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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

INTERNATIONAL DIVISION

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The Honorable Charles A. Vanik
Chairman, Subcommittee on Trade
Committee on Ways and Means
House of Representatives

Dear Mr. Chairman:

Subject: U.S.-Japan Cooperative Efforts in Energy Research and Development (ID-80-36)

DLG03958

This is in response to your letter of February 1, 1980, requesting information on the nature and status of U.S.-Japan cooperative efforts in energy research and development. The information obtained on this subject is based primarily on our discussions with officials of the Departments of State and Energy (the main U.S. agencies involved in the cooperative effort) and with Japanese Embassy personnel in Washington, D.C., and on a review of associated documents. We also talked with the National Science Foundation, which is participating in one of the projects.

The United States and Japan initially signed a 5-year agreement in 1974 to cooperate in energy-related research and development, but no specific projects were negotiated under that agreement. Then in May 1978, the then Japanese Prime Minister 1/ outlined the so-called "Fukuda Initiative," which again expressed a strong desire on the part of Japan to cooperate with the United States on energy-related matters. On May 2, 1979, such an agreement was signed. (See encl. 2.)

In a speech at the conclusion of a visit with President Carter in May 1978, Prime Minister Fukuda stated that:

> " * * * The development of new alternative sources of energy invites expanded Japanese-American cooperation. Since world oil reserves are expected to come close to depletion at the

1/Takeo Fukuda was Prime Minister of Japan from Dec. 1976 to Nov. 1978.

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> end of this century, both our countries should strengthen our cooperative efforts for energy conservation and the development of new energy sources * * *."

Although no amount was specified, Fukuda did propose a joint research fund, stating that:

> "Colossal investments in human and material resources are needed for research and development in all these areas. With a view to making more efficient use of limited resources available, and to make Japan-U.S. cooperation more meaningful, I wish to propose that Japan and the United States seriously study the establishment of a joint fund for the advancement of science and technology, to serve as a framework for international cooperation in these areas."

The May 1979 agreement is an umbrella agreement for cooperation in several areas and is to run for 10 years. The areas of initial emphasis are to be nuclear fusion and coal conversion; additional areas include solar energy conversion by means of photosynthesis and geothermal energy, high energy physics, and such other areas in energy and energy-related research and development as may be mutually agreed upon. The agreement contains no dollar amounts, stating only that cooperation "will be undertaken on the basis of equitable sharing of costs and benefits."

To date, the projects either agreed upon or being negotiated are:

1. Nuclear fusion (Doublet III Project)
2. Coal liquefaction (Solvent Refined Coal Project SRC II)
3. Solar energy (basic research in photosynthesis)
4. Geothermal energy (Fenton Hill Hot Dry Rock Project)
5. High Energy Physics (basic laboratory research)
6. Magnetohydrodynamics (energy conservation through more efficient power generation).

The Doublet III and High Energy Physics agreements have been signed. The other four are in various stages of negotiation and some further agreements are expected to be signed this spring. The Doublet III Agreement is included as enclosure 3 as an example of a signed project agreement.

The six projects involve various funding arrangements and two also involve the Federal Republic of Germany. Though there will be an exchange of scientists between the two countries, all of the projects will be carried out in the United States. The two largest projects are for nuclear fusion and coal liquefaction. Japan has committed $70 million for the joint nuclear fusion project which will cost about $140 million over 5 years; it is negotiating for a 25-percent share of the $1.51-billion coal liquefaction project, which would amount to about $362 million over 8 years. The geothermal, solar, and high energy physics projects are much smaller in scale and Japan's participation in each is anticipated to range from $2 million to about $6 million annually. The magnetohydrodynamics project is only in the preliminary stages of discussion. U.S. officials believe that Japanese financial participation in these and other cooperative projects over the 10 years of the umbrella agreement may possibly approach $1 billion.

Enclosure 1 describes the progress made under the cooperative agreement and the six project areas currently covered by it, as seen by cognizant U.S. and Japanese officials. It also briefly discusses Japan's unilateral energy research and development program, including its energy conservation efforts; Japan's participation in the International Energy Agency research program; and the U.S. initiative to Japan for non-energy-related research and development cooperation.

We have not followed our usual procedure of obtaining agency comments on this report due to the short response time for gathering the information, a matter discussed with your staff. As arranged with your office, we plan to distribute the report to any other interested parties.

Sincerely yours,

J. K. Fasick
Director

Enclosures - 5

U.S.-JAPAN COOPERATIVE EFFORTS IN ENERGY RESEARCH AND DEVELOPMENT

UMBRELLA AGREEMENT - A FRAMEWORK FOR COOPERATION

Positive assessment by both sides

Both United States and Japanese officials believe that the progress that has been made in cooperative energy research and development (R&D), since the May 1979 umbrella agreement was signed, has been a very positive aspect of U.S.-Japan relations in an area of great importance to both nations. The umbrella agreement was negotiated and signed in a very short time (one year), as such things go, and specific project agreements are also generally progressing satisfactorily.

The size and degree of cooperation concerning project agreements are setting a precedent. Officials emphasized the importance of the actual transfer of substantial funds from one country to another for research and development, believing it may have important implications for what is possible in future international cooperation. Such cooperation, they said, is all the more important because the resources necessary to carry out successful research and development, especially in such areas as nuclear fusion, are very substantial. An official also pointed out that private industry would not be willing or able to assume the financial cost and the risks involved. Thus, increasingly, only the wealthiest countries will be able to afford such research efforts.

Impact of the agreement

Both United States and Japanese officials told us that the umbrella agreement has had a positive effect on cooperation in energy research and development, although some of the cooperative projects would have been carried out even without the agreement.

The Japanese were extremely interested in U.S. research in nuclear fusion and an agreement would likely have been reached without the umbrella agreement. However, the level of Japanese funding would probably have been less. Furthermore, coal conversion was included, at U.S. insistence, as a priority area of cooperation in the umbrella agreement in return for allowing Japan's participation in the nuclear fusion project. Thus, the two largest projects represent a tradeoff between the United States and Japan.

An official familiar with the High Energy Physics agreement said the agreement formalized an exchange that was already going on and also increased Japan's financial contribution. This is also true for the solar energy project; officials believe that the funds allotted for each exchange scientist in this project might not have been proposed without the umbrella agreement. There are indications that the agreements already signed are encouraging discussions on cooperation in other areas, such as magnetohydrodynamics.

The general benefits of the agreement cited by the U.S. officials we spoke with included

--sharing expertise and ideas,

--pooling financial resources,

--more efficient and timely experiments,

--less duplication, and

--a more rapid dispersion of technology.

All of the jointly funded projects identified under the agreement will be carried out in the United States, and most of the funding allocated for exchange of scientists will be spent in the United States. Japan will generally contribute financial support and technical experts. In return, the United States is sharing its facilities and technology.

A U.S. official summarized the impact of the umbrella agreement by saying it has provided a "framework" for cooperation in energy research and development.

Patent rights the most troublesome aspect

Even though progress under the umbrella agreement has been good, some problems have come up. The one mentioned most often was the sharing of patent rights to inventions resulting from the cooperative efforts. U.S. officials said that the problem centers around Japan's legal restrictions when government funds are involved, because the Government of Japan cannot legally grant royalty-free licenses. A Japanese official said Japan expects to set up a semi-private corporation by October 1980 which will help ease patent and licensing difficulties.

The patent problem was termed the most troublesome in negotiations on the coal conversion project because the process is so close to commercial viability. In this project, which

also involves Germany, a private company is to be included in the negotiations by each party. The United States and Germany each have single private companies participating in the project. Japan has been having difficulty in coming up with an appropriate private partner that can satisfy all interested private Japanese sectors. A Japanese official indicated that the solution will probably involve having a group of companies participate, and officials on both sides believe the agreement can be concluded by the end of April 1980.

The U.S. Department of Energy (DOE) has been primarily responsible for negotiating the project agreements with Japan. In Japan, however, various agencies have been responsible for different projects. For example, Japan's Ministry of International Trade and Industry (MITI) and Ministry of Foreign Affairs have been involved in the coal liquefaction discussions. U.S. officials noted that the the involvement of more than one agency has at times slowed the negotiations. U.S. officials said a delay has also occurred in the solar project --the only one in which more than one U.S. agency is involved.

PROJECTS UNDER THE UMBRELLA AGREEMENT

Doublet III fusion project

For almost 30 years, the U.S. Federal Government has been sponsoring nuclear fusion research for the purpose of developing a virtually inexhaustible source of energy. The Japanese have also focused on fusion as one of the primary energy sources for the 21st century, and this, along with solar energy, was singled out by Prime Minister Fukuda in his May 1978 speech as a particularly useful area for joint R&D.

Nuclear fusion involves the joining of two light atoms and takes place only at extreme temperatures. When fusion occurs, there is a concurrent release of energy, and it is this energy in the form of heat that can be used in fusion reactors to produce steam to generate electricity or to provide power for process heat applications. The process for achieving fusion magnetically confines a gas of charged particles, called a plasma, and then heats it to more than 100 million degrees. The high temperature enables the particles to overcome their natural repulsion and causes them to fuse. Through nuclear fusion R&D, scientists hope to produce a controlled fusion reaction on a scale large enough to provide economical power in commercial quantities.

The U.S.-Japan cooperative agreement establishing a joint fusion research program was the first to be completed under the May 2, 1979, umbrella agreement. It is also the first cooperative effort to involve a transfer of funds from Japan to the United States. The Agreement for Cooperation on the Doublet III Project was signed on August 28, 1979, by the U.S. Department of Energy and Japan's Atomic Energy Research Institute (JAERI), a quasi-governmental agency.

Doublet III, the largest fusion device of its kind in the world, has been operated for DOE by the General Atomic Company since late 1978. After the Doublet III agreement was signed, a DOE/JAERI steering committee was established to oversee the management of the joint project. The committee had its first meeting in November 1979 and plans a second meeting for May 1980.

Under this agreement, the Japanese Government is to spend approximately $70 million over a 5-year period to upgrade the project. The Japanese Government funded $12 million for Doublet III in fiscal year 1979, and DOE provided $10 million. Total cost of the project is estimated at $140 million. This funding will be used to design, procure, install, and operate new equipment as well as to finance joint research projects using the upgraded tokamak 1/ facility. A team of seven JAERI scientists was sent to the General Atomic Company in LaJolla, California, to work on the project in August 1979 after the agreement was signed. JAERI is responsible for the team's salary, travel, and living expenses, which are not included in the $70 million.

U.S.-Japan discussions on the Doublet III project began in the fall of 1978, well before the May 1979 umbrella agreement was signed. The Doublet III Agreement took almost a year to negotiate, but DOE officials indicated that no serious problems arose during the negotiations. According to a DOE official, one potential problem, that of patent rights, was avoided because DOE negotiated with JAERI, which, unlike Japanese Government agencies, is able to grant irrevocable royalty-free licenses, as is DOE. In a cooperative project such as Doublet III, the United States receives patent rights on inventions arising from joint research as well as third-country patent rights. Japan is given a royalty-free license, which is comparable to a patent.

1/A tokamak is a hollow, doughnut-shaped device which confines the plasma with a spiraling magnetic field and an internal magnetic field.

DOE officials maintain that both the United States and Japan benefit by cooperating on the Doublet III project. The Japanese will be providing substantial funding to help cover the cost of the U.S.-based project, but, by cooperating on research experiments at the facility, Japan will be able to bypass a step in its own tokamak fusion program. The Japanese have built two small tokamaks, but have none the size of the Doublet III. In addition, both countries will benefit from the exchange of scientific information, as this will enable them to move more rapidly and will cut down on duplication.

Both countries have begun working on the next generation of tokamaks--the U.S. Tokamak Fusion Test Reactor, being built at Princeton, New Jersey, and its Japanese counterpart, referred to as the JT 60. Neither government has expressed an interest in cooperating on these projects. One DOE official noted that these tokamak facilities were already planned as independent projects before the United States and Japan began their discussions on nuclear fusion.

In August 1979, the two governments established a Coordinating Committee on Fusion Energy (known as the Fusion Committee) to plan and manage personnel exchange programs, Joint Institute of Fusion Studies, and joint planning efforts in addition to the Doublet III project. This committee has already developed a program of personnel exchanges through March 31, 1980, and is now working on a detailed personnel exchange agreement for the year beginning April 1980. In addition, DOE would like to cooperate with Japan in fusion materials research and is in the process of determining which U.S. projects might interest the Japanese.

SRC II coal liquefaction project

At the time of the Fukuda Initiative in May 1978, the Japanese were primarily interested in cooperating with the United States on such long-range projects as fusion and solar energy. DOE officials, however, felt strongly that the two countries should also cooperate on coal conversion projects, some of which could be ready for commercialization by 1987. The United States had been discussing one such joint effort with the Federal Republic of Germany since early 1978. Both the U.S. Government and private industry are now keenly interested in the early commercialization of synthetic coal liquids to fulfill U.S. needs for liquid fuels. Other sources, such as fusion, solar, and geothermal energy have great potential, but their impact before the end of the century is uncertain.

During the negotiation of the umbrella agreement, Japan agreed to look more broadly at energy cooperation. U.S. officials indicated that Japan could participate in the U.S. fusion program if it also cooperated in coal conversion projects. Japan agreed, and the umbrella agreement gives equal priority to cooperative efforts in fusion and coal conversion.

A form of coal conversion, known as coal liquefaction, changes coal into a clean-burning liquid fuel by increasing its hydrogen to carbon ratio from 0.8 to 1.5. As the ratio increases, the resultant products range from a low-sulfur, ash-free solid material with a melting point of 300 to 400 degrees fahrenheit to liquids comparable to boiler fuels and gasoline. At present, there are seven coal liquefaction processes which are most likely to contribute to the U.S. energy supply in the near future.

After the umbrella agreement was signed in May 1979, the Japanese evaluated these coal liquefaction processes and determined that they would like to participate in the solvent refined coal project, referred to as SRC II, in Morgantown, West Virginia. This 8-year multiphase project involves the design, construction, and operation of a demonstration coal liquefaction plant. The preliminary plant design phase began after October 1978. The project is now in the final design phase, with construction to begin in March 1981.

The SRC II process is designed to produce clean, non-polluting liquid fuel from high sulfur bituminous coal. The Morgantown plant will be designed to process 6,000 tons of coal daily with a heating value approximately equivalent to 20,000 barrels of oil per day. Total cost of the project is estimated at $1.51 billion, which includes $1.36 billion for plant construction and $150 million for research and development.

Representatives from DOE and Japan's MITI and Ministry of Foreign Affairs have been working on an agreement in which Japan would finance 25 percent of the total cost of the project, and would send Japanese scientists to the United States to work on the project. The Japanese would also have representatives on the SRC II steering committee which, like the Doublet III steering committee will oversee the planning and management of the project. In November 1979, the Federal Republic of Germany agreed to participate in this project, including paying 25 percent of the total costs. The terms of the agreement now being negotiated with Japan are expected to be similar to the German agreement, and DOE officials hope it will be signed sometime in April 1980.

Negotiations with the Japanese have been complicated by a number of factors. The project will involve not only three governments but also three private companies, one from each of the participating countries. These firms must work out the details of this cooperative arrangement, once the government-to-government agreements have been signed. In addition, because the project could be ready for commercial use within 10 years, the Japanese are particularly concerned about patent rights. At present, the Gulf Oil Corporation, whose subsidiary, the Pittsburgh and Midway Coal Mining Company, is prime contractor on the project, owns all foreign patent rights. DOE is presently negotiating this matter as part of its cost-sharing arrangement with Gulf Oil.

Germany has already designated the private firm, Ruhrkohle, to work with Gulf, but Japan has had difficulty choosing a company to work with Gulf and Ruhrkohle, and this has also slowed the negotiations. Japan is now considering having a consortium of firms participate, primarily for political reasons; if a number of firms participate, the cooperative effort can legitimately be called a national project.

Negotiations have also been delayed because Japan's MITI and Ministry of Foreign Affairs are involved in the discussions. DOE did not have this problem with Germany, whose Federal Ministry for Research and Technology was that government's sole representative. DOE further noted that discussions with the Japanese have complicated matters with Germany because arrangements made with the Japanese must also be acceptable to the Germans.

DOE officials believe that all three countries stand to gain both financially and technically from this trilateral effort. One DOE official did note that coal liquefaction is of such national importance that the United States would have pursued the SRC II project without the cooperation of the two countries; however, the United States is interested in developing and spreading this technology as rapidly as possible in order to increase the world supply of oil. DOE officials feel this can be accomplished most effectively by including these two countries in the research and development stages. In return for financing 50 percent of the project, Japan and the Federal Republic of Germany will receive an equity in a technology that will hopefully have widespread application. Japan is expected to be given the same option as Germany--25 percent of the product from the operation of the SRC II plant and a 25 percent share of any net proceeds from the sale of the product or of the plant itself.

DOE hopes to participate in some Japanese coal conversion projects. The Japanese have already suggested U.S. participation in one project now underway in Japan, and DOE officials are considering it. The United States is not currently considering any other cooperative efforts in this area.

Solar energy project

The United States and Japan both recognize solar energy as one of the ultimate energy sources of the future and have been working on a cooperative agreement since September 1979. Unlike the Doublet III and SRC II projects which are experimental in nature, cooperation in the solar field will take the form of basic research in photosynthesis.

The term photosynthesis defines a broad range of research areas, both biological solar energy conversion and non-biological physical/chemical processes. The major overall objective of the cooperative effort is to improve the understanding of the potential practical use of photosynthesis in energy storage and conversion.

In the summer of 1979, the two governments agreed on the desired type of cooperation. It will involve a two-way exchange of scientists, with the scientists' home countries assuming responsibility for their personnel's salary, travel, and living expenses. In addition, each visiting scientist would be allotted $40,000 by his own country; this money would be given to the host institution and would help to support the research activities of the visiting scientist during his stay. A cooperative agreement which will include these exchange terms is expected to be signed sometime during 1980.

Once the agreement is signed, each government will decide how many of its scientists will participate in this exchange on a yearly basis for a period of 10 years. Officials at DOE indicated that Japan is expected to provide a few hundred thousand dollars for the project in fiscal year 1980 and may allocate a few million dollars for each subsequent year. This funding would be used only to finance the scientific allotments ($40,000 per scientist). Total funding could go as high as $20 million over the 10-year period of the agreement.

One U.S. official told us that the following problems have arisen during the negotiations.

--U.S. negotiators have been attempting to establish an exchange ratio of one U.S. scientist to Japan for every three Japanese scientists to the United

States. U.S. officials are not interested in a 1:1 ratio because the United States is more advanced than Japan in solar energy research.

--Coordination among government agencies has been time-consuming, especially for the United States. This is the only cooperative project under the umbrella agreement that involves two U.S. Government agencies--the National Science Foundation and DOE. The Japanese Government is also represented by two agencies--the Science and Technology Agency and the Ministry of Education, Science, and Culture.

--The National Science Foundation and DOE will be funding and managing this program jointly, but they have not yet worked out the details of this joint sponsorship. They are attempting to establish a joint program office for this purpose. The cooperative solar energy agreement cannot be signed until this office is set up.

--Japan is concerned about patent rights. Partly for this reason, representatives from the two governments have decided that a separate agreement covering patent rights and other legal issues will be drawn up for each scientist's visit. The host country is to own the patent rights in its own and third countries; the visiting country will have patent rights in its own country. U.S. negotiators had not foreseen patent rights as a problem as photosynthesis is a long way from being commercially feasible.

--Neither government has indicated which agency will sign the agreement, which could delay its signing.

Fenton Hill geothermal project

The heat in the earth's crust is an enormous potential source of non-polluting "clean" energy. More than 99 percent of this resource exists in the form of "hot dry rock;" the remaining 1 percent is in either geopressure or a "wet" form such as hot springs. Harnessing this abundant energy has been a research area in many countries for several years. U.S. hot dry rock activities are a major component of DOE's Geothermal Technology Development Program. Japan's primary emphasis has been on developing the wet sources of energy associated with their many hot springs.

In June 1978, after nearly 4 years of negotiations, the two countries signed an implementing arrangement for exchanging geothermal energy technology. Under this arrangement, each country gains the benefit of certain geothermal technological advances.

Since finalizing the implementing arrangement, representatives of the United States and Japan have been negotiating an agreement whereby Japan would join the U.S.-based Fenton Hill hot dry rock project in New Mexico, which began in 1972. On September 19, 1979, representatives of the Federal Republic of Germany signed an agreement for funding up to 25 percent of the Fenton Hill project for 4 years, with total payment not to exceed the equivalent of $10 million. Terms of the cooperative agreement with Japan are to be the same as those for Germany. U.S. officials indicated that the negotiations with the Japanese are almost complete, and that Japan is expected to obligate funding shortly after the beginning of its fiscal year in April 1980.

High Energy Physics project

High Energy Physics, one of the cooperative areas listed in the umbrella agreement, is the second project negotiated under this agreement. The United States and Japan signed the cooperative agreement in November 1979.

Scientist exchanges with many nations, including Japan, have been taking place for many years, but mostly on a university-to-university basis. The November agreement formalizes this exchange with Japan, whose scientists will be assigned to various U.S. facilities. During its 1980 fiscal year, Japan will be contributing about $5.7 million to the U.S. research program.

In negotiating this agreement, the United States insisted on a minimum $5 million annual contribution by Japan. The $5.7 million Japan will contribute the first year is small in comparison with DOE's budget of $326 million for fiscal year 1980 but represents a substantial increase over the fiscal year 1979 Japanese contribution of about three quarters of a million dollars. This contribution will not include the scientists' salaries, travel, and living expenses, which Japan must fund separately.

Magnetohydrodynamics project

The United States and Japan have been independently researching an energy-enhancing process known as magnetohydrodynamics (MHD) and are discussing possible cooperation under

the umbrella agreement. MHD is the basis for generating electric power by passing a hot gaseous conductor through a magnetic field instead of the solid conductor used in conventional generators. The process eliminates the conventional intermediate mechanical step and converts the energy of the moving conductor to electrical energy directly. Thus, the MHD generator combines the conventional "turbine" and "generator" in a single unit. Since there are no moving parts, the MHD generator can operate at temperatures which would destroy the materials of a conventional turbine. It is the higher combustion temperature that provides the potential capability to produce more power from the fuel which feeds the process. The MHD process is projected to be up to 50 percent more efficient regardless of the heat source.

U.S. scientists have been involved in developing practical MHD applications ever since Westinghouse engineers built an experimental generator in 1941. Interest in developing the technology was sporadic until the early 1970s, when the United States began to focus its program on developing coal burning systems for electric utilities. While such other fuels as oil and natural gas can be used in the MHD process, the United States believes that coal is the most viable long-term fuel for MHD, even though it creates waste disposal and corrosion problems.

The U.S. Government is now developing a commercially viable process. DOE estimates that about $273 million in Federal funds had already been spent by the end of 1979 and that development costs through the 1980s will total about $2 billion. DOE has requested $72 million for MHD-related research and development in fiscal year 1980.

Encouraged by the cooperative agreement with Japan on nuclear fusion, U.S. officials approached Japan about the possibility of participation in the U.S. MHD program. The Japanese Government funds MHD research at about $5 million annually under its Moonlight Project (see p. 12) to conserve natural resources, but its research concerns MHD systems using oil and natural gas as the basic fuels instead of coal.

Discussions with the Japanese over the last 6 months have helped clarify their knowledge of U.S. MHD research. U.S. researchers and development engineers have accomplished much more than the Japanese had realized, so they are now very interested in exchanging information. While the United

States is concentrating on MHD systems using coal, some of the technology under development could be applied to MHD systems using Japan's energy sources. The United States has proposed a joint MHD development program under the umbrella agreement, but discussions are still in an exploratory stage.

JAPAN'S UNILATERAL PROGRAM

Japan's unilateral non-nuclear energy research and development program stems from the 1973 oil crisis. The program is divided into three areas: new energy sources, energy conservation, and waste energy recycling, which are known respectively as the Sunshine, Moonlight, and Stardust Projects.

The Sunshine Project is aimed at developing new energy techniques which will supply clean energy to meet a considerable portion of the energy demand through the 20th century. The kinds of new energy technology to be developed on a priority basis are solar, geothermal, and hydrogen energy technology and technology for the gasification and liquefaction of coal.

As an example of a Sunshine Project result, a Japanese Embassy official told us that Japan has had a solar-powered electric generator for 2 years now, which is providing electricity to a small Japanese community. He said such work is limited to small-scale projects because Japan does not have enough land space to build large solar collectors.

The same official said the many hot springs in Japan provide great possibilities for geothermal energy on a small scale in many areas. Environmental considerations are an important complication, because the hot springs occur generally in very scenic and, thus, resort areas.

He commented on the hot dry rock experiment project Japan is negotiating with the United States, saying that it is a new area of geothermal research for Japan. This approach could possibly tap the many volcanic heat sources in Japan. See enclosure 4, page 30, for more information on the objectives of the Sunshine Project.

The Moonlight Project was begun in 1978 as a means of promoting full-scale research, development, and demonstration of energy conservation technology. An area of concentration is trying to improve efficiency in energy generation. One project involves attempting to improve gas turbine generation efficiency by creating a hybrid power plant that combines gas and steam turbines. Another project concerns magnetohydrodynamics,

similar to the MHD project being discussed with the United States under the cooperative agreement, except that it will use oil or natural gas instead of coal as the basic energy source.

The Moonlight Project also promotes conservation research and development in private industry through subsidies and industrial standardization in such things as equipment. A final area is the promotion of international cooperation in conservation research and development. See enclosure 4, page 37, for a Moonlight Project list and descriptions.

The Stardust Project was described to us as dealing with waste recycling. However, it is only in the early stages of implementation and no further information was made available to us.

JAPAN'S PARTICIPATION IN INTERNATIONAL ENERGY AGENCY PROJECTS

The International Energy Agency (IEA) is an autonomous body within the Organization of Economic Cooperation and Development, which was established in November 1974 in the wake of the 1973/74 energy crisis.1/ One element of IEA's program is the establishment and conduct of cooperative energy research, development, and demonstration projects in priority areas, including energy conservation; nuclear reactor safety experiments; and solar, geothermal, ocean, wind, and fusion energy.

During 1978 and 1979, Japan participated in about 40 percent of those IEA projects in which it has a related national program; the United States participated in about 90 percent. IEA has been encouraging Japan to increase its involvement in IEA projects. A Japanese Embassy official told us that Japan is trying to participate more in IEA programs but that its participation basically involves exchanges of information with other participants. Japan is participating in one or more projects in all but one of IEA's priority areas. Enclosure 5 shows the projects in which IEA members are participating.

1/IEA members are Australia, Austria, Belgium, Canada, Denmark, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States. The European Communities also participate in the work of the Agency.

One project being negotiated under the umbrella agreement is under the auspices of an IEA implementing agreement. The Fenton Hill hot dry rock project began under IEA auspices and was subsequently included as a project under this umbrella agreement.

NON-ENERGY R&D COOPERATION

The United States and Japan are working on an agreement that would extend cooperation in research and development into non-energy fields. This results from a proposal by President Carter to Prime Minister Ohira in May 1979 that the two countries cooperate in research and development in non-energy fields as a complement to cooperative activities in energy-related fields resulting from the "Fukuda Initiative" in 1978. The Office of Science and Technology Policy, Executive Office of the President, is heading the U.S. negotiating team.

The project areas are expected to be space, environmental protection, health, disaster prevention, agriculture, and basic research in physics. At their second meeting in February 1980, the two teams discussed possible cooperation in some 24 projects within these general research areas. A U.S. official told us that many of the projects discussed involve areas in which the United States and Japan are doing parallel research. With this cooperation, hopefully, the projects will become complementary and duplication will be reduced. At present, the projects being considered are all to take place in the United States; however, this is expected to change as more areas for cooperation are identified.

The total average annual cost of the 24 projects was estimated at about $370 million, with the Japanese share suggested at about $90 million. Starting dates range from those already ongoing to those expected to start in fiscal year 1983. Some are projected to run through fiscal year 1990.

AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND THE GOVERNMENT OF JAPAN ON COOPERATION IN RESEARCH AND DEVELOPMENT IN ENERGY AND RELATED FIELDS

The Government of the United States of America and the Government of Japan,

Desiring to further strengthen cooperative relations between the two Governments, looking toward the twenty-first century,

Recognizing that the energy problem is one of the most important questions to be resolved for world prosperity in this century and in the twenty-first century,

Determined to play a constructive role in resolving this problem through close cooperation,

Believing that cooperation between the two Governments in research and development in energy and related fields is of mutual advantage in insuring a stable supply of energy resources to meet the rapidly growing requirements of not only their own peoples, but all the peoples of the world,

Recognizing the contribution such research and development can make to improvement of the environment, and

Desiring to complement cooperation in energy research and development in appropriate international organizations, including the International Energy Agency,

Have agreed as follows:

ARTICLE I

The two Governments will maintain and intensify their cooperation in research and development in energy and related fields on the basis of equality and mutual benefit.

ARTICLE II

1. Cooperation may be undertaken in the following area:

(a) Areas of initial emphasis:

(i) Fusion;

(ii) Coal conversion;

(b) Additional areas:

(i) Solar energy conversion by means of photosynthesis;

(ii) Geothermal energy;

(iii) High energy physics;

(iv) Other areas in energy and energy-related research and development as may be mutually agreed.

2. Cooperation in the areas referred to in paragraph 1 above will be undertaken on the basis of equitable sharing of costs and benefits and, with regard to the areas of initial emphasis referred to in paragraph 1(a) above, also in accordance with the principle of balance between areas.

ARTICLE III

Cooperation in the areas referred to in Article II may take the following forms:

(a) Conduct of joint projects and programs, and other cooperative projects and programs;

(b) Meetings of various forms, such as those of experts, to discuss and exchange information on scientific and technological aspects of general or specific subjects and to identify research and development projects and programs which may be usefully undertaken on a cooperative basis;

(c) Exchange of information on activities, policies, practices, and legislation and regulations concerning energy research and development;

(d) Visits and exchanges of scientists, technicians or other experts on general or specific subjects; and

(e) Other forms of cooperation as may be mutually agreed.

ARTCILE IV

Implementing arrangements specifying the details and procedures of cooperative activities in the areas referred to in Article II will be made between the two Governments or their agencies, whichever is appropriate.

ARTICLE V

1. The two Governments will establish a United States-Japan Joint Committee on Energy Research and Development (hereinafter referred to as "the Joint Committee") to review

activities and accomplishments under this Agreement and to give appropriate advice to the two Governments regarding future cooperation.

2. The Joint Committee will consist of six members, three of whom will be designated by the Government of the United States of America and three of whom will be designated by the Government of Japan.

3. The Joint Committee will meet at least once each year, at a mutually agreed time, in the United States of America and Japan alternately.

4. Subordinate committees to facilitate implementation of cooperation in the areas referred to in Article II will be established in accordance with the implementing arrangements referred to in Article IV or as otherwise mutually agreed.

ARTICLE VI

Each Government will notify the other Government of the internal administrative arrangements it has made to insure effective implementation of this Agreement.

ARTICLE VII

1. Scientific and technological information of a non-proprietary nature arising from the cooperative activities under this Agreement may be made available to the public by either Government through customary channels and in accordance with the normal procedures of the participating agencies.

2. The two Governments will give due consideration to the equitable distribution of industrial property resulting from the cooperative activities under this Agreement and of licenses thereof and to the licensing of other related industrial property necessary for the utilization of the results of such cooperative activities, and will consult each other for this purpose as necessary.

ARTICLE VIII

Nothing in this Agreement shall be construed to prejudice existing or future arrangements for cooperation between the two Governments, except as provided in paragraph 3 of Article XI.

ARTICLE IX

Activities under this Agreement shall be subject to budgetary appropriations and to the applicable laws and regulations in each country.

ARTICLE X

The termination of this Agreement shall not affect the carrying out of any project or program undertaken in accordance with the implementing arrangements referred to in Article IV and not fully executed at the time of the termination of this Agreement.

ARTICLE XI

1. This Agreement shall enter into force upon signature and remain in force for ten years.

However, either Government may at any time give written notice to the other Government of its intention to terminate this Agreement, in which case this Agreement shall terminate six months after such notice has been given.

2. This Agreement may be extended by mutual agreement of the two Governments.

3. The Agreement between the Government of the United States of America and the Government of Japan on Cooperation in the Field of Energy Research and Development, signed on July 15, 1974, is superseded by this Agreement.

DONE at Washington on May 2, 1979, in duplicate in the English and Japanese languages, both being equally authentic.

FOR THE GOVERNMENT OF THE UNITED STATES OF AMERICA:

James R. Schlesinger

FOR THE GOVERNMENT OF JAPAN:

Sunao Sonoda

ENCLOSURE III

AGREEMENT

BETWEEN

THE UNITED STATES DEPARTMENT OF ENERGY

AND

THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE

ON COOPERATION IN DOUBLET III PROJECT

Whereas the Government of the United States of America and the Government of Japan have signed an Agreement on Cooperation in Research and Development in Energy and Related Fields (hereinafter referred to as "the U.S.-Japan Agreement") on May 2, 1979;

Whereas Article IV of the U.S.-Japan Agreement provides that implementing arrangements specifying the details and procedures of cooperative activities will be made between the appropriate agencies of the two Governments;

Whereas the United States and Japan exchanged Notes establishing an agreement in Fusion Energy on August 24, 1979;

Whereas in accordance with Article V of the U.S.-Japan Agreement which provides for the establishment of committees as mutually agreed to facilitate implementation of cooperation, the agreement established by the exchange of Notes established a Coordinating Committee on Fusion Energy which shall exercise its duties in relation to this Agreement;

Whereas the United States and Japan have exchanged Notes on August 24, 1979, in which JAERI has been designated as the Japanese organization to conclude details of the cooperation activites using the Doublet III facility;

Now therefore the United States Department of Energy (DOE) and the Japan Atomic Energy Research Institute (JAERI), hereinafter referred to as "the Parties", agree as follows:

Article I

OBJECTIVE

The aim of cooperation under this agreement is to undertake experimental research on tokamak plasmas with doublet and dee-shaped cross-sections in the Doublet III, a tokamak facility, located at La Jolla, California. (hereinafter referred to as "the Doublet III facility".)

Article II

PROJECT

The Parties shall undertake the upgrading of and carry on a research program using the Doublet III facility to investigate doublet and dee-shaped plasma cross-sections. The Doublet III project shall be undertaken as follows:

1. The present Doublet III facility has a magnetic field of 2.6 Tesla, 5 Volt-seconds, auxiliary neutral beam heating of 7 Megawatts, and a doublet shaped vacuum vessel. The improvements made to the Doublet III facility will result in the improvements to the facility such as a magnetic field of 4 Tesla, 10 Volt-seconds and up to approximately 20 Megawatts of auxiliary heating, and a new dee-shaped vacuum vessel as a future option. The precise technical details of such improvements shall be decided by the Doublet III Steering Committee (hereinafter referred to as "the Steering Committee") as set forth in Article III. Procurement for such improvements and other operational activities of the Doublet III facility shall be vested in a DOE Prime Contractor.

2. Prior to and subsequent to such upgrading of the Doublet III facility, an experimental research program in doublet and dee-shaped plasma cross-sections shall be jointly developed and carried out by the Parties. A team of staff from JAERI (hereinafter referred to as

"the JAERI team") shall be assigned to the Doublet III facility in accordance with Article V to take part in such development under its own leadership sharing the machine time of the Doublet III facility as determined by the Steering Committee. Day to day operations of the experimental research program will be the responsibility of the DOE Prime Contractor.

Article III

MANAGEMENT

1. The Parties agreed to establish the Steering Committee.

2. The Steering Committee shall be composed of up to two members from each Party. Each Party shall also designate an alternate representative who shall serve as a member of the Steering Committee should the designated representative be unable to do so. Each Party shall inform the other Party in writing of all designations under this paragraph. Each Party shall have one vote in the Steering Committee and all decisions shall be by unanimity. DOE shall implement the decisions of the Steering Committee. The Steering Committee shall invite representatives of the Prime Contractor and the JAERI team, and other advisors to meet with them, as appropriate.

3. The Steering Committee shall review and approve the annual program of work including allocation of funds provided by the Parties, objectives and milestones and any changes thereto for the Doublet III Project. The proposed annual budget will be prepared by the Prime Contractor with advice from the JAERI team. The Steering Committee shall review the implementation and management of the program of work and resolve priority issues within the Doublet III Project. The Steering Committee shall undertake special studies and technical reviews as it deems appropriate.

4. The Chairmanship of the Steering Committee shall be vested in one of the DOE members.

5. The Steering Committee shall meet in La Jolla, California, unless an alternative location is mutually agreed upon, on a date mutually agreed upon when the Chairman so notifies the members of the Steering Committee in writing, but at least twice a year.

6. Annually, the Steering Committee shall review and submit to the Coordinating Committee on Fusion Energy for the purpose of Article 4(1)(a)-(e) of the agreement established by the exchange of Notes, a summary of the planned major improvements to the Doublet III facility, the annual program of work and annual budget, including the financial contributions from each Party.

7. The Steering Committee shall work within the oversight of the Coordinating Committee on Fusion Energy which shall take into account the principles embodied in Articles I and II of the U.S.-Japan Agreement.

8. Day to day coordination necessary for the implementation and the management of the programs of work on site shall be carried out between personnel designated by each Party.

Article IV

FINANCE

1. JAERI shall provide to DOE a financial contribution in United States dollars as mutually determined on an annual basis which lump sum shall be paid on or before July 31 of each calendar year in accordance with procedures to be identified by DOE prior to the first deposit. After signature of this agreement, JAERI shall provide to DOE the JAERI financial contribution for Japanese fiscal year 1979 in accordance with the following procedures:

a. The first remittance of 2,437,500,000 Yen converted to U.S. dollars at the rate of currency exchange in effect at the time of transmittal of funds shall be made immediately upon receipt of an invoice.

b. A second remittance, equivalent to the balance between the first remittance and $12,500,000 in U.S. dollars shall be made immediately after such additional funds are provided to JAERI.

2. It is understood that the ability of the Parties to carry out their obligations under this Agreement is subject to the availability of appropriated funds.

3. If at any time either Party is unable to provide its financial contribution or either party terminates this Agreement pursuant to Article VIII, DOE shall not be obligated to continue to expend any funds for the Doublet III Project, unless otherwise mutually agreed.

4. DOE shall provide to JAERI annually an accounting for funds of the Doublet III Project.

Article V

ASSIGNMENT OF PERSONNEL

1. Each assignment of staff shall be the subject of a separate assignment agreement between the Prime Contractor, with the approval of DOE, and JAERI.

2. JAERI shall be responsible for the salaries, insurance and allowances to be paid to its personnel.

3. JAERI shall bear the travel and living expenses of its personnel while on assignment to the Doublet III facility unless otherwise agreed.

4. DOE, through its Prime Contractor, shall assist in arranging for accommodations for JAERI's personnel and their families.

5. DOE, through its Prime Contractor, shall provide all necessary assistance to JAERI's personnel and their families as regards administrative formalities, including travel arrangements.

6. JAERI's personnel shall conform to the general rules of work and safety regulations in force at the site, or as agreed in the separate assignment agreements.

7. The members of the JAERI team shall be given assistance necessary for the execution of their research activities under this Agreement by DOE and its Prime Contractor.

Article VI

LIABILITY

Compensation for damages incurred during the implementation of this Agreement shall be in accordance with the applicable laws of the countries of the Parties.

Article VII

INFORMATION AND PATENTS

1. The Parties shall exchange information necessary to carry out the Doublet III Project.

2. All information arising from this Agreement shall be promptly exchanged between the Parties.

3. The application or use of any information exchanged under or arising from this Agreement shall be the responsibility of the Party receiving it, and the other Party does not warrant the suitability of such information for any particular use or application.

4. The information exchanged under and arising from this Agreement may be given wide distribution. Such information may be made available to the public by either Party through customary channels and in accordance with the normal procedures of the Parties.

5. Copyrights of either Party or of cooperating organizations or persons shall be accorded treatment consistent with internationally recognized standards of protection.

6. Proprietary information shall not be accepted for or utilized in the Doublet III Project without the express written approval of DOE. For the purposes of this Agreement, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example, computer programs, design prodecures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:

A. Is not generally known or publicly available from other sources;
B. Has not previously been made available by the owner to others without obligation concerning its confidentiality; and
C. Is not already in the possession of the recipient without obligation concerning its confidentiality.

It shall be the responsibility of the Party supplying proprietary information to identify the information as such and to ensure that it is appropriately marked.

7. Inventions made or conceived in the course of or under this Agreement resulting from improvements to the Doublet III facility and during the joint research (hereinafter referred to as "arising inventions") shall be identified and reported promptly by DOE to JAERI. Information regarding inventions on which patent protection is to be obtained shall

not be published or publicly disclosed by the Parties until a patent application has been filed in either country of the Parties, provided, however, that this restriction on publication or disclosure shall not extend beyond six months from the date of reporting of the invention. It shall be the responsibility of DOE to appropriately mark reports which disclose inventions that have not been appropriately protected by the filing of a patent application.

8. Arising inventions shall be owned (1) by JAERI in Japan subject to a royalty-free, non-exclusive, irrevocable license to DOE and the nationals of its country designated by it and (2) by DOE in the United States and third countries subject to a royalty-free, non-exclusive, irrevocable license to JAERI and the nationals of its country designated by it.

9. Each Party shall assume the responsibility to pay awards or compensation required to be paid to its own nationals according to its own laws. Each Party shall without prejudice to any rights of inventors under its national laws, take all necessary steps to provide the cooperation from its inventors required to carry out the provisions of this Article.

Article VIII
ADDITIONAL PROVISIONS

1. This Agreement shall enter into force upon signature and shall remain in force for a period of five (5) years.

2. This Agreement may be terminated at the discretion of either Party upon 6 months advance notice in writing by the Party seeking to terminate the Agreement.

3. Any termination shall be without prejudice to the rights which may have accrued under this Agreement to either Party up to the date of such termination. In the event of such termination, the settlement of payments from JAERI to DOE and the furnishing of information between DOE and JAERI shall be as mutually agreed.

4. Upon termination of this Agreement, whether in accordance with paragraph 1 or 2 above, the Steering Committee shall decide on the liquidation of the assets of the Doublet III Project acquired pursuant to this Agreement in whole or in part, and any distribution which might be made to the Parties. The Steering Committee shall, so far as practicable, distribute assets of the Doublet III Project, or the proceeds therefrom, in proportion to the contributions and outstanding obligations of the Parties pursuant to this Agreement.

5. This Agreement may be amended or extended by mutal written agreement of the Parties.

6. Activities under this Agreement shall be subject to the applicable laws and regulations of the countries of the Parties. All questions related to this Agreement arising during its term shall be settled by the Parties by mutual agreement.

7. DOE shall be solely responsible for all assets of the Doublet III facility acquired prior to the execution of or outside the scope of this Agreement. The research activities other than those to be carried out by the JAERI team in accordance with the provision of Article II-2 of this Agreement shall be the sole responsibility of DOE.

Done at Washington, D.C., this 28th day of August 1979, in duplicate in the English and Japanese languages, both being equally authentic.

FOR THE DEPARTMENT OF ENERGY:

Edwin E. Kintner

Edwin E. Kintner, Director
Office of Fusion Energy

FOR THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE:

H. Fukunaga

Hiroshi Fukunaga, Member
Board of Directors

INDICATIVE PLAN FOR SUNSHINE PROJECT

I. Objective and Period of Sunshine Project

Since the securing of a long-term, stable supply of energy is highly important for national life and economic activity, the Sunshine Project is aimed at supplying clean energy to meet a considerable portion of the demand for energy several decades hence by promoting research and development on new energy techniques which need to be put to practical use from the standpoint of the national economy, in comprehensive, systematic and efficient ways for the period from 1974 to 2000.

II. Kinds of New Energy Technology and Goals of Research and Development

The kinds of new energy technology to be developed on a priority basis (hereafter called "priority technology") to attain the goals of the Sunshine Project are solar energy technology, geothermal energy technology, technology for the gasification and liquefaction of coal, and hydrogen energy technology. The goals of research and development on each of these kinds of priority technology are as follows; (Other new energy techniques may be added to the priority technology, as the occasion may demand, based on the results of research and development to be carried out according to the stages of technical development, or on the results of the study of the possibilities of development):

Source: MITI: "Sunshine Project: New Energy Research and Development in Japan" (BI-35, May 1979).

1. Solar Energy Technology

(1) Technology for Solar Energy Power Generation System

(a) Technology for Solar Thermal Power Generation System

To develop technology for converting solar heat into electrical energy economically and efficiently and to develop a high-performance, large-capacity solar heat power generation system by the year 2000.

(b) Technology for Photovoltaic Conversion System

To develop technology for converting solar light into electrical energy economically and efficiently, and to develop a high-performance, low-cost photovoltaic conversion system by the year 1990 or thereabouts.

(c) Others

To conduct research for the practical application of other solar energy power generation methods such as thermionic conversion and space power generation.

(2) Technology for Solar Cooling and Heating and Hot Water Supply Systems

To establish cooling and heating as well as hot water supply systems suitable for individual houses, apartment houses, and large buildings, and to develop a

variety of highly economical cooling and heating as well as hot water supply systems by the year 1980 or thereabouts. Also, to develop an innovative regional cooling and heating system by the year 1990 or thereabouts on the basis of the results of development.

(3) Technology for New Applications of Solar Energy

To develop a basic technology for utilizing solar energy in new areas, such as industrial heat sources, and to attempt to put such technology to practical use.

2. Geothermal Energy Technology

(1) Technology for Exploration and Extraction of Geothermal Energy

To establish methods for confirming the amount of geothermal deposits and to develop technology for exploring and assessing geothermal resources as well as technology for excavating high-temperature rock in order to reduce the risks involved in development.

(2) Technology for Power Generation Utilizing Hot Water

To develop the technology for corrosion-resistive materials, technology for high-efficiency heat exchange, etc., and to develop a high-efficiency binary-cycle power generating system by the late 1980's.

(3) Technology for a Volcanic Power Generating System

To develop the technology for fracturing into hot dry rock, technology for forming man-made hot water systems, etc., and to develop high-efficiency, large-capacity volcanic and hot dry rock power generating systems by the mid-1990's.

(4) Technology for Multipurpose Utilization of Geothermal Energy

To develop the technology for transporting geothermal fluids, and to develop geothermal energy utilization systems for regional heating, agriculture, and other purposes.

(5) Technology for Environmental Preservation

To develop the technology for environmental preservation in order to prevent adverse effects on the natural environment and ecosystem from the extration and utilization of geothermal fluids.

3. Coal Gasification and Liquefaction Technology

(1) Coal Gasification Technology

(a) Technology for Manufacturing Synthetic Natural Gas

To develop the technology for manufacturing synthetic natural gas (SNG) by the high pressure fluidized-bed gasification method, the molten salt or molten iron

gasification method, etc., and to develop a large-capacity SNG manufacturing plant by the late 1980's.

(b) Technology for Gasification Power Generation

To develop the low calorie gasification technique and build a large-capacity gasification plant for power generation purposes and to develop a gas turbine/steam turbine compound cycle power generation system combined with said gasification plant by the early 1980's.

(c) Technology for Plasma Gasification

To develop plasma gasification techniques for economically manufacturing hydrogen and acetylene by the early 1990's.

(2) Coal Liquefaction Technology

To develop techniques for manufacturing synthetic crude oil from coal, including direct hydrogenation techniques and extrative hydrogenation techniques and to develop a synthetic crude oil manufacturing plant by the early 1990's.

4. Hydrogen Energy Technology

(1) Techniques for Manufacturing Hydrogen

To develop hydrogen manufacturing techniques such as the high-temperature high-pressure electrolysis process,

the thermochemical process, and the direct thermal decomposition process, and to develop a large-capacity hydrogen manufacturing system by 2000.

(2) Techniques for Transporting and Storing Hydrogen

To develop techniques for liquefying hydrogen, techniques for manufacturing hydride, and techniques necessary for the transportation and storage of hydrogen by means of portable containers, and to develop a safe and convenient system for transporting and storing hydrogen by 2000.

(3) Techniques for Utilizing Hydrogen

To develop various kinds of techniques for utilizing hydrogen, including the combustion techniques, techniques for chemical utilization, techniques for power utilization and fuel cells, and to establish an economical and safe hydrogen utilization system.

(4) Techniques for Safe Handling of Hydrogen

To identify safety problems involved in the manufacture, transportation, storage, and utilization of hydrogen, and to develop disaster prevention and other safety techniques, while attempting to systematize standards for safety techniques, including environmental countermeasures.

(5) Hydrogen Energy System

To establish, as the final goal, a hydrogen energy system consisting of the various techniques mentioned above from (1) to (4).

Table I-2 Large-scale research and development projects for energy conservation

Name of the Project	Outline of the project	Period of R & D	Current situation and future plan of R & D	R & D cost
Waste heat utilization technology system	About 60 percent of energy consumed in mining and industries is discharged as waste heat. It is intended to research and develop an elemental technology as well as a total system for recovery and use of waste heat for the purpose of energy saving in mining and industries and also for making effective use of it for society.	Fiscal '76-'81	Elemental technology of heat recovery, heat exchange, thermal transfer and thermal storage is being studied. Pilot equipment and pilot plants will be made in the future and experiements will be made for materialization	about 3 billion yen
Magneto-hydro-dynamics(MHD) generation technology	This is a direct generation system for obtaining electric power by feeding combustion gas at high temperature at high speed through a strong magnetic field. It is intended to greatly improve thermal efficiency in combination with thermal power generation.	Phase 2: Fiscal '76-'82 (Phase 1: Fiscal '66-'75)	Mark VII test facility (using ordinary magnets) is in production. Experimental run will be made for 200 hrs. at 100kw. After this stage, manufacture and run of Mark VIII testing facility (using superconducting magnets) will be carried out.	about 12 billion yen
High efficiency gas turbine	Generation efficiency is about 40 percent, even for the most efficient steam power plants at the present time. But it is intended to significantly improve the generation efficiency to 55 percent or higher by a hybrid power plant that combines gas turbines and steam turbines. For this purpose, turbines with an inlet gas temperature of 1,500°C will be developed. At the same time, regional heating and air conditioning will be made by a multi-stage use of heat.	Fiscal '78-'84	Research and development of heat resistant metal, heat resistant ceramic materials and turbine blade cooling technics has been started. A prototype plant of 100,000kW class will be designed, manufactured starting in fiscal '82 and a trial run will be performed.	about 15 billion yen

Source: MITI: "Promotion of the Moonlight Project" (BI-36, June 1979).

Table I-3 Large-scale research and development projects for energy conservation

Name of the Project	Fiscal Year '76	'77	'78	'79	'80	'81	'82	'83	'84	Remarks
1. Waste heat utilization technology system										Development of elemental technology of waste heat recovery at factories and steel mills, especially heat pipes, heat exchangers, heat pumps, as well as sensible heat recovery from hot cokes and hot water conveyance.
(1) Technology for heat recovery and heat exchange		Basic research		▼	Research and development →					
(2) Technology for thermal transfer and thermal storage		Basic research		▼	Research and development →					Total amount of expenses for research and development: about 3 billion yen
	million yen 78	277	617							
2. Magneto hydro dynamics (MHD) generation technology										Development of direct power generation system of obtaining electric power by feeding combustion gas of high temperature at high speed through a strong magnetic field will be made. Run for 200 hours with the output of 100KW is the target. Mark VII will be used for research on durability of generation channel, and Mark VIII will be an integrated system that combines superconducting magnets, heat exchanger, etc. It will be operated for research.
(1) Experiment and research of MHD generator (Mark VII) using copper and iron magnets		Design ▼ Commencement of work	Construction		Completion ▼	Run →				
(2) Experiment and research of MHD generator (Mark VIII) using superconstructing magnets					Design ▼ Const-ruction Comencement of work	Comple-tion ▼ Run →				Total amount of expenses for research and development: about 13 billion yen
	million yen 196	486	635							
3. High efficiency gas turbine										Integrated thermal efficiency will be increased to 55 percent by combining gas turbine generation and steam turbine generation. Gas turbine with an inlet gas temperature of 1,500°C will be developed for this purpose.
(1) Development of heat-resistant materials and elemental technology			Development of heat-resistant materials and elemental technology →				Commence-ment of work		Completion	
(2) Manufacture, trial run and research of prototype plant (100,000KW class)							Design ▼ Const-ruction ▼		Run →	Total amount of expenses for research and development: about 15 billion yen

Table 1-4 Research and development of leading and basic technology for ene

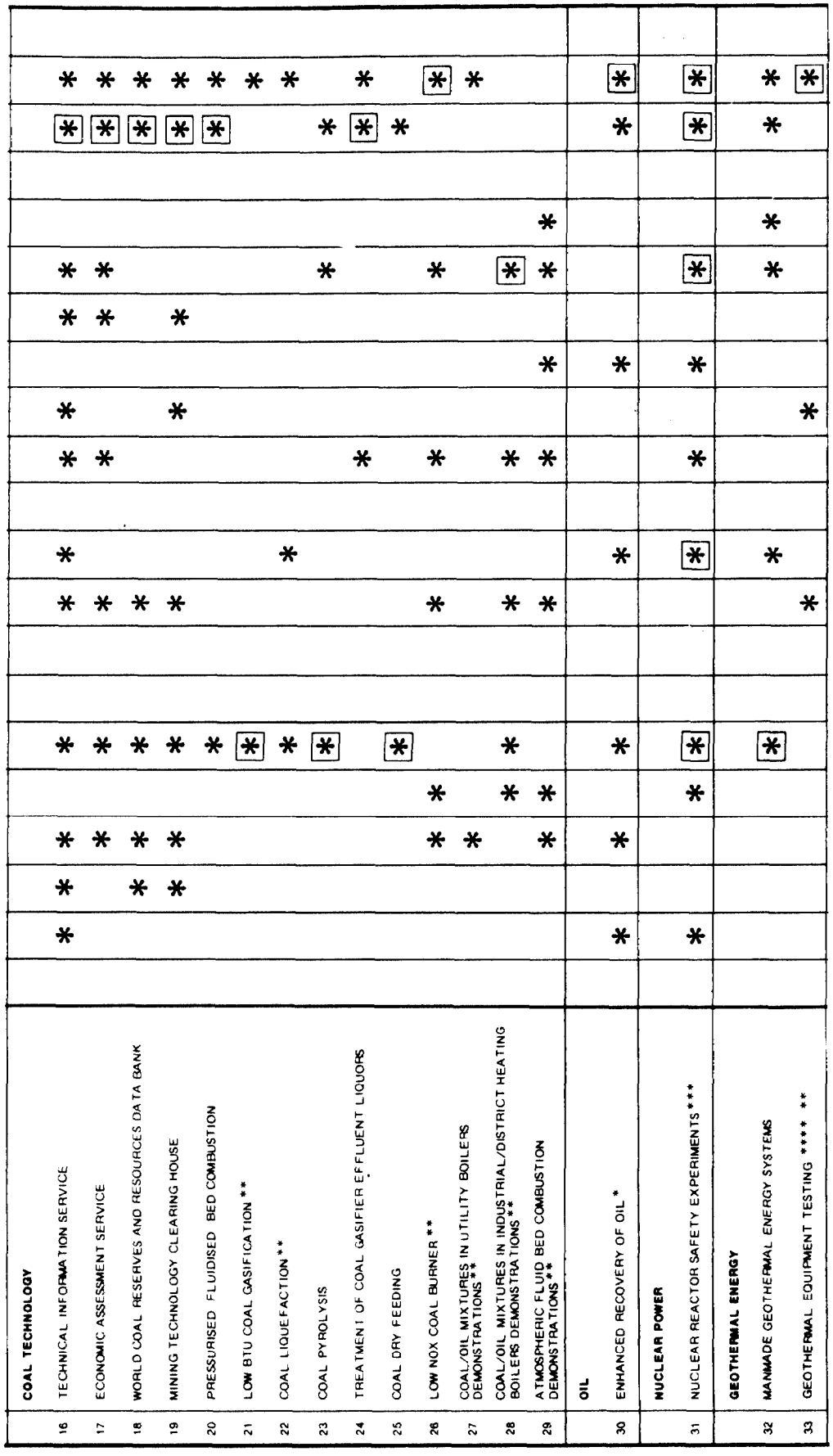
Name of project	Period of R & D	Budget for fiscal '79	Outline of project
Superconduction technology (1) Research in technology of conversion and transportation of electric energy (2) Research in extremely low temperature technology	Fiscal '78-'82	(million yen) 49	Basic research in superconductive transmission cable system and superconductive materials for conductors will be made for energy conservation of power transportation to cope with extended distances and areas of transmission network that accompany increased demand for electric power. Foundation of superconductive power transmission technology without transmission loss will be established. At the same time, integrated development of extremely low temperature technology will be made, for it is necessary for superconductive power transmission.
Advanced type battery Research in storage of electric power with redox battery	Fiscal '78-'87	11	Levelling of load fluctuation with storage of electric power is effective for accomplishing energy conservation in electric power system. Pumping-up power generation has been in practical use as means of storage of electric power of large capacity. However, it is expected that it will become hard to find suitable places for construction of such power plants in the future. Therefore, research and development toward materialization of large capacity electric power storage quipment with redox flow type battery will be made. The battery is considered to be one of most hopeful secondary batteries, in view of its high efficiency and long life.
New motive power Research on flywheel motive car	Fiscal '77-'81	(million yen) 28	Theoretical and experimental research will be made for maneuvering stability and safety of the flywheel motive car of a hybrid driving system, which is a combination of flywheel and Starling and is of higher energy efficiency than current reciprocating engine motive cars.
Heat Utilization Technology (1) Research in energy saving technology for glass melting furnace	Fiscal '78 -	(million yen) 6	For the purpose of saving energy in the glass manufacturing industry, research in the application of in-liquid combustion has been carried out. This research has aimed to develop technology for glass melting surface in exchange for the existing heat-treatment surfaces, and to develop a new settling process.
(2) Research on dyeing and processing technology at low temperature	Fiscal '78-	5	A New dyeing and processing technology system ,will be developed for energy conservation in dyeing and processing industry. It will mean a large reduction in the processing temperature, simplification of processing control and reduction of energy consumption.

Name of project	Period of R & D	Budget for fiscal '79	Outline of project	Organization in charge
(3) Research into heat pipes	Fiscal '75 -	6	Design standards for various kinds of heat pipes will be developed to increase the efficiency of thermal transfer and basic data. It is useful for development of high performance heat transmission equipment.	Mechanical Engineering Laboratory
(4) Research into energy saving technology in the manufacturing of black lead	Fiscal '79-	4	In order to reduce the treatment time by 25%, a survey of materials which can endure thermal destruction and can be made into black lead by quick heating will be made. In addition research into configuration and pretreatment is to be carried out, as well as the development of an advanced adiabatic material and remodeling of furnaces, which will bring about energy savings of 15%.	Government Industrial Research Institute, Osaka
(5) Research on infrared ray radiation from ceramics	Fiscal '79-	4	For the use of dyeing and firing potterly, development of ceramic materials, which radiate infared rays effectively will be carried out.	Government Industrial Research Institute, Nagoya
(6) Research on a heat supply system for making use of waste heat and hot drainage and a process of for plants and livestock	Fiscal '79-	5	In order to increase the utilization efficiency of energy in the fields of agriculture and livestock, research on heat supply systems and relevant technology will be made.	National Chemical Laboratory for Industry

COUNTRY PARTICIPATION IN IEA CO-OPERATIVE PROGRAMMES AND PROJECTS IN ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

		AUSTRALIA	AUSTRIA	BELGIUM	CANADA	DENMARK	GERMANY	GREECE	IRELAND	ITALY	JAPAN	LUXEMBOURG	NETHERLANDS	NEW ZEALAND	NORWAY	SPAIN	SWEDEN	SWITZERLAND	TURKEY	UNITED KINGDOM	UNITED STATES	EUROPEAN COMMUNITIES
	ENERGY RESEARCH DEVELOPMENT AND DEMONSTRATION STRATEGY		*	*	*	*	*		*	*	*		*	*	*	*	*	*		*	*	*
	ENERGY CONSERVATION																					
1	URBAN PLANNING						*	[*]		*											*	
2	CONSERVATION IN BUILDING COMPLEXES (WIEHL/ESSLINGEN)						[*]														*	
3	COMMERCIAL BUILDINGS ENERGY ANALYSIS			*	*	*	*			*			*				*	*		*	[*]	
4	RESIDENTIAL BUILDINGS ENERGY ANALYSIS +			*		*				*			*				[*]	*			*	
5	COMMERCIAL BUILDINGS ENERGY MEASUREMENT *			*	*													*		[*]	*	
6	AIR INFILTRATION INFORMATION CENTRE *				*	*				*			*				*	*		[*]	*	
7	HEAT PUMPS WITH THERMAL STORAGE		[*]			*	*		*	*			*	*			*	*			*	
8	ADVANCED HEAT PUMPS		*	*	*	*	[*]				*		*			*	*	*		*	*	
9	COMBUSTION PROCESSES									*							*			*	[*]	
10	CASCADING		*	*	*		*				*		*				*	*			[*]	
11	HEAT TRANSFER/HEAT EXCHANGERS																*	*		[*]	*	
12	HEAT STORAGE ASSESSMENT					*	*										*	[*]			*	*
13	ARTIFICIAL LAKE STORAGE OF HEAT *					*	[*]						*				*				*	
14	CEMENT MANUFACTURE						*							*			*			*	[*]	
15	HIGH TEMPERATURE MATERIALS FOR AUTOMOTIVE ENGINES *						*														[*]	

ENCLOSURE V



	COAL TECHNOLOGY	
16	TECHNICAL INFORMATION SERVICE	
17	ECONOMIC ASSESSMENT SERVICE	
18	WORLD COAL RESERVES AND RESOURCES DATA BANK	
19	MINING TECHNOLOGY CLEARING HOUSE	
20	PRESSURISED FLUIDISED BED COMBUSTION	
21	LOW BTU COAL GASIFICATION **	
22	COAL LIQUEFACTION **	
23	COAL PYROLYSIS	
24	TREATMENT OF COAL GASIFIER EFFLUENT LIQUORS	
25	COAL DRY FEEDING	
26	LOW NOX COAL BURNER **	
27	COAL/OIL MIXTURES IN UTILITY BOILERS DEMONSTRATIONS **	
28	COAL/OIL MIXTURES IN INDUSTRIAL/DISTRICT HEATING BOILERS DEMONSTRATIONS **	
29	ATMOSPHERIC FLUID BED COMBUSTION DEMONSTRATIONS **	
	OIL	
30	ENHANCED RECOVERY OF OIL *	
	NUCLEAR POWER	
31	NUCLEAR REACTOR SAFETY EXPERIMENTS ***	
	GEOTHERMAL ENERGY	
32	MANMADE GEOTHERMAL ENERGY SYSTEMS	
33	GEOTHERMAL EQUIPMENT TESTING **** **	

	SOLAR ENERGY																						
34	PERFORMANCE OF SYSTEMS FOR HEATING AND COOLING			*		[*]	*			*	*		*	*		*	*	*		*	*	*
35	DEVELOPMENT OF COMPONENTS FOR HEATING AND COOLING		*	*		*	*	*		*	[*]		*	*		*	*	*			*	
36	TESTING COLLECTORS FOR HEATING AND COOLING		*	*	*	*	[*]	*		*	*		*	*		*	*	*		*	*	*
37	INSTRUMENTATION PACKAGE			*	*		*			*			*			*		*		*	*	[*]
38	TREATMENT OF METEOROLOGICAL INFORMATION		*	*	*	*	*			*			*			*	[*]	*		*	*	*
39	SMALL SOLAR POWER PLANT DEMONSTRATIONS		*	*			[*]	*								*	*	*			*	
	BIOMASS CONVERSION																					
40	TECHNICAL INFORMATION SERVICE		*	*	*				[*]								*			*	*	
41	FORESTRY ENERGY		*		*				*					*	*		[*]				*	
	OCEAN ENERGY																					
42	WAVE POWER				*				*		[*]									*	*	
	WIND ENERGY																					
43	LARGE SCALE WIND ENERGY DEMONSTRATIONS					*	*										*				*	
44	TECHNOLOGY OF WIND ENERGY CONVERSION SYSTEMS		*		*	*	[*]		*		*		*	*	*		[*]				[*]	
	FUSION ENERGY																					
45	SUPERCONDUCTING MAGNETS										*						*	*			[*]	*
46	PLASMA/WALL INTERACTIONS (TEXTOR)				*		*				*						*	*	*		*	[*]
	HYDROGEN																					
47	HYDROGEN PRODUCTION FROM WATER			*	*		[*]			[*]	*		*				*	*			[*]	[*]

* *These projects were entered into after the period covered by the descriptions in this report.*
** These projects are the subject of Statements of Intent.
*** Finland, a non IEA country takes part in this project.
**** Mexico, a non IEA country will take part in this project.

* *Participation in project*
[*] *Operating agent*

Source: IEA: "Annual Report on Energy Research, Development and Demonstration, 1978-1979."