



HOKKAIDO UNIVERSITY

Title	The Fukushima Nuclear Disaster : One of the World's Worst-Ever Cases of Pollution
Author(s)	Yoshida, Fumikazu
Citation	Economic Journal of Hokkaido University, 41, 1-38
Issue Date	2013-03-08
Doc URL	https://hdl.handle.net/2115/52218
Type	departmental bulletin paper
File Information	EJHU_41_1.pdf



The Fukushima Nuclear Disaster: One of the World's Worst-Ever Cases of Pollution

Fumikazu Yoshida

If we review the accident at Fukushima Daiichi Nuclear Power Plant on 11 March 2011 and examine the nuclear disaster that has followed it from the standpoint of the theories that have been developed to deal with the problems of pollution, and analyze it first from the point of view that focuses on “the causes of pollution” and “the damage that pollution causes”, and then, further, to go on to consider the various theories or concepts that relate to issues of “responsibility”, “countermeasures”, “social cost”, “relief”, and finally to weigh up proposals for “an alternative policy”, it should become possible to determine the extent of the problem, the issues that have to be faced and the courses of action that we need to take, the prospects for finding a solution, and a timeline that may lead to its resolution.

JEL Classification: Q53, Q54, Q56, Q51

Keywords: Nuclear Disaster, Pollution, Great East Japan Earthquake, Nuclear Power, Renewable Energy

I Introduction

Until recently, the Japanese have tended to think that such disasters as the Minamata disease (organic mercury poisoning from a chemical factory in Kyushu in the 1950-60s), the Itai-itai disease (cadmium pollution at Toyama from the Kamioka mine in the 1950-60s), Yokkaichi air pollution (from a power and petrochemical plant at Yokkaichi in the 1960-70s) — and all similar problems caused by industrial pollution — were things of the past, and that their causes and consequences have been understood and overcome. The Fukushima nuclear disaster, however, has been responsible for the largest and worst case of pollution to have occurred during the postwar era. It is much more than just a reiteration of past pollution problems as a result of neglecting the lessons they were supposed to have taught us: its complexities and scale are greater than anything that has gone before.

Environmental economists (of whom I am one) have worked out a method to deal with the problems caused by pollution through the analysis and resolution of the various cases of pollution that have formerly occurred in Japan. Our work has been based on a variety of what for want of a better word we may call ‘theories’: concepts and principles that deal with “the causes of pollution”, “the nature of the damage caused by pollution”, “an assessment of the responsibility for the pollution”, “styles of countermeasure to deal with the consequences of pollution”, “the social costs”, “types of relief”, “alternative policies” and so on¹⁾. Among these, “the causes of pollution” and “the damage caused by pollution” are foundational, for upon them we build theories of “responsibility”, “social cost”, “countermeasures”,

“relief” and finally “alternative policies” (such as, in the case of nuclear power plants, their “denuclearization”). If we therefore analyze the nuclear power plant disaster from the standpoint of the theory of pollution and its problems, it should become possible to determine the full nature and extent of the problem, which will then in its turn help us to clarify the issues that still need to be resolved, set a course of action and a timeline for their resolution and find in all this some prospects of hope for an ultimate solution.

At the end of the lawsuits held in the early 1970s to resolve the issues brought about by Minamata disease, the case of Yokkaichi air pollution and the Itai-itai disease, the judges delivered what we can recognize to have been historic rulings. As a student who aspired to conduct research on the problems of pollution, I read these judgments published in special numbers of “Houritu Jiho” (Journal of Law) or “Jurist” and remember their contents even now. These rulings had a major impact on Japanese society and on major Japanese corporations, not only by systematically denoting “the causes of pollution”, “the nature and extent of the damage”, “the issue of responsibility”, but also by clarifying the course of relief afforded to the victims and the responsibility of the polluters.

The experience of the four major tribunals led Japan to establish the polluter pays principle while at the same time inaugurating a relief system for the victims. We also came to recognize the importance of joint efforts made by the responsible corporations and victims, together with the administration and scientists, lawyers, to clean up the mess caused by pollution and to restore the environment to its former state of relative health. Yet, even when the problems of pollution are localized, it has been necessary for more than 40 years to continue these efforts of reclamation and restoration, while, in the Minamata disease case and other similar cases the issue of victims’ relief has even now not been satisfactorily resolved. We have also learned that in addition to such essential countermeasures as cutting off the source of the pollution, decontamination and the relief of damage to health, we also need to make conscious efforts to resolve social conflict and overcome social discrimination in order to rebuild local communities that have been divided by the problems of pollution. Many issues remain concerning the cost burden generated by relief for the victims, the cleanup of pollution and appropriate countermeasures to contain the source of the pollution.

Although, at the time of writing, more than two years has passed since March the 11th, 2011, the day of the Great East Japan Earthquake and the TEPCO Fukushima Daiichi Nuclear Power Plant disaster, it is still difficult to obtain a complete, or even a relatively accurate, picture of the event, or work out a direction in which to go to cope with the myriad of problems that it has thrown up. So severe are they that we can characterize this disaster as a “second war defeat” since its impact on the nation questions the whole basis of Japan’s postwar society. Quite apart from the immense dangers that the ‘accident’ still poses, the dimension of the “emergency” caused by these circumstances requires us first to reexamine and where necessary revise the old polluter pays principle and the victims’ relief principle that have been established as result of the experience of the problems caused by postwar pollution. Since the Nuclear Damage Liability Facilitation Fund provides the legislation to relieve the victimizer (rather than the victim), while the

principle of “*res nullius*” responsibility has already been raised by the polluters (the victimizers), it will therefore be of the greatest significance to analyze the nuclear disaster of Fukushima from the standpoint of the principles already established to deal with the problems of pollution. At the same time, society demands a systematic and thorough explanation of the theories and principles that underlie the concepts of “the causes of pollution”, “the nature and effects of the damage caused by pollution”, “pollution’s social costs”, “deciding on the responsibility for pollution”, “countermeasures against pollution” and, finally, “proposals for alternative energy” that will enable us to grasp the whole picture of the largest and worst nuclear disaster of the postwar years and map out future prospects for reform.

On the basis of research and considering the facts about the disaster that have so far been revealed, this present article attempts to look first at the nuclear disaster from the perspective of the general concept of pollution and its problems and then go on to analyze the disaster in terms of the theoretical concepts of “the causes of pollution”, “the damage caused by pollution”, “the social costs of pollution”, “the responsibility for pollution”, “countermeasures against pollution” and finally the theoretical concepts of “alternative sources of energy”. The first half of this article (II-XII) is based on contributions published in 2011 on the “Asahi Shimbun” *webronza* (web site), and for the second half (XIII-XIV) on contributions published in the evening edition of the “Hokkaido Shimbun” from November to December of the same year. These have been reorganized, with some new information added and the appropriate adjustments made.

II The perspective afforded by the theory of ‘the problems of pollution’

As a scholar who for many years has been devoting himself to the study of Japan’s pollution and environmental problems from the standpoint of environmental economics, I want first to point out the following features that are relevant to the nuclear disaster.

(1) The purpose of an analysis of pollution and the environmental problems that follow in its train is to determine the actual situation and the scope of the damage, and then to suggest how, wherever possible, we may counteract the effect of such damage. Yet since research into and countermeasures against the Fukushima nuclear disaster have been delayed, knowledge concerning the scope and degree of the radioactive damage caused by Fukushima’s damaged reactor is still seriously insufficient. Indeed, tardy disclosure of information and improper instructions for evacuation are everywhere manifest. Data collected by the System for the Prediction of Environmental Emergency Dose Information (SPEEDI) have been forwarded to the U.S., but have not been used for the evacuation of the local population. SPEEDI is “computer-based decision support system” used by researchers, and its function is for a real-time Dose assessment in radiological emergencies.

(2) In the present instance, the investigations so far have identified “saving on safety measures” or “a site location mistake” as overlapping causes of this nuclear disaster and the pollution that it has caused and that ought to have been avoided.

The Investigation Committee on the Accident at the Fukushima Nuclear Power Stations is carrying out the current investigation and needs to shed light not only on the support that has been provided since the accident, but also on problems existing before the accident, such as the lack of preventive measures, while also focusing on future necessary measures to correct flaws in (national) regulations and standards. These conclusions should be used during the overhaul of all nuclear power plants across the country.

(3) While the provision of relief to the victims is delayed, a system to protect and relieve the victimizer (in this case TEPCO) has been set up. When the Nuclear Damage Liability Facilitation Fund Law designed to bail out TEPCO was passed, the reason given was to avoid bankrupting the victimizer so as to ensure that indemnities would be carried out. The logic of this reasoning is clearly similar to that which led to the split-up of Chisso Corporation after the outbreak of Minamata disease: despite the enormous number of victims, the political and economic domination of the victimizer entails an asymmetric relationship between “the victimizer and victims”. As, for example, Chisso Corporation’s compensation contract (which took the form of a simple ‘solatium’ or apology) forced the victims to abandon their right to institute a lawsuit to claim for indemnifications. Another example: in the face of a lawsuit to request the decontamination of a golf course, TEPCO has argued that “radioactive material not being the property of TEPCO, TEPCO has no responsibility for decontamination”. This use of the “*res nullius*” responsibility concept to evade the polluter pays principle cannot be ignored. It can be regarded as an example of neo-liberal “disaster capitalism”²⁾ trying to ride out the catastrophe it has caused. If this is allowed to continue, a vast quantity of public funds will be used for decontamination and TEPCO’s responsibility will be shelved. To argue that “profit is a private monopoly, but risk is taken over by the state” is unacceptable.

(4) The issue of insufficient compensation to residents for “voluntary evacuation” is a question for the administrative authorities. During the Minamata disease, the authorities advocated “self-regulation” of seafood consumption as a method to lessen their liability for indemnities and therefore reduce the total amount. Now, the Nuclear Safety Commission has initially tolerated the dumping of radioactive contaminated water in the sea since they claim that it will be diluted. But even diluted in seawater contaminants will be concentrated thousands of times throughout the food chain. Such elementary knowledge concerning the environmental consequences of pollution, one of the vital teachings of the Minamata disease, is now apparently being forgotten.

(5) We must also recognize that another consequence of contamination is the problem of discrimination and what has been called “reputational damage”. The outbreak of Minamata disease meant that people would no longer buy products labeled “Minamata”, while locals could not reveal their identities for fear of facing discrimination. That Fukushima Prefecture and neighboring areas are likely to face the similar problems of discrimination is an issue of grave concern. Of course,

the polluter is responsible, and sufficient compensation ought to be obligatory.

(6) We anticipate long-term pollution and the enormous costs of decontamination, while analysis concerning the social costs due to the nuclear disaster will be a major challenge for environmental economics, a matter that we shall discuss in detail later.

As I have said, the problems experienced during earlier outbreaks of Japanese pollution and the course these problems followed are now being repeated. Indeed, it might be better to say that the phenomenon is a symptom of a regular and recurring characteristic of Japanese society.

The nuclear disaster, however, is characterized by radioactive contamination and is on a scale that reaches far beyond the scope of traditional environmental issues. Rather than simply being a local problem, it has been from the beginning a nationwide and potentially international issue (some say that it has the potential to affect the whole of the northern hemisphere).

If we consider the nature of the devastation and the number of victims (115,000 people subject to evacuation, about 1 million people in a relatively high level radiation zone) as well as the extent of affected area (an evacuation area of 800km², equivalent to Tokyo's 23 wards and the city of Hachioji combined, while the contaminated area extends up to 200km radius, from the whole of the Kanto region to Iwate and Yamagata), then we understand that the Fukushima Daiichi Nuclear Power Plant accident has been the cause of injury to human society and the natural environment on a scale that is unprecedentedly wide-spread and life-threatening in its effects³⁾.

While the polluting company is one of Japan's major corporations and its political and economic powers are formidably strong, the state's involvement and the institutions dealing with nuclear power are specific to Japan. Moreover, as earthquake-prone Japan has 54 nuclear power plants nationwide, the risk of a similar situation occurring actually exists and makes this problem even more serious. In that sense, this disaster is the result of the failure of Japan's energy policy. It is an environmental issue, but it is at the same time a management problem arising from the energy crisis.

III The theoretical concept of the causes of pollution as applied to the nuclear disaster

The events that followed the tsunami were so severe that Masao Yoshida, the director of the TEPCO Fukushima Daiichi Nuclear Power Plant at the time, himself confessed at a press conference on November 12 that "During the week after March 11th, I thought many times that I would die". At the height of the immediate crisis the Prime Minister even examined the possibility of evacuating 30 million people from the metropolitan area. As for the causes of the accident, many questions have been asked, yet we wonder how many of them have been answered in the interim report published on December 26, 2011, of the Investigation Committee on the Accident at the Fukushima Nuclear Power Station⁴⁾. We can thus understand that what we may call the theoretical concept of "the causes of pollution"

is at the root of the concept of nuclear pollution.

For example, does the interim report offer answers to certain basic questions?

- Why, in an earthquake-prone region like Japan, have 54 nuclear power plants been built?
- Why, although closer to the epicenter and also hit by the tsunami, was the Onagawa Nuclear Power Plant, managed by the Tohoku Electric Power Company, able to prevent a total loss of power, while the Fukushima Power Plant was not?
- Why have measures against severe accidents been left to the voluntary initiatives of the operator?
- Why had no adequate measures been taken against a total loss of power?

The interim report of the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations focuses on the official response after the earthquake and tsunami, and draws attention to certain failures that have, in various ways, been widely reported: poor communication between TEPCO and the government, a lack of cooperation within the cabinet over measures to cope with the crisis, and the fact that even TEPCO itself did not really grasp the full implications of the developing situation nor notice the dysfunction of the emergency condenser in Unit 1.

The investigators have also pointed out failures of foresight and planning: when considering preventive measures against severe accidents, insufficient attention was paid to the risk of a tsunami that might exceed the design criteria, while the response to a total loss of power or an emergency situation was inadequate; and no one seems to have taken into consideration the effects of a combined earthquake and tsunami of such a magnitude. But the real problem is why these failures should have been allowed to continue unnoticed and uncorrected in the first place.

We may cite for comparison the tsunami countermeasures undertaken by Tohoku Electric Power Company, whose Onagawa Nuclear Power Plant was built 15 meters above sea level, while, as an earthquake countermeasure, its earthquake-resistance strength was three times that required by the Building Standards Act. Consequently, although closer to the epicenter of the earthquake, it was somehow able to secure the power supply. TEPCO's Fukushima Nuclear Power Plant, on the other hand, had taken neither of these measures.

The Fukushima Nuclear Power Plant, built originally by the U.S. General Electric Company (GE), was not designed to withstand either earthquakes or tsunamis, and though, over the last 40 years, earthquake resistance standards have certainly become more stringent, no drastic measures to strengthen the plant's defenses had been carried out. It is no exaggeration to say that at the time of the disaster the Fukushima Nuclear Power Plant was a defective plant. Nuclear power is thought to be cheaper than other sources, yet as the cost of large-scale thermal power has decreased, so the cost advantages of nuclear power have begun to crumble.

Mr. Toru Hasuiki (former secretary general of the Association of the Families of Victims Kidnapped by North Korea), who served as head of maintenance personnel in the Fukushima Daiichi Nuclear Power Plant, explains in his book *Watashi-*

gaaishita Tokyo Denryoku (I loved TEPCO)⁵⁾ that since thermal power generation by natural gas has been steadily becoming cheaper, spending more money on securing the safety of nuclear power plants was likely to make electricity derived from nuclear power the more expensive method of the two. So, since cheapness of operation was selling point, stringent reductions were made in operating costs while “remodeling where necessary” was to be carried out “to secure old plants”. At the same time, management took the decision to use nuclear power plants for as long as possible after the legal depreciation period of 20 years had passed, a decision that was the source of big profits for the power companies.

We can postulate the following as likely causes for the total loss of power: (1) the immediate collapse of power transmission lines due to the earthquake, (2) the breakdown due to the tsunami in the operations of the emergency diesel power supplies placed beside the sea, (3) an inadequate supply of batteries in the control room so that it became inoperable. At the same time, during the process leading to core meltdown, deficiencies in the vent and filter (installed in the EU) became apparent. We can therefore point out, as an underlying cause, “savings in safety measures”.

According to the interim report, TEPCO ran a trial calculation in 2008 on the effects of a tsunami based on expert opinions and the views of the national Earthquake Headquarters. The result indicated the need for a seawall of at least 15.7m in height. Current estimates suggest that the installation of such a seawall would cost tens of billions of yen and that it would take about four years to build⁶⁾. In fact and ironically, only on March 7, 2011, four days before the earthquake, did the Nuclear and Industrial Safety Agency (NISA) learn of the estimation of 15.7m, but did not specifically request that such countermeasures should (at once or at any time) be undertaken⁷⁾. It goes without saying that while TEPCO was clearly afraid of the rising cost of “cheap nuclear power” that would follow installation of a seawall, we need also to bear in mind the responsibility of the state and its loose application of regulations that were themselves already loose.

During their interviews, the TEPCO executives are all reported to have affirmed, “We never thought that a natural disaster would exceed the design criteria, nor that it would be necessary to deal with it”. Nobody has clearly explained why they believed this, but testimonies such as “There would be no end if we were to start making hypotheses about likely catastrophes” or “Since the Kashiwazaki-Kariwa Nuclear Power Plant was able to deal with the situation, we judged that the design was correct” (Yoshida, director at the time) indicate the company lacked any proper awareness of possible dangers⁸⁾. During the Hamaoka Nuclear Power Plant trial, the Chairman of the Nuclear Safety Commission, Haruki Madarame, speaking as a witness for the Chubu Electric Power Company, stated that “To hypothesize a total loss of power would mean the impossibility of being able to operate a nuclear power plant at all” and that “A pragmatic and clear-cut attitude is needed”. If this blinkered attitude has been the official position, then the problem is not simply confined to TEPCO: it is one that affects the whole Japanese nuclear power system.

Since such a ‘safety philosophy’ appears unable to envisage a severe accident nor seems to see any need to think about a long-term total loss of power should an

accident happen the government authorized the continued running of the Fukushima Nuclear Power Plant, until, finally, the inevitable accident occurred. Since all the nuclear power plants nationwide operate according to the same standards, they must all have the same problems.

The interim report fails to come to grips with the structural and organizational history that lies behind such a lack of awareness and so many misjudgments. In other words, it has been unable to analyze the structure and get to the core of what has been called a “Nuclear village” (Group dynamism). If we hope to take advantage of the lessons that are being revealed during the investigation of the accident, and consequently engage in fundamental reforms of the regulations for the safety and running of the plants, we need first a full-fledged analysis and verification of the report’s findings.

The Commission on the accident at Three Mile Island (Dauphin County, Pennsylvania, 1979) held 150 public hearings within six months and produced a report that included recommendations for improvement. In Germany, the Ethics Commission for a Safe Energy Supply, while not investigating any specific accident, has carried out some theoretical groundwork in support of denuclearization. Yet in Japan, we have now learned, no minutes were taken of government meetings over the possibility of nuclear accidents, a record that is essential for any investigation of actual accidents and planned countermeasures. Such an oversight is either an elementary mistake or an attempt to hide the decision process. In either case, the absence of such a record shows that Japan, unable as a consequence to withstand the judgment of history, possesses neither the characteristics nor the appearance of a modern nation. It is more than doubtful that this country is fully qualified to operate such high technological resources as nuclear power hardware and software.

In its report “Fukushima Lessons Learned” (October 2011), the Swiss nuclear safety and inspection agency (ENSI) has pinpointed 39 organizational and technical failings and inadequacies in the running and supervision of the Fukushima Nuclear Reactor; among them are:

(1) a deficient educational program (for staff), (2) a poor corporate culture, (3) limitations placed on safety precautions for economic reasons, (4) the safety inspector was a member of METI (and thus not an impartial observer), (5) structural defects in the overall supervision system, (6) inadequate supervision in depth, (7) the operator (TEPCO)’s lack of a safety culture, (8) a weakness in procedures for decision-making, (9) the inadequate preparation of emergency measures, (10) excessive demands of staff, (11) regulatory deficits, (12) a delay in emergency planning, (13) insufficient measures for protection against radiation, (14) insufficient information provided for the local population, (15) the dangers inherent in group dynamics (the concept of the “Nuclear Village”), (16) Stressful working conditions, and so on...

IV Background causes: A Questioning of Japanese society and science

The Great East Japan Earthquake and the subsequent nuclear disaster have brought to the surface a major issue that concerns Japanese society and the nature of science and technology as these are practiced in Japan. Although experts at

once pointed out that the meltdown had reached level 7, it took from one to two months for the government and TEPCO to admit that this was so. They repeatedly used the expression “beyond expectations”. But the term “beyond expectations” is dishonest since it refuses to admit that “the expectations” were based on calculations or models that were themselves inexact. This vague and self-exculpatory expression has been repeatedly used by all the experts, from seismologists to meteorologists, from civil engineers to nuclear engineers, and finally by the managers of TEPCO itself.

The “unexpected” tsunami has been made the cause of the damage that led to the “total loss of power” at Fukushima Daiichi Nuclear Power Plant. In drawing up earlier models, the Japan Society of Civil Engineers had estimated a tsunami of no more than 5.7 m, yet the nonpartisanship of this estimation is very questionable since parties interested in the electrical power industry played a key role in drawing it up. The expression “beyond expectations” became a “watchword” or mantra that has been used as a shield to protect people from the recognition of their own responsibility.

A number of critical essays have now been published that deal with the process of nuclear ‘accidents’, starting with “Hiroshima” and leading to “Fukushima”. In “The New York Times” dated 16 March 2011, Jonathan Schell, for example, states in his article “From Hiroshima to Fukushima”⁹⁾ that “The problem is neither in emergency generators nor safety standards, but in the fact that it is human nature to make mistakes”, and he concludes that a nuclear accident is an event that is endemic to the modern history of nuclear power use (and, presumably, that operators will continue to make mistakes).

My own view is rather different. I think it is necessary to consider that “Hiroshima” and “Fukushima” are the result of problems that have to do specifically with the nature of Japanese society itself. Sixty years ago, driven by the ideology of the “Greater East Asia Co-Prosperity Sphere” and heedless of differences in national power, Japan started a war which those who led the nation into that war knew in their hearts that they would never be able to win. All the way until the very end, denying the disjunction between ideology and reality, Japan continued to ignore the worsening war situation and the air raid damage on the metropolitan area. Only after the atomic bombings of Hiroshima and Nagasaki did Japan finally admit defeat and the “end of war”.

Equally shortsighted ideologies and myths, such as “Nuclear power is safe” or “Nuclear power is cheap” underlie the Fukushima Daiichi Nuclear Power Plant accident. Japan, unlike most other countries, is prone to earthquakes, so, why have nuclear power plants been built in such a country? Furthermore, why is their concentration along the coast supposed to guarantee safety? Those who use the “defense-in-depth” principle of safety as their argument repeatedly dismiss such doubts and queries: there is always, they say, a back-up line of defense.

Although there has been a spate of accidents, cover-ups and falsification of data, the construction of new nuclear power plants and their expansion has continued without any effort being made to learn lessons from these disturbing events, generalize from them, and take actions to prevent their recurrence. Indeed, under the banner of “resourceless Japan” and despite being unable to make a fast-breeder

reactor or a reprocessing plant, the government has continued to pursue the development of “nuclear fuel cycle” technology, never looking with due care at the difficulties that this technology poses or the principles that lie behind it. As a result, the disposal of spent nuclear fuel has now become a pressing problem. We have also learned that cost estimates for the direct disposal of spent nuclear fuel have been concealed¹⁰. The theory of “resourceless Japan” (that Japan has no natural resources) is a kind of delusion that was once used to rationalize the pre-war invasion of the continent, and has now, since the war, been touted to support the development of nuclear energy and the reprocessing of nuclear fuel. After spending almost 19 trillion JPY, only about a half of the spent nuclear fuel could be reprocessed into MOX fuel to the value of 900 billion JPY. The nuclear deterrence theory is then used to paper over this failure of economic rationality¹¹.

Another major problem is that the concepts of “risk management”, “risk training” and “logistics” have not taken root in Japanese society. Quite simply, it is as if people thought that preparing for an “unlikely event” by the performing on a daily basis tasks of risk management and training would be calling into question the ideas “safe” and “cheap”. Finally, without their being seriously considered, worst-case situations such as “core meltdown” and “total loss of power” are simply perceived as “beyond expectations” and are replaced with the desired predictions.

Once accidents or disasters have occurred, however, a downward spiral begins, and further damage accrues exponentially: the logistics of important goods is mishandled, while insufficient replacement of personnel and lack of rest lead to further exhaustion among the workforce. This was a characteristic of the pre-war Imperial Japanese Army and nothing has subsequently changed. Responsibility for evacuation training is left to the municipalities where nuclear power plants are located, while the training, as such, consists in simply following an elementary scenario. When an emergency situation actually occurs, as it did this time, no concrete evacuation order is issued to surrounding towns and villages, thus forcing the inhabitants to evacuate at their own discretion. On this occasion, information transmitted directly through mobile phone by employees who actually worked in the nuclear power plant played a critical role in advising people to evacuate (according to interviews).

A further cause of confusion lies in the fact that, while a “roadmap” has been drawn up to deal with the crisis, the actual situation and full details of the reactor’s condition since the accident remain unknown and implementation of the roadmap is delayed. At the same time, a problem of vertically integrated science and engineering has emerged: considering power supply problems to fall within the competence of electric power engineering, nuclear reactor experts were only focusing on problems linked to the reaction within the reactor; they did not take into account any problems of electricity supply to the reactor or the possibility of power outage, such as “total loss of power”.

We have now learned from the power companies themselves that, though they are expected to be in control of the whole process, only the plant manufacturer actually knows everything about the plant and its workings. It is true that Fukushima Daiichi Nuclear Power Plant was the first “Full Turn-Key” nuclear power plant, which is to say, the plant manufacturer built and delivered it, yet

there is no way of verifying whether the plant was built strictly according to the GE design. Such ignorance uncovers the superficiality of much Japanese science and technology. Here is how the former nuclear power plant site supervisor, Mr. Norio Hirai, testified: “For example, TEPCO’s Fukushima Nuclear Power Plant was operated while a steel wire had been left inside one reactor. This could have led to a major accident that might have affected the whole world. The worker actually noticed that he had dropped the steel wire, but he wasn’t aware that his careless action could have caused a severe accident. In that sense, new nuclear power plants built by unskilled workers are as dangerous as old ones.”¹²⁾

Despite their having to face the daily likelihood of earthquakes and tsunami and the ever-present threat of nuclear disaster, the Japanese people have retained their human dignity. While this shows the courage of which Japanese society is capable, certain issues that affect Japanese society adversely have also been exposed. “People can see human dignity in tragedy, but it is with the same pair of eyes that they can see deprivation in prosperity. Nuclear power experts were disdainful of amateurs’ opinion. But, finally, the amateurs’ apprehensions were 100% right”¹³⁾. That says it all.

Technology is just a means to an end, a means to a social purpose. Society must not concentrate only on the means and lose sight of the goals. If the means do not fit the purpose, then it is up to society to choose a different means. Although I believe in the power and resilience of Japanese society, I do not think that it will be possible to give Japan a fresh start without admitting the problems that the disaster at Fukushima Nuclear Power Plant has brought to everyone’s notice, and, as a consequence, rethinking the whole basis of Japanese technology, science and society.

V The theoretical concept of “background causes” as applied to nuclear power plants: An analysis of nuclear power from the perspective of environmental safety governance

I believe that to begin with we must analyze the historical causes of this nuclear disaster from the perspective of environmental safety governance. The concept of environmental governance is a combined political and economic analysis of environmental issues. It is also a methodology that determines the location of problems and offers to provide solutions by means of an analysis of the interactions of “institutions, laws, customs” with “each actor’s strategy and their conditions”¹⁴⁾. It observes the way the legal system regulates each actor’s actions, while also observing the manner by which interactions between the actors create the legal system.

The Japanese legal system and the regulations concerning nuclear power have been placed under a dual administration: the Nuclear Reactor Regulation Law under the former Science and Technology Agency, and the Electricity Business Act under the Agency for Natural Resources and Energy of the former Ministry of International Trade and Industry. No laws exist, however, that deal with radioactive contamination as an environmental issue. This topic is excluded from the Environmental Basic Act, and although we may have believed that it is laid down in the

Atomic Energy Basic Act, no law actually establishes it concretely and unequivocally. It is slightly handled in Article 64 of the Nuclear Reactor Regulation Law and Article 26 of the Act on Special Measures Concerning Nuclear Emergency Preparedness, but in neither case do the articles assume large-scale and extensive radioactive contamination. Moreover, since no concrete legal regulations concerning countermeasures have been instituted to deal with severe accidents such as tsunami, earthquakes and total loss of power, these countermeasures have been left to the voluntary efforts of companies.

So it has come about that on the narrow, crescent-shaped Japanese archipelago, the authorities, for more than 40 years, have allowed, have indeed encouraged, the construction and running of 54 plants without any concrete legal system designed to deal with radioactive contamination likely to be generated by a large-scale nuclear power plant accident. So when the Fukushima accident actually, and perhaps inevitably, happened, both the tardy response to the nuclear accident itself and the inadequate response to the subsequent radioactive contamination was the logical outcome of this legal ambiguity. Yet while, crucially, there has been no radical reform of the legal regulations nor any concern over the intensification of seismic activity around the Japanese archipelago, the movement to restart nuclear power plants has been gradually gathering momentum.

I wish now to move on to an analysis of the nuclear power generation actors (the participants). The largest group of actors is naturally composed of the power companies themselves; but in Japan, in addition to the 9 power companies who conduct nuclear power generation with a regional monopoly and a “fully distributed cost” method, the Japan Atomic Power Company acts as a business operator, while heavy electric machinery manufacturers are also important participants, since companies like Toshiba, Hitachi and Mitsubishi participate in the construction and maintenance of nuclear power plants through the multilayered structure of the subcontracting system.

Japanese technology for commercial nuclear power generation was originally imported from the United States, and General Electric built the Fukushima Dai-ichi Nuclear Power Plant. At the time, it was even called the “GE village”. Since the technology was imported from abroad, the safety of nuclear power use was guaranteed by the foreign country’s safety standards. Consequently, because problems specific to Japan such as tsunami and earthquakes were not taken into account and many of the standards were merely translated without necessarily being fully understood, a failure of clear thinking with regard to adequate safety regulations appropriate to Japanese conditions naturally persisted.

An analysis of the governmental actors responsible for overseeing these issues is a more complex task. On the one hand, the former Science and Technology Agency (the current Ministry of Education, Culture, Sports, Science and Technology) was responsible both for implementing the Nuclear Reactor Regulation Law and for the development of homegrown nuclear power technology, while, on the other hand, the Agency for Natural Resources and Energy of former Ministry of International Trade and Industry was in charge of the Electricity Business Act that defined the “National policy, Private management” method for the generation of nuclear power. Thus a dual system was established. Throughout the 1980s and

the 1990s, further impediments to ensuring safety lay not only in a conflict between the Science and Technology Agency and the Agency for Natural Resources and Energy over competence, but also because of the compartmentalization of public administration. The government has not been able to mobilize actors in order to push for regulation improvement. This is also the underlying cause that explains why SPEEDI data, which are under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology, could not be used for an evacuation plan.

Following the Central Government Reform of 2001, application of the Nuclear Reactor Regulation Law has fallen to the agency of the Ministry of Education, Culture, Sports, Science and Technology; but the actual inspection is performed by the Nuclear and Industrial Safety Agency (330 people) under the authority of the Ministry of Economy, Trade and Industry, and then only after approval by the Nuclear Safety Commission under the authority of the Cabinet Office. So, while the result is double-checked, the reform has also made the regulation system a good deal more complex; it has also created a conflict of interest by putting maintenance of the safety regulations under the authority of the “pro-nuclear energy” Ministry of Economy, Trade and Industry.

In fact, access to information and the human resources at play are overwhelmingly weighted on the side of the power companies (information asymmetry). Although the Nuclear and Industrial Safety Agency is supposed to regulate operations, its human resources are insufficient and collusion with the power companies is well established (see **Figure 1**). There are also problems concerning the Nuclear and Industrial Safety Agency executives themselves. First, senior executives specialize in nuclear matters too late in their careers. Second, most executive pro-

Figure 1 Regulation Related to Nuclear in Japan

	Safety regulation	Safety Regulation	Security	Nuclear Security
Nuclear Commission	Peaceful use	Planning	Policy check	Policy check
Nuclear Safety Commission	Guideline Double check	Guideline Double check		
Ministry of Education, Science	Research Reactor Act on Compensation for Nuclear Damages	Regulation on Radiation	Security Supports	Research Reactor RI Facility
Ministry of Economy, Trade	Commercial Reactor Radioactive Waste Management			Commercial Reactor Radioactive Waste Management
Ministry of Foreign Affairs			International Negotiation	International Negotiation
Ministry of Welfare, Work	Labor Safety	Health Effects		
Ministry of Transportation	Transportation Shipping Of Radioactivity			

motions result from the rotation of internal personnel within the Ministry of Economy, Internal Trade and Industry. For example, when the Fukushima accident occurred, the director was Mr. Nobuaki Terasaka, a graduate in economics, while the officer in charge of public relations was changed to Mr. Hidehiko Nishiyama, a graduate in law. As an unfortunate consequence of such arrangements, true professionals are unable to “rise through the ranks” to positions of management and only the “Nuclear Village” remains. Even if related institutions publish research results — as the Japan Nuclear Energy Safety Organization (JNES, 480 people) in fact did when they reported the possibility of core meltdown damage due to a tsunami¹⁵⁾ — the Nuclear and Industrial Safety Agency is not able to exploit them.

After the Chernobyl accident, Japan, too, should have decided what measures to take to counteract severe accidents at its nuclear plants; yet, at the time, any consideration of countermeasures to cope with severe accidents was thought equivalent to admitting that nuclear power is not safe. This explains why the government, considering the possibility of lawsuits across the country, and the power companies, worrying about the effect on the neighborhoods near nuclear power plants, both opted for no regulations but handed over the responsibility for countermeasures to voluntary efforts¹⁶⁾. And it is why, when the governmental Investigation Committee on the Accident at the Fukushima Nuclear Power Stations conducted interviews with some of the persons concerned, the manager of the Nuclear Emergency Preparedness Section of Nuclear and Industrial Safety Agency told the Committee that “As AM (Accident Management) belonged to the field of “voluntary security” and was not a regulation, we focused on near-term regulatory tasks and were swayed by them”¹⁷⁾. As this statement shows, the biggest problem since the “trouble cover-ups” that TEPCO and other companies concocted in 2002 is that attention has been given to detailed regulations and reports, and no longer to essential countermeasures against severe accidents, which were postponed and left to voluntary initiatives. As the old idiom reminds us, we “have failed to see the wood for the trees”. At the same time, a sharing of roles among the administrative actors responsible for enforcing regulations and cooperation with local governments was delayed. The Fukushima accident has shown that, even now, the measures taken are totally inadequate since most of emergency evacuation plans are intended for towns and villages that host nuclear power plants and do not include areas further afield that may be contaminated. Katsutake Idogawa, the mayor of Futaba Town, which hosts a nuclear power plant, has said “Of course, if these data had been available, I would have organized (the evacuation) differently. Our guilt is beyond measure”. And he has severely criticized the government for not providing the residents with forecast data concerning the diffusion of radioactive materials. For, as he pointed out, “The evacuation order was given by the government, but since that day there has been no guidance or instructions about the actions to take afterward. I deeply regret this”. (Testimony before the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission, January 30, 2012)

On any reckoning, the Fukushima accident ought to lead, inevitably, to fundamental reforms of the legal system concerning nuclear power and to a radical re-examination of each actor’s role within a cooperative relationship. The existing

Nuclear Reactor Regulation Law should have prevented this accident, but there was a flaw in the law. We need legal regulations on the evaluation of tsunami, countermeasures to cope with a total loss of power, and means to prevent severe accidents. The Electricity Business Act and the Nuclear Reactor Regulation Law should be unified. Safeguards, radiation regulations and an Act on Compensation for Nuclear Damages should be integrated within the Nuclear Regulation Committee as an independent agency. The monitoring of radiation should be conducted at a prefectural level as a legally delegated affair. Disaster prevention measures must be drastically strengthened¹⁸⁾. Without such fundamental reforms of safety regulations as these, any restarting of the nuclear power plants is unthinkable.

VI The theoretical concept of “relief” as applied to nuclear disaster

One hardly needs to say that the cost of an accident at a nuclear power plant is bound to be tremendous. For many years I have myself been studying the social costs of environmental damage and the health hazards engendered by environmental problems from the perspective of environmental economics, and while this nuclear accident has points in common with past cases of pollution, there are some significant differences with regard to future developments, such as the rise in every kind of incurred cost and the far greater range of invisible radioactive contamination.

The chairman of Fukushima Prefectural Medical Association (Mr. Yuzo Takaya) said during his interview that at the time of the earthquake disaster no members of the Medical Association were represented on the Disaster Response Headquarters of the prefectural government. He also reported that hospitals along the coast (2713 beds) were no longer functional, and that the psychiatric hospital functions (905 beds) had been completely wiped out. In Fukushima Prefecture, the Obstetric and Pediatric departments had no more patients, and 125 doctors or 12% of doctors formerly working in the prefecture have now left. The treatment of chronic diseases, such as those requiring dialysis, has become a serious problem. No emergency cases can be accepted locally and it takes more than two hours to transfer them to the cities of Fukushima or Sendai.

After the triple disaster people's lives and the living environment have been utterly changed; amongst the irreversible or long-term consequences are:

- destroyed houses, tsunami damage, fire, the nuclear accident
- death or disappearance of family members, the abandoning of pets or livestock
- loss of income due to the nuclear accident or evacuation
- anxiety due to life in an evacuation center or acute-phase and chronic-phase treatments
- shortage of food, water, hygiene products and lack of toilets, bathing facilities and heating
- family breakup, life in temporary housing, community disruption, loneliness, loss of livelihood and economic instability
- anxiety over likely health damage due to radiation exposure, children, infants, pregnant women (with fetus)

Although a clinic has been installed within the Big Palette evacuation center of Kohriyama City, the temporary housing remains unheated, and a feeling of distrust towards administrative agencies is growing stronger. The evacuees have to accept that 30-40 years must pass before they will be able to return to their homes. And while anxiety over the evacuees' general health is a matter of concern, it is, in particular, most important to carry on with thyroid gland examinations to monitor any signs of radiation sickness. An international center is being planned for this purpose.

We may learn numerous lessons from this accident: "no More Fukushima"s would be one; others would have to do with the importance of ensuring electrical power supplies, efficient means of communication, clearly defined evacuation routes and adequate supplies of gasoline; we must also recognize the need to secure and provide iodine tablets, to maintain up-to-date knowledge of levels of radioactivity; most important, perhaps, would be to prepare for the earthquake that is predicted to strike the Kanto-Tokyo region in the foreseeable future.

While the "psychological care team" from Kyoto Prefecture and Kyoto University continues to support evacuees now living in Aizu, the problems of drug shortage and the management difficulties of providing personal information are getting worse and the risk of depression amongst the evacuees is growing greater. All of this, when combined with the feeling of so many survivors that there is "no end in sight", adds greatly to their heavy burden of stress.

Since the laws relating to the siting of power plants award subsidies to those living in the shadow of such plants, we wish to ask how these subsidies are to be distributed among Fukushima Prefecture's separate localities. And are these localities still dependent upon nuclear power plants? Shuji Shimizu, the Vice President of Fukushima University, who for many years has studied the relationship between the power source siting laws and municipalities where nuclear power plants are located, speaks for the residents living next to nuclear power plants when he says "Nuclear power plants do have chimneys but the smoke they emit cannot be seen. I wish that the smoke were colored". Since it would be easy to perceive the direction of the wind by watching the drift of the smoke, it would be possible to evacuate windward should an accident occur. The issue here is of hazards to health. Damage due to radioactive contamination is not only an immediate problem for employees working at the nuclear power plant but also for residents in the neighborhood of the plants.

Other significant forms of damage to health are the highly damaging emotional, psychological and social stresses that the survivors are now undergoing. Fukushima City, the site of Fukushima University, is 60km from the nuclear power plant, and young children living there have been evacuated to places far from their homes; but some children cannot be evacuated. Sometimes, in the course of evacuation, parents and children or couples are separated or are forced to move to places that they have never visited before. Those who choose to stay in their own homes seal up the windows and watch the TV news flashes and reports night and day. Significant numbers of people are close to nervous breakdown, and the provision of social care is not sufficient.

In towns closer to the nuclear power plant, all the residents have been evacu-

ated; even city offices and their administrative functions have been moved to other prefectures. This is the first time that such a thing has happened in the history of Japanese local government. Income loss due to the suspension of business in offices, agriculture and fishery trades can be calculated in monetary terms, and, to some extent, we can even estimate the expenditures and opportunities lost as a consequence of evacuation, soil pollution and the cessation of planting because of radioactivity, even the consequences of the pollution of the sea. Such calculations have certainly been made in previous cases of serious and deadly pollution. In the case of the Itai-itai disease, one of the four major instances of pollution to have severely affected post-war Japan, the source of the pollution was heavy metal contamination. The polluter, a mining company, had to pay compensation to farmers (about 12 billion JPY), and the amount of compensation paid after planting had become impossible because of pollution was far greater than the amount paid out in medical care compensation (about 80 billion JPY). The company that was the source of pollution had also to pay for about one-third of the colossal cost for soil decontamination (about 13 billion JPY)¹⁹⁾.

The Fukushima nuclear disaster, however, has caused a far greater range and variety of damage. Because of harmful rumors, farmers and fishermen can no longer sell their goods. The value of the land assets is also decreasing, and the number of visitors is falling. The halting of operations at the power plant, the closing down of factories and the evacuation of residents have led to a reduction of tax revenues, while the number of students who enroll in educational institutions is dropping.

The report “Calculation of damage caused by pollution”²⁰⁾ lists “the nature of the damage caused by pollution” as ① the irreversibility of the victim’s position, ② the difficulty of avoiding damage, ③ the extent of the damage, ④ the loss of profitability occasioned by the damaging act, ⑤ the continuity of the damage. These criteria can all be applied to the Fukushima nuclear disaster. As Nobuo Kojima, a lawyer of the Japan Federation of Bar Associations, has pointed out²¹⁾, this damage can, in particular, be characterized by (1) the unprecedented magnitude of the large-scale damage, (2) the long-term continuity of the damage, (3) the complete destruction of the bases of people’s livelihood. No legal system exists to take the necessary countermeasures to cope with this situation. Japanese nuclear power plants have operated for more than 40 years without any specific legislation designed to deal with radioactive contamination in cases of a large-scale nuclear accident. The reality of radioactive contamination spreading and dangerous radioactive wastes accumulating are deeply serious concerns. Preventive measures to protect the local residents from the hazards of radiation require a comprehensive health study that rejects easy and bland presuppositions and necessitates a program of long-term health monitoring. Pollution abatement and the evacuation of residents in danger of harm to their health will be necessary.

It is often said that history repeats itself, but when the scale of the Fukushima nuclear disaster is compared to earlier cases of pollution, it is seen to be incalculably larger and more serious. Even considered on a short-term basis, the Fukushima nuclear disaster has raised certain issues that are quite new in their extensiveness. ① the problem of criteria for compensation and midterm guidelines

for damages, ② a survey and monitoring of the residents' health, ③ standard measures of safe radioactivity, ④ the disposal standards of radioactive material, ⑤ the extent of the evacuation zone, ⑥ the problems of decontamination. In order to relieve the victims and ensure their safety, national and local governments, residents, scientists and lawyers must continue to consult and negotiate over issues of compensation and its standards. The Japan Federation of Bar Associations has issued a written opinion and a chairman's statement in which proposals are made and problems relating to the government's policies and standards are strenuously pointed out²²⁾.

VII The theoretical principle of "social cost" as applied to nuclear disaster

Since, as the consequence of the accident at the Fukushima Daiichi Nuclear Power Plant, the operation of all 54 nuclear power plants nationwide has now been brought to a halt, I shall therefore consider the problem of the power supply system and its cost.

The Japanese Institute of Energy Economics originally estimated that if all the 54 nuclear power plants across the country stopped working, the cost of supplying alternative fuels, such as oil and natural gas (LNG), would increase in 2012 by about 3500 billion JPY. This would mean that the price of electricity for an average household would rise by 18 percent. This represents a burden raise for each family of about 1,000 JPY per month²³⁾.

Yet these estimates calculate the cost of thermal power generation as an alternative to nuclear power plants in a simplistic way. While they show the burden increase, they indirectly assume as a necessary consequence a restart of the nuclear power plants. But if we go back to the beginning of the problem, we have to recognize that the Fukushima nuclear disaster is the result of promotion of nuclear power generation within an earthquake-prone zone, so that even if no further nuclear accident happens, we shall need to renew the facilities for both thermal and nuclear power generation. These are the costs that should be compared in the original estimates.

It is therefore necessary to reconsider what the real cost of nuclear power actually amounts to, based on the situation here in Japan since March 11, 2011.

【Costs range of nuclear power】

Until now the main reasons given for the promotion of nuclear power have been that "nuclear power is cheap", "nuclear power is safe" and "nuclear power is the trump card in the battle against global warming". Now, the "nuclear power is safe" myth is no longer viable. Nor, when we consider the many trillion yens' worth of damage that the accident has caused, does the "nuclear power is cheap" argument hold anymore. Even if the costs occasioned by the accident are not taken into account, some studies have already shown that nuclear power is not cheap in the first place. For example, Takeshi Murota's "Economics of Nuclear Power"²⁴⁾ or Ken-ichi Oshima's "Political Economy of Renewable Energy"²⁵⁾.

According to Oshima, nuclear power involves 4 types of cost: (1) the direct cost of power generation, (2) the backend cost (fuel reprocessing, reactor decommission-

ing and disposal of radioactive wastes), (3) the public investments (development and location cost), (4) the cost generated by an accident and its compensation. On the basis of data listed in the annual securities report of the nine power companies, the sum of costs (1), (2) and (3) from 1970 to 2007, gives the following results. The cost for 1kWh has risen to 10.68 JPY for nuclear power, 9.90 JPY for thermal power, 7.26 JPY for hydraulic power, 3.98 JPY for general hydraulic power, 53.14 JPY for pumped-storage hydraulic power, and 12.23 JPY for the combination of nuclear and pumped-storage hydraulic power. It is clear that nuclear power is not cheap. Moreover, (2), the backend cost is not adequately reckoned.

【The social cost of nuclear power】

The nuclear disaster at the Fukushima Daiichi nuclear power plant is a “multiple disaster” never before experienced in human history, composed of one part that can be evaluated in monetary terms and of one part that cannot. While, as we see below, there are common points and differences with traditional pollution cases, the present disaster is also characterized by a high degree of uncertainty; and though huge future costs are expected as inevitable, their actual extent is quite beyond our power to foresee. This is linked to the problem of economic measurement of the social cost due to a nuclear disaster (“the social cost of nuclear power”).

- “Invisible pollution” with “no direct fatalities”
- Health hazards (radioactive contamination of residents and workers, social stress)
- Income loss due to suspension of business in offices, agriculture and fishery
- Soil pollution with a halt to all planting and marine pollution caused by radioactivity
- Expenditures and opportunity loss caused by evacuation
- “Reputational damage” (farm and marine products, land assets, tourism)
- Reduction of tax revenues (halt of power plant operations, the closedown of factories, evacuation of residents)
- Reduction in numbers of students enrolled in educational institutions, and consequent loss of educational opportunities²⁶⁾

A number of important empirical and theoretical studies clarify the characteristics of the “nuclear seismic disaster” that has generated the wide-ranging multitude of issues listed above. They support policy proposals that will contribute to the relief of victims, as well as providing tools to study the social cost of nuclear power more deeply, and more objectively.

Supposing an economic loss of 50 trillion JPY and evaluating the total amount of electricity generated by nuclear power over 40 years of exploitation to 75,000 billion kWh, Hitoshi Yoshioka has calculated that the cost per kWh will rise by about 6.7 JPY. This is more than double the figure provided by the Ministry of International Trade and Industry in 1999 (5.9 JPY per kWh)²⁷⁾.

After the accident, the government carried out a review of the cost of nuclear power. According to the estimates (December 2011) of the “Cost Verification Committee”²⁸⁾, which included accident costs and social costs such as CO₂ emissions, the generation cost of nuclear power is at least 8.9 JPY per kWh. This is about 1.5

times the price previously published by the power companies and the government. If we add the cost of the removal of radioactive material, the decommissioning of the reactors and consequent compensations, the cost will rise further. And since coal-fired and LNG-fired thermal power generation cost around 10 JPY per kWh, the cost advantage of nuclear power generation has already disappeared. Under favorable conditions, wind and geothermal power can compete with nuclear power. In 20 years' time, solar power is more likely to be cheaper.

We do not therefore need to include the accident cost in our calculations to conclude that nuclear power is not (and never has been) cheap. If we add the cost of the accident to the reckoning, it is even more evident that nuclear power is actually the most expensive form of power generation. Yet, despite its not being viable economically, Japanese electricity policy uses nuclear power as the base-load source of electricity production.

Given, however, that nuclear fuel itself is cheaper than the fuel used for thermal power, restarting the already-built nuclear power plants will, in fact, be a way for power companies to save on (1) the direct cost of power generation, although this does not take into account (2) the backend cost, (3) the public investments and (4) the cost generated by the accident. So that if — on the stopping of nuclear power plants — we calculate the loss at several hundred million JPY per day, management will make use of this argument to support a decision for their restart; and, indeed, by doing so, even if each power company has to pay tens of billions of JPY for earthquake and tsunami countermeasures, nuclear power generation would still be a profitable business. However, hurrying up the restart of nuclear power plants in a seismically active zone like the Japanese archipelago means taking the risk of a second nuclear disaster. In such a case, because of the enormous (4) damage cost, there is no doubt that Japan itself would collapse and would not be able to recover.

VIII The theoretical principle of “compensation” as applied to nuclear disaster

As a consequence of the Fukushima Daiichi Nuclear Power Plant nuclear disaster — itself the result of the Great East Japan Earthquake and the subsequent tsunami — TEPCO will now be obliged to pay a huge amount of money in compensation. The way things stand it is more than likely that TEPCO's total debt will exceed its total assets and that it will suffer a capital deficit. While this possibility brings into immediate focus any growing conflict between TEPCO and the state over the burden sharing of compensation, the most important issue is actually to know if, in the case of insolvency, TEPCO will be kept alive as a company or be allowed to go bankrupt.

In section II, I wrote “we can already observe similarities with the case of Minamata disease in that the state has quickly expressed its intention to participate in the compensation process by adopting policies that give priority to the relief of the victimizer rather than to the relief of the victims”. This has now actually become the point of political issue over the Fukushima Daiichi Nuclear Power Plant nuclear disaster.

In the terms of the Nuclear Damage Liability Facilitation Fund Law, TEPCO

is nominated as the main actor in the compensation process, while the state and the other power companies will cover any shortage of funds, this sum to be repaid out of TEPCO's annual operating revenues. In other words, although TEPCO continues to operate, the newly created "Fund", supported by the power companies and the government, will be used to compensate the victims of the damage. But even if the compensation process is managed by the government and regardless of the percentage of the burden carried by the state, the burden borne by citizens, through the injection of public funds for payment of compensation and the raising of electricity prices, will inevitably be huge. The financial institutions and power companies support this option so that the unified generation and transmission and regional monopoly of the Japan-specific electric power production system can be maintained as it is.

On the other hand, if TEPCO is allowed to go bankrupt, all claims and corporate bonds become null and void, while the power industry itself continues to function as before. Such a procedure was followed in the case of JAL. Questions of the separation of the generation, transmission, distribution and dismantling of nuclear power are all now open for discussion. Suggestions have been made for the selling of the transmission sector to the state in order to acquire funds for compensation; other suggestions have proposed the management of nuclear power by the state²⁹⁾. The Japan Federation of Bar Associations has also proposed the legal liquidation of TEPCO through the sale of its current assets in order to pay compensation, the cession of power transmission and distribution business to the state, and the use of the reserve fund for fuel reprocessing and the payment of debts³⁰⁾.

According to the blog³¹⁾ of Taro Kono, a member of the Liberal Democratic Party, "Every day people from the Ministry of Economy, Trade and Industry, TEPCO and the Federation of Electric Power Companies throng the Diet Building, and attempt to speak with every member of the Diet. It seems that they are all lobbying on behalf of their own particular interests. <If TEPCO is partitioned the supply of electricity will be disrupted> <Insisting that TEPCO pay compensation will lead to a financial crisis>. The main strategic objectives of the Ministry of Economy, Trade and Industry, TEPCO and the Federation of Electric Power Companies are to prevent the partitioning of TEPCO and to raise the burden carried by the state. The composition of the present government formed from the former Democratic Party of Japan confirms this orientation, since many of its members come from the former Democratic Socialist Party and in the past had connections with The Federation of Electric Power Related Industry Worker's Unions of Japan.

To argue "If TEPCO is partitioned the electricity supply will be disrupted" is just a means to protect the monopoly of unified power generation and transmission, while, as for the financial crisis argument, I here cite a relevant article by Hoshi-Kashyap-Schade³²⁾ which points out that it all depends on the response of the regulatory agency. JAL, just like TEPCO, is an important company, but it is now undergoing a rehabilitation process in accordance with the Corporate Rehabilitation Law. Neither JAL nor TEPCO need special schemes of liquidation procedure, such as are used for example by financial institutions. With regard to damages, Hoshi and his fellow writers say, "The Corporate Rehabilitation Law just determines the procedure for debt restructuring. It's not a strict allocation rule. In a reorganiza-

tion plan, considering fairness, even claims with a statutory lien are often put together with other general claims into one class. What is important is to carefully draw up a fair reorganization plan under the supervision of the court. In this sense, rather than an inflexible rule, the Corporate Rehabilitation Law is a process to ensure fairness.”³²⁾

Taro Kono’s blog also reports³³⁾ that a young bureaucrat of the Agency for Natural Resources and Energy sent him a “Ghost Draft for the Energy Agency” which had been crushed by his superiors (“Current energy policies issues revealed by the disaster, Ministry of Economy, Trade and Industry, April 24, 2011”). The ghost draft lists nine “Priority Problems”.

- ① Settling the Fukushima nuclear power plant accident
- ② Providing a stable power supply during the summer (to avoid sudden and large-scale power outages)
- ③ Avoiding a financial crisis brought on by TEPCO’s uncertain finances
- ④ Urgent implementation of compensation to the victims of the nuclear accident in Fukushima
- ⑤ Minimizing the burden on citizens
- ⑥ Realizing a fair burden-sharing among stakeholders so as to win the people’s approval and confidence (essential to smooth processing)
- ⑦ Radical revision of nuclear power regulations, including countermeasures to cope with remotely triggered earthquakes and the breaking-up of NISA
- ⑧ Radical revision of power generation business regulations, including the separation of electric power generation and transmission
- ⑨ Improving the decision-making and implementation of the rehabilitation process, including the breaking-up of TEPCO

Although this list of nine items, with which many people agree, clearly organizes the challenges posed by Japan’s current energy problems, the alternative mechanism proposed by the government will determine the basis for the policies that will deal with these nine problems.

Among the problems listed above, the mechanism proposed by the government sets ② the stable power supply and ③ the avoidance of financial crisis as nominal goals, while trying ④ to implement a compensation system as soon as possible to ⑤ lighten the burden placed on the citizens. But the attempt to avoid ⑧ any radical revision of the regulations affecting the power generation business and ⑨ the split-up of TEPCO is obvious. It will therefore be extremely difficult to realize ⑥ a fair burden-sharing among the stakeholders and so satisfy the wishes of the people.

Although the proposed mechanism clearly needed a fundamental (and thus lengthy) review before it could be adopted, it was, in order to settle TEPCO’s accounts, decided upon immediately without sufficient discussion amongst members of the National Assembly or even within the Cabinet; nor was there any public debate. Here, the important thing is to know what the purpose of the whole process is. If we hope to reduce as much as possible the burden on public finance and citizens and pay proper compensation, while also looking ahead to the reduction of our dependency on nuclear power and the reorganization of Japanese system for elec-

tric power supply, then it will be necessary to consider the option of the separation of electric power generation and its transmission.

IX The theoretical principle of “compensation” as applied to the nuclear disaster :

Verification of the “TEPCO Management and Finance Investigation Committee Report”

We have until next winter (the winter of 2012/13) to decide whether or not to restart some or all of the nuclear power plants: this is our greatest current concern. After the accident in Fukushima and before the report of the Accident Investigation Committee had been released, few local governments were ready to agree to the restarting of nuclear power plants after a stress test only. It is a justifiable question to wonder if nuclear power plants, scattered as they are all over the country, will be able to withstand earthquakes and tsunamis such as those experienced during the Great East Japan Earthquake. As the chairman of the Nuclear Safety Commission admits, Japanese nuclear safety regulations have never assumed situations such as the total loss of power or core meltdown, and he agrees that a fundamental reform of the regulations is necessary. Yet although so many nuclear power plants have been built in such an earthquake-prone territory as Japan, no sufficient countermeasures against earthquakes have ever been taken. Hurrying up the restart of nuclear power plants could lead to a second accident. If so, Japan would not have the capacity to recover.

The TEPCO Management and Finance Investigation Committee published its report on October 3 2011³⁴⁾, and the fact that it strongly urges the restart of nuclear power plants and a rise in the electricity bill constitutes, in the light of the circumstances I have just referred to, very serious issues that cannot be overlooked by an environmental economist such as myself. Indeed, in contrast with media coverage, which in general represents the report favorably as pressing for a severe restructuring of TEPCO, I consider, after a deep review, that it contains many problematic proposals. While it aims for the restructuring of TEPCO by streamlining the management, it gives to the state the responsibility of providing the compensation due to the nuclear accident, leaves unquestioned the responsibility of financial institutions as lenders, makes an imaginary excess of liabilities over TEPCO's assets, presses for the restart of the Kashiwazaki Kariwa nuclear power plant and for a rise in the price of electricity, and finally avoids the issue of TEPCO's legal liquidation.

Furthermore, the impartiality of the report is itself questionable, for though it pretends to be a third party committee that was originally established in August under the “Nuclear Damage Liability Facilitation Fund Law” in order to call for an objective assets evaluation and expenses revision (due diligence process) when the Facilitation Fund provides financial assistance to the nuclear power operator (TEPCO in this case), the committee members and the report are in fact simply a mouthpiece for the Facilitation Fund itself. Therefore, the problems of this report are problems of the law as it stands. This important fact is signified in the report by considerations concerning the evaluation of TEPCO's assets. Despite the length,

it is cited below³⁵⁾.

(1) After its establishment the facilitation fund of Article 41, Paragraph 1, No.1 of the Facilitation Fund Law will provide assistance to TEPCO through subsidies to the funds devoted to the payment of damage compensation that TEPCO will be obliged to perform, with the prerequisite that revenue of the equivalent amount will be recognized. In addition, the consolidated net assets after adjustment has been executed will carry the prerequisite that the nuclear damages costs that have already been incurred (397.7 billion JPY for the first quarter) and the nuclear damages that should be appropriate in the future are not implemented in the allowance.

(2) On the basis of Article 52, Paragraph 1 of the Facilitation Fund Law, the amount of special contributions will be determined in accordance with standards specified by ordinance of the competent minister, in light of TEPCO's future balance of payments, and to the extent that it does not pose impediments to smooth business operations and stable electricity supply. Since accounting the cost will remain at TEPCO's charge in the future, the ascertainment of the above actual net assets is not taken into consideration.

(3) Since we expect a large deficit by the end of the fiscal year (March 2012), and as the duration and the amount of special contributions are uncertain, the occurrences of future taxable income cannot be comprehended. Therefore the adjustment of tax effect is not implemented.

(1) states that under the Facilitation Fund Law, TEPCO, in order to pay damages, will receive subsidies from the state that are recognized as profits of the same amount. Thus the damages cost is not implemented in the allowance. TEPCO is supposed to pay back these subsidies through special contributions. However, according to (2), as special contributions are decided by ordinance of the competent minister, their duration and amount are uncertain, and therefore are not incorporated in any trial calculations. In a normal case, there is no bank to lend funds while the repayment amount and the repayment plan remain deliberately ambiguous.

As the Japan Federation of Bar Associations has pointed out, if damage compensation obligations were implanted in the allowance, TEPCO would become insolvent. For example, even if only the amount of transitory compensations (about 2 trillion 618.4 billion JPY) and the amount of annual compensations for first year (about 1 trillion 24.6 billion JPY) are subject to allowance obligations, TEPCO would not, as the report states, be in excess of 1 trillion 602.5 billion JPY in assets, but in fact be burdened with deficits of at least around 2 trillion 40.5 billion JPY. Crushed by debt, legal liquidation procedures including the application of the Corporate Rehabilitation Law would then have to be seriously considered³⁶⁾.

From the point of view of environmental economics, we cannot overlook the report's extremely debatable (and highly dubious) forecast of the amount of damages that are likely to be incurred. As there has so far been no case of exposure, the

amount of damage caused by radioactivity has been estimated as zero³⁷⁾. At the same time, three scenarios for the running of nuclear power plants have been prepared. In the case where nuclear power plants cease to operate, the report claims that a fund-raise from 4 to 8 trillion JPY will be needed, and that if there is no significant increase of electricity rates, the formulation of a viable business plan will be compromised³⁸⁾. Such a claim represents the biggest problem. If the whole thing is nothing more than a forced choice between the restart of nuclear power plants and the increase of electricity rates, then “Minimize the burden of citizens” is just an empty slogan. It is necessary to go back to the beginning and reconsider the prerequisites: we should consider, amongst our choices, the legal liquidation of TEPCO, the responsibility of the supporting financial institutions, compensations paid by the profit on sales of business of electric power generation and transmission and liberalization of the electric power industry. To say that the restart of nuclear power plants and the increase of electricity rates are necessary in order to avoid TEPCO’s insolvency is a flagrant example of the confusion of the means for the end. In fact, the conditions laid down by the three megabanks for additional financing to TEPCO (scheduled April 2012) are a price hike and the restart of nuclear power plants³⁹⁾. Priority is clearly being given to the profits of financial capital. And the responsibility of the lender who has been unable, or has failed, to evaluate the risk of nuclear power exploitation remains unquestioned.

X The theoretical principle of “countermeasures” as applied to a nuclear disaster:

The reality of “a cold shutdown condition” and “accident contained” declarations

In a statement on the Fukushima Daiichi Nuclear Power Plant issued on December the 17th 2011, the government announced a “cold shutdown condition” and claimed that the “accident (had been) contained”. But this announcement was made while the government and TEPCO were still working to achieve the “cold shutdown condition” by the end of the year, as had been agreed on in the second phase (step 2) of the roadmap towards restoration after the accident. The prerequisite for a cold shutdown condition requires that temperature at the bottom of the pressure vessel inside the reactor should be held at less than 100 degrees and that the leakage of radioactive materials should be kept under control. But since the expression “cold shutdown” has always been used only when operations in a nuclear reactor are temporarily stopped, for example to perform periodic inspections, it implies a safe situation when the reactor is hermetically sealed and the water is cooling not boiling. So, use of the expression “cold shutdown” for a reactor that has suffered an accident is not in line with the usual definition. Moreover, the accident has been declared “contained” while there is no prospect of return for the residents. The governor of Fukushima Prefecture, Yuhei Sato, has reacted indignantly to the declaration and has signified that, as a matter of course, “the accident is not yet contained”. Governor Sato has also explained that the residents feel anxious about the leakage of treated water while the amount of contaminated water continues to grow.

Even the chairman of the Nuclear Safety Commission, Haruki Madarame, has admitted “This is not a normal nuclear reactor facility anymore. As we do not know what is happening inside and what has become of the reactor core, it is extremely difficult to properly anticipate what might happen next.”⁴⁰⁾ So why, when it is quite obvious that the accident is far from being contained, should a “cold shutdown condition” and “accident contained” declaration have been made at this particular moment? The answer is of course obvious, and it is perhaps hardly necessary to say that at the root of such an announcement lie such issues and the concerns they raise as when to restart the nuclear power plants now stopped nationwide for periodic inspection and when to lift the evacuation orders to residents in the vicinity of the nuclear power plant. The basic factors when dealing with pollution cases are (1) the elucidation of the cause of pollution and its source, (2) countermeasures to the source of the pollution emission, and finally (3) a study of damage and the relief of victims. On each of these matters, the investigation of the Fukushima disaster is still in its early stages.

(1) As for elucidation of the cause of pollution and its source (“the causes of pollution” as applied to the nuclear disaster), we await the results of the investigation headed by The Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, but the formal report is not likely to be released before July 2012. The report must challenge not only the adequacy of the safety regulations and countermeasures at the Fukushima Daiichi Nuclear Power Plant but also how these apply to all the nuclear power plants across the country. Stress tests that rely only on simulations will not be acknowledged as valid or adequate.

(2) Furthermore, measures to counter the source of pollution emissions are problematic, too. We are still quite ignorant of many important features of the contamination of underground water or seawater that is being brought about by the radioactive pollution emitted by Fukushima Daiichi Nuclear Power Plant; and since, as Chairman Madarame admits, it is not possible to go onsite or discover the actual situation within the reactor, we cannot predict how the state of the plant will evolve. Yet the option of releasing contaminated water into the ocean is still permitted.

(3) Even if we consider only the damage caused by nuclear pollution and the relief that must be given to victims, we recognize that further huge efforts are needed. Study of radioactive contamination is insufficient and many residents in the vicinity are still seized with great anxiety because of high levels of radiation. Even among those living about 60km distant from the plant, anxiety about high levels of radiation still persists. While it is necessary to give priority to evacuation and decontamination, it should be done carefully so as to avoid spreading pollution over a wider area.

Although, as we see, none of the three basic conditions for dealing with cases of pollution have at this stage been met, the authorities have declared a “cold shutdown condition”, and have claimed that the “accident (has been) contained”. The

urge behind this choice of timing inspires nothing but suspicion. We require measures that take into account the reality of Fukushima and that attempt to grasp what is really going on at the plant. Yuko Endo, mayor of Kawauchimura, a village that has been forced to evacuate in its entirety to Kohriyama City, stated that the accident can only be considered contained “when the removal of fuel, the decommissioning of the reactor and the process of residents return has been completed”. If we consider this nuclear disaster to be the world’s largest and worst case of pollution, then we should be prepared for its resolution to take time as well as huge effort and cost. If we are over-eager to announce that the problem is over, the damage could be even greater.

XI The theoretical concept of “countermeasures” as applied to nuclear power plants; and why the unconditional restart of Tomari Nuclear Power Plant for commercial operations should not be allowed

The people of Japan are deeply concerned about the commercial restart of Unit 3 of the Hokkaido Electric Power Company Tomari Nuclear Power Plant. If the authorities permit a restart, it will be the first time since March 11, 2011, that commercial operations have been allowed to begin again. I am a representative member of a body of 50 researchers working in Hokkaido on this issue and I should like to quote from an emergency statement that we produced on 15 August 2011.

Despite official reassurances, radioactive material emitted by the TEPCO Fukushima Daiichi Nuclear Power Plant accident, triggered by the Great East Japan Earthquake on March 11, is still uncontained and widespread damage resulting from this radioactivity has been confirmed. Since nuclear plants need water, all 54 nuclear power plants across the country are situated, like the Fukushima Nuclear Power Plant, beside the sea, where they can be greatly affected by earthquakes and tsunamis. It is now clear that if another accident were to occur, the range of the damage it would inflict would be even more extensive and equally fatal. The official claim that “Nuclear power is safe” has been put to the test and is no longer believed.

Units 1 and 2 of the Hokkaido Electric Power Company Tomari Nuclear Power Plant have been in service for more than 20 years while Unit 3 has now been in operation for more than three years. Seismologists have identified active fault lines not only along Japan’s Pacific coast, but also off the coast that faces the Sea of Japan, and in 1993 an earthquake off the southwest coast of Hokkaido caused considerable damage; the Tomari Plant was among those installations that were affected. As the party in charge of business operations at the plant, and to reassure the people of Hokkaido, Hokkaido Electric Power Company has the obligation to disclose information and analysis with regard to these issues. At the same time, it is necessary that an impartial third party organization should perform a close investigation to verify the information given.

An “Agreement on Environmental Protection and Measures to Ensure the Safety of Tomari Nuclear Power Plant and its Surroundings” was first concluded in 1986, and has subsequently been revised three times. The agreement was drawn up between Hokkaido Electric Power Company and the Prefecture of Hokkaido,

the village of Tomari, the towns of Kyowa and Iwanai, and the village of Kamoenai. Although Article 14 states that the signatories can request such measures as the “temporary stoppage of the nuclear reactor”, only the prefecture and the four closely related localities have had any part to play in this agreement. Yet, as we have seen during the aftermath of the accident at Fukushima Daiichi Nuclear Power Plant, even the city of Fukushima, 60km from the site of the accident, has suffered serious after-effects from radioactive fallout. If we take this into consideration, we see that it is essential to enlarge the range of localities that need to be parties to this agreement.

On March the 7th 2011, the Hokkaido Electric Power Company Tomari Nuclear Power Plant commenced a test operation of Unit 3. This reactor is at the cutting-edge of nuclear power technology, but it has been planned for plutonium thermal use, which intensifies the dangers and their effects immensely. Adjustment operations continued for over five months until such time as the Unit was due to start commercial operations, but the accident at the TEPCO Fukushima Daiichi Nuclear Power Plant has been a lurid illustration of how an earthquake and/or a tsunami can transform what has been thought a safe nuclear power plant into a huge source of radioactive contamination that brings fear not only to the neighborhood directly surrounding the plant, but to all the residents of areas within range of the fallout.

In April 2012, the Hokkaido Electric Power Company announced emergency measures to strengthen the safety properties of the Tomari Nuclear Power Plant. The Company has also indicated how long it will take to carry out such measures and ensure that they are properly put into place.⁴¹⁾

- (1) To be able to supply electric power from sources outside the power plant → about 4 years
- (2) To deploy additional mobile generator sets → within 2 years
- (3) To secure a seawater electric pump and its substitute → within 1 ~ 2 years
- (4) To implement measures against submersion of electrical equipment → about 4 years
- (5) To implement measures against submersion of the area where critical safety equipment has been installed → about 3 years

In addition, the Company is considering the construction of a seawall.

Yet, despite the strong likelihood that the Japanese archipelago has entered a new phase of seismic activity that calls for the speediest implementation of such measures, the budget allotted for each fiscal year means that the measures cannot be fully implemented for approximately two to four years. So slack a response demonstrates that the Company has no sense of urgency, and the people of Hokkaido have been shocked by such a dilatory attitude.

At the same time, and even taking into account the situation after March 11, the Governor of Hokkaido, who is an important party to the safety agreement that includes a clause on “the temporary stoppage of the nuclear reactor”, has had to request the disclosure of information concerning Hokkaido Electric Power Com-

pany's response and push for the acceleration in the implementation of proposed measures. She has also had to urge a review of the range of localities included within the agreement. The start of the commercial operation of Unit 3 at the Hokkaido Electric Power Company Tomari Nuclear Power Plant will be the first in Japan since the accident on March 11. Since this can set a precedent for similar operations in the future, we need a more than usually detailed assessment and a conformity inspection of the Unit and must insist on severe operating conditions regarding safety before units can restart. We should therefore refuse to tolerate the start of commercial operations that lack any of the required conditions, and we should immediately prepare a concrete schedule to ensure the safety of Tomari Nuclear Power Plant and draw up an evacuation plan that takes within its scope the area within a 80km ~ 100km radius of the plant.

We have therefore proposed five conditions that we insist should be fulfilled before there can be any restart of commercial operations at Unit 3 of the Hokkaido Electric Power Company Tomari Nuclear Power Plant: information disclosure and impartial third party verification, expansion of the range of concerned localities, acceleration in the implementation of countermeasures, a concrete schedule to ensure safety, and a wide area evacuation plan. We have asked all parties concerned to consider these proposals with the greatest seriousness.

From a nationwide point of view, we need in response to the accident at Fukushima Daiichi Nuclear Power Plant to be told what were the true causes of the accident and how the course of events unfolded thereafter, and we must insist on the application of drastic standards and stronger safety measures. Niigata Prefecture, for one, will not accept the restart of nuclear power plants until this is assured. Hirohiko Izumida, governor of Niigata Prefecture, is insistent on the need for a true account of the causes and the unfolding course of the accident at Fukushima Daiichi Nuclear Power Plant as a prerequisite for the restart of nuclear power plants. "Is the tsunami the only cause for the loss of power supply? Did the earthquake rupture a pipe? In the event of accident, who has the right to decide on a seawater injection in order to prevent core meltdown? We do not know anything."⁴²⁾

While Governor Izumida is certainly right, and we may not yet know all that we should like to know about the accident and its aftermath, we have at least learned some lessons from the consequences of the disaster of March 11, and we must consider most carefully what the lessons teach us. And once the current periodic routine inspections have been concluded, we must debate what conditions we shall need to impose before the restart of nuclear power plants across the country can be authorized. We need a careful policy statement that will clarify all these issues.

XII Alternative policy :

The "why" and the "how" of German denuclearization

《Miranda Schreurs (Professor, Free University of Berlin) and Fumikazu Yoshida (Professor, Hokkaido University) are co-authors of this essay》

Two of the questions that Dr. Schreurs and I raise in our essay are "Do we

need to close down nuclear power plants? Can we live without nuclear power?" The Fukushima accident led the German Chancellor to create the "Ethics Commission for a Safe Energy Supply", and the Commission has considered whether we need to abandon nuclear power. Since the German conclusions may offer a model for Japan, I describe in detail the "why" and the "how" of the German denuclearization process.

That the Fukushima accident should have occurred in "a highly organized, high-tech country like Japan" has had a very great impact on the German people (so the Chancellor's ethics committee reports). After the accident, German television aired images of hydrogen explosions almost every day. Yet, while the German Federal Ministry for the Environment and the German Meteorological Service published detailed information about the accident on their website, the Japanese Meteorological Agency issued no relevant information whatsoever, and numerous anxious enquirers from Japan have been forced to access "Relative distribution of radioactive particles emitted by Fukushima", a map prepared by the German Meteorological Service.

While the radioactive contamination of Germany from the fallout of the accident at the Chernobyl Nuclear Power Plant in 1986 was the original spur to the institution of German policies designed to phase out nuclear power plants in Germany by 2022, the accident at Fukushima Daiichi Nuclear Power Plant that resulted from the earthquake and the tsunami has given considerable momentum to these plans. The legislation that abolishes nuclear power plants by 2022 was adopted in 2002 by the coalition government of the Social Democratic Party and the Green Party in place since 1998. The decision the Germans have now taken is simply to bring everything forward.

The report of the 17-strong Ethics Committee (of which Miranda Schreurs is a member) makes the following points⁴³⁾:

- Even if the safety of nuclear power plants is high, accidents can happen.
- Should an accident occur, nuclear power is more dangerous than any other source of energy.
- To leave the responsibility of spent fuel disposal to the next generation is an ethical issue and one that we cannot neglect.
- There are safer sources of energy than nuclear power.
- Yet because of global warming, the use of fossil fuels is not a solution.
- The development of renewable energy and energy efficiency measures that would be a corollary of the gradual phasing out of nuclear power offers a great opportunity for the economy of the future.

If Japan is to learn from these conclusions, she must understand that it is necessary to ask whether nuclear power is a proper means of energy. Earthquake-prone Japan needs to evaluate and compare the cost and risks of nuclear power with other forms of power generation, the scale and extent of damage in the case of an accident, and her responsibility toward future generations. The choice of technology should be decided by society on the basis of ethical value judgments.

I shall first discuss the "how" of German denuclearization. Germany's new nuclear energy policy, confirmed by an amendment of Germany's Atomic Energy Act,

aims to abolish nuclear power plants by 2021-2022. Eight old reactors have already been stopped and disconnected from the power grid. In 2010, Germany's nuclear energy counted, as it does in Japan, for about 11% of the country's primary energy supply, and 22% of its electric power. Oil is the largest source of primary energy, accounting for 33%, while brown coal is the largest source of electric power, accounting for 24%. Such data indicate how challenging is the task of taking measures against global warming while at the same time phasing out nuclear energy. Even when stopped, the safety of a nuclear reactor remains an important issue. In Germany, too, the storage and disposal of spent fuel are serious concerns, and while not planning to reprocess fuel she needs to address questions of safety and the use of new technology.

Germany is currently considering such possible alternatives to nuclear power as photovoltaic power, solar thermal power, wind power, geothermal power, wave power, biomass, cogeneration, a power grid, batteries and smart technology, and she is seeking to collaborate with Japan in carrying out research and development in many of these fields. Although Germany has actively pursued the reduction of greenhouse gases in accord with the Kyoto Protocol, the abolition of nuclear power will in itself do nothing to achieve the Kyoto Protocol targets. The energy policy outlined by the German government makes energy saving and renewable energy the main pillars in its reduction of greenhouse gas emissions, while the keystone is a reduction in energy consumption. Such goals as a 40% reduction in emissions of CO₂, a 20% share of renewable energy in primary energy consumption, and a 20% improvement in energy efficiency indicate that the outlines of this energy policy meet and even surpass the goals set by the European Union's "three 20 targets" policy.

The outline, based on principles of acceptability and transparency, involves a series of 120 policies and measures mobilized in such domains as renewable energy, storage and grid, energy saving, improvement of building insulation, transportation, and the improvement of conventional power generation. The financial cost of the necessary measures is estimated at 300 million euros in 2011 and 2012 and, then, at approximately 3 billion euros every year from 2012. It is planned to use the funds for renewable energy (research and development + market penetration), energy saving (research and development + market penetration), modernization and improved insulation of buildings, as well as domestic and international projects devoted to counter the challenges of climate change.

In the interests of energy saving, Germany has, for more than 10 years, debated the formulation of policy objectives and a policy framework so that she can phase out the use of nuclear power and move on to the introduction and development of sources of renewable energy. Working in harness, NGOs, citizens, farmers, political parties, entrepreneurs and the government have cooperated to create concrete projects that will lead to a marked saving of energy and have participated actively in the promulgation of renewable energy. What Japan now urgently needs is the establishment of a policy framework with well-defined goals, but also the formation of bodies of professionals who have the impartial expertise necessary to guide the decisions of the politicians. It requires time to make political decisions based on public debate: nonetheless, in Japan it is essential.

Although the cost of the project will be high, the EU is planning a single energy grid and a single market for the whole EU, and wishes to extend this with a connection to North Africa, and though energy costs in the emerging countries tend to rise because of increasing demand, it is a necessary step for successful future power generation. So now, in Germany, this project, known as the “German Apollo Program”, will bring new opportunities through the participation of universities and the development of new technologies. For example, the development of alternatives to the automobile is a chance to strengthen the energy industry’s competitiveness. Japan, too, during the process of overcoming the problems of pollution and the oil crisis in the 1970s, has succeeded in developing a world-class system of energy and environmental technology.

To be able to turn a crisis into an opportunity for renewal will depend upon the ability of a people, and since the Japanese do not want to be told that “The wise learn from other’s experience, while the fool cannot even learn from his own mistakes”, Japan has to draw lessons from the Fukushima accident, and by learning from the German example make concerted efforts to set appropriate goals for de-nuclearization by establishing a comprehensive policy framework under the necessary aegis of trained professionals. And at the same time, Japan has to strengthen cooperation with other countries on the promotion and development of renewable energy and energy saving.

XIII The potential of Hokkaido: Hopes for combined heat and power

We may begin by taking a look at renewable energy in Hokkaido. Wind power is the least expensive resource. The Cape Soya Wind Farm in Wakkanai City is the largest in Japan with 57 wind power stations capable of producing 57,000 kilowatts. The Ministry of the Environment has calculated that there are sufficient suitable sites for wind power generation in Hokkaido, Tohoku and Kyushu to surpass the current combined capacity of nuclear, thermal and hydroelectric power generation. Two major problems are the expense of laying transmission lines, although there are proposals to use the disused railroads of former Japanese National Railways as sites for transmission lines, and the rapid variation in output depending on wind speed. And since the Hokkaido Electric Power Company has decided to limit the introduction of wind power generation to only 5% of the total installed capacity of 7.4 million kilowatt, this is a problem that will have to be faced if wind power is to have a future.

Another promising source of energy is photovoltaic power generation, and the strength of the Japanese semiconductor industry is one of the reasons why Japan was the world leader in terms of installed solar power generation capacity until about 2003. However, Japan has subsequently been out-distanced on the use of solar power by Germany and Spain, and since Japan has wind power generation technology but a limited domestic market, it is mostly sold abroad. And while we must recognize the necessity of increasing sources of decentralized energy such as biomass, geothermal and small hydroelectric generation, the lack of a Feed-In Tariff policy means that there is little progress in the diffusion of such sources of renewable energy, in spite of Japan’s high technological competence. Renewable en-

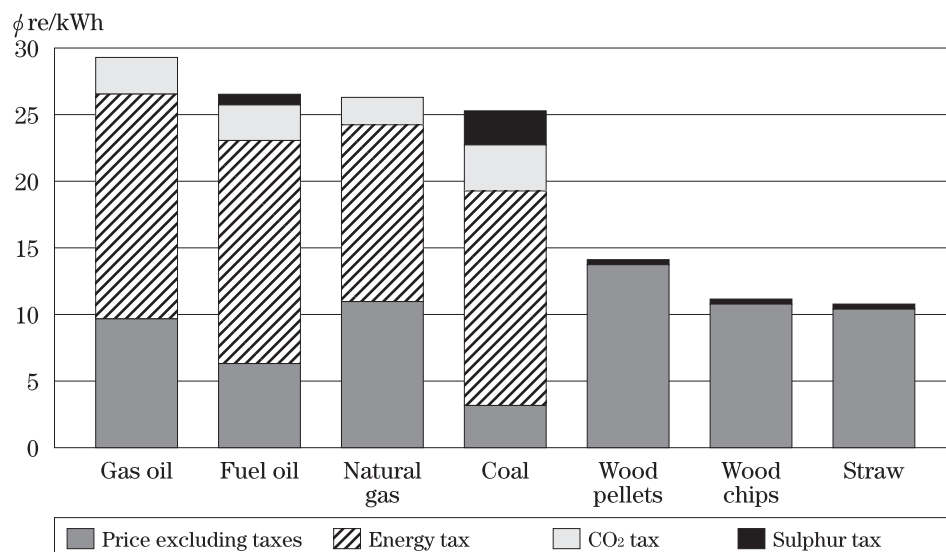
ergy represents 40% of the total electric power consumption in Denmark and 25% in Germany. Policy implantation and implementation is the key in Japan, too.

We may consequently hope, especially in Hokkaido, for a comprehensive utilization of heat and electricity, since it is possible to increase the heat utilization factor through cogeneration and district heating. In Denmark, for instance, after the wheat has been harvested the straw is used as raw material for electricity generation and heat production. The generators are actually located on the wheat fields and the electricity and heat are supplied to the surrounding municipalities. There are approximately 700 cogeneration plants in Denmark, whose total area is about the same as that of Hokkaido. Wind and solar power generation depend on the weather, but biomass systems provide storage and depend neither on the weather nor on light or darkness.

When we consider that there are 6000 biomass plants in Germany operating on wood chips, straw and livestock manure, and compare this with the agriculture and forestry resources of Hokkaido, we see that the potential for cogeneration in Hokkaido is significant. We should recognize these systems as sustainable infrastructures and should finance mechanisms for their development amongst agricultural cooperatives.

Another important tool to consider is an environmental tax. The price of fuel in Denmark is a concrete example of its implementation (see **Figure 2**). Before tax, the cheapest fuel is coal; then, rising in price, come heavy oil and gasoline; finally, the most expensive fuels are wood pellets, wood chips and straw. If nothing is done to change this, mostly fossil fuels like oil will be used and large quantities of carbon dioxide will be emitted, but if an energy tax and carbon tax is imposed on fossil fuels, then wood pellets, wood chips and straw will become relatively less expensive. Such environmental taxes will lead to the reduction in the use of fossil fuels and to the promotion of non-fossil fuels. Tax revenues can also be used for social

Figure 2 Environmental Related Tax in Denmark



security costs.

A feed-in tariff policy is an effective way of promoting and diffusing sources of renewable energy with high initial installation costs that discourage investment, but if the duration of operations and the money that can be made from the electric power business were to be preset, investment in renewable energy would be stimulated and fund raising facilitated. As diffusion progresses, so the cost will continue to decrease; we shall also need, rather than an across-the-board purchase price, a system with a purchase price for each type of renewable energy.

Sapporo consumes about one-third of the electricity used in all Hokkaido. If an accident were to occur at the Tomari Nuclear Power Plant, Sapporo would be directly affected since it is located about 60km from the plant. That is one reason why I hope that Sapporo will promote measures concerning energy saving and heating and increase the use of renewable energy, while further cooperation between urban and rural areas will allow an augmentation of wood biomass use. Sapporo and Hokkaido present us with many possibilities for developing safe and renewable forms of energy.

For instance, Hokkaido Gas Company is building a liquefied natural gas reception terminal in Ishikari Bay New Port, and, from the start, I have recommended that Hokkaido Gas Company and Hokkaido Electric Power Company cooperate to build a natural gas-fired power plant that will be able to supply Sapporo with electricity and heat through the use of cogeneration. Sapporo and Hokkaido will need to cooperate on urban planning, and if this is fruitful, it can also be the source of new business and employment opportunities.

XIV Policy to reduce reliance on nuclear power:

A review of short, medium and long-term prospects

One can achieve any goal if one sets one's mind to it, as the following example shows. Since July 2009, when Sapporo began to charge for garbage collection and disposal, the city has reduced the amount of garbage it produces by more than 40%. A significant reduction in the quantity of combustible garbage has made it possible to dismantle the most obsolete of the four incineration facilities located in the city without building any new ones, while generating a cost reduction of 37 billion JPY. Charging for garbage disposal is a mechanism of the same kind as an environmental tax.

Since the Fukushima accident, Hokkaido Electric Power Company has taken such emergency safety measures as the deployment of mobile generator sets in Tomari Nuclear Power Plant, but, as we have seen, it does not plan to implement important measures against the threat of a tsunami for another 3 or 4 years. This is too late. We need urgent measures to ensure that the nuclear power plant can resist earthquakes and tsunami of the same scale as those that devastated the Tohoku coast of the Japanese mainland. Since the Fukushima accident, it has been the eager wish of Hokkaido residents that the Tomari nuclear power plant shall be operated safely. No Hokkaido resident has any desire to see the Hokkaido Electric Power Company suffer the same fate as the Tokyo Electric Power Company.

Yet while we need urgent measures to ensure that the Tomari nuclear power

plant can be operated safely, how much will adequate safety measures cost? A great deal of money, obviously, but I am sure that if Hokkaido Electric Power Company releases all the information it has without holding anything back, each household will agree on sharing this burden. It will be too late to take measures in a few years' time.

Should Unit 3 of the Tomari Plant (which has been operating for the last 3 years) run until the end of its life expectancy, then it will be necessary to think much more carefully about how we are to secure its safety, while finding a way to close down Units 1 and 2 (which have both been operating for more than 20 years) and switch to another energy source, as well as finding a way to reduce electricity consumption. Full and open discussions on these issues are essential.

The prerequisite for such a debate is for a third party that is not associated with the government or the electricity company to undertake an impartial audit.

The accident at Fukushima has exposed the falsity of the claims that nuclear energy is safe and has clearly shown the need to reform Japan's national energy policy, including that of Hokkaido and the Hokkaido Electric Power Company. During a period of sudden environmental change, such as the one brought about by the collapse of the myth of safe nuclear energy, we have to reject the opacity of official communiqués, make ceaseless efforts for dialogue with Hokkaido residents, and break off the cozy relationship between administration and business.

We need, more specifically and indispensably, the full release of public information on energy policy and, in order to ensure more fairness and transparency, we must have public audits and regulations ordered and carried out by third party organizations, including the Hokkaido Prefectural Assembly.

It is important to review the energy policy and keep the public fully informed of the goals, which may be classified as short, medium and long-term.

【Short Term Goals】

We insist on the complete revocation of the thermal use of plutonium. Until the official investigation report on Fukushima accident has been released, Units 1 and 2, now undergoing routine inspection, should not be restarted, and counter-measures against earthquakes and tsunami should be carried out as soon as possible. Safety measures concerning Unit 3 should be strengthened and their implementation moved forward. If Unit 3 continues to operate, then measures to ensure that the nuclear power plant can resist earthquakes and tsunami of the same scale as those of the Great East Japan Earthquake should be undertaken with all possible speed.

【Medium Term Goals】 (Until 2020)

In order to reduce reliance on nuclear power, we should begin at once to increase the use of natural gas-fired power generation and renewable energy by strengthening of the transmission network and intensifying the proactive planning of cogeneration. As the Act on Special Measures concerning the Procurement of Renewable Electric Energy by Operators of Electric Utilities has already been passed, the concrete implementation of its directives in Hokkaido is essential. Hokkaido Electric Power Company has already announced plans for natural

gas-fired power generation in cooperation with Hokkaido Gas Company, and has said that it is considering the expansion of the framework for the introduction of renewable energy.

【Long Term Goals】 (Until 2050)

As long as there are no new construction projects or additional installations, it should be possible to phase out all nuclear power units by 2050: Tomari Unit 3 could be the last nuclear reactor operating in Japan. In the meantime, we have to examine strategies and plans to achieve denuclearization through energy saving and renewable energy. In Hokkaido, the future potential of such renewable sources of energy as wind power, biomass, photovoltaic power, geothermal power and others, is considerable.

A study made by the Japan Center for Economic Research has calculated that where there is sufficient diffusion of renewable energy (not only wind power and photovoltaic power but also geothermal power, biomass and small hydroelectric generation) and if improvements are made in energy saving, the cost in 2050 would be cheaper than if we were to continue operating nuclear power plants⁴⁴⁾. Specifically, the cost of nuclear power will be 20 JPY / kWh, while during the period of an oil crisis the energy saving would be 1.5% per year. The amount of energy supplied by nuclear power before the Fukushima accident can be covered by newly introduced sources of renewable energy and energy saving. Denuclearization represents a cost rise in the short term, but in the long term the benefits are likely to far outweigh the disadvantages.

I should therefore like to propose the establishment of the “Hokkaido Energy and Environment Council”. The council would be composed of members of the national government, Hokkaido Prefecture and the prefectural assembly, concerned localities, Hokkaido Power Company, Hokkaido Gas Company, energy specialists, and citizens’ groups, and their task would be to make extensive investigations, conduct consultations and seek for consensus. Although not itself a decision-making body, it is needed as a forum for deliberation and the sharing of information.

In 2012, all three of the Tomari reactors have been stopped. In that case, it is essential that Hokkaido Electric Power Company should work in partnership with other energy-related businesses and all the relevant administrative agencies if it hopes to gain the cooperation of residents in programs to save energy through the development of such alternative forms of power generation as thermal power. The initiative of the Governor of Hokkaido will be especially crucial.

The future presents us with three crucial risks: the risk of global warming, the risk of nuclear disaster, and the risk of over reliance on imported fossil fuels. It is of vital importance that we adopt an outlook that seeks for a reduction of these risks.

A reconstruction plan with these short, medium and long-term goals, supported by the people of Hokkaido, could transform the crisis engendered by the Great East Japan Earthquake into the cornerstone of a peaceful life in the 21st century, for our descendants in Hokkaido, Japan and the world.

Reference

- 1) Ken-ichi Miyamoto, *Environmental Economics*, 1989, 2007, Iwanami shoten.
- 2) Nomi Kline, *The shock Doctrine, The Rise of Disaster Capitalism*, 2007, Metropolitan Books.
- 3) The Japan Federation of Bar Associations, The proposal of the flame-work of compensation for the Fukushima Accidents by TEPCO, 17th of June 2011.
- 4) The interim report of the Investigation Committee on the Accident at the Fukushima Nuclear Power Station, published on December 26, 2011.
- 5) Toru Hasuike, *Watashigaaishita Tokyo Denryoku (I loved TEPCO)*, 2011, Kamogawa Shuppan, p.64.
- 6) The interim report, op.cit., p.396.
- 7) The interim report, op.cit., p.405.
- 8) The interim report, op.cit., p.396.
- 9) Jonathan Schell, From Hiroshima to Fukushima, *New York Times*, March 16, 2011.
- 10) "Cost of direct disposal uncovered," *Mainichi Shimbun*, 1st of January 2012.
- 11) The Japan Federation of Bar Associations, 2011, p.4.
- 12) Norio Hirai, *Jyokyo*, Vol.11.No12, 2011, p.31.
- 13) "Human dignity in tragedy", Daiki Shoki, *Nippon Keizai Shimbun*, 15th of April, 2011.
- 14) Fumikazu Yoshida, *Lecture on Environmental Economics*, 2012, Hokkaido University Press, Chapter 4.
- 15) JNES, An analysis of 2PSA(BWR) at the time of earthquake, JNES/NSAG10-003, October 2010.
- 16) NHK, *Series Nuclear Crisis, Safety Myth*, 27th of November 2011.
- 17) *The interim report*, op.cit., p.429.
- 18) Yoshihiro Nishida, The Agenda of Japanese Nuclear Power, *International Conference*, 22th of December 2011.
- 19) Fumikazu Yoshida, 2010, op.cit., p.93.
- 20) Kiyoshi Suzuki et al., *Calculation of damage caused by pollution*, 1977, Shin-Nippon Houki Shuppan, p.35.
- 21) Nobuo Kojima, 2011, Disaster by the accident of Fukushima Daiichi Nuclear Power station and its legal problem, *Houritsu Jiho*, 2011, Vol.83, No. 9/10, pp.55-65.
- 22) The Japan Federation of Bar Association,
(<http://www.nichibenren.or.jp/activity/document/statement>)
- 23) The Japanese Institute of Energy Economics, An analysis of electricity demand by 2012 considering restart of nuclear power station, 24th of June 2011.
- 24) Takeshi Murota, *Economics of Nuclear Power*, Nippon Hyoronsha, 1988.
- 25) Ken-ichi Ohshima, 2010, *Political Economy of Renewable Energy*, Toyo Keizai Shinposha.
- 26) Shuji Shimizu, *Why can we depend on nuclear power for the future?*, 2011, Jichitai Kenkyusho.
- 27) Hitoshi Yoshioka, 2011, "Policy meaning of Nuclear disaster of Fukushima, *Gendai Shiso*, May 2011, p.86.
- 28) Cost Verification Committee, *Report*, 19th December 2011.
(<https://www.npu.go.jp/policy/policy09/pdf/20111221/hokoku.pdf>)
- 29) Nobuo Gohara, "The selling of the transmission sector to the state in order to acquire funds for compensation," *Asahi Judiciary*, 2011.4.30.
- 30) The Japan Federation of Bar Association, 2011, "The proposal of the flame-work of compensation for the accident of Fukushima Daiichi", 17th June 2011.
- 31) Taro Kono (<http://www.taro.org/gomame/>) 4th of May 2011.
- 32) Hoshi-Kashyap-Schade, "The Corporate Rehabilitation Law for TEPCO problems", *Weekly Diamond Magazine*, Special Report, No.121, 23th of April 2011.
- 33) Taro Kono, "Ghost draft for the Energy Agency," 5th of May, 2011. (<http://www.taro.org/go->

- name/)"
- 34) *TEPCO Management and Finance Investigation Committee Report*, 3rd October 2011.
(<http://www.cas.go.jp/jp/seisaku/keieizaimutyousa/dai10/siryoushiki2.pdf>)
 - 35) Op.cit.,p.85.
 - 36) The Japan Federation of Bar Association,2011, The official statement of the President on the report of TEPCO Management and Finance Investigation Committee, 14th October 2011.
 - 37) *TEPCO Management and Finance Investigation Committee Report*, p.97.
 - 38) Op.cit.,p.105.
 - 39) "Price hike and restart is the condition of loan", *Nippon Keizai Newspaper*, 10th January 2012.
 - 40) Nuclear Safety Committee, Briefing 12th December 2011.
(<http://www.nsc.go.jp/info/20111212.pdf>)
 - 41) Hokkaido Electricity Power Company
(http://www.hepco.co.jp/ato_env_ene/atomic/fukushima/moreover.html)
 - 42) *Hokkaido Newspaper*, 7th August 2011.
 - 43) *Deutschlands Energiewende — Ein Gemeinschaftswerk für die Zukunft vorgelegt von der Ethik-Kommission Sichere Energieversorgung Berlin*, den 30. Mai 2011.
 - 44) Japan Center for Economic Research, *Bulletin*, January 2012.