

Development of Environmental Technologies in Japan and International Cooperation for Dissemination

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Diversity of environmental problems and Japan's experience

The environmental problems which the world faces today are many and diverse. During the high-growth period of its economy in the 1960s and 1970s, Japan experienced the same serious environmental pollution by industrial emissions and urban environmental problems that are now causing problems in developing countries. Typical examples are air pollution with sulfur dioxide in districts that have petrochemical complexes and water contamination with various pollutants, and motor vehicle exhaust fumes in large cities.

In the process of its generation, such serious environmental pollution took a heavy tolls of lives and in addition afflicted many people with diseases.

As a result, public demands for strong and comprehensive measures to protect the environment rapidly became louder, and industry, too, came to recognize the need for environment protection, since it had to have public support in order to construct factories and power plants and expand existing ones. At the government's urging, the so-called "Anti-Pollution Diet" (special Diet for anti-pollution measures) convoked in the autumn of 1970 enacted or revised 14 laws to combat air and water contamination, curb industrial emissions and extend relief to pollution victims. As a result, the most advanced legislation for environmental protection in the world took shape, and administrative systems to combat pollution were set up.

Solutions to environmental problems and technological measures

The high growth of the Japanese

economy began in the 1960s, and when the public demanded action against the pollution which was a by-product of growth, there were strong fears that measures to prevent pollution which were too rash would hamper the operations of companies and retard economic growth. However, as a result of concerted efforts by the government and industry, Japan kept its economy growing at the highest rate among industrialized countries during the 25 years until the 1990s, and at the same time was acknowledged as the only developed country that had curbed pollution significantly. This was pointed out in a report on Japan by the OECD. Thus, Japan was successful in combating pollution while at the same time ensuring continued economic growth. How was this possible? Firstly, anti-pollution investment contributed to the expansion of demand. Secondly, Japanese industry developed technologies to meet various laws and regulations for environmental protection.

In the environmental protection area, where Japan was praised by the OECD, technologies to prevent pollution have reached a high level. Japan now faces the task of transferring such technologies to a great many developing countries that are endeavoring to protect their own environments.

However, among the global environmental problems that all industrialized countries including Japan are faced with, there are some areas which call for new technologies to be developed. The greatest problem is how to combat the global warming mainly caused by carbon dioxide (CO₂).

To prevent global warming, utmost endeavors should be made to save energy and also switch to new energy

sources that do not emit CO₂, and at the same time, technologies to separate CO₂ at the source and use them to mankind's advantage should be developed. Moreover, massive afforestation should be carried out to arrest and fix CO₂ emitted into the atmosphere by utilizing the photosynthesis of plants and microorganisms. Research into such innovative environmental technologies is yet in basic incipient stages, so international cooperation should be arranged to muster the wisdom of mankind and develop it through international cooperation and under long-term planning.

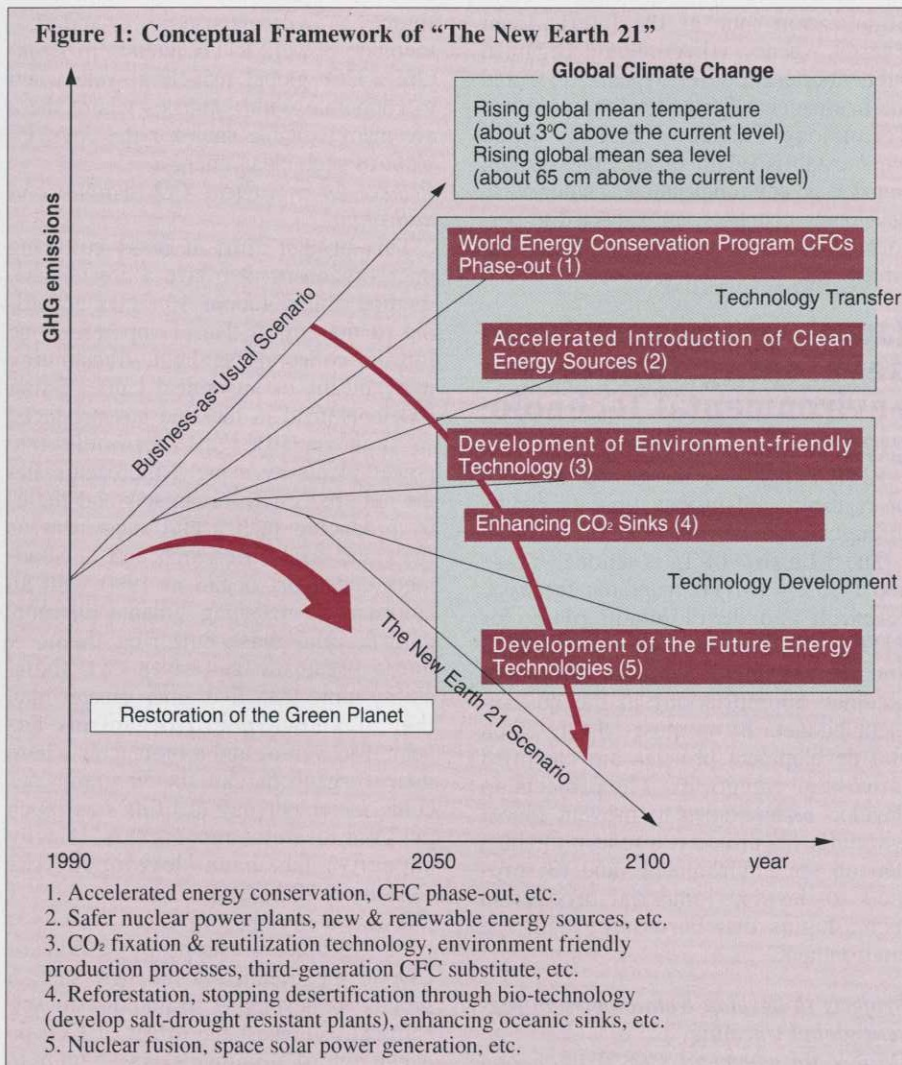
International cooperation under long-term planning

"The New Earth 21" (Action Program for the Twenty-First Century) through the development and transfer of technologies: five approaches (to be explained later)

(a) In June 1990, Japan proposed "The New Earth 21" (Action Program for the Twenty-First Century) to the world. This plan calls for cooperation by all countries to regenerate, in the coming 100 years, the global environment which has been damaged by imposition of various burdens during the 200 years since the Industrial Revolution. The plan is based on the recognition that a technological breakthrough and the transfer and dissemination of superior technologies throughout the world are indispensable to sustainable economic growth, in which the preservation of the global environment and economic progress are in perfect harmony.

(b) As shown in the accompanying figure, "The New Earth 21" will be car-

Figure 1: Conceptual Framework of "The New Earth 21"



ried out by means of the following five concurrent approaches:

*Energy-saving endeavors throughout the world;

*Extensive introduction of clean energy sources;

*Development of innovative technologies for environmental protection;

*Increase in the variety of CO₂ absorbents;

*Development of innovative energy-related technologies.

Of the above, the first and second have their emphasis on the transfer to other countries, particularly developing ones, of technologies developed by industrialized countries including Japan, although new

technologies to improve energy efficiency, too, have to be developed at the same time. The third to fifth call for the development of new technologies. When it proposed "The New Earth 21", Japan set up the Research Institute of Innovative Technology for the Earth (RITE), an organization intended to undertake the development of technologies referred to in the third and fourth above, and having an open stance as regards conducting research in cooperation with other countries.

Active participation in the Climate Technology Initiative (CTI)

The signatory countries to the Treaty

on the Framework Convention on Climate Change held their first meeting in Berlin in March 1995. At this meeting, called COP1, they passed the Climate Technology Initiative (CTI or the Berlin Mandate), which set the goal for reducing CO₂ emissions from 2000 and beyond and calls for the implementation of technological measures for the attainment of this goal through international cooperation.

CTI calls for the propagation throughout the world of existing energy-saving technologies and clean energy technologies, which contribute to the prevention of global warming, and the development of innovative technologies such as technologies to develop through international cooperation clean energy, like hydrogen energy, by use of microorganisms and technology to separate and seal up CO₂. Seven task forces have been set up in the International Energy Agency (IEA), and each has named a leader country to undertake CTI projects. CTI is essentially the same as "The New Earth 21" proposed by Japan, which is actively cooperating and participating in this project.

The Green Initiative

At the Special Session of the General Assembly to Review and Appraise the Implementation of Agenda 21 (Earth Summit+5 held in June, Japanese Prime Minister Hashimoto Ryutaro proposed an overall strategy to prevent global warming called "the Green Initiative." In line with the Green Initiative strategy, Japan will propose the development and propagation of "green technology" which will contribute to solving the problem of climate change and the transfer of green technology to developing countries under "the Green Aid Program."

Substance of Green Technology

The "Green Technology" plan calls for the following:

i. Development and propagation of energy-saving technologies.

ii. Accelerated introduction of non-fossil energy sources

Increasing the cost-efficiency of solar energy, introduction of low-pollution automobiles, development of technolo-

gies for utilizing bio-energy, and promoting the development and use of atomic energy on condition of ensuring its safety.

iii. Global afforestation and forest preservation.

Plants that excel in resistance to harsh environmental conditions such as the conditions of a desert should be developed, measures to prevent desertification should be taken, and afforestation and forest preservation projects should be carried out throughout the world as joint endeavors by the public and private sectors.

iv. Development of innovative environmental and energy technologies

Technologies to seal up CO₂ in seawater or in the ground should be developed, and projects for biological CO₂ fixation and utilization and chemical CO₂ fixation and utilization should be carried out.

Substance of Green Aid

The Green Aid Program is a program to propagate in developing countries green technologies that are already available and green technologies that will soon become available. In developing countries, the amount of CO₂ emissions is expected to increase hereafter. The following steps should be taken to implement the Green Aid Program:

i. ODA and private sector cooperation

Official development assistance and private sector cooperation should be extended to the areas of environment and energy, and green technologies should be widely introduced in developing countries in order to ensure that fund shortages do not hamper them in taking measures to prevent global warming.

ii. Human resources and informative infrastructure

Human resources and informative infrastructure should be completed to ensure rapid propagation of green technologies through the education of people and the dissemination of information.

Organization to undertake the Green Initiative

The prime minister proposed that the Green Initiative should be carried out through bilateral and multinational cooperation and that an international

organization such as the International Energy Agency (IEA) should organize such cooperation. In Japan, RITE and the International Center for Environmental Technology Transfer (ICETT), which were established to ensure the smooth transfer of environmental technologies to developing countries, are expected to perform the leading role in implementing Green Aid.

Japan's progress so far in developing innovative environmental technologies (RITE's activities)

RITE is fostering the growth of seeds of research and propagating its results throughout the world.

The Ministry of International Trade and Industry (MITI) maps out the basic research and development plans for RITE, which it undertakes in research and development projects that have obtained appropriations in the government budget. By purpose, the research and development projects are classified into three categories: (1) projects to develop technologies to prevent global warming, (2) projects to reduce the burden on the environment, and (3) projects to develop industrial production technologies that harmonize with the environment.

Projects to develop technologies to prevent global warming

Project for chemical CO₂ fixation and utilization

CO₂ contained in large amounts in the flue gas from such facilities as thermoelectric power plants is separated by means of a high-polymer membrane, hydrogen produced by electrolysis of water is added to it, the CO₂ and hydrogen are made to react with each other by means of a high-performance catalyst, such as a copper, lead or zinc catalyst, and methanol is synthesized. Research for chemical CO₂ fixation and utilization began in 1990. At present, there is a facility capable of producing 50 kilograms of methanol a day. For this project to be employed on a practical basis, hydrogen must be produced by using such non-polluting energy

sources as hydroelectric power and photovoltaic power. RITE intends to structure a CO₂ global recycling system and to cooperate with countries where there are many suitable sites for the development of such clean energy.

Project for biological CO₂ fixation and utilization

This project aims at mass-culturing microorganisms that have a greater CO₂ fixation ability (about 10 times according to the target) than Temperate Zone forests, collecting sunlight, transmitting it by means of an optical cable, fixing CO₂ contained in the flue gas produced in such facilities as thermoelectric power plants by using a bioreactor and the cultured micro-organisms and thereby producing such useful substances as fuels and feeds. Research and development endeavors began in 1990 with an emphasis on detecting suitable microorganisms and mass-culturing them. A micro-organism that has a CO₂ fixing ability more than five times greater than that of known micro-organisms has been discovered, and a bioreactor where micro-organisms can fix 50 grams per cubic meter per day (10 times as much as Temperate Zone forests' fixing capacity) has been developed (the capacity is 200 liters).

CO₂ ocean storage project

This project presupposes storage of CO₂ in the ocean. As the first step, a project to develop a technology to scientifically forecast the effect of CO₂ on ocean micro-organisms was begun in the current fiscal year. Japan, the United States and Norway are engaged in joint research for this project under the CTI scheme sponsored by the IEA.

Project for CO₂ fixation in a desert using biological function

From the viewpoint of fixing dilute CO₂ in the atmosphere, there are growing expectations regarding the afforestation of deserts, which are at present vast, unused land spaces. The project for CO₂ fixation in a desert using a biological method is aimed at creating a new variety of plants that can grow with less water than normal plants (water-saving plants) by means of the latest biotechnological processes, such as gene transfection. Research for this pro-

ject began in 1993. Basic research has already been conducted, and the researchers have succeeded in finding an enzyme that has a high photo-synthetic ability and in increasing the ability to eliminate active oxygen generated in plants under strong sunlight.

Development of technologies to reduce substances that are burdens on the environment

Project to develop new refrigerants

This project is aimed at developing refrigerants and blowing agents that do not destroy the ozone layer and have little global warming effect. As a result of research conducted so far, three ethereal compounds that meet the above conditions have been discovered out of more than 500 candidate substances.

Project to develop biodegradable plastics

This project has three objectives: producing plastics by using micro-organisms, producing biodegradable plastics from natural polysaccharides such as starches including cornstarch, and designing a biodegradable plastic by chemical synthesis. Researchers are pursuing these three objectives from a comprehensive viewpoint.

Development of environmentally friendly production technologies

From a long-range viewpoint, an effective way for industry to protect the environment is to convert production processes to ones that do not discharge substances that become burdens on the environment or to processes that require much less energy and material inputs than conventional ones. Technologies for achieving these objectives are still at an early stage, and time-consuming assiduous basic research has to be conducted from a long-term viewpoint. There are, at present, projects underway which aim to attain the following objectives:

Project for biological production of hydrogen by environmentally acceptable technologies

This project is aimed at selecting from photosynthetic bacteria a micro-organism that has a high hydrogen-producing ability and enhancing its

hydrogen-producing ability by genetic engineering, enabling such a microorganism to dispose of household garbage, sewage and sludge, and use them as a nutrient for photosynthetic bacteria.

Project to develop high-performance bioreactor for the production of biochemicals

This project is aimed at developing production technologies that do not impose a heavy burden on the environment by reinforcing the biological functions of microorganisms and using enzyme reaction at room air temperature and pressure.

Project to develop environmentally friendly catalysts

This project, as a first step, is aimed at developing a photo-catalyst which can decompose water into hydrogen and oxygen by means of sunlight and developing a selective catalyst which can be used to produce methanol from methane at room air temperature and pressure.

Detection and growth of seeds for research

RITE intends to encourage basic research for the development of global environment preservation technologies, which has only just begun, throughout the world. It expects that researchers in diverse fields of science will take part in global environment preservation endeavors. Beginning in 1991, RITE has been inviting proposals concerning research from scientists throughout the world every year, selecting 10-odd superior plans out of about 200 proposals received annually, and furnishing about ¥10 million per plan as a subsidy every two years. To date, it has selected 81 proposals judged as worthy. (For your reference: RITE's Internet home page address is <http://www.rite.or.jp/>)

Present degree of cooperation by Japan in environmental technologies

Record of ODA in the environmental arena

In the Official Development Assistance Outline laid down by the Cabinet in June 1994, Japan mentioned "the preservation

of the environment" as the basic ideal for ODA and said that "the compatibility between development and environment" is one of the principles in assisting developing countries. During the UN Conference on Environment and Development (UNCED) held in June 1992, Japan declared that it would extend ODA totaling somewhere between ¥900 billion and ¥1 trillion during the five years from fiscal 1992.

ODA extended by Japan in the four years from fiscal 1992 to fiscal 1995 totaled about ¥980 billion. Thus, Japan attained the target declared at UNCED one year in advance. Areas covered include living environment improvement, disaster prevention, forest preservation, pollution prevention (prevention of atmospheric and water contamination), energy saving, and nature conservation. (See the table.) There are problems, however, in yen loans, which represent the greater part of ODA by Japan for the environment: requests by developing countries are rare. Moreover, such requests center on projects to complete waterworks and sewer systems, and requests relating to facilities for preventing industrial pollution, such as desulfurizing equipment, are extremely rare.

Record of Green Aid plan

For the purpose of awakening the governments and industry of developing countries to the magnitude of environmental problems and inducing them to take environmental protection measures, MITI has been implementing the Green Aid plan since fiscal 1992. The aim of the Green Aid plan is the transfer and dissemination of Japan's energy and environmental technologies in developing countries. Its outline is shown in the accompanying figure. Principal projects undertaken under the plan are as follows:

*Acceptance of trainees and sending of experts to help developing countries foster the growth of energy and environment experts.

*Implementation of energy-saving model projects, research into CO₂ fixation and utilization for electric power generation, international joint research

Table 1: Bilateral ODA extended by Japan for environment protection classified by purpose

Unit: ¥1 billion

Fiscal year	Living environment	Forest preservation	Pollution control	Disaster prevention	Others	Total
1992	163.3 (58.2)	18.0 (6.4)	30.2 (10.8)	54.6 (19.5)	3.7 (1.3)	269.8
1993	137.4 (50.3)	16.9 (7.4)	39.1 (17.2)	13.6 (6.0)	4.8 (2.0)	211.8
1994	112.8 (66.9)	8.7 (5.2)	36.2 (21.5)	5.8 (3.4)	5.2 (3.1)	168.7
1995	129.6 (54.9)	25.2 (10.7)	18.3 (7.7)	45.3 (19.2)	17.6 (7.5)	236.0

Note 1. The figures are the sums of loans, outright grants and technological cooperation but do not include aid extended by international bodies.

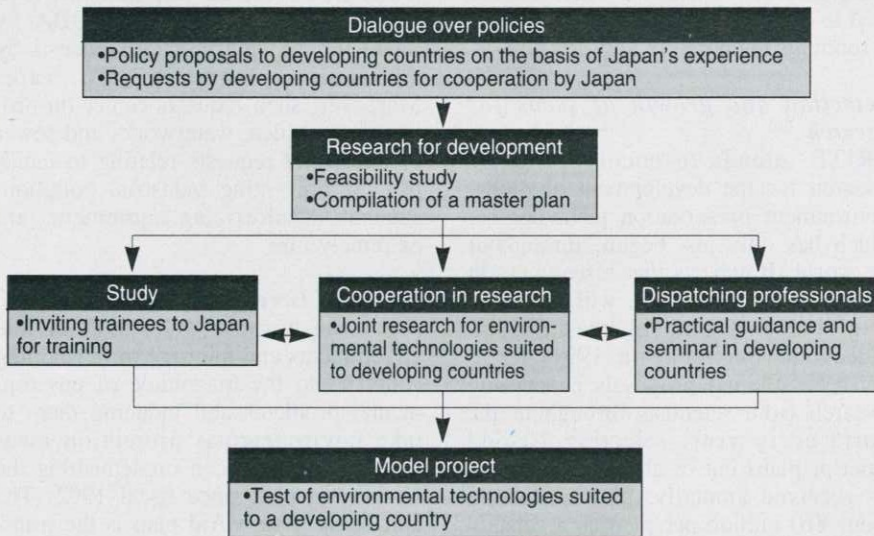
Note 2. The figures in parentheses are the percentage of the relevant item to the total ODA for environment protection.

Note 3. The living environment includes waterworks and sewer systems and waste disposal.

"Others" include nature, environmental administration and the prevention of ocean contamination.

Source. "Official Development Assistance by Japan, 1996," a report by the Ministry of Foreign Affairs.

Figure 2: Outline of the Green Aid Plan



Source: "Environmental Problems in Developing Countries and Cooperation by Japan" by MITI

for photovoltaic power generation, all as research projects to prove the technologies concerned.

A test of blast furnace material (scrap steel) preheating equipment and a model project conducted in Indonesia from fiscal 1992 to fiscal 1995 are among the energy-saving model projects.

The APEC Virtual Center Project for Environmental Technology Exchange

In commemoration of the APEC summit in Osaka in November 1995, Japan launched the APEC Environmental Technology Exchange Promotion Project and its management body. Under this project, the APEC Virtual Center for Environmental

Technology Exchange (APEC-VC) was set up to transfer to the developing countries in the Asia-Pacific region the data and information concerning policies, technologies and environment measurements accumulated by Japan in the course of its endeavors to improve the environment in slightly more than a quarter century. The APEC-VC formally began operation in April 1997. (APEC-VC's home page address is <http://www.apec-vc.or.jp/>)

Conclusion

Cooperation among all countries is indispensable to settling environmental problems such as global warming. Fortunately, Japan is in a position to help developing countries overcome their environmental problems, because this country overcame the environmental pollution caused by industrial emissions and urban environment problems through painful joint endeavors by the government and industry, with great sacrifices made. Japan wishes to convey its experiences in both successes and failures to developing countries and is hoping that they will use the technologies and know-how that Japan has acquired in the process of combating pollution. Japan has also prepared steps to transfer and propagate such technologies.

To combat new environmental problems facing the world, which are more difficult to solve than global warming, Japan has proposed "The New Earth 21" and Green Initiative, has set up RITE as an organization to undertake the development of innovative technologies for environment protection, and is spearheading a drive to develop CO₂-reducing technologies.

Thus, Japan is endeavoring to actively perform its international role in solving diverse environmental problems. It is strongly hoped that other countries will understand Japan's endeavors and cooperate with Japan in this respect.

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