In his Peace Proposal issued in January 2012, "Human Security and Sustainability: Sharing Reverence for the Dignity of Life," Daisaku Ikeda, president of Soka Gakkai International, which has great political influence in Japan, said, "I therefore urge a rapid transition to an energy policy that is not reliant on nuclear power." However, after that, Komeito, a political party supported by Soka Gakkai, being part of the coalition government, has been playing a supporting role to the government's policy of promoting nuclear power. The consistency of its position has been questioned both inside and outside the religious group.

Particularly noteworthy was the December 1, 2011, declaration by the Japan Buddhist Federation, to which most traditional Buddhist sects belong, "Seeking a Way of Life Not Dependent on Nuclear Power Generation." The statement points out, "Japan is the only country in the world that has experienced atomic bombings," and then, "because of that misery and suffering we Japanese continue to proclaim to the world the preciousness of life." It stressed, "In the shadow of the pursuit of convenience, people living near nuclear power plants spend their daily lives threatened by accidents and a legacy of radioactive waste that cannot be processed. We create the waste and leave the problems to the future."

The declaration further states that the infringement on life by nuclear power is unacceptable from the viewpoint of the peace that the Buddhist spirit desires.

> Based on the Buddhist spirit, the Japan Buddhist Federation has worked toward world peace in order to build a society in which everyone's life is respected. But, on the contrary, we have expanded our desire for comfort and convenience. In the shadow of the pursuit of convenience, people living near nuclear power plants spend their daily lives threatened by accidents and a legacy of radioactive waste that cannot be processed. We create the waste and

> leave the problems to the future. That is why we must deeply regret that we have opened ourselves to nuclear accidents that threaten peaceful lives and even life itself.

And finally, the declaration shows that the basis for seeking a life not dependent on nuclear power is grounded in a religious spirit.

> The Japan Buddhist Federation calls for reducing dependence on life-threatening nuclear power generation and aims to realize a society using sustainable energy not dependent on nuclear power. Rather than desiring prosperity built on others' sacrifices, we must choose a way that harmonizes individual happiness and the welfare of all.
>
> As we individually face this issue as a challenge for all of us, we will rethink our way of life, get rid of excessive material desires, know what's enough, and do our best to realize a humble living before nature. We thus pledge that we will build a society where everyone's life is protected.

This presents an ethical ideal based on Buddhism that seeks to know what is sufficient and live humbly before nature without dependence on nuclear power that threatens life.

An individual Buddhist's position

In Japan, religious groups *per se* generally do not concern themselves with political problems. That tendency is particularly strong in the traditional Buddhist world. Under such circumstances, the fact that after the Fukushima nuclear accident the Japan Buddhist Federation issued its statement had great significance. Moreover, it was unusual for Buddhist organizations and individuals to clearly declare their opposition to dependence on nuclear power. The Monshu (chief priest) of the Jodo Shinshū Hongwanji School, Koshin Ohtani, is a rare example of an influential person who represents a major religious school declaring his personal support for a nuclear power phase-out.[98]

In his 2014 book, Ohtani points out that nuclear power have three "unsolved fundamental problems."

> First, current science and technology cannot render radioactive waste

[98] Koshin Ohtani,『いまを生かされて』(*Living Now*), Tokyo, Bungeishunju, 2014, in "Afterword."

harmless. … It takes tens of thousands, or hundreds of thousands or even millions of years before radioactive waste is no longer dangerous to humanity. … In building nuclear power plants, people focus on their immediate interests to the detriment of the future.

Second, once a major accident happens, there is a possibility that it cannot be dealt with. The recent accident (Fukushima) is a typical example. … Among the nations of the world, Japan has very many volcanoes, earthquakes and tsunami. Our mountains including the beautiful Mt. Fuji, valleys and Inland Sea islands are all gifts of crustal movement. There is no way we can think that nuclear power plant sites are exempt from that geologic movement. … Is there any place where the impermanence of all things does not apply?

Third, the operation of nuclear power plants even in normal circumstances inevitably exposes workers to radiation. If those workers could find safer work that paid the same, they would not take the more dangerous option. It is those who are vulnerable and without options that are sacrificed. With the decline in Japan's birth rate and the aging of society, labor shortages will be filled by laborers from other countries where economic conditions are not good. This is the internationalization of discrimination. Is that what a beautiful country does? Is that what a wise country does?

In addition to these three points, Ohtani adds further reflections under the heading "As those who are loved by Amitābha."

Human desires are unlimited. In earlier times, because outside physical and social limitations were great, desires controlled themselves. However, in modern times, through the use of intelligence, various restrictions have been removed, and desires can be fulfilled as they are.

But human intelligence is still incomplete and cannot adequately control the negative consequences of the realization of desire. An extreme example is the use of nuclear energy. There is no future for humanity if we just decide what we want now without considering whether it is possible to harmonize our choices with the future survival of other living things, including human beings. It is not our task to eliminate desire, but to lead it toward harmony.

To that end, we need a sense of values that transcend day-to-day interests. The Enlightenment at which Buddhism aims, i.e., becoming the Buddha, can be a hint for that.

Ohtani looks upon the immorality of nuclear power and says that Buddhism should be able to present "a sense of values which transcend day-to-day interests." He is an example of how the problem of nuclear power, like the problem of war and peace, is an important ethical problem with which religions must be involved.

Chapter 3
The possibility of natural energy

When all of Japan's nuclear power plants were stopped in 2011, it became clear that the country does not face an electricity shortage even without nuclear power. Therefore, phasing out nuclear power generation does not necessarily require "alternative energy." Even so, it is important to know about the possibilities that can replace nuclear power. Germany, anticipating sufficient profitability, has already converted to natural energy development as a national policy. Throughout the world, nuclear power generation is already considered to be behind the times. In developing countries where infrastructure is not well established, small-scale natural power generation is spreading rapidly. Japan should also focus on its research and development.

Nuclear power is supported by the profit community's closed structure known as the "nuclear power village." As a result, there has been little possibility for local residents to have a say in important decisions concerning nuclear policy. On the other hand, promoting renewable energy would provide increased opportunities for local residents to participate in decision making related to energy production and consumption. This would also likely deepen mutual ties among citizens. Switching from a lifestyle that consumes energy without restraint to one that utilizes energy in moderation is a necessary condition for building a self-sustaining society.

To promote such a shift, including plans to save electricity, it will be necessary to deepen the lifestyle of "poverty" mentioned in the 2011 bishops' statement. Promoting energy saving and creating for ourselves social systems that sustain it are also the way to promote the "ecological spirituality," "integral ecology," and "ecological conversion" advocated by Pope Francis. So, let us now consider the possibilities and current state of natural energy and how we must live in order to benefit from them.

1. Conversion to renewable energy

Various forms of new energy

For the realization of a sustainable future society, new sources of energy are needed. Because of the global need to reduce carbon dioxide emissions, "renewable energy" is

especially indispensable.

With regard to energy, various terms have progressively appeared. The same word is often used with various meanings depending on the context. An understanding of the various terms related to energy regulation is therefore necessary in any discussion of a nuclear-free society.

"Renewable energy" is obtained from endurable natural phenomena such as sunlight, wind, geothermal heat, solar heat, heat existing in the atmosphere and nature, and biomass (organic matter derived from animals and plants). It is also called "non-exhaustible energy" because there is no worry of its exhaustion in the future. This is the opposite of non-renewable or exhaustible energy (fossil energy) sources such as petroleum, coal and natural gas. The use of non-renewable energy discharges environmental pollutants such as carbon dioxide and nitrogen oxide, whereas renewable energy does not emit these and so is sometimes called "clean energy."

From the viewpoint of use, renewable energy may be classified into two categories: "natural energy" and "recycled energy." "Natural energy" includes "solar power" converting sunlight directly into electricity, "solar thermal energy" using solar heat to supply hot water and air conditioning, "wind power" generating electricity by the rotation of windmills, and "snowmelt energy" providing cooling by snow and ice stored during winter. "Recycled energy, on the other hand, uses biomass to generate electricity. Biomass is a collective name for biological resources from animals and plants such as wood chips and waste materials, biomass gas, sludge or manure that are either burned directly or converted into gas.[99]

In daily life, the terms renewable energy and natural energy are often used interchangeably. On the other hand, the term "new energy" is also often used of new energy sources and new ways to produce energy.

In Japan's New Energy Law enacted in 1997 and revised in 2002, "new energy" refers to non-fossil fuels. More broadly, however, new energy includes renewable energy, recycled energy and even such exhaustible energy sources as fossil fuels.

Among natural new energy sources that are already beginning to function are solar power generation, solar thermal utilization, wind power generation and snow and ice heat utilization. In addition to biomass use for power generation, waste incineration, refuse derived fuel, and reusing cooking oil as diesel fuel are among various forms of recycled energy. Exploiting the temperature difference between the atmosphere and river water or utilizing heat exhaust from factories are other possible sources of new energy

[99] Utilization of biomass energy resources means that the emission and absorption of carbon dioxide is "carbon neutral," generating and fixing equal amounts of carbon dioxide, and thus keeping the amount of carbon dioxide on the earth constant.

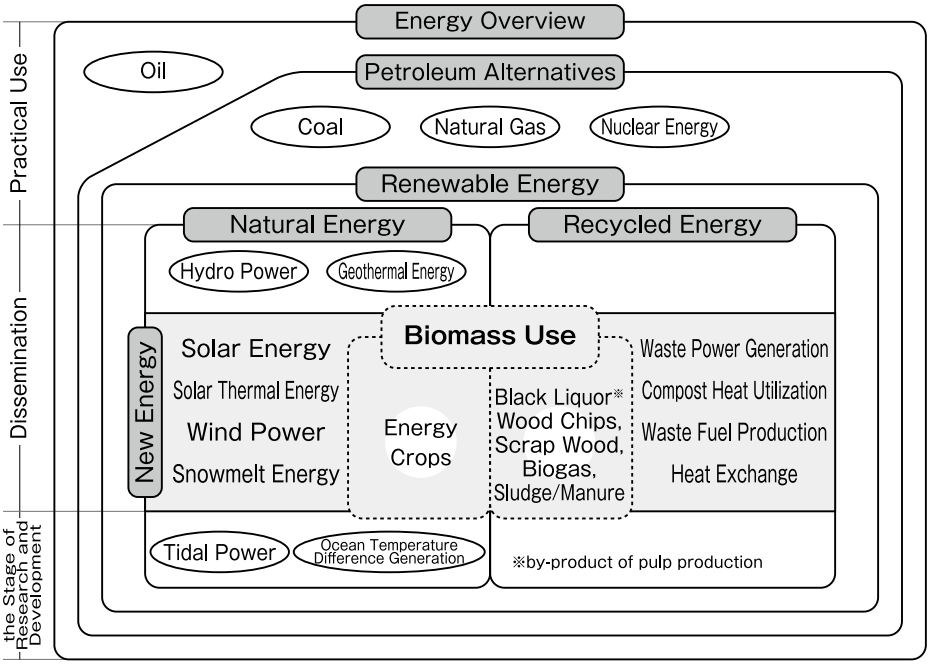


Diagram 3.3.1: New Energy

that are being researched. Small-scale hydro generation and geothermal generation are already in use, and wave power generation and ocean thermal energy conversion are in the stage of research and development but legislatively these are not specified as new energy. (Diagram 3.3.1)

"New energy" can include the use of exhaustible resources when new ideas and technologies enable their cleaner and more efficient use. The heat generated by Cogeneration of natural gas can be used to produce hot water and heating. Fuel cells that generate electricity through a chemical reaction between hydrogen and oxygen are yet another form of new energy.

There are already well-known examples of the use of new energy for transportation. Electric vehicles do not emit exhaust gases. Hybrid vehicles combine gasoline engines and electric motors. Vehicles that use natural gas for fuel have reduced harmful emissions. Methanol-fueled vehicles are also in use.

There are many forms of new energy, and Japan with its variety of geographic features, climates, seasons and natural blessings can expect to be home to various renewable energies.

Dissemination of renewable energy

Renewable energy is not immune to criticism. For example, it requires large initial capital investments, and because reliance upon daylight is easily affected by the weather, assuring a stable supply is difficult. Compared with existing energy, renewable energy is still expensive and not yet efficient. In addition, due to geographic conditions, restrictions may be imposed upon the installation of facilities. A further criticism is that the installation and operation of facilities may cause environmental damage.

However, research, development and introduction of practical renewable energy are progressing rapidly. New energy offers advantages in terms of stability because renewable energy is distributed by small facilities set up in various places. Thus, it is possible to disperse the risk of accidental blackouts as compared to large-scale centralized power sources like nuclear power. Furthermore, it is possible to adapt the type, scale, method of operation etc. of renewable power plants to the topography, weather and climate of the region. Policy developments such as a fixed-price purchase system, total purchase system, separation of electrical power production from power distribution and transmission, and new ideas like roof lending and solar sharing are making renewable energy practical globally (Iida, 2011).

According to a report by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, "The Current Situation and Problems Surrounding Renewable Energy, 2014," the share of renewable energy generation as a percentage of all electricity production of the main advanced nations is Spain 30%, Germany 22%, UK 11%, France 15% and the United States 12%. Japan's share is 11%. Regarding this, Lester Russell Brown points out that Japan seems unaware that the country is being left behind in a worldwide energy shift (Brown et al, 2015). Based upon its success thus far, Denmark, which obtained 39 percent of its electricity from wind power in 2014, plans to increase that to 50 percent by 2020. Furthermore, the country is planning to obtain from renewable energy all its domestic electricity and heat by 2035 and all energy, including transport energy, by 2050. While in Japan coal-fired power plants continue to be built, in the United States, of more than 500 coal-fired power plants operating at the beginning of 2010, more than 180 have already closed or are scheduled to be closed. In the U.S., there are 600 companies and agencies that generate and procure all their electricity from renewable energy sources. In China, wind power now exceeds nuclear energy, and coal consumption began to decrease in 2014.

To promote renewable energy in Japan, an "Excess Electricity Purchasing Scheme for Photovoltaic Power" that obligates power companies to buy the excess electricity generated from sunlight at homes and business places went into effect in November 2009. A "Feed-in Tariff Scheme for Renewable Energy" began in July 2012. Under this

scheme, the country guarantees that electric power companies will purchase electricity generated by renewable energy at set prices. Electric power companies collect a "Renewable Energy Levy" from electricity users and use it to subsidize the introduction of still costly renewable energy. After the introduction of this system, by 2014 renewable energy use excluding large-scale hydropower rose from 1.4 percent to 3.2 percent in three years. The introduction of renewable energy capability has increased sharply since 2012, with capacity reaching 39.42 million watts as of the end of March 2015. The average annual capacity growth rate has risen by 33 percent.

However, Japan is only six percent self-sufficient for its energy needs, and there is a high reliance, 90 percent, on exhaustible energy. Clearly, Japan must establish a new relationship with energy.

On April 1, 2016, "generalized liberalization of electricity retailing" for households began. In the Tokyo metropolitan area, different industries such as gas companies, mobile phone companies and railroad companies can now provide electricity with a variety of rate plans. By contracting with companies that use more renewable energy for power generation, consumers can choose a lifestyle that follows their values by reducing stress on the environment. The choices of many individual consumers together become a force to influence the direction of the power market.

Examples of Renewable Energy Initiatives and Future Possibilities

Various effects can be anticipated from the introduction of renewable energy. Lowering dependence on imported fuel will improve energy self-sufficiency, thus contributing to energy security. In the event of an emergency, even if it becomes difficult to supply energy from large-scale sources, renewable energy has the advantage of ensuring that at least some energy can be provided to a region. Another fruit of renewable energy is its contribution to preventing global warming by reducing carbon dioxide emissions, thus advancing the implementation of environmental policies. Increased employment opportunities in related businesses and community revitalization through cooperation among residents are other major advantages that come from introducing renewable energy.

The renewable energy fixed price purchase system covers five types of energy: solar, wind, hydro, geothermal and biomass. There are already concrete examples of each sort (Agency for Natural Resources and Energy, 2016; Land Policy Bureau, 2014).

Solar power generation, which uses photovoltaic cells to convert solar energy into electricity, is extensively used from general households to mega solar installations. It has the advantage of being relatively easy to maintain and can be used as an emergency power supply. The downside is that output depends on the weather and concentrating generation in a certain area leads to voltage rises in the power distribution system which

require costly power regulation.

The citizen-owned solar power generation business "Ohisama Fund (Sun Fund)" in Iida City, Nagano Prefecture, has attracted nationwide attention as a groundbreaking model of local production for local use of energy. This private company which functions as an NPO has funded the installation of photovoltaic facilities on the roofs of public buildings and provided generation units to private homes with no initial investment required. By the end of March 2013, the fund had 1,878 investors and a value of 1.18 billion yen. Residents take pride in their accomplishment, community involvement has increased, the population has grown, and regional revitalization has advanced thanks to increased local investment. For Iida, this regionally focused renewable energy business is a solution to problems common in mountainous areas in Japan such as a declining birthrate, an aging population, declining social infrastructure resulting from population decrease and declining regional identity. Citizens are now starting work on a small hydroelectric power generation business.

Wind power, which generates electricity by the rotation of wind turbines, ranges from large wind farms to small structures installed on public facilities such as schools and municipal halls. The advantage is that large-scale wind farms can generate power at a cost comparable to that of thermal power and hydropower day and night so long as the wind blows. However, there are problems in that a vast flatland is necessary, and suitable sites with good wind conditions are limited.

A well-known example of using electricity sales profits is Yusuhara-cho in Kochi Prefecture. The community's Windmill Foundation uses revenue earned by wind power to promote the town's environmental projects, such as subsidies for the introduction of solar power generation facilities and forestry management. In addition to wind power generation, the town is working on the utilization of other natural energy, such as small hydropower generation to power a junior high school and streetlights or turning thinned timber into fuel pellets.

Hydroelectric power generation produces electricity by using water falling from a dam or similar structure to turn a turbine. In recent years, small- and medium-sized types that can generate electricity in agricultural canals and small rivers have drawn attention. Advantages include stability, the high potential as a distributed power supply powered by relatively small-scale equipment and the fact that many suitable sites have not yet been developed. The challenge is that the construction of small- and medium-sized dams is relatively expensive and requires the adjustment of water rights.

An example of citizens and government working together to produce hydroelectric power is the Kachuugawa Small Hydropower Civic Power Station "Genki-kun" in Tsuru, Yamanashi Prefecture. With a small hydropower generator in the river flowing in

front of the city hall as a symbol, Tsuru has become famous as "the city of small hydropower stations." Citizen participation in environmental education programs and projects is increasing. In addition, efforts are being made to operate and monetize renewable energy by selling mini publicly issued bonds and green power certification.

Geothermal energy uses steam or hot water produced by underground heat to turn turbines and generate electricity. Once the steam has done its work, it is condensed and returned underground. Output is stable, large-scale development is possible and plants can operate day and night. As a volcanic country, Japan has the third largest Geothermal energy resources in the world. However, there are disadvantages, such as a long development time of about 10 years, high development costs and the overlapping of development areas with hot springs and park facilities. It is difficult to get local cooperation in developing this form of generation.

For a long time, the Sobetsu district of Hokkaido's Morimachi Town has been using heat from a local hot spring and geothermal energy for greenhouse cultivation of vegetables. By cultivating and shipping summer vegetables such as tomatoes in winter, the community has succeeded in securing stable production volume and profit. Installing boilers is unnecessary, so running costs are low, contributing to the independent management of small businesses.

Biomass power generation uses biological resources (biomass) such as animals and plants as energy sources to generate electricity, converting woody biomass, agricultural residues and food waste to energy. The advantages are the effective use of resources, waste reduction and the fact that weather is not a concern. On the other hand, it is difficult to maintain a steady supply of raw materials and there are costs connected with the collection, transportation and management of raw materials.

"Biomass Town Maniwa" in Okayama Prefecture is famous among Japan's numerous biomass towns as being especially advanced. Responding to concern that the opening of the Chugoku Odan Expressway in 1992 would increase the outflow of young people from the urban areas and worsen depopulation, young business people and leaders in various fields organized the "21st Century Maniwa Juku (study center)" to focus on using wood resources, a major local asset. Under the rubric Collect-Convert-Use, the organization actualizes the biomass town concept by utilizing wood-based waste, livestock excreta, food waste, scrap wood, etc. The center also explores ways to improve the utilization rate of each of those resources. Each year, more than 2,000 people from Japan and abroad join bus tours to learn about the city's initiatives and to visit the facilities.

These examples demonstrate common results of the successful introduction of renewable energy. Making use of local characteristics such as topography and climate along with the energy management principle of local production for local use creates new

employment opportunities. In addition, connections among people are strengthened through cooperation on projects. Schemes of circulation of not only material but also financial resources for local development are well organized. Citizens become aware of how the introduction of renewable energy contributes to the solution of various local problems, and projects that bring together the present generation become the basis for gathering and training the next generation of local leaders.

2. Efforts to prevent global warming

Energy saving

The next major impetus for a wider understanding of the energy problem after the Chernobyl nuclear power plant disaster was the UN Framework Convention on Climate Change adopted for the prevention of global warming at the United Nations Conference on Environment and Development in 1992. The consensus is that global warming arises due to an increase in greenhouse gases, including the carbon dioxide emitted from fossil fuel used for power generation. In Article 4 of the Convention, the goal was set to return greenhouse gas emissions to the 1990 level by the year 2000, and various initiatives to realize this were promoted both in Japan and overseas.

The 3rd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change held in 1997 is generally known as COP 3. In the "Kyoto Protocol" adopted at COP 3, a target was set to reduce greenhouse gas emissions by five percent or more from the 1990 level in developed countries between 2008 and 2012. Japan initially set its target at plus-minus zero percent, while America set it at plus two percent. However, the EU set its reduction target at minus 15 percent. The difference between the EU and Japan shows a fundamental difference of recognition and attitude on environment issues. While the EU already had the concrete policy objective of converting to natural power sources, Japan tried to maintain its greenhouse gas emissions at the current level through "Eco Tech" aimed at reducing costs through water conservation and electricity saving. By the end of the conference, Japan had set a reduction target of six percent. Due to the Global Financial Crisis, Lehman Shock, which resulted in reducing emissions by nine percent from 2007 to 2009, and by adding greenhouse gas absorption by forests and utilizing the Kyoto Mechanism[100], Japan achieved its target. In

[100] This is one of the flexible measures that can be used by countries to achieve targets where numerical targets have been imposed on greenhouse gas emissions by the Kyoto Protocol. The system allows countries whose greenhouse gas emissions exceed their allowance to purchase emission allowances from foreign countries and regards reductions in greenhouse gas emissions implemented abroad as domestic reductions.

fact, though, emissions increased 1.4 percent.[101]

A Promotion of Measures to Cope with Global Warming Act was enacted in Japan in 1999. Based on its Article 25, the Japan Center for Climate Change Actions (JCCCA) was founded. JCCCA has played a central role in laying the foundation for energy conservation efforts in Japan through nationwide activities such as support for global warming prevention activities by local consortiums, education for energy saving, development of a *Power-Saving Manual for Homes* and support for such projects as the Eco-Diagnosis Project for Homes.

At the United Nations Conference on Climate Change (COP 21) held in Paris from November 30 to December 13, 2015, a new legal framework, the Paris Agreement, was adopted. All the participating countries have agreed to clearly stated numerical targets to hold global temperature increase to less than two degrees above the pre-Industrial Revolution level. Conventional wisdom had been that global warming countermeasures to reduce greenhouse gas emissions were the responsibility solely of industrialized countries. In fact, however, that did not work. Therefore, it was a big step forward when all the participating countries agreed to suppress the rise in temperature. However, under this agreement, each country will voluntarily set its own target for emissions reduction, and so the agreement has left the formulation of concrete plans to each country.

Prior to COP 21, Japan submitted a target plan to reduce greenhouse gas emissions by 26 percent of the 2013 level by 2030. However, considering that in 2013 emissions were the second highest in history due to the impact of the nuclear power plant accident, 26 percent is far from a high goal and has aroused criticism from the international community. However, regardless of whether target values be too low or too ambitious, Japan ought to be committed to various energy saving measures in the future, systematic promotion of renewable energy and energy creation.

New forms of energy saving

Why do we consume so much energy in the first place? The level and development capabilities of Japan's eco-technology are high, and energy-saving practices have been available since the 1990s.

Nevertheless, if we think about reasons for the failure to reduce energy consumption, clearly the pattern of "mass production, mass consumption, mass disposal" blocks change.

Before a single product is sold, it must go through processes such as procurement

[101] Although Japan achieved the goal in terms of numbers, in fact that was accomplished by emissions trading. Carbon dioxide emissions in Japan have not been reduced.

and processing of raw materials, manufacture at factories, shipping to suppliers, and delivery to wholesalers and retailers. The life-cycle process of any products from raw material procurement to disposal is also an energy consuming process. We purchase products at shops and on the Internet, but after using them we discard them as trash. There are various tools used to visualize this load on the environment, such as food mileage program, virtual water, ecological footprint, etc. However, the basic problem is that we live in a material culture of "mass production, mass consumption, mass disposal" that requires a large amount of energy from manufacture of products to their disposal. The energy crisis is a result of our lifestyle.

In the past, energy saving was focused on controlling electricity usage. However, merely using appliances for a short time to save electricity means little in the face of a lifestyle that includes continually discarding products that have been mass produced. We need to analyze the structure of contemporary society that encourages mass consumption of energy and then think about new methods of energy conservation. Even slight changes in current ways of thinking may well make it possible to explore new forms of energy saving.

Creating regional sustainability

The movements for advanced natural energy introduction in Japan and the rest of the world have something in common, namely the fact that they began with the voluntary efforts of local communities. The Intergovernmental Conference on Environmental Education organized by UNESCO in 1977 and held in cooperation with the United Nations Environment Program, adopted the "Tbilisi Declaration." Its action guidelines for environmental problems clearly illustrate the principle, "Think Globally, Act Locally." In fact, when it comes to addressing environmental issues, tackling what can be done at the local level while keeping the overall picture in mind is sometimes a major transformative force. Grassroots efforts that germinate locally gradually involve more people, and draw cooperation from industry, government and academics. Further technological development and policy support follow, and eventually a new system will have developed.

In the United States, photovoltaic power generation became popular when the Sacramento Municipal Utility District (SMUD) in 1993 introduced a "Solar Pioneer" system that rewarded homeowners who installed solar energy. In Denmark, which pioneered wind power generation, the beginning was an effort by a wind power cooperative in a small town called Nisolberg (Iida, 2011, p. 92).

In Japan as well, many progressive initiatives have begun with citizen action in mountainous rural areas. Since the 1992 Rio Earth Summit, metropolitan areas and regional cities are forming what is called "a virtuous cycle of economics and the environ-

ment" in which government and citizens cooperate to tackle environmental problems. However, they are focused on energy conservation and face a dilemma in attempting to take measures against environmental problems such as global warming while aiming for economic growth. Efforts towards energy creation through natural energy use aimed at fundamentally changing values and social structure started early in mountainous areas. For example, as mentioned earlier, even before the Great East Japan Earthquake, the "biomass town" of Maniwa in Okayama prefecture and the civil power station of Iida city in Nagano prefecture introduced local production for local use of sustainable new energy through collaboration between the government and residents.

The common feature of these new energy projects is that they were introduced as providing solutions to local problems and counted among those the formation of local community leaders. Japan has many social problems that are related to the nuclear power issue and earthquake reconstruction. These include employment, the declining birthrate, the aging society, welfare, childcare, medical care, education, human rights and the environment. Many of them are complicated by economic disparities. As the population concentrates in urban areas, leaving a shortage of workers in rural areas depending on primary industry, the problem of aging has become increasingly serious, with about 49 percent of such communities depopulated. Since environmental problems are related to other social problems and greatly affect people who are disadvantaged, the introduction of new energy may well contribute to providing solutions to other problems.

The process of resolving regional problems and creating a sustainable community while converting regional weaknesses to assets involves new systems and mechanisms that support new values where residents make policy decisions. Government, industry and citizens who once tended to confront each other over regulations have found ways to cooperate while exploiting the strengths of their respective positions. As a result, local leaders are formed through the encounter of people with various social backgrounds. As residents participate in policy decisions, a climate of coexistence and enriched exchange is created that fosters quality relationships that differ from merely quantitative development and growth.

Connected with this in Japan as in other places, a new business model called "social enterprise" has appeared. Also called "social business" and "community business," social enterprise is a collective term for activities that seek to solve various social issues such as environmental problems, poverty, birthrate decline, population aging and regional promotion through business activities. Organizational forms include not-for-profit organizations (NPOs), intermediate corporations and even stock corporations. In areas where government officials and volunteer organizations once dealt with social problems, now social enterprises are expected to conduct their businesses to solve problems, develop and

utilize new products and services together with schemes to provide them, and establish new social values. Social enterprises are hoped to also be active in initiatives such as the introduction of new energy that require new values and new ways of doing things.

3. Reducing electrical energy dependence

Reconsidering energy consumption

The November 2011 statement of the Catholic Bishops' Conference of Japan did not simply call for a phase-out of nuclear power. While recognizing that electrical energy is indispensable to daily life, the bishops said it is necessary to reform our excessive dependence upon it. Here we will look at how that is desirable and possible.

As has been pointed out, it is important to increase the proportion of renewable energy in energy consumption. However, compared to nuclear and thermal power, renewable energy produces less electricity per facility. Attempts to use renewable energy sources to produce large amounts of electricity comparable to what nuclear and thermal power produce can create new environmental problems (Ozawa, 2013). Moreover, although "natural energy" has an image of being environmentally friendly, wind power generation emits damaging low frequency sound and causes death to birds that collide with the generators. Solar power generation facilities cover extensive surface areas, raising concerns about their impact on animal and plant life. Hydro power and geothermal generation also require considerable intervention in the natural environment. There are also concerns about changes in the landscape due to the installation of power generation facilities. No matter what the energy source, some environmental burden is unavoidable.

The German environmental thinker Gerhard Liedke says "The energy budget paid by humans is the measure of violent behavior against nature." That is, "Higher energy consumption corresponds to greater violence." (Liedke, 1993)

If phasing out nuclear power generation is not to create new environmental problems, it is essential that we abandon the idea that progress can be equated to unlimited energy use. It is essential to reconsider whether we really need all the energy we are using every day and to review our energy wasting lifestyle and society.

"Energy saving" may be the only method of generating electricity without imposing a burden on the environment. It is possible to think of cutting back on or not using electricity as a way of producing electricity (Hennicke and Seifried, 1996).

The electricity that we directly use, however, is only a part of energy consumption. In fact, we must consider the reduction of energy consumption through heating, transportation and the placement of companies and factories, throughout the communities in which we live. In addition to directly reducing the amount of electricity used, we ought

to be aware that water and underground resources are necessary to make electricity and the whole problem of the global environment is deeply involved in it. However, let us see what sorts of things each of us can do now about energy saving. Even if it seems that installing photovoltaic power generation facilities at home is too much, anyone can turn their residence or workplace into a "power saving station."

Promoting energy saving will initiate a review of society's entire living and social structure, leading to the transformation of social systems. In short, the key is to create a system that encourages and rewards energy saving, rather than leaving it to individual person's or company's efforts. There are two units of electricity to consider here. The kilowatt (kW) is the amount of electricity used in any moment. The kilowatt-hour (kWh) is the amount of electricity used over that period. In energy saving it is important not only to reduce the amount of electricity used (kWh), it is also important to lower power consumption (kW) during peak hours. Therefore, as an electricity rate system to motivate energy saving, as for kW saving, we need a time zone rate system that increases costs during peak usage periods, and, as for kWh saving, we need a progressive rate system that increases costs in accord with the amount of electricity used. In this way, when the three areas of technology, electricity usage and the social system are linked, society as a whole will promote energy saving.

Ecological spirituality and poverty

In the context of large social structures, the ecological role of individuals and churches seems limited. They may doubt that they can make a meaningful contribution to energy saving. In response to this question, the environmentalist Manfred Linz answers as follows.

> Individuals and groups can play a starting role in society's advance. Certainly, those actions alone are insufficient. But no change will occur if there is no one to make a start. The power that pioneers possess of insight and action is the most important prerequisite for social change to begin. (Linz, 2012, p. 60).

In other words, while we should not overestimate the role that individuals and groups can play, neither may we underestimate it. As Japan deals with the challenge of phasing out nuclear power, Christians and their churches can use electricity moderately to prove that a satisfying life is possible without being excessively dependent on electrical energy. It would be a way to be "salt of the earth and light of the world."

Energy saving will help bring about the "poverty" the bishops' statement speaks of by causing a reevaluation of the social system, building a recycling economy, and prompt-

ing changes in people and society. About that, the Japanese bishops say the following.

> Therefore, Christians have an obligation to bear genuine witness to the Gospel especially through the ways of life expected by God; "simplicity of life, the spirit of prayer, charity towards all, especially towards the lowly and the poor, obedience and humility, detachment and self-sacrifice." We should choose anew a simple and plain lifestyle based on the spirit of the Gospel, in cases like saving electricity. We live in the hope that science and technology will develop and advance based on the same spirit. These attitudes will surely lead to a safer and more secure life without nuclear plants.

It will also deeply harmonize with the philosophy of "integral ecology" and "ecological conversion" that Pope Francis emphasized in his encyclical *Laudato Si'*. The addition to the "human ecology" and "social ecology" that have been spoken of by the Catholic Church on environmental issues is an emphasis on strong connectedness between, on one hand, each one's relationship to oneself and the inner environment lived out therein and, on the other, the problems of the environment of the outer world. From that point of view we recommend changing to a lifestyle oriented towards ending nuclear power.

In his encyclical, the Pope emphasized three themes:

(1) gratitude for the many blessings of the created world (praise);

(2) recognition that all things are interconnected (integral ecology);

(3) the healing of the injured world (concrete action).

Integral ecology is based on "an approach to ecology which respects our unique place as human beings in this world and our relationship to our surroundings" (15) and stresses the fact that there is an unbreakable connection in environmental, social and human problems (141). Rather than fragmented and segmented research, we need the wisdom to recognize that safeguarding the environment involves "an interrelation between ecosystems and between the various spheres of social interaction" (141).

Then, in order to spread such an ecology, the pope strongly recommends a different way of life, an "ecological conversion" (cf. 203-208; 216-221). "The ecological crisis is also a summons to profound interior conversion" (217). In that case, Christian faith and spirituality become a profound motive to foster passion to defend and preserve the earth. Although the pope talks about St. Benedict and Blessed Charles de Foucault, he also proposes as a model St. Theresa of Lisieux, who encouraged small acts of love in one's immediate context (230-240).

At the same time, Pope Francis calls for "civic love." There is civic and political value in people's taking care of each other, even in small things, such as "universal frater-

nity" (228) and a "culture of care" (231). "We must regain the conviction that we need one another, that we have a shared responsibility for others and the world, and that being good and decent are worth it" (229). This is yet another fruit of ecological conversion. For this to happen requires cooperation and support among various groups, experts and local governments in civil society.

Moreover, "change is impossible without motivation and a process of education" (15), so education connecting humans and the environment becomes very important. Environmental education can influence everyday actions and habits such as saving water, separating refuse or turning off unnecessary lights (211). Integral ecology consists in an accumulation of everyday casual behaviors. For us humans, yearning for beauty and harmony, ecology is indeed a problem of life led every day. For that reason, all educational environments such as schools, homes, media and catechesis must be involved (213).

Also, in our families and communities, we should discuss what kind of new way of living we should choose as well as small practical steps such as recycling resources and trash to counter the throwaway culture. To deepen the environmentally minded theology and spirituality, parishes, schools, and social information centers should cooperate with local bishops to encourage the formation of "citizens awakened to the environment." Cooperation in dialogue with government policymakers and other religions is also important.

As mentioned above, conversion of mind and heart toward the "integral ecology" recommended by *Laudato Si'* with a spirituality sprung from it draws us to the poor and humble Christ and invites to know the realities of the world and to practice justice. In that sense, this encyclical proclaims that nuclear energy and the nuclear power problem are linked to individual dignity and human rights as well as sustainable energy, climate change, the economy, the needs of the poor, immigration and pollution.

The "poverty" for which the bishop's statement appeals is an aspect of the "integral ecology" and "ecological spirituality" raised by *Laudato Si'*. It will lead to a new lifestyle that deepens relationships with God, society and nature while affirming the importance of human dignity in consumption and in life. *The Catechism of the Catholic Church* (2833) teaches that "poverty" is "the virtue of sharing" that fairly shares as needed without monopolizing wealth. In other words, "poverty" is placed under a more universal purpose of jointly using the wealth of the world for the whole human race, rather than simply asceticism for the development of one's personal virtue. Therefore, this lifestyle based on "sobriety" and "solidarity" is not a regression to an inconvenient life. Rather, it can be perceived as progress towards a new abundance and integration for humanity and society. This "new quality of life" is a well-balanced and happy way of living with true peace of mind, free of greed for consumption, and filled with joy in the depths of one's being.

Appendices to Part 3

Science views creation and ethics

In 2004 the International Theological Commission of the Vatican issued a statement titled *Communion and Stewardship: Human Persons Created in the Image of God*. This report develops moral theology with the theme of the relationship between humanity as image of God and nature. Regarding the natural world, the commission presents a view of the world in which the act of creation continues dynamically through collaboration between God and human beings. The commission proposes that we see humans in the evolving history of the universe under the light of faith (62), and the emergence of life and its evolution as taking place in the history of the cosmos and the Earth (63). In light of the various environmental problems and techniques of genetic manipulation that we are confronted with, it proceeds to consider the ethical problem of human responsibility as the image of the triune God to all creation with a conclusion as follows: "In these (scientific and technical) areas, just as human persons are called to give witness to their participation in the divine creativity, they are also required to acknowledge their position as creatures to whom God has confided a precious responsibility for the stewardship of the physical universe" (95).

Humanity is one among the creatures living on the Earth. Living organisms cannot survive in an isolated existence, but can exist by being deeply involved with the natural environment of the Earth. Further, the Earth receives energy from the sun, and at the same time it emits energy towards outer space. Instead of being a closed system, living things constitute an open system to the Earth, and the Earth is an open system to the universe. The Earth is a planet of the solar system born about 4.6 billion years ago from gases and dust derived from a supernova explosion. As the temperature of the hot surface declined 4 billion years ago, the oceans and tectonic plates formed. Movements of plates (plate tectonics) and circulations of the atmosphere and the water around the surface caused the climate to stabilize and life was born. As energy in the form of radiation and ultraviolet rays reaching the surface from the universe became more moderate, living organisms have evolved along with the history of the Earth.

Living creatures maintain their lives and pass genetic information on to their descendants. The DNA that constitutes a gene can repair itself when it is damaged by radiation or the like, but mistakes may occur at that time. Even misreadings may occur

when DNA is transcribed. Gene mutations due to mistranscription of DNA can cause death in individual organisms, but it also causes branching out to new species and promotes evolution. Thanks to this mechanism, living things have evolved along with changes in the magnitude of energy that the Earth captures and releases.

Humanity, which was born about 7 million years ago, started an agricultural life about 10,000 years ago, affecting the environment of the Earth differently from other creatures. Sometimes human beings destroyed the environment, but the Earth system has a certain resilience. While constantly receiving energy from the sun, it is protected by the magnetosphere from the strongest energy. The interaction of the earth (the crust and plates, the core, and the mantle), the water (oceans), the atmosphere, living organisms and humans, affecting each other, have formed the Earth system.

The Earth system referred to here can never be explained by a view of nature based on mechanism or constituent reductionism. Ethics will be needed in the future, taking into consideration relationships between the whole Earth system and humans. In the tradition of the Catholic Church, humans as image of God are open to others, creating the common good in society and participating in the common good in the natural world. Recapitulating from the above-mentioned modern scientific way of thinking, "human existence open to others" is expanded to the whole Earth system: all "beings" are open to others, forming an order throughout the natural world while maintaining its balance. From this point of view, new consideration is needed about the use of nuclear energy and the destabilization of nuclei by human-caused nuclear fission.

Given this perspective, if the risks associated with development are disproportionately imposed upon specific people including future generations and poor people are forced to endure injustice, we must analyze social, political and economic situations, think about what to do concretely, and act. In doing so, we must build sound relationships among people while also aiming to deepen healthy relationships between human beings and nature.

Humans are given a natural environment from God, where they have a home and make use of various things. However, if we do not deal with the natural environment as a partner, and only exploit it according to its utility for human interests, we will disturb the natural order. We must reaffirm that human existence is enabled by various relationships with the natural environment and that the richness of human life is conditioned by the richness of nature. In addition, we must not forget that the relationship between human beings and nature and relationships among humans in society are mutually related and influenced. If wealth and power are concentrated in the hands of a few people, the order based on the common good of human society will be disturbed, and that disorder will also affect the natural environment. Now that human influence on nature is increas-

ing, that disruption will be even greater.

Jinzaburo Takagi and the Bible

Jinzaburo Takagi (1938-2000) was one of the pioneers in opposing nuclear power in Japan. He studied nuclear chemistry at Tokyo University, and after graduation he worked in the nuclear power industry before he started teaching at Tokyo Metropolitan University. However, he decided to live as a citizen scientist, quit the university, and established a movement to think about how to make use of science and technology, sharing knowledge with citizens about these. He was also the founder of Citizen's Nuclear Information Center. Takagi was convinced that opposition to nuclear weapons and opposition to nuclear power were inseparable.

Takagi was not a Christian, but after he participated in a workshop at a Protestant church in 1993 he made a contribution: "Did the Bible Foresee Nuclear Power?" (Takagi, 1993). In this essay in which he reads the Old Testament from an ecological perspective, Takagi asks, "Given today's situation in which nuclear power has been developed, exists, and exposes humanity to threat, does the Bible or Christianity have anything to offer for the survival of humanity and other living things?" Takagi, who questioned the way people are presented in Chapter 1 of the book of Genesis as being "the image of God" and having "dominion over the earth," found in his reading that Genesis draws a picture of runaway human desire and warns against it, and he came across a story of the flood caused by God to stop this. Thus, Takagi had a deep interest in humanity depicted as the "caretaker of creation" in the story of the flood and the ark in Chapter 9.

> Here you cannot miss the difference from Chapter 1. Here all the earth's things are entrusted to the hands of humanity, but the words "rule" or "dominion" are not used. God says, "I give you all these things," but this can be understood as having responsibility as caretaker or guardian.

While acknowledging that such a positive reading is possible, Takagi raises a question that is linked to nuclear problems, asking whether the Bible may be too human-centered or too terrestrially focused:

> Nuclear power is a technique that introduces matter that is foreign to the original terrestrial world to destroy the stability of the nucleus. It thereby tries to obtain non-terrestrial (astronomical!) power. It is inherently incompatible with the principles of terrestrial life and we typically see that irreconcilable

> conflict in Hiroshima, Nagasaki and Chernobyl. Considered in this way, nuclear development is literally a Promethean act of stealing heaven's fire, which should have been forbidden.

In this way, Takagi finds the "expansionism" of human desires arriving at the use of nuclear energy in the erasing of distinctions between the heavens and the earth. He finds the distinction between the law of the heavens and the law of the earth not in the book of Genesis, but in the book of Job. Takagi considers Chapter 38 of the book of Job.

> I am surprised that the distinction between the law of the heavens and the law of the earth, which I said is missing in the Bible (Genesis), is clearly written here. It is to be remarked that Yahweh talks about the inviolable region for humans while the relationship with nature (the universe) is not mentioned in the context of human specificity as "the image of God." When I read Job from this point of view, it seemed to me to be obvious why the righteous Job had suffered. He was certainly a straightforward person. But humans are just humans. Even though humanity is only a small entity in the universe, it is an expansive entity trying to exploit the earth to the full and extend its dominion to the universe by use of its cleverness. Humans seem destined to have such tendencies. And so, with an intention of living justly with a correct understanding of its own place proportionate to the universe or proper in nature, humans must always fight against that expansionism within and endure numerous hardships. By taking on those hardships, humans will be able to fulfill their responsibility as stewards of the earth. Otherwise, humanity as "the image of God" will become arrogant administrators, i.e., absolute monarch, of the earth.

Takagi warns that unless we fight against the expansive character of our own desires, humans will forget to distinguish between the law of the heavens and the law of the earth, grasping at nuclear energy use, and thereby inviting a society under nuclear-based control.

Robert Spaemann's anti-nuclear theory

Robert Spaemann (b. 1927) is a leading German Catholic philosopher who has a deep friendship with the former Pope Benedict XVI. Spaemann tries to establish ethics in relation to ontology in dialogue with Aristotelian philosophy and medieval Christian

thought and place it in the contemporary context. For Spaemann, the ethical *Aufgabe* (duty) is required by the ontological dimension of *Gabe* (gift). From that perspective, he says that the relationship between man and nature must be based on the fact that our existence is open to others (Spaemann, 1989).

Spaemann has questioned the peaceful use of nuclear energy since the 1950s, and in 1979 he declared that nuclear power plants should not be operated so long as there are no nuclear waste treatment facilities for final disposal. In July 2011, when his anti-nuclear thought was newly in the limelight immediately after the Fukushima Nuclear Power Plant accident, Spaemann published *The Arrogance of the Atomic Age*.

Spaemann presented his view on consensus building regarding the use of nuclear technology in about 1980. According to his view, radioactivity causes a situation that cannot be restored, and since future generations cannot change this fact they are forced to accept it. Therefore, those who recognize historical solidarity with future generations cannot accept a consensus made by a merely intragenerational majority. We must also take the opinions of people with expert knowledge into account, even though they may be a minority, Spaemann thinks that a state does not fulfill its responsibility if it intends to produce facts prematurely without waiting for people with such expertise and knowledge to finish their debate (Spaemann, 1979, pp. 44-45). In other words, when human beings intervene in nature by technology such as nuclear power, unless it is proven that the intervention is really necessary, and that it is certain to cause only slight damage, the state is responsible for preventing the use of such technology (Spaemann, 1979, pp. 46-47). And it is necessary, he claims, to explore the possibility of other sources of energy replacing nuclear power with their physical, technological, social and economic implications, and allow them to be compared honestly with nuclear power, a necessity compelled by Christian conscience. (Spaemann, 1980, p. 71).

The biggest reason Spaemann advocates the abandonment of nuclear power in Germany, which is not an earthquake-prone country, is that moving ahead with nuclear power in the absence of the prospect of determining the final disposal of radioactive waste is to treat future generations with extreme irresponsibility and even frivolousness. In 2006, in an article published in the German center-right newspaper *Frankfurter Allgemeine*, Spaemann said,

> Starting nuclear power generation before the problem of final disposal was completely solved was an irresponsible bet even though a solution might finally be found in the future. The confidence that a solution will be found is a pseudo-religious belief that there will always be a pre-established harmony between what we demand and what the universe is ready to supply.

In presenting his opinions Spaemann warns of the insatiable curiosity of scientists and the optimism towards the development of science and technology which is essentially tied to it (Spaemann, 2011, p. 111).

He thinks about technology, especially nuclear power, like this because of what he thinks about the way human beings and nature should be:

> When we humans destroy nature, we destroy our own foundation. If nature becomes a problem, in that respect the problematic is always human beings themselves. To put it better, however, it is precisely for that reason that it is necessary to abandon human-centered views today. It is because humans will continue to destroy nature as long as nature is interpreted functionally according to humans' own desires and nature conservation is carried out from this point of view. ... Only by learning to respect the richness of living things as valuable in themselves, overcoming the anthropocentric viewpoint, in other words, only in a religious relationship to nature will modern people be able to establish the foundation of human existence from a long-term perspective. Human-centered functionalism eventually destroys humans themselves. (Spaemann, 1979, pp. 35-37)

From *Rerum Novarum* to *Laudato Si'*

An encyclical is a pastoral document that the pope sends to the bishops of the Catholic Church concerning matters of high importance affecting the whole church. The word comes from the Greek *enkyklios* (circular, general), a proclamation by a ruler or administrator regarding laws and commands. Papal encyclicals have been issued since the seventh century but became a normal means of papal guidance in the 18th century.

The first encyclical dealing with social problems was Leo XIII's *Rerum Novarum* (Rights and Duties of Capital and Labor) in 1891. Pius XI marked the anniversary of that encyclical with *Quadragesimo Anno* (In the 40th Year) in 1931. Almost all modern popes, such as John XXIII with his 1963 *Pacem in Terris* (Peace on Earth), have issued encyclicals dealing with social issues

The teachings of the Church on social issues represented by encyclicals and other pastoral documents from the magisterium are called "the social doctrines of the Church." This is a faith-based consideration for responding to the situation of the world and society in each era. These social doctrines, on one hand, are anchored in fundamentally unchanged values and principles based on faith and, on the other, present a commentary on how to deal with the unique problems of particular times and circumstances. The first

encyclical expressing the social teaching of the church, *Rerum Novarum*, dealt with the necessity to find a new way of interacting with society due to the problems of workers after the Industrial Revolution and the establishment of the separation of church and state. Since then, popes have issued encyclicals in the milestone years (40, 70, 80, 90 and 100 years) from the promulgation of *Rerum Novarum* in order to apply the church's social theory to each era.

In addition, when it is recognized that there is an especially serious problem and it is judged urgently necessary to express the church's perspective about it, encyclicals are promulgated separately from the memorial of *Rerum Novarum*. The first of such encyclicals was *Pacem in Terris*, promulgated by John XXXII in 1963. This encyclical responded to catastrophic threats caused by the arms race between the United States and the Soviet Union that became critical in the Cuban missile crisis of 1962. The next was Paul VI's *Populorum Progressio* (On the Development of Peoples) in 1967. This encyclical responded to the situation in which countries newly independent from the colonial situation fell into poverty and the world was divided into a few rich developed countries and a majority of poor countries.

And as has been touched upon in this book, in 2015 Pope Francis promulgated the first social encyclical to respond to environmental problems, *Laudato Si'*.

Steps toward nuclear power plant abolition in Germany (1)

In the former West Germany, the Federal Department of Nuclear Power was established in 1955, beginning the peaceful use of nuclear power. In 1957 a research reactor was built in Garching on the outskirts of Munich, and in 1960 a commercial nuclear power plant began operation in Karlstein, outside Frankfurt, with power transmission starting the following year. Initially both the governing and opposition parties supported nuclear power generation to lower electricity rates and raise living standards. In the 1970s, with the 1973 oil shock, 14 nuclear reactors began to operate, and electric power companies planned to construct 120 nuclear plants by 2010, especially in the Rhine basin.

However, in 1973, when an attempt was made to build a nuclear power plant in Breisach on the Rhine River, fears that climate change caused by steam discharged from the power plant cooling tower would have a bad effect on grape cultivation led to a petition against construction. Sixty-five thousand people signed. In response, the planned construction site was moved 19 km, but a large demonstration of up to 28,000 people occurred in 1975, and the electric power company was not able to obtain permission to operate, so the plan was abandoned. Following that, such demonstrations occurred in various places, and an anti-nuclear network was formed. With the Three Mile Island nuclear power plant ac-

cident in the United States in 1979, this movement accelerated further.

Steps toward nuclear power plant abolition in Germany (2): The Catholic Church

In response to the anti-nuclear movement that became popular in the 1970s, the Catholic Church leadership early on expressed a critical view of nuclear power.

In 1977, the secretariat of the German Bishops' Conference published its basic views on nuclear energy use, "Problems with Nuclear Energy Utilization." The conference said that if there is no means of energy supply besides nuclear power, it can be used under the condition of instituting the maximum safety measures. However, if it is possible to cover demand by other means, such as energy saving, efficient use or renewable energy, it is not responsible behavior to expand the use of risky nuclear power. Again in 1980, the year after the Three Mile Island nuclear power plant accident, the bishops' conference made a statement with the same message, "Future of Creation / Future of Man."

In 1989 after the Chernobyl accident, the bishops' conference issued a joint statement with the Evangelical Church in Germany (Evangelische Kirche in Deutschland: EKD), a federation of Protestant churches. The statement took a cautious view toward promoting nuclear power, describing "the use of nuclear power as a transient solution to the supply of human energy" ("God loves life," Part 3: "Earth as the place of life"). In 1996, the 10th anniversary of the Chernobyl accident, they declared their commitment to abolish nuclear power ("Evaluating nuclear energy use").

To mark the 20th anniversary of the Chernobyl accident in 2006, the bishops published a comprehensive document on environmental issues. They pointed out the basic problems of nuclear power, saying, "It is doubtful whether nuclear energy can continue to be a valid solution. Uranium must be imported, and its quantity is limited. But above all there are unresolved and unignorable problems involved with operation (such as intermediate and final disposal sites). Considering justice among generations, we should not merely impose these problems on future generations. This conflicts with the principles of prevention and proportionate means as well" ("Climate change - The focus of global, intergenerational and ecological justice").

In May 2011, the bishop's conference document originally planned to commemorate the 25th anniversary of the Chernobyl accident described the ethical evaluation of nuclear energy use based on the Fukushima nuclear power plant accident. With the issue of the final disposal of nuclear waste unresolved and the possibility of catastrophe or terrorist attacks considered, they declared that the use of nuclear energy cannot be ethically justified today ("Responsibility to Creation - For Sustainable Energy Use: On the Ethical Foundations of Sustainable Energy Supply").

Steps toward nuclear power plant abolition in Germany (3): The Protestant Churches

The Evangelical Church in Germany (Evangelische Kirche in Deutschland: EKD), a federation of Protestant Churches, has been active in the movement to abolish nuclear power.

In 1987, the year after the Chernobyl accident, an EKD General Assembly resolution pointed out the ethical issues of nuclear power use: "The recognition has spread that this type of energy acquisition is not consistent with the Biblical obligation to till and keep the land because of the risk of not being able to cope with current nuclear power generation reliably."

In 1998, the year the Green Party, whose policy is to promote the movement to abolish nuclear power, entered the government, the EKD announced a resolution of the General Assembly calling for the removal of nuclear power plants. From 2006 to 2010, when extending the use of nuclear power was discussed under the Merkel administration, the EKD said that "nuclear power is not a responsible contribution to climate protection, but hinders the necessary conversion of energy supply," and opposed prolonging its use. A 2008 General Assembly resolution further opposed the policy of extending the period of nuclear power plant operation as an effective bridge for the transition to renewable energy.

Natural energy and a recycling-oriented symbiotic society

It can be said that introducing new types of energy production with local participation is a process of developing human resources within the given area and fostering cooperation among people. Even in the absence of any tangible resources such as funds, when people realize that the intention and hope of creating a better future constitute an inexhaustible resource inherent in the human being, progress toward a sustainable and cohesive society has already begun (Morotomi, 2015).

In addition, although we tend to focus on advanced initiatives, the process by which people in a community make connections plays a specifically important role. It is an invisible resource, "social capital," i.e., a bond formed by the trust among neighbors that fosters local leaders and brings out resources inherent in people. Unlike a large-scale centralized power source such as a nuclear power plant, small-scale natural energy diversifies the way people and society connect with energy. Like the connections between humans and nature, connections among people have a big impact on the better management of natural energy production.

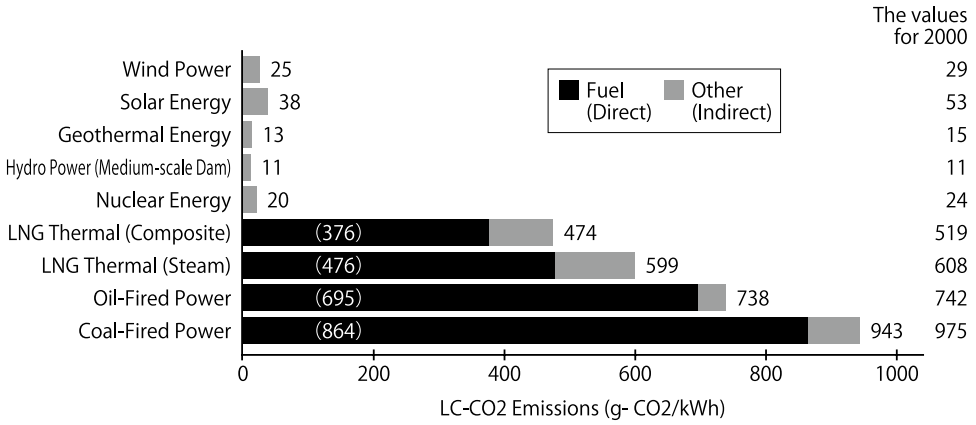
When a society is rich and energetic or peaceful and free and people want to go on

living there, that is apparently due to institutions, laws, facilities and services. But, in fact, does it not depend even more on the involvement of people living there and the richness of human relations? While Japan is a developed country, one in six children lives in relative poverty. If most people in society do not pay any attention to people other than themselves and do not form relationships with each other, even if systems are sufficiently developed and there are many fine facilities, society will not function properly and there will be a crisis of disintegration (Kadowaki, 2010; Abe, 2011). The Fukushima Daiichi Nuclear Power Plant, which was producing electricity in a rural area to provide it to large cities on the premise that rural and city lives are separate realities, should be a warning against such disintegration.

The building of a better society was once government work. Thus, it was the government's intention to revitalize rural areas by introducing nuclear power plants. However, administrative ability has limits. To assure that nuclear power is not part of the future and to promote new energy, it is important not only to criticize the limits of government but also to encourage all citizens to awaken to their responsibility and to commit themselves to the community. The connections and ties among people who actively participate in policy decisions will be a great force in realizing a nuclear power phase-out and energy conversion.

Can nuclear power be a measure against global warming?

Nuclear power generation does not emit carbon dioxide in operation and so has been said to be one of the trump cards to counter global warming. However, when comparing with other power generation methods, it is necessary to calculate not only emissions during power generation but also emissions in the entire lifecycle of each method. CO_2 emissions from power generation methods in Japan have been studied by the Central Research Institute of the Electric Power Industry, and a report was issued in 2010. Based on data as of 2009, this report shows results of lifecycle CO_2 emissions of each method of power supply, i.e., total emissions from resource mining to waste disposal, including construction, operation and dismantling of facilities. It separately reports on direct emissions from power generation and indirect emissions related to resources, materials and facilities. Of course, in the case of power generation methods except fossil-fuel dependent ones, all emissions are indirect. Clearly, CO_2 emissions from nuclear energy and natural energy are much smaller than in any of the thermal energy methods. Comparing nuclear energy and natural energy, although emissions from nuclear energy are smaller than that those of sunlight and wind energy, it is more than that of geothermal or hydro power. Although the graph below is based on the same report, data as of the year 2000 is attached on the



right side and show the results of efficiency improvements.

However, there are several points to note.

The Central Research Institute's research only covers CO_2 emissions, not other greenhouse gases. As an example of also targeting greenhouse gases other than CO_2, there is a report by a German research institute, Oeko-Institut e.V., which calculates greenhouse gas emissions by nuclear power. According to their report, CO_2 emission is 31 g/kWh, and the emission of other greenhouse gases with greenhouse effects equivalent to CO_2 is 33 g/kWh (Fritsch, 2006).

Meaningful measures against global warming require setting a baseline within 2°C of the temperature when the industrial revolution began. Atmospheric concentrations of greenhouse gases have already risen considerably, and effective reductions are required immediately. Clearly, some 440 nuclear reactors operating around the world have not produced sufficient results. In order to assert that nuclear power is an effective countermeasure against global warming, it is necessary to indicate how many more nuclear reactors would be needed, and how long it would take to reach that number.

Most current nuclear plants were built in the 1970s when the oil shocks occurred and in the 1980s before people became conscious of global warming. In fact, the spread of nuclear power does not appear to have contributed to a lessening of dependence on fossil fuels, nor is it accompanied by a reduction in greenhouse gas emissions. There are many difficulties in the logic of using nuclear power to prevent global warming. Basically, it will be impossible to create a society with small energy consumption while continuing to operate nuclear power plants, so to say that nuclear plants are effective global warming prevention measures is wrong. (Nishio, 2008, pp. 91-93; Yoshioka, 2011, pp. 55-60)

Conclusion

On November 8, 2011, the Catholic Bishops' Conference of Japan issued the statement *Abolish Nuclear Plants Immediately: Facing the Tragedy of the Fukushima Daiichi Nuclear Plant Disaster*, in which they said, "In the message *Reverence for Life*, we Japanese bishops could not go so far as to urge the immediate abolishment of nuclear plants. However, after facing the tragic nuclear disaster in Fukushima, we regretted and reconsidered such attitude. And now, we would like to call for the immediate abolishment of all the power plants in Japan." Now, five years after that statement, we have published this book to renew that call.

This book reinforces that statement. The introduction raises two sets of questions: "What should we have learned from the Fukushima nuclear power plant accident?" and "What are we to do? How shall we take a new look at our own lives? With whom must we join hands in order to build a new future?"

In that statement, the bishops have already proposed how we must learn to live in a post-Fukushima world.

- We, who "have responsibilities to protect all life and nature as God's creation, and to pass on a safer and more secure environment to future generations", "need the wisdom to know our limits" in regard to science and technology, seeing through the "safety myth" of nuclear power generation.
- Even though some people express the opinion that nuclear power cannot be abolished because that would lead to energy shortages and an increase in CO_2 emissions (for the discussion of the relationship between nuclear power and CO_2, see pp. 213-215), we must opt for attitudes "to protect life, which is so precious, and beautiful nature, …not [to] focus merely on economic growth by placing priority on profitability and efficiency."
- The huge amount of dangerous radioactive waste and responsibility for its custody will become a negative legacy to future generations. We must take this seriously as "an ethical problem."
- The national policy of promoting nuclear power must change to give priority to the

development and promotion of renewable energy, accompanied by a reform of a lifestyle excessively dependent on electric energy. This means changing our overall lives.

- We Christians should develop a simple lifestyle based on the Gospel spirit of Christian "poverty."

The purpose of this book is to provide evidence in support of these recommendations. The editorial committee and the authors are all committed to the abolition of nuclear power and dedicated to building a better world through overcoming nuclear power's threats in terms of technology, society and faith. In May 2015, Pope Francis issued his encyclical *Laudato Si'*. Inspired by this encyclical's guidelines on environmental issues we will continue journeying toward phasing out nuclear power for the sake of peace.

Summaries of Each Section and Chapter

A history of nuclear energy use and exposure

Part 1, Chapter 1 reviewed the history of the use of nuclear energy that began with the development of the atomic bomb. Starting with the nuclear attacks on Hiroshima and Nagasaki, Japanese citizens have repeatedly experienced disasters of nuclear power from nuclear tests, the criticality accident at a nuclear fuel facility and nuclear power plant accidents. Therefore, we must keep in mind the harm caused by nuclear technology. We must remain in solidarity with *hibakusha* (atomic victims) around the world and work towards the resolution of the nuclear issue.

Considering the history of the use of nuclear energy over the past 70 years, clearly the logic of nation states and corporations developing and promoting nuclear technology has taken precedence over everything, to the detriment of people's dignity. The American government, which used nuclear weapons in Hiroshima and Nagasaki, and the Japanese government, which is responsible for the protection of survivors, have not yet dealt in good faith with atomic bomb survivors who have suffered so much pain. Even in the history of the peaceful use of nuclear energy, many people have suffered from radiation exposure. And when problems have occurred, they have been handled by political judgments intended to cover them up through the power of money and the hiding of information. The use of nuclear energy seems always to involve the cruel power to create victims. Might this be related to the fact that nuclear technology arose from a situation of war and was developed with the intent of destruction and annihilating enemies?

Steps toward "human recovery"

Chapter 2 of Part 1 introduces the voices of victims of the Fukushima nuclear power plant accident and gives us a chance to encounter them. The question arises whether apologies and compensation by the country, prefecture and electric power company that have promoted nuclear power as a national policy have not lacked in good faith for the sake of the victims. Even after the accident, those who have promoted nuclear power continue to exercise as much power as before the accident. They can induce public opinion to suggest the impression that the accident is coming to an end. Since March 2011, have those responsible for the accident given their attention to each of the victims and considered the pain of suffering of each a priority? In fact, was not the reconstruction of damaged property such as buildings and roads prioritized over the needs and livelihood restoration of those victims? In addition, nuclear power plants are now being restarted with insufficient reflection on the accident or investigation of its causes.

In the afflicted area, there are many people who even now make their living through work related to the nuclear power plants. They have complicated thoughts about discussions of the pros and cons of nuclear power and their problems. Such an atmosphere remains that even speaking about the disaster with their neighbors is difficult. We pray for those who are troubled by being caught between the reality of the accident and the need to make a living. At the same time, we must hear the anguish of those who suffer the effects of the accident, especially of vulnerable people such as the elderly, the handicapped, women and children.

Restoration of the livelihood of the victims should not be devoid of consideration for human beings. Its basic intent must be that the different individual needs be met, providing support for restoring the human right to live a dignified life and organizing social structures that enable such support. Putting the community's resources, talents and wealth to work promoting "human recovery" is a laborious but fruitful challenge that Christians see as contributing to the building up of the Reign of God in our time.

The conflict between ethics and the activities of scientists and nuclear engineers

Part 2 of this book examined the scientific and technical aspects of nuclear energy. We saw a conflict between the work of scientists and nuclear engineers and ethics. When judging the use of technology, we cannot rely upon criteria that arise from science itself.

The use of nuclear energy entails great risks that are not comparable to those arising from other sources of energy. There is no escaping the danger. Even if a nuclear accident does not occur, the more we use nuclear energy, the more nuclear fission products (Ashes of Death) harmful to life will be created. Rendering these substances harmless exceeds the limits of human capacity. It is no longer possible to leave the judgment of whether to

use such energy to a limited number of politicians, bureaucrats, and experts.

The problem of ethical judgment in the use of technology is an important issue that must be faced by Japanese society. Certainly, one cause of the nuclear power plant accident was that insufficient attention was paid to values and ethics involved with the utilization of nuclear energy. This is, of course, true of the state and industries. It is also true of we citizens who are also beneficiaries of nuclear energy. One of the most important tasks facing humanity is to consider the value standards that orient the way using science and technology and determining its limits. There is now a need for science and technology to be based on correct value standards that do not condone the sacrifice of some people nor threaten the survival of future generations by inflicting deep damage on the natural environment.

Christian ethical viewpoint on the use of nuclear energy

Part 3 is the core of this book. It casts light from the perspective of Christianity as well as various forms of modern thought on the ethical questions involved in the utilization of nuclear energy becoming clear in Parts 1 and 2.

The conflict between the utilization of nuclear energy incompatible with both the global environment and all life forms, including humans, and the original freedom of humanity created in the image of God is the underlying theme of this section. Harmonious relationships with themselves, others, the earth (the natural environment) and God make it possible for human beings to live peacefully and happily. For every living organism including human beings to live on the earth, the nucleus of the substance of the natural world must be stable. However, human use of nuclear energy threatens the survival of living species by splitting nuclei and producing substances emitting strong radiation. In order to be saved from this situation, we, as the image of God, must return to a proper relationship to nature consistent with justice and the common good.

Ethical thought in the face of the nuclear society

It is rare for contemporary thinkers to discuss nuclear issues, but the pioneering thinkers referred to in this book have analyzed the distorted reality that the use of nuclear energy brings to society. According to them, nuclear power has the danger of destroying the equilibrium between humanity and nature, as well as solidarity between current and future generations, and spreading irresponsibility and inequality. The development of nuclear energy, which requires a strong power structure, constricts society. Power seeking strength fosters consumerism based on economic supremacy, utilitarianism and scientific-technological supremacy, and undermines humanity's altruistic social nature. Contemporary thinkers have begun to expound new ideas such as "environmental eth-

ics," "responsibility to future generations" and "environmental justice" in line with Christian ethical positions.

Integration according to *Laudato Si'*

This encyclical by Pope Francis teaches a new way of human life that integrates a traditional Christian perspective with new ideas opposing the dominance of technocracy in the modern world. At its root is the pope's perception of the contemporary civilization that has given free rein to the advancement of technology and lost the wisdom to govern it. In his apostolic exhortation *Evangelii Gaudium* (The Joy of the Gospel), he points out that the economic and political system of modern society, by the greedy pursuit of commercialization and corporate profits and the enforcement of law-and-order, produces worldwide disparities of wealth, poverty and social exclusion of the weak that goes against Gospel values. This analysis can be linked to the suffering of the victims of the Fukushima nuclear power plant accident in their disrupted lives.

In other words, Francis emphasizes that there are close links between environmental problems that point to the fragility of the planet and poverty. "We are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental" (139). He proposes "an *integral ecology*, one which clearly respects its human and social dimensions" (137). "This will help to provide an approach to ecology which respects our unique place as human beings in this world and our relationship to our surroundings" (15).

According to the encyclical, human beings should live while integrating "responsibility to God," "responsibility to society" and "responsibility to the created world." The model is Jesus Christ, who lived in perfect harmony with God and with creatures, and who in his resurrection embraces the world and leads it to perfection.

In order to "protect our common home," the encyclical calls for changing our lifestyles and the direction of our society. So as to responsibly protect its beauty, Francis proposes the "ecological conversion" that John Paul II had advocated. This requires a sincere dialogue that builds a transparent decision-making process at every level of social, economic and political life. Such an ecological spirituality should be deepened in dialogue and collaboration with people of various religions.

Natural energy and ecological spirituality

In a society centered on natural energy, new ways of interacting among people will unfold, which is different from a society in which nuclear power is managed by a monolithic national power and people are managed and controlled. It is a "recycling-oriented symbiotic society" in which people deepen the bonds of the community by local produc-

tion for local use of energy. In order to make this a reality, it is necessary to change attitudes relying upon conventional means and administrative systems so that each citizen can participate in policy decisions affecting the community's livelihoods.

Nuclear power plants produce huge, even wasteful, amounts of electricity. On the other hand, utilizing the resources inherent in human beings, their will and hope to combine their powers to build a better future using sustainable energy, finds expression in the Japanese bishops' comments on "poverty" in their 2011 statement. This is not an anxiety about making sacrifices by letting go of a comfortable life now but rather an awareness of rich new values not seen before. This sort of "poverty" in modern society requires that we deepen our understanding of the entire life and social structure of excessive consumption of energy and resources, and then undertake its transformation. In order to break away from ways of living wasteful of electricity we need efforts to save energy. Creating a framework of society where power saving is rewarded will be a fruit of the "ecological spirituality" or "integral ecology" proposed by Pope Francis. At the same time, it is a step towards social reconstruction to overcome the disaster of nuclear accidents in the context of "human recovery". For believers, it should be a step towards the realization of the Reign of God proclaimed by Jesus Christ.

Japan is turning to face the challenge of phasing out nuclear energy. In this situation, the church and its members have the opportunity to use electricity moderately to show that it is possible to create a society without being excessively dependent on electric energy.

Based upon the above, the editorial committee of this book issues a call to all people, especially to those who share our faith.

Questions and calls to government, business, media and the people of Japan

(1) Looking back five years to the November 8, 2011 statement of the Catholic Bishops' Conference of Japan after the Fukushima Daiichi nuclear accident, we wish to reaffirm the call they made then. "In the message *Reverence for Life*, we, Japanese bishops could not go so far as to urge the immediate abolishment of nuclear plants. However, after facing the tragic nuclear disaster in Fukushima, we regretted and reconsidered such attitude. And now, we would like to call for the immediate abolishment of all the power plants in Japan."

(2) We who live in Japan have repeatedly experienced disasters caused by nuclear power. Therefore, we have a responsibility to remember the history of how we have both suffered and caused nuclear damage and to tell that history to the world and later gener-

ations. In particular, the Japanese government and media should show the world a responsible attitude towards nuclear issues.

(3) We call on the government and all business corporations involved in nuclear power to consider the various problems associated with the use of nuclear energy from the standpoint of ethics, that is, from the viewpoints of justice and equity, and sincerely to ask whether to keep it or not for the future. Domestically, there is an imbalance between the big cities that benefit from nuclear energy and the areas where power plants are located, imposing the risk of accidents. Recognizing that nuclear waste has a serious impact on future generations, we must also practice "intergenerational ethics" for our descendants.

(4) We ask the government and all business corporations involved in nuclear power to be aware of the serious impact on society of catastrophic nuclear accidents, especially those of Chernobyl and Fukushima. We ask them to provide clear and complete information for the sake of an honest debate on the issues.

(5) Government and municipalities in the afflicted areas should aim for "human recovery," ensuring the right of victims to live fully human lives and rebuild their lives according to their individual needs. We ask especially that the rights of vulnerable people not be ignored. To rebuild community in the disaster area, close coordination of the knowledge and experience of all those engaged in science, technology, politics, economy, welfare, education, art, religion and so forth is necessary.

(6) We citizens must reflect upon newly emerging powers in societies propelling scientific and technological research and development, and also new ways of understanding what economy and progress are meant to be. Technologies dealing with nuclear energy are associated with extremely high risks. These include the difficulty of radioactive waste disposal and the risk of targeting by terrorist attacks. It is a technology developed from military motives and diversion to military use is always possible. Nuclear energy constitutes a structural threat to human dignity.

(7) We citizens, recognizing that safeguarding the climate and the environment is required by ecological justice, must each cooperate unstintingly to the extent that we are able. We have a responsibility and obligation to the future to protect the environment of earth, air, water, all living things and human beings as a "home for life."

(8) We citizens must overcome consumerism and choose lifestyles based on moderation and solidarity. This is not a retreat from development, but as Pope Francis points out, it is rather progress towards new riches and integration for human beings and society.

Recommendations to the Catholic Church

(1) We should pray for the unity of all people living in societies with nuclear power. Nuclear power divides us in various ways. Let us ask God, the merciful One, that dialogue and reconciliation be possible among families and friends divided because of accidents, between urban power consumers and those in areas with nuclear facilities and among those with differences of opinion regarding nuclear power.

(2) As the church, let us cooperate with "human recovery" efforts. Let us make that intention clear, build networking and share information. We can expand the circle of solidarity through activities supporting the victims, including prayer and learning, recreational programs and such.

(3) Let us call on the churches of neighboring countries (South Korea, Taiwan, Hong Kong, Australia, Indonesia, Philippines, India etc.) and other Christian churches and denominations as well as various religions for collaboration toward removal of nuclear power generation. And let us make our voice heard by the Holy See, which has not yet made any clear statements about nuclear power plants.

(4) Making our own the vision of *Laudato Si'* ("integral ecology" and "ecological spirituality") and putting that into practice, let us think about a new lifestyle, caring for human dignity and developing our new relationship with God, society and nature in acts of consumption and in daily living. For example, at our parishes or schools and religious communities or their institutions as well as in personal efforts, might we work to develop such habits as decreasing consumption, conserving energy, reducing environmental impact and greening? (1) For private and public prayer, we can prepare and distribute texts and materials on the theme of building a just relationship with creation. (2) We can practice the "Three R's" in every aspect of our lives with clothing, food, housing, transportation and so on by reducing waste, recycling and reusing. (3)By building cooperative relationships with organizations both inside and outside the church related to environmental as well as justice and peace issues, we can encourage and cultivate awareness of ecological and social justice.

"Poverty" in the Catholic tradition is not a painful penance, but a "virtue of sharing" that fairly shares wealth as needed by offering others what is abstained from private use in order to put worldly goods under common use for all humanity. (cf. *Catechism of the Catholic Church*, 2833).

Taking the contemporary environmental crisis as a call from God for conversion to reconciliation with creation, let us deepen our communion with the Trinitarian God who has made this beautiful universe, participate together in the divine act of creation and pray for its fulfilment.

Finally, let us listen to St. Francis of Assisi, and the famous phrase in his *Canticle of the Sun*, *"Laudato si' mi signore"* (Be praised, my Lord), after which the papal encyclical was named.

In this hymn, St. Francis sings of the communion of humanity and nature brought about by a life of love and poverty. God's blessings, poverty and freedom are inextricably connected, and when these three harmonize, we can live a life that is simple, natural and unspoilt, filled with pleasing joy, and without any need of nuclear power.

The Canticle of the Sun by St. Francis of Assisi

Most High, all powerful, good Lord,
Yours are the praises, the glory, the honor,
and all blessing.
...
Be praised, my Lord, through all your creatures,
especially through my lord Brother Sun,
who brings the day; and you give light through him.
And he is beautiful and radiant in all his splendor!
Of you, Most High, he bears the likeness.
Praised be You, my Lord, through Sister Moon
and the stars, in heaven you formed them
clear and precious and beautiful.
Praised be You, my Lord, through Brother Wind,
and through the air, cloudy and serene,
and every kind of weather through which
You give sustenance to Your creatures.
Praised be You, my Lord, through Sister Water,
which is very useful and humble and precious and chaste.
...
Praised be You, my Lord, through Sister Mother Earth,
who sustains us and governs us and who produces
varied fruits with colored flowers and herbs.
Praised be You, my Lord,
through those who give pardon for Your love,
and bear infirmity and tribulation.
Blessed are those who endure in peace
for by You, Most High, they shall be crowned.

...
Praise and bless my Lord,
and give Him thanks
and serve Him with great humility.
(Quotes & Art)
<https://www.youtube.com/watch?v=O3fsSs6Z69o>

References

Part 1

Alexievich, Svetlana, 1997: *Chernobyl Prayer: A Chronicle of the Future*, Japanese version, Taeko Matsumoto, trans., Tokyo: Iwanami Shoten, 2011.

Arima, Tetsuo, 2012:『原発と原爆―「日・米・英」核武装の暗闘』(Nuclear Power and the Atom Bomb—Secret Feud among Japan, the USA and the UK over Nuclear Weapons), Tokyo: Bungeishunju. (in Japanese)

Citizens' Commission on Nuclear Energy, 2014:『原発ゼロ社会への道―市民がつくる脱原子力政策大綱』(Road to a No-Nukes Society—General Principles of Policies Created by Citizens to Abandon Nuclear Power), http://www.ccnejapan.com/20140412_CCNE.pdf (in Japanese)

Citizens' Nuclear Information Center, 2015:『原子力市民年鑑2015』(Citizens' Yearbook on Nuclear Energy 2015), Tokyo, Nanatsumori Shokan, Inc. (in Japanese)

Daigo Fukuryu Maru Peace Association (ed.), Shoichiro Kawasaki (chief supervisor), Shigeo Yamamura, Shuhei Okuyama and Hiromitsu Toyosaki (supervisors), 2014:『第五福竜丸は航海中―ビキニ水爆被災事件と被ばく漁船60 年の記録』(The Daigo Fukuryu Maru En Route—60 Years of Records on the Bikini Hydrogen Bomb Disaster and the Exposed Fishing Boat), Tokyo: Daigo Fukuryu Maru Peace Association. (in Japanese)

Director-General of Labour Standards Bureau, Ministry of Labour, 1976:「電離放射線に係る疾病の業務上外の認定基準について」(Regarding Certification Criteria for Ionizing Radiation-related Diseases On and Off the Job), Official Notice from the Director-General of the Labour Standards Bureau, Ministry of Labour, Issuance No. 810, Nov. 8. 1976. (in Japanese)

Higuchi, Kenji, 1991:『これが原発だ―カメラがとらえた被曝者』(*This is Nuclear Energy—Photographs of* Hibakusha), Tokyo: Iwanami Shoten. (in Japanese)

Higuchi, Kenji, 2011:『闇に消される原発被曝者［増補新版］』(Nuclear Power Hibakusha Relegated to the Shadows (New Expanded Ed.)), Tokyo: Hachigatsu-Syokan. (in Japanese)

Hino, Kosuke, 2013:『福島原発事故―県民健康管理調査の闇』(The Fukushima Nuclear Accident—Shady Health Care Survey of Prefectural Citizens), Tokyo: Iwanami Shoten. (in Japanese)

Hino, Kosuke, 2014:『福島原発事故―被災者支援政策の欺瞞』(The Fukushima Nuclear Accident—Deceptions in Disaster Victim Aid Policies), Tokyo: Iwanami Shoten. (in Japanese)

Hino, Kosuke, 2016:『原発棄民―フクシマ5 年後の真実』(People Abandoned by Nuclear Power—The Truth 5 Years after Fukushima), Tokyo: Mainichi Shimbun Publishing. (in Japanese)

Hizumi, Kazuo and Ryuichi Kino, 2012:『検証福島原発事故・記者会見―東電・政府は何を隠したのか』(Verification of the Fukushima Nuclear Accident—Press Conference—What TEPCO and the Government Hid), Tokyo: Iwanami Shoten. (in Japanese)

Human Rights Now (ed.), 2014:『国連グローバー勧告―福島第一原発事故後の住民がもつ「健康に対する権利」の保障と課題』(UN Grover Recommendations—Guaranteeing 'Right to Health' of Inhabitants after the Fukushima Nuclear Accident and Related Tasks), Tokyo: Godo-Shuppan. (in Japanese)

Ieda, Osamu, 2014:『なぜ日本の災害復興は進まないのか―ハンガリー赤泥流出事故の復興政策に学ぶ』(Why Disaster Recovery does not Progress in Japan—Learning from Recovery Policies of the Ajka Alumina Plant Accident in Hungary), Tokyo: Gendaijinbun-sha. (in Japanese)

Ie, Masaji (ed.-in-chief), 2012:『「居住の権利」とくらし―東日本大震災復興をみすえて』(Life and the Right to Housing—Focusing on the Recovery from the Great East Japan Earth-

quake), Tokyo: Fujiwara Shoten. (in Japanese)

Igawa, Mitsuo, 2002:「原子力平和利用博覧会と新聞社」(Newspaper Companies and the Exhibition on Peaceful Uses of Nuclear Power). In: Toshihiro Tsuganesawa, ed.,『戦後日本のメディア・イベント1945-1960年』(Postwar Japanese Media Events 1945-1960), Kyoto: Sekaishisosha. (in Japanese)

Institute of Disaster Area Revitalization, Regrowth and Governance, Japan Civil Network (JCN) and Save Fukushima Children Lawyers' Network (SAFLAN) (eds.), 2015:『原発避難白書』(Nuclear Plant Evacuation Whitepaper) , Kyoto: Jinbun Shoin. (in Japanese)

International Commission on Radiological Protection (ICRP), 2009: *Application of the Commission's Recommendations for Protection of People in Emergency Exposure Situations*, (Japanese translation by Toshimitsu Honma), ICRP Committee to Study Recommendation Translations (ed.), Tokyo: Japan Radioisotope Association, 2013.

International Physicians for the Prevention of Nuclear War (IPPNW), 1991: *Radioactive Heaven and Earth. The health and environmental effects of nuclear weapons testing in, on, and above the earth*, New York.

Japan Confederation of A- and H-Bomb Sufferers Organizations, 2005:「いまだから伝えたい被爆者からあなたへ―被爆60 年「わたしの訴え」中間報告」(What the Hibakusha Want You to Know, Especially Now—Interim Report on 'My Appeal' 60 Years Since Exposure), http://www.ne.jp/asahi/hidankyo/nihon/spread/img/057myappealjapanese.pdf (in Japanese)

Jomaru, Yoichi, 2012:『原発とメディア―新聞ジャーナリズム2 度目の敗北』 (Nuclear Power and the Media—The Second Defeat of Newspaper Journalism), Tokyo: Asahi Shimbun Publications, Inc. (in Japanese)

Kawasaki, Ken'ichiro, Kaori Suganami, Masahiro Takeda and Kenji Fukuda (2012):『避難する権利、それぞれの選択―被曝の時代を生きる』(The Right to Evacuate and Various Choices—Living in an Age of Exposure to Radiation), Tokyo: Iwanami Shoten. (in Japanese)

Kimura, Akira and Hiroko Takahashi, 2016:『核の戦後史―Q&Aで学ぶ原爆・原発・被ばくの真実』(*Post-war Nuclear History— Q&A for Learning the Truth about the A-bomb, Nuclear Power and Radiation Exposure*), Osaka, Sogensha. (in Japanese)

Kimura, Akira and Peter Kuznick, 2010:『広島・長崎への原爆投下再考―日米の視点』(Rethinking the Atomic Bombings of Hiroshima and Nagasaki: Japanese and US Perspectives), Kyoto: Horitsu Bunka Sha. (in Japanese)

Kino, Ryuichi, 2013:『検証福島原発事故・記者会見2―「収束」の虚妄』(Fukushima Nuclear Accident Review and Press Conference 2—Falsity of 'Settlement'), Tokyo: Iwanami Shoten. (in Japanese)

Kishi, Nobusuke, 1983:『岸信介回顧録―保守合同と安保改定』(Memoirs of Nobusuke Kishi—Merger of the Conservative Party and Revision of the Security Treaty) , Tokyo: Kosaido Publishing. (in Japanese)

Koide, Hiroaki, 2010:『隠される原子力・核の真実―原子力の専門家が原発に反対するわけ』(Hidden Nuclear Power and the Truth on Nuclear—Why an Expert on Nuclear Power Opposes Nuclear Power Generation), Tokyo: Soushisha. (in Japanese)

Komori, Atsushi, 2016:『日本はなぜ脱原発できないのか―「原子力村」という利権』(Why Can't Japan Abandon Nuclear Power?—The Vested Rights of Japan's 'Nuclear Power Village'), Tokyo: Heibonsha. (in Japanese)

Maeda, Tetsuo, 2005:「ビキニ水爆被災の今日的意味」(The Present Significance of the Bikini Hydrogen Bombing Disaster). In: Tetsuo Maeda (ed.-in-chief) and Global Hibakusha Kenkyukai (eds.),『隠されたヒバクシャ―検証＝裁きなきビキニ水爆被災』(Concealed Radiation Victims—Verification=No Reckoning of the Bikini Hydrogen Bomb Disaster), Tokyo: Sofusha. (in Japanese)

Matsuzaki, Michiyuki, 2013:「がんリスクは10 ミリシーベルトでも有意に増加―日本の原発労働者の疫学調査がICRP のリスク評価の見直しを迫る」(Risk of Cancer Increases Significantly Even at 10 Millisieverts—Epidemiological Study of Japan's Nuclear Plant Workers Calls for Review of ICRP's Risk Assessment). *Journal of Japanese Scientists*, 48(1):37-43, Tokyo: The Japan Scientists' Association. (in Japanese)

Ministry of Education, Culture, Sports, Science and Technology (MEXT), Dispute Reconciliation Committee for Nuclear Damage Compensation, 2011:「原子力損害賠償紛争審査会（第18回）配付資料・参考2-1 自主的避難関連データ」 (Materials Distributed to the 18th Meeting of the Dispute Reconciliation Committee for Nuclear Damage Compensation, Ref. 2-1, Voluntary Evacuation-related Data). http://www.mext.go.jp/b_menu/shingi/chousa/kaihatu/016/shiryo/__icsFiles/afieldfile/2011/12/06/1313895_3_1.pdf (in Japanese)

Ministry of Foreign Affairs (MOFA), Foreign Policy Planning Committee, 1969:「わが国の外交政策大綱」(General Principles of Our Nation's Foreign Policy), Sept. 25, 1969, http://www.mofa.go.jp/mofaj/gaiko/kaku_hokoku/pdfs/kaku_hokoku02.pdf+ (in Japanese)

Miyake, Yasuo, Yoshio Hiyama, Nobuo Kusano (eds.-in-chief) and Daigo Fukuryu Maru Peace Association (ed.), 2014:『新装版・ビキニ水爆被災資料集』(Collection of Documents on the Bikini Hydrogen Bomb Disaster, Special Edition), Tokyo: University of Tokyo Press. (in Japanese)

Morikawa, Sei and Yukio Yamakawa, 2015:「原発事故被害者に対する支援政策の課題―避難住宅政策と医療・健康対策について」(Aid Policy Tasks for Nuclear Accident Victims—Regarding Evacuee Housing Policies and Medical/Health Policies). In: Masafumi Yokemoto and Toshihiro Watanabe (eds.),『原発災害はなぜ不均等な復興をもたらすのか―福島事故から「人間の復興」、地域再生へ』(Why do Nuclear Disasters Result in Unequal Reconstruction—Toward 'Human Rehabilitation' and Community Revival after the Fukushima Accident), Kyoto: Minerva Shobo. (in Japanese)

Nakagawa, Yasuo, 2011:『増補・放射線被曝の歴史―アメリカ原爆開発から福島原発事故まで』(History of Radiation Exposure—From America's Development of the Atom Bomb to the Fukushima Nuclear Accident, Expanded Ed.), Tokyo: Akaishi Shoten. (in Japanese)

Nakamura, Seitaro, 1954:「科学者の良心」(The Benevolence of Scientists). *Kaizo*, 35(8): 120-125, Aug. 1954, Tokyo, Kaizosha. (in Japanese)

National Research Council (NRC), 1989:『リスクコミュニケーション―前進への提言』(Risk Communication—Recommendations for Advancement), Yuzo Hayashi and Jun Sekizawa (chief translators for Japanese ed.), Tokyo: The Chemical Daily Co., Ltd. (in Japanese)

Nishio, Baku, 2015:『原子力・核・放射線事故の世界史』(World History of Atomic Energy, Nuclear Weapons and Radiation Accidents), Tokyo: Nanatsumori Shokan, Inc. (in Japanese)

Ohta, Masakatsu, 2014:『日米〈核〉同盟―原爆、核の傘、フクシマ』(Japan-US 'Nuclear' Alliance—The Atom Bomb, Nuclear Umbrella and Fukushima) , Tokyo: Iwanami Shoten. (in Japanese)

Oishi, Matashichi (auth.) and Kudo, Toshiki (ed.), 1991:『死の灰を背負って―私の人生を変えた第五福竜丸』(Bearing the Ashes of Death—Daigo Fukuryu-maru, the Boat that Changed my Life), Tokyo: Shinchosha. (in Japanese)

Oishi, Matashichi, 2003:『ビキニ事件の真実―いのちの岐路で』(Truth about the Bikini Incident—Crossroads of Life), Tokyo: Misuzu Shobo. (in Japanese)

Oishi, Matashichi, 2007:『これだけは伝えておきたいビキニ事件の表と裏―第五福竜丸・乗組員が語る』(I Want to Tell You Just This about the Two Sides of the Bikini Incident—Crew of the Daigo Fukuryu-maru Speaks) , Kyoto: Kamogawa Co., Ltd. (in Japanese)

Oishi , Matashichi, 2011:『矛盾―ビキニ事件、平和運動の原点』(An Absurdity—The Bikini Incident, Origin of the Peace Movement) , Tokyo: Musashino Books. (in Japanese)

Pacific Islands Center, 2011:『マーシャル諸島』 (The Marshall Islands), http://blog.pic.or.jp/

images/book/guidebooks/guidebook_marshall_2011.pdf (in Japanese)

Prieur, Michel, 2012: *Ethical Principles on Disaster Risk Reduction People's Resilience*, European and Mediterranean Major Hazards Agreement, Council of Europe. https://www.coe.int/t/dg4/majorhazards/ressources/pub/Ethical-Principles-Publication_EN.pdf

Radiation Effects Research Foundation (RERF), 2013:「放射線影響研究所のご案内」(Introduction to the Radiation Effects, Research Foundation), http://www.rerf.or.jp/shared/introd/introRERFj.pdf (in Japanese)

REN21 (Renewable Energy Policy Network for the 21st Century), 2015: *Renewables 2015—Global Status Report*, Japanese translation., Noriaki Yamashita and Minori Maesono (eds.), Institute for Sustainable Energy Policies (ISEP), http://www.isep.or.jp/library/1959 (in Japanese)

Shibata, Hidetoshi, 1985:『戦後マスコミ回遊記』(Account of the Peregrinations of Post-war Mass Communications), Tokyo: Chuokoron-Shinsha. (in Japanese)

Shimazono, Susumu, 2013:『つくられた放射線「安全」論—科学が道を踏みはずすとき』(The Created Theory of Radiation 'Safety'—When Science Gets Off Track), Tokyo: Kawade Shobo Shinsha. (in Japanese)

Shirai, Satoshi and "Give us back our livelihood, give us back our land" Fukushima Nuclear Power Plaintiffs Group and Defense Counsel, 2015:『福島を切り捨てるのですか—"20 ミリシーベルト受忍論"批判』(Will Fukushima be Left Out?—Criticizing the '20-mllisievert Tolerance' Theory), Kyoto: Kamogawa Co., Ltd. (in Japanese)

Soeda, Takashi, 2014:『原発と大津波警告を葬った人々』(The People Who Deep-sixed Warnings about Nuclear Power and Great Tsunamis), Tokyo: Iwanami Shoten. (in Japanese)

Suzuki, Manami, 2014:『日本はなぜ原発を輸出するのか』(Why is Japan Exporting Nuclear Power?), Tokyo: Heibonsha. (in Japanese)

Takagi, Jinzaburo, 1986:「今月の視点」(This Month's Focus), Genpatsu Toso Joho, No. 146, Sep. 1986, p. 7, Tokyo: Citizens Nuclear Information Center. (in Japanese)

Takagi, Jinzaburo, 2000:『原発事故はなぜくりかえすのか』(Why do Nuclear Power Accidents Occur Repeatedly?), Tokyo: Iwanami Shoten. (in Japanese)

Takahashi, Tetsuya, 2012:『犠牲のシステム—福島・沖縄』(Sacrificial System—Fukushima and Okinawa), Tokyo: Shueisha. (in Japanese)

Takahashi, Hiroko, 2012:『新訂増補版・封印されたヒロシマ・ナガサキ—米核実験と民間防衛計画』(Hiroshima and Nagasaki Sealed—America's Nuclear Experimentation and the Civil Defense Plan, Revised and Expanded Edition), Tokyo: Sofusha. (in Japanese)

Takemine, Seiichiro, 2005:「塗り替えられる被災地図隠されたヒバクシャを追う」(Pursuing the Radiation Victims Concealed by the Recoloring of the Disaster Maps). *In*: Tetsuo Maeda (editor-in-chief) and Global Hibakusha Kenkyukai (eds.),『隠されたヒバクシャ—検証＝裁きなきビキニ水爆被災』(Concealed Radiation Victims—Verification=No Reckoning of the Bikini Hydrogen Bomb Disaster), Tokyo: Sofusha. (in Japanese)

Takemine, Seiichiro, 2015:『マーシャル諸島終わりなき核被害を生きる』(Living through the Endless Radiation Exposure Damage in the Marshall Islands), Tokyo: Shinsensha. (in Japanese)

Taketani, Mitsuo, 1955:「濃縮ウランの受入をめぐって」(Concerning the Acceptance of Enriched Uranium) (a conversation with Michitaka Kaino). *Horitsu Jiho*, 27(8): 89-99, Aug. 1955, Tokyo: Nihon Hyoronsha. (in Japanese)

Toyosaki, Hiromitsu, 2006:「棄てられる日本と世界のヒバクシャ」(The Abandoned Hibakusha of Japan and the World), *PRIME*, 24: 79-87, Yokohama: International Peace Research Institute, Meiji Gakuin University. (in Japanese)

Tsutsui, Tetsuro (auth.) and Fukushima Accident 'Settlement' Measures Project Team (eds.), 2015:「特別レポート1・100 年以上隔離保管後の「後始末」(Special Report 1: 'Settlement' after

100 years or more of isolated storage), Tokyo: Citizens' Commission on Nuclear Energy http://www.ccnejapan.com/20150608_CCNE_specialreport.pdf. (in Japanese)

Tsuzuki, Masao, 1954:「欧米に於ける原子力と放射能障害との問題」(Nuclear Power and Radiation Damage Issues in Europe and the US). *Shiso*, 362: 935-943, Aug. 1954, Tokyo: Iwanami Shoten. (in Japanese)

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2011: *Sources and Effects of Ionizing Radiation, UNSCEAR 2008 Report to the General Assembly with Scientific Annexes, Vol. II, Scientific Annexes C, D and E*, United Nations Publications.

Wada, Nagahisa, 2014:『原子力と核の時代史』(History of the Age of Nuclear Power and Nuclear Weapons), Tokyo: Nanatsumori Shokan, Inc. (in Japanese)

Wada, Nagahisa and Japan Citizens' Congress to Prohibit Atomic and Hydrogen Bombs (ed.), 2011:『原子力・核問題ハンドブック』(Nuclear Power and Nuclear Weapons Handbook), Tokyo: Nanatsumori Shokan, Inc. (in Japanese)

Yamagiwa, Akira, Seiitsu Tachibana (eds.) and Ryonosuke Okada (transl), 1993:『資料マンハッタン計画』(Documentary Material: The Manhattan Project), Tokyo: Otsuki Shoten. (in Japanese)

Yamashita, Masatoshi, 2012:『核の海の証言―ビキニ事件は終わらない』(The Ocean's Testimony on Nuclear Weapons—The Bikini Incident Has No Ending), Tokyo: Shinnihon Shuppansha. (in Japanese)

Yamashita, Yusuke, Takashi Ichimura and Akihiko Sato, 2013:『人間なき復興―原発避難と国民の「不理解」をめぐって』(A Restoration Lacking People—Concerning Nuclear Evacuation and Citizens' Lack of Understanding), Tokyo: Akaishi Shoten. (in Japanese)

Yamazaki, Masakatsu and Shizue Hinokawa (eds.), 1997:『増補・原爆はこうして開発された』(This was How the Atom Bomb was Developed, Expanded Ed.), Tokyo: Aoki Books.

Yoshida, Chia, 2016:『ルポ母子避難―消されゆく原発事故被害者』(Accounts of Mother and Child Evacuations—The Disappearing Nuclear Power Accident Victims), Tokyo: Iwanami Shoten. (in Japanese)

Yoshimi, Shunya, 2012:『夢の原子力―Atoms for Dream』(Dreams of Nuclear Power—Atoms for Dreams), Tokyo: Chikumashobo, Ltd.

Yoshioka, Hitoshi, 2011a:『新版・原子力の社会史―その日本的展開』(History of Nuclear-powered Society—Its Japanese-style Development), Tokyo: Asahi Shimbun Publications, reference document 269. (in Japanese)

Yoshioka, Hitoshi, 2011b:『原発と日本の未来―原子力は温暖化対策の切り札か』(Nuclear Power and Japan's Future—Is Nuclear Power an Ace up the Sleeve for Combating Global Warming?), Tokyo: Iwanami Shoten. (in Japanese)

Yoroi, Takayoshi, 2012:「原発被曝労働の何が問題か―それでも原子力発電を続けるのか」(What Problems do the Workers Exposed at Nuclear Plants Have?—Even So, Will Nuclear Power Generation Continue?). *Sekai*, 827: 93-100, Feb. 2012, Tokyo: Iwanami Shoten. (in Japanese)

Part 2

Aoyama, Michio, 2014:「東京電力福島第一原子力発電所事故に由来する汚染水問題を考える」(Considering the Issue of Contaminated Water Arising from the Accident at Tokyo Electric Power Co.'s Fukushima Daiichi Nuclear Power Station). *Kagaku*, 84(8): 856-865, Aug. 2014, Tokyo: Iwanami Shoten. (in Japanese)

Ban, Hideyuki, 2011:「核燃料サイクル等技術検討小委員会【3】意見書（2011 年10 月25 日）」(Opinion Paper: Subcommittee for Review of Nuclear Fuel Cycle and Other Technology (3)

(Oct. 25, 2011)), https://www.env.go.jp/council/06earth/y0613-04/ref03-3.pdf (in Japanese)

Citizens' Commission on Nuclear Energy, 2014:『原発ゼロ社会への道―市民がつくる脱原子力政策大綱』(Road to a Nuclear-free Society: An Interim Report for Forming the New Public Consensus), http://www.ccnejapan.com/20140412_CCNE.pdf (in Japanese)

Ethics Commission on Safe Energy Supply, 2011:「ドイツのエネルギー大転換―未来のための共同事業」(Complete Turnaround for Germany's Energy—A Joint Undertaking for the Future). In: Fumikazu Yoshida and Miranda Schreurs, ed. & transl.,『ドイツ脱原発倫理委員会報告―社会共同によるエネルギーシフトの道すじ』(Report from Germany's Ethics Commission to Abandon Nuclear Energy—Pathway to an Energy Shift through Social Cooperation), Tokyo: Otsuki Shoten. (in Japanese)

Fukushima Nuclear Accident Documentation Team (ed.), Tomomi Miyazaki and Hideaki Kimura (commentary), 2013:『福島原発事故東電テレビ会議49 時間の記録』(Record of 49 Hours of TEPCO Teleconferences on the Fukushima Nuclear Accident), Tokyo: Iwanami Shoten. (in Japanese)

Goto, Hiroshi, Takashi Sayama and Toru Aoki, 2013:「原発作業員座談会・いま、イチエフはどうなっているか―真の事故収束に向けて」(Nuclear Plant Workers' Round Table Discussion: How are the Ichi-F Workers Doing Now? Toward a Real Restoration from the Accident). *Sekai*, 842: 93-100, Apr. 2013, Tokyo: Iwanami Shoten. (in Japanese)

Gundersen, Arnold, 2015:「いつ何を知ったのか」、『終わりなき危機―日本のメディアが伝えない、世界の科学者による福島原発事故研究報告書』(What was Known and When: Endless Catastrophe—Research Reports on the Fukushima Nuclear Accident by World Scientists that Japan's Media Fail to Relay), Helen Caldicott (ed.-in-chief) and Megumi Kawamura (transl.), Tokyo: bookman.sha. (in Japanese)

Ino, Hiromitsu and Koichi Takitani, 2014:「不確実さに満ちた過酷事故対策―新規制基準適合性審査はこれでよいのか」(Severe Accident Countermeasures Full of Uncertainties—Are the Inspections for Compliance with the New Regulatory Standards Sufficient?). *Kagaku*, 84(3): 333-345, Mar. 2014, Tokyo: Iwanami Shoten. (in Japanese)

Ishibashi, Katsuhiko, 2014a:「原発規制基準は「世界で最も厳しい水準」の虚構―大飯原発運転差止判決が迫る根本的見直し」(The Fiction of Nuclear Power Regulatory Standards Being the World's Strictest—Radical Review Urges Decision to Halt Operation of the Oi Nuclear Plant). *Kagaku*, 84(8): 869-877, Aug. 2014, Tokyo: Iwanami Shoten. (in Japanese)

Ishibashi, Katsuhiko, 2014b:「川内原発の審査書案は規則第5 号に違反して違法だ―基準地震動策定の驚くべき手抜き」(The Inspection Document Draft for the Sendai Nuclear Plant Violates Regulation No. 5—Astounding Lapses in Standard Earthquake Countermeasures). *Kagaku*, 84(9): 942-946, Sep. 2014, Tokyo: Iwanami Shoten. (in Japanese)

Kamioka, Naomi, 2014:『原発避難計画の検証―このままでは、住民の安全は保障できない』(*Verification of Nuclear Plant Evacuation Plans—Residents' Safety Cannot be Guaranteed as they Stand*), Tokyo: Godo-Shuppan. (in Japanese)

Kansai Electric Power Co., 2014:「高浜原発3,4 号機の原子炉設置変更許可申請の補正書について（平成26 年10 月31 日）」(Regarding Amendments to the Application for Approval of Alteration of Nuclear Reactor Installment for Takahama Nuclear Power Station Units 3 and 4, Oct. 31, 2014), http://www.kepco.co.jp/corporate/pr/2014/pdf/1031_2j_01.pdf

Kimura, Hideaki, 2012:『官邸の100 時間―検証福島原発事故』(100 Hours in the Prime Minister's Residence—Investigation: The Fukushima Nuclear Accident), Tokyo: Iwanami Shoten. (in Japanese)

Kino, Ryuichi, 2014:「難航する汚染水対策―問題の先送りが事態を深刻にしていく」(Contaminated Water Countermeasures Hitting Difficulties—Delays in Dealing with it will Exacerbate the Situation). *Kagaku*, 84(8): 846-853, Aug. 2014, Tokyo: Iwanami Shoten. (in Japanese)

Koiwa, Masahiro, 2012:「原子炉圧力容器の脆化予測は破綻している―でたらめな予測式をごまかす意見聴取会」(Embrittlement Prediction for Reactor Vessels Materials Failed—Opinion Hearing Deceptive with Falsified Prediction Formula). *Kagaku*, 82(10): 1150-1160, Oct. 2012, Tokyo: Iwanami Shoten. (in Japanese)

Kondo, Shunsuke, 2011:「福島第一原子力発電所の不測事態シナリオの素描」(Rough Sketch of the Fukushima Daiichi Nuclear Plant Contingency Scenarios). *In*: Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident, *Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident Investigation and Verification Report*, vol. end document, Mar. 2012, Tokyo: Discover 21, Inc. (in Japanese)

Kumamoto, Kazuki, 2014:『電力改革と脱原発』(Electric Power Reformation and Abandonment of Nuclear Power), Tokyo: Ryokufu. (in Japanese)

Kyushu Electric Power Co., 2013a:「第6 回原子力発電所の新規制基準適合性に係る審査会合（平成25年8 月1 日）資料1-1「川内原子力発電所1 号炉及び2 号炉重大事故等対策の有効性評価成立性確認」(6th Examination Meeting Concerning Conformity of Nuclear Power Plant with New Regulatory Standards (Aug. 1, 2013), Document 1-1: "Confirming Feasibility of Evaluating the Validity of Measures Against Serious Accidents, etc., at Sendai Nuclear Power Station Units 1 and 2"), https://www.nsr.go.jp/data/000034349.pdf (in Japanese)

Kyushu Electric Power Co., 2013b:「第9 回原子力発電所の新規制基準適合性に係る審査会合（平成25年8 月15 日）資料1-1 「玄海原子力発電所3 号炉及び4 号炉重大事故等対策の有効性評価成立性確認」」(9th Examination Meeting Concerning Conformity of Nuclear Power Plant with New Regulatory Standards (Aug. 15, 2013), Document 1-1: "Confirming Feasibility of Evaluating the Validity of Measures Against Serious Accidents, etc., at Genkai Nuclear Power Station Units 3 and 4"), https://www.nsr.go.jp/data/000034379.pdf (in Japanese)

Mabuchi, Sumio, 2013:『原発と政治のリアリズム』(Nuclear Energy and Political Realism), Tokyo: Shinchosha. (in Japanese)

Ministry of Economy, Trade and Industry (METI), 2014:「エネルギー基本計画」(Basic Energy Plan), http://www.enecho.meti.go.jp/category/others/basic_plan/pdf/140411.pdf (in Japanese)

Ministry of Labor, Labor Standards Bureau, 1972:「労働安全衛生法および同法施行令の施行について」(Regarding Implementation of the Industrial Safety and Health Act and its Enforcement Ordinance), Ministry of Labour, Labour Standards Bureau Notification No. 602, Sep. 18, 1972. (in Japanese)

Nakajima, Teruyuki, Toshimasa Ohara, Mitsuo Uematsu and Yuichi Onda, eds., 2014:『原発事故環境汚染―福島第一原発事故の地球科学的側面』(Environmental Pollution from Nuclear Accidents—Earth Science Aspects of the Fukushima Daiichi Nuclear Accident), , Tokyo: University of Tokyo Press. (in Japanese)

National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC), 2012: *The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission (Main Text)*, Tokyo: Tokuma Shoten. (in Japanese)

Nuclear and Industrial Safety Agency, 2011:「東京電力株式会社福島第一原子力発電所及び広島に投下された原子爆弾から放出された放射性物質に関する試算値について」(On Estimated Values Regarding Radioactive Substances Released from Tokyo Electric Power Co.'s Fukushima Daiichi Nuclear Power Station and the Atomic Bomb Dropped on Hiroshima). (in Japanese)

Nuclear Regulation Authority (NRA), 2014:「九州電力株式会社川内原子力発電所の発電用原子炉設置変更許可申請書（1号及び2号発電用原子炉施設の変更）に関する審査書（案）」(Examination Documents Regarding the Application for Approval of Alteration of Nuclear Reactor Installment for Electric Generation (Alternation of Unit 1 and Unit 2 Nuclear Reactor Facilities for Electric Generation) at Kyushu Electric Power Co.'s Sendai Nuclear Power Station (draft)), https://

www.nsr.go.jp/data/000070038.pdf (n Japanese)

Ono, Yoshiyasu, 2013:『エネルギー転換の経済効果』(Economic Effects of Energy Conversion), Tokyo: Iwanami Shoten. (in Japanese)

Oshima, Ken'ichi, 2011:『原発のコスト―エネルギー転換への視点』(*The Cost of Nuclear Power—Focus on Energy Conversion*), Tokyo: Iwanami Shoten. (in Japanese)

Oshima, Ken'ichi and Masafumi Yokemoto, 2014:「福島原発事故のコストと国民・電力消費者への負担転嫁の拡大」(The Costs of the Fukushima Nuclear Accident and Expanded Burden Shifting to Electric Power Consumers). *The Business Review*, 65(2): 1-24, Aug. 2014, Osaka: Osaka City University Society of Business Research. (in Japanese)

Sadamatsu, Atsushi, 2014:「高レベル放射性廃棄物をめぐる「公共圏の豊富化」の試みについての分析―日本学術会議「回答」と原子力委員会「見解」」(An Analysis of Japanese Public Discourses between the Science Council of Japan and the Japan Atomic Energy Commission on the High-level Radioactive Waste Problem). *Kankyo Shakaigaku Kenkyu*, 20: 180-195, Dec. 2014, Tokyo: The Japanese Association for Environmental Sociology. (in Japanese)

Science Council of Japan (SCJ), 2012:「高レベル放射性廃棄物の処分について」(Regarding Disposal of High-level Radioactive Waste), http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-22-k159-1.pdf (in Japanese)

Science Council of Japan (SCJ), 2014:「高レベル廃棄物の暫定保管に関する技術的検討」(Technological Considerations regarding Interim Storage of High-level Radioactive Waste), http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-22-h140919-2.pdf (in Japanese)

Science Council of Japan (SCJ), 2015:「高レベル放射性廃棄物の処分に関する政策提言―国民的合意形成に向けた暫定保管」(Policy Recommendations on Disposal of High-level Radioactive Waste—Interim Storage for National Consensus-building), http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-23-t212-1.pdf (in Japanese)

Soramoto, Seiki, 2014:『汚染水との闘い―福島第一原発・危機の深層』(The Battle against Contaminated Water: The Fukushima Daiichi Nuclear Plant—Depths of the Crisis), Tokyo: Chikuma Shobo. (in Japanese)

Tokyo Electric Power Co. (TEPCO), 2012:「福島第一原子力発電所の事故に伴う大気への放出量推定について（平成24年5 月現在における評価）」(Regarding Estimates of Emissions to the Atmosphere Resulting from the Accident at the Fukushima Daiichi Nuclear Power Station (Assessment as of May 2012)), http://www.tepco.co.jp/cc/press/betu12_j/images/120524j0101.pdf

Tsutsui, Tetsuro, 2013:「死を内包する技術体系―原子力技術と軍事的論理の一側面」(Fatality-implying Technical System—One Aspect of Nuclear Power Technology and Military Logic), *Sekai*, 845: 225-231, Jul. 2013, Tokyo: Iwanami Shoten. (in Japanese)

Tsutsui, Tetsuro, 2015:「水鉄砲で火の粉を落とす―形骸化する規制審査」(Missing Sparks with a Water Pistol—Regulatory Examinations Losing Substance). *Kagaku*, 85: 506-509, May 2015, Tokyo: Iwanami Shoten. (in Japanese)

von Hippel, Frank and IPFM (eds.), 2011:『徹底検証・使用済み核燃料再処理か乾式貯蔵か―最終処分への道を世界の経験から探る』(Managing Spent Fuel from Nuclear Reactors—Experience and Lessons from Around the World), Masafumi Takubo (transl.), 2014, Tokyo: Godo Shuppan. (in Japanese)

Yoshioka, Hitoshi, Kohta Juraku, Shinji Miyadai and Atsushi Sugita, 2015:『原発決めるのは誰か』(Who Will Decide the Fate of Nuclear Power?), Tokyo: Iwanami Shoten. (in Japanese)

Yoshioka, Hitoshi and Kotaro Nawa, 2015:『技術システムの神話と現実―原子力から情報技術まで』(Myths and the Truth about Technical Systems—From Nuclear Power to Information Technology), Tokyo: Misuzu Shobo. (in Japanese)

Part 3

Abe, Aya, 2011:『弱者の居場所がない社会―貧困・格差と社会的包摂』(Society with No Place for the Weak—Poverty, Disparities and Social Inclusion), Tokyo: Kodansha. (in Japanese)

Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, 2014:「平成26年再生可能エネルギーをめぐる現状と課題」(The Current Situation and Problems Surrounding Renewable Energy, 2014 Ed.), https://www.meti.go.jp/shingikai/enecho/shoene_shinene/shin_energy/pdf/001_03_00.pdf

Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, 2016:「再生可能エネルギー固定価格買取制度ガイドブック2016（平成28）年度版」(Guidebook on Fixed Price Purchase System for Renewable Energy, 2016 Ed.), http://www.enecho.meti.go.jp/category/saving_and_new/saiene/data/kaitori/2016_fit.pdf

Arendt, Hannah, 1958: *The Human Condition*, Hayao Shimizu (transl.), 1994, Tokyo: Chikumashobo, Ltd.

Beck, Ulrich, 1986: *Riskogesellschaft—Auf dem Weg in eine andere Moderne* (Risk Society—On the Way to a New Modernity), Ren Higashi and Midori Ito (transl.), 1998, Tokyo: Hosei University Press. (original in German)

Beck, Ulrich, 2011: Interview. *The Asahi Shimbun*, May 13, 2011. (in Japanese)

Bloch, Ernst, 1918: The Spirit of Utopia, Fujihiko Komura (transl.), 1997, Tokyo: Hakusuisha, Inc. (original in German)

Bloch, Ernst, 1954-1959: *Das Prinzip Hoffnung*, (The Principle of Hope), 3 Vols., Hajime Yamashita, Kyokichi Seto, Keiji Kataoka, Masayuki Numazaki, Shoji Ishimaru and Kazuo Hosaka (transl.), 2012-2013, Tokyo: Hakusui-sha. (original in German)

Carson, Rachel, 1962: *Silent Spring*, Ryoichi Aoki (transl.), 1987, Tokyo: Shinchosha.

Brown, Lester R., Janet Larson, J. Matthew Roney and Emily E. Adams, 2015: *The Great Transition—Shifting from Fossil Fuels to Solar and Wind Energy*, Junko Edahiro transl.), 2015, Tokyo: Iwanami Shoten.

Christian Network for a Nuke-Free Earth, 2011:『原発総被曝の危機―いのちを守りたい』(Danger of Total Radiation Exposure from Nuclear Plants—We Want to Protect Life), Tokyo: Yugakusha. (in Japanese)

Ethics Commission on Safe Energy Supply, 2011: Germany's Energy Turnaround – A Collective Effort for the Future. In: Fumikazu Yoshida and Miranda Schreurs (ed. and transl.),『ドイツ脱原発倫理委員会報告―社会共同によるエネルギーシフトの道すじ』(Report by Germany's Nuclear Abolishment Ethics Committee—The Road to an Energy Shift through Collective Effort), Tokyo: Otsuki Shoten. (original in German)

Fritsch, Uwe R., 2006: *Comparison of greenhouse gas emissions and abatement cost of nuclear and alternative energy options from a lifecycle perspective*, Darmstadt: Öko-Institut e.V., 2006, p. 4. http://www.oeko.de/oekodoc/315/2006-017-en.pdf

Harada, Masaki, 2010:「自然科学と神学」(Natural Science and Theology). *In*: Jochi Gakuin Shin Katorikku Daijiten Editorial Committee (ed.),『新カトリック大事典別巻』(New Catholic Encyclopedia, Separate Vol.) , Tokyo: Kenkyusha. (in Japanese)

Hennicke, Peter and Dieter Seigfried, 1996: *Das Einsparkraftwerk: Eingesparte Energie neu nutzen*, Park Seung-Joon (transl.), 2001, Tokyo: The Energy Conservation Center, Japan. (original in German)

Iida, Tetsunari, 2011:『エネルギー進化論―「第4の革命」が日本を変える』(Energy Evolutionary Theory—The 4th Industrial Revolution will Transform Japan), Tokyo: Chikumashobo, Ltd.

Jesuit Social Center Tokyo (eds.), 2012:『傷つけられた世界を癒すために―3・11後に日本で環境・原発問題について考える』(To Heal a Wounded World—Thinking about Environmental

and Nuclear Power Issues in Japan after 3-11), Narashino City: Kyoyusha, Inc. (in Japanese)

Jonas, Hans, 1966: *The Phenomenon of Life: Toward a Philosophical Biology*, Kazuyuki Hosomi and Ryo Yoshimoto (transl.), 2008, Tokyo: Hosei University Press. (original in German)

Jonas, Hans, 1979: *The Imperative of Responsibility: In Search of Ethics for the Technological Age*, Hisatake Kato (transl.-in-chief), 2000, Tokyo: Toshindo. (original in German)

Jungk, Robert, 1977: *The Nuclear State*, Masahiro Yamaguchi (transl.), 2015, Tokyo: Nihon Keizai Hyoronsha Ltd. (original in German)

Kadowaki, Atsushi, 2010:『社会力を育てる―新しい「学び」の構想』(Cultivating Social Power—New Conception of 'Learning'), Tokyo: Iwanami Shoten. (in Japanese)

Kito, Shuichi, 2002:「環境倫理と公私問題」(Environmental Ethics and Public Versus Private Issues). *In*: Takeshi Sasaki and Kim Tae-Sung Jin (eds.),『地球環境と公共性』(The Global Environment and Publicness), Tokyo: University of Tokyo Press. (in Japanese)

Land Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism, 2014:「平成25年度再生可能エネルギーの活用による地域活性化に関する調査事例集」(Sampling of Surveys on Regional Vitalization through Use of Renewable Energy, FY2014), http://www.mlit.go.jp/common/001053792.pdf (in Japanese)

Leopold, Aldo, 1949: *A Sand County Almanac*, Yoshiaki Niijima (transl.), 1997, Tokyo, Kodansha.

Liedke, Gerhard, 1993:「被造物が立ち帰るまで」(Until the Creatures Come Back), Haruo Ando (transl.). In: Tomisaka Christian Center (ed.),『エコロジーとキリスト教』(Ecology and Christianity), Tokyo: Shinkyo Publishing Co., Ltd. (in Japanese)

Linz, Manfred, 2012: *Weder Mangel noch Übermaß—Warum Suffizienz unentbehrlich ist*, München: Oekom. (in German)

Ozawa, Shoji, 2013 『エネルギーを選びなおす』(Renewing our Choice of Energy), Tokyo: Iwanami Shoten. (in Japanese)

Metz, Johann Baptist, 1968: *Theology of the World*, Fumio Tabuchi (trans.), 1970, Tokyo: Kyo Bun Kwan Books.

Moltmann, Jürgen, 1964: *Theology of Hope: On the Ground and Implications of a Christian Eschatology*, Toshikazu Takao (transl.), 1968, Tokyo: Shinkyo Publishing Co.,, Ltd.

Morotomi, Toru, 2015:『「エネルギー自治」で地域再生！―飯田モデルに学ぶ』(Revive Communities through Energy Autonomy!—Learning from Iida City's Example), Tokyo: Iwanami Shoten. (in Japanese)

Nishio, Baku, 2008:『原発は地球にやさしいか―温暖化防止に役立つというウソ』(Are Nuclear Plants Earth-friendly?—The Lie of their Usefulness in Preventing Global Warming), Tokyo: Ryokufu Shuppan. (in Japanese)

Nishio, Baku, 2015:『原子力・核・放射線事故の世界史』(World History of Atomic Energy, Nuclear Affairs and Radiation Accidents), Tokyo: Nanatsumori Shokan. (in Japanese)

Radkau, Joachim, 2012:「日本語版へのあとがき―フクシマの事故の後に考えたこと、そしていくつかの個人的告白」(Afterword to Japanese Edition—Thoughts after the Fukushima Accident and a Few Personal Confessions). *Nature and Power: A Global History of the Environment*, Takeshi Ebine and Naoko Morita (transl.), Tokyo: Misuzu Shobo. (in Japanese)

Spaemann, Robert, 1979:「政治的倫理の問題としての自然界への技術介入」(Introduction of Technology into the Natural World as a Problem of Political Ethics). *In*:『原子力時代の驕り―「後は野となれ山となれ」でメルトダウン』(Pride of the Nuclear Power Age—Meltdown at 'After Us Let Ruin Come'), Naoshi Yamawaki and Maiko Tsuji (transl.), 2012, Tokyo: Chisen Shokan. (in Japanese)

Spaemann, Robert, 1980:「エネルギー政策の倫理的な諸観点」(Several Ethical Points of View on Energy Policy), ibid. (in Japanese)

Spaemann, Robert, 1989: *Glück und Wohlwollen. Versuch über Ethik*, Hisao Miyamoto and Naoshi Yamawaki (transl.-in-chief), 2015, Tokyo: University of Tokyo Press. (original in German)

Spaemann, Robert, 2011:「理性、原子力、信仰―野放図な科学、軽薄な成長政策、排除された残余リスクについて」(Intellect, Nuclear Power and Faith—Regarding Unbridled Science, Frivolous Growth Policies and Excluded Residual Risk), op.cit. (in Japanese)

Takagi, Jinzaburo, 1983:『核時代を生きる―生活思想としての反核』(Living in the Nuclear Age—Anti-nuclear as a Livelihood Philosophy, Tokyo, Kodansha.

Takagi, Jinzaburo, 1993:「聖書は核を予見したか」(Did the Bible Foresee Nuclear?). In:『エコロジーとキリスト教』(Ecology and Christianity), Tokyo: Tomisaka Christian Center.

Takagi, Jinzaburo, 1996:「核の社会学」(Nuclear Sociology). In:『環境と生態系の社会学』(*Environmental and Ecological Sociology*), Tokyo: Iwanami Shoten. (in Japanese)

Tanaka, Haruhiko, 2003:「「持続可能な開発のための教育」とは何か―予備的考察」(What is 'Education for Sustainable Development'?—Preliminary Observations).『持続可能な開発のための学び―別冊開発教育』(Learning for Sustainable Development—Separate Vol., Development Education), Tokyo: Development Education Association and Resource Center. (in Japanese)

United Nations World Commission on Environment and Development (ed.) and Saburo Ohkita (ed.-in-chief), 1987:『地球の未来を守るために』(To Protect the Earth's Future), Okayama: Fukutake Shoten (now Benesse Corp.). (in Japanese)

Yoshioka, Hitoshi, 2011:『原発と日本の未来―原子力は温暖化対策の切り札か』(Nuclear Plants and Japan's Future—Is Nuclear Energy Global Warming Countermeasures' Ace in the Hole?), Tokyo: Iwanami Shoten. (in Japanese)

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本書は『今こそ原発の廃止を――日本のカトリック教会の問いかけ』（2016 年 10 月初版発行）の英訳です。

ABOLITION OF NUCLEAR POWER
An Appeal from the Catholic Church in Japan

2020 年 7 月 10 日発行

編　者　日本カトリック司教協議会
『今こそ原発の廃止を』編纂委員会

発　行　カトリック中央協議会
〒135-8585 東京都江東区潮見 2-10-10 日本カトリック会館内
☎03-5632-4411（代表）
https://www.cbcj.catholic.jp/

印 刷　三美印刷株式会社