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(FOUO 19/81)

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ECONOMIC

MAJOR INDUSTRIES' PLANT, EQUIPMENT INVESTMENT PLANS FOR 1981 REPORTED

Tokyo NIHON KEIZAI SHIMBUN in Japanese 2 Feb 81 p 1

[Text] While decreased corporate profits are being predicted because of a stagnant economy, large industries are showing surprisingly strong interest in plant and equipment investment. According to the direct survey of 45 major industries conducted by the NIKKEI SHIMBUN, only six firms replied that the plant and equipment investment for 1981 (construction base--same below) would be below that of the previous year (nominal base) and although the increase is smaller than the increase of 1980, practically all of the enterprises planned bigger investments than the previous year. The management [of major industries] prediction holds true, in this respect, for all domestic plant and equipment investments. Supported by electric industry investments, managements seem to want to aggressively cope with technological renovations brought about mainly by electronics industry. Furthermore, the majority of these investments are dependent on private capital and hardly anticipate any monetary inducements such as the lowering of the official rate. However, plant and equipment investments of medium and small-medium enterprises are generally expected to decrease, except for some outstanding ones, and provide a sharp contrast with the situation of big industries.

The government's economic prediction for 1981 is that there would be a real growth rate of 7.3 percent and nominal rate of 10.7 percent, as compared with the previous year. However, the survey of 45 managements revealed that only 14 firms, or only 30 percent plus, planned investments exceeding 10.7 percent. In view of this finding, it can be said that while the investment interest of leading enterprises is strong, it is not as bullish as the government predicts.

However, only 13 percent of the firms replied that there would be a decrease in investments from the previous year. Furthermore, even firms that indicated decreases include some, like Bridgestone, which said that "investments would still be twice that of the average for the past several years." Considering the fact that the majority of the industries made the largest investments in 1980 since immediately before the first oil shock of 1973, investments planned for 1981 must still be considered firmly committed.

This outlook is apparent in the overall plans for non-governmental plant and equipment investments and in the managements' assessment of the government's economic prediction. Of the 45 firms, only six replied that the government's prediction was reasonable. The other managements are not as optimistic. However, 90 percent of the enterprises believe that the real growth rate would be over 5 percent. Converted to the nominal base, this would be a growth rate approaching the two-digit figure. This supports judgement of the managements among the major industries that non-governmental plant and equipment investment has a sound basis.

It appears that the biggest motive behind the interest of big industries in plant and equipment investments is to aggressively cope with technological renovations, including, first of all, the electronics breakthrough which is said to have triggered a new industrial revolution. In particular, the Matsushita Electric Industrial Co., Ltd. and Sony Corporation, which are expected to have increased demands for VTR (video tape recorder), are planning 40 to 50 percent increases over the previous year. On priority investment items, over 20 percent of all of the manufacturers stated, "new technologies and R&D of new products," and a noticeable feature was interest in items related to biotechnology (biochemistry). It seems to indicate the arrival of a new trend in technological renovations.

In both domestic and export demands, the outlook is cloudy for the automobile industries but the Toyota Motor Co., Ltd., is planning investments of 280 billion yen, its highest ever and an increase of 27.5 percent over the previous year. Investments to increase production were limited to the minimum and priority was placed on R&D of compact cars, the world market competition of which is entering a crucial period.

On the other hand, since 8 years have passed since the first oil shock, views are being expressed that investments for energy and resource conservation have "reached the uppermost limits technologically," but over 60 percent of the surveyed industries answered that "there would still be returns for the investments." Especially, of the non-manufacturing corporations, 11 of the 12 firms showed an aggressive attitude toward increasing investments for energy conservation purposes and there are views that "energy conservation for private homes will become important from now" (Yoshimi Mizukami, president of Hasegawa Komuten Co., Ltd.). Even in the manufacturing industries, new fields are opening technologically "because microcomputers have changed the purposes of energy conservation investment" (Yoshitaro Magoku, vice president of Toray Industries Inc.).

In this industrial situation, the noticeable feature of the recent survey was the fact that firms making investments to increase production had increased surprisingly. Firms which gave "increased productive capability" as their investment motive occupied over 60 percent of the entire group. Among these, in addition to electrical and automotive industries, basic industries such as steel, petrochemicals, etc. which had been making only renovation investments, are drawing attention by their participation. There are indications that the basic industries, which survived two consecutive oil shocks and received the direct blows of spiraling oil prices, have finally recovered and are beginning to have confidence in their future outlook.

Thus, following 1980, high investment levels are planned for 2 straight years but in raising capital, there are 25 firms, or over half, which plan to manage with their own funds. In reply to the question, "will investment plans be readjusted if the official rate is lowered during the investment period," only one firm replied that "there was a possibility of readjustment." It is clearly evident that big industries have drawn up the plant and equipment investment plans on the basis of their own firm economic assessments and will not be swayed by slight changes which normally occur in the economic environment.

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ECONOMIC

GOVERNMENT, PRIVATE STRATEGY FOR DEVELOPING NEW ENERGY RESOURCE

Tokyo ENERUGI FORAMU [ENERGY FORUM] in Japanese Vol 311 No 26, Nov 80 pp 66-82

[Article: "Japan's Challenge Extending Into the 21st Century; Resources Are Limited, but Technologies Are Not; A System to Tackle the Development of New Energy Has Been Organized with the Concerted Efforts of Government and People; This Event, Which Is Epoch-Making in Modern Japanese Industrial History, with Forceful Development of Strategy and United Efforts of Government and People, Will Bring Victory to Japan's Challenge Extending Into the 21st Century"]

[Text] Energy is indispensable in our daily lives and the development of economy and society. The demand for energy in this country has increased rapidly with the development of the economy so much so that Japan is today the second largest energy consuming national after the U.S.--one-tenth of the world's energy consumption.

What enabled such a rapid increase in energy consumption was cheap and plentiful petroleum. However, total dependence on petroleum made Japan's energy supply structure weak and fragile. The petroleum shock of 1973 revealed very clearly how much Japan's economy and society depended on imported oil.

The situation surrounding petroleum overseas since then has become more and more unstable. Every single event that takes place in the Middle East and its development is closely watched by the world, and everyone scrambles to secure petroleum for himself time and again.

In order to maintain and develop a modern economy and society which are built on the foundation of consuming a large amount of energy, how to overcome the insecurity surrounding petroleum becomes the most grave and urgent problem today.

For this reason, all major countries have each unfolded development of various energy resources to take the place of petroleum. In this country, too, in addition to the development of nuclear energy, further utilization of coal and LNG and development of new energy resources such as solar energy, geothermal energy, coal liquefaction and gasification, wind power and biomass are being tackled in earnest.

The Sunshine Plan was launched in 1974 and set into motion in order to push forward the activities related to research and development of new energy technologies among other endeavors systematically and in general.

The objective of the Sunshine Plan is to create clean energy through development of new technologies centered around four new energy resources; solar, geothermal, coal (liquefied and gasified), and hydrogen over an extended period reaching into the year 2000. Research and development activities over the past 7 years have progressed more or less smoothly, and some of the major projects have progressed from the basic research stage into the development stage including plant construction.

Stepping Up the Drive for the Sunshine Plan

A crisis in Japan's energy supply was again triggered by an Iranian disturbance the year before last. Internationally, an agreement concerning cutback on petroleum imports and development of energy resources as a substitute for petroleum was reached at the Tokyo Summit held in June last year. The understanding of the severity of energy situation was thus deepened and the expectation for the new energy was notably raised.

The attitude toward the drive of the Sunshine Plan was examined by every side against these settings. The New Energy Development Office belonging to the Industry and Technology Council, an advisory organ to the Minister of Commerce and Industry, has over the past 6 months repeatedly and carefully examined this matter and it has reported the need for stepping up the drive for the Sunshine Plan.

In response to the recent development in domestic and foreign energy situations, the report recommends that the Sunshine Plan, which was originally drafted as a long-range plan extending into the year 2000, be carried out in cooperation with the general energy policy in order to supply as much new energy as possible as soon as possible. Among all the development items being studied, those new energy technologies which show signs of being able to provide a large quantity of energy at an early stage should be given priority and concrete goals for the utilization of these new energy technologies be established.

Those themes which are to be given priority include coal liquefaction technology, deep geothermal power generation technology, and solar energy power generation technology.

Coal liquefaction technology is a technology which is to raise coal, the reserve of which far surpasses that of petroleum and is also distributed all over the world, to a level comparable with petroleum by eliminating the inconveniences of handling the solid fuel by converting it into liquid. This is the technology which is pursued most enthusiastically worldwide today.

According to the new Sunshine Plan, a goal has been set to supply an amount of energy equivalent to more than 15 million kiloliters (approximately 290,000 barrels/day) of petroleum in liquefied coal by 1990, and the development of pilot plants and demonstration plants is being pushed forward in earnest in order to establish the utilization technology as soon as possible.

The deep geothermal power generation technology is a technology which is to exploit the rich geothermal energy of this country which is well known for its volcanic activities and to utilize it for the purpose of power generation. The geothermal energy resources are purely domestic energy resources. A country in need of natural resources such as ours ought to try to make the best use of these geothermal resources to the best of its ability. In order to be able to realize large-scale utilization of these resources, in addition to the exploitation of the shallow (approximately 1,500 meter deep) geothermal energy, we ought to begin exploitation of the deep geothermal energy at depths in the range of 3,000-4,000 meters.

However, at such a depth, confirmation of its existence becomes increasingly more difficult and so is drilling on account of the higher temperature encountered. In order to make this exploitation economically feasible, both the exploitation technology and the drilling technology must be firmly established first. The new Sunshine Plan aims to supply an amount of energy equivalent to 7 million kiloliters of petroleum by 1990.

The solar energy power generation technology deals with an inexhaustible energy resource. However, its density per unit area is small and also varies widely according to the weather, time, and season. Therefore, the solar energy technology is a technology which attempts to concentrate the solar energy and transform it into a form which can be easily handled by man. Various technologies for converting the solar energy into these significant forms of energy include, for example, solar space cooling and heating system (the solar system) and solar energy power generation. The former in particular has already reached a stage to try out its popularization as a result of the past technological development. On the other hand, a solar power generator which can be installed for each family is considered to suit the situation of this country best, so that development of the technology which can lower the cost of solar power generator is being pursued in earnest today.

It is expected that this solar power generator and the solar system combined together will be able to convert solar energy equivalent to approximately 7 million kiloliters of petroleum and deliver it by 1990.

Therefore, the Sunshine Plan must be stepped up in order to achieve the goal of supplying a considerable amount of energy by 1990 and all efforts for development ought to be carried out with this goal in mind. An approximately similar conclusion was arrived at by the demand and supply study group of the general energy investigation committee which examined the perspective of energy demand and supply.

Conditions for Stepping Up the Drive of Sunshine Plan

In order to realize the goals indicated by these reports, and to carry out the Sunshine Plan in an effective format, it goes without saying that research and development must put emphasis on those technologies which are compatible with the existing energy supply system and are also easily applicable and popularized. At the same time, a system capable of strongly backing up a smooth execution of the speeded up plan must be built.

The following activities were carried out in 1980. (1) The fund needed for the long-range development was secured. (2) A Consolidated New Energy Development Organization which coordinates the development capabilities of the government, the academia, and the people was established. (3) A New Energy Foundation which coordinates efforts related to the new energy development and utilization and directs the course of action in the private sector was organized. (4) On the part of government, new legislation was passed which clearly defines the policies concerning development and introduction of various energies (including new energies) as petroleum substitute and development and introduction of alternate energies. Thus, the framework to promote the development of new energy has been completed. It is expected that efficient development and utilization of new energy shall be realized in the future by allowing these to function properly.

(1) Securing Fund for Long-range Development

The capital needed for development will increase rapidly when plant development begins in earnest in the future. In order to achieve the goals of the plan centered around the key themes, it is estimated that 2.4 trillion yen (public fund 1.6 trillion yen, private fund 800 billion yen) will be needed. In order to carry out the projects according to the plan smoothly, the required capital must be supplied to the system stably so that not only the general account capital must be expanded but also the special account capital must be put to practical use.

In 1980, an electric resource diversification account was newly established under the special account for the promotion of electric resource development, and at the same time an electric resource development promotion tax was introduced as the source of revenue. The fund for the development of power generation technology related to the development of energy as a substitute for petroleum is to be payed from this account. On the other hand, a special account for the coal and petroleum policy was renamed "special account for coal, petroleum, and petroleum-alternate energy," and the fund for the development of various technologies related to petroleum-alternate energy, except for the power generation technology, is to be payed from this account. As a result, a means of supplying the necessary capital in a stable manner for the development of new energy technologies which are expected to be utilized, especially for plant development which requires a large sum of money, has been established.

(2) Establishment of a Consolidated New Energy Development Organization

According to the Sunshine Plan, the basic research and elementary technology research are to be carried out at the national research institutes and universities. With the progress of these research activities, the work has gradually shifted to the plant development stage. Therefore, since 1977, all work related to the plant development was entrusted to the Electric Resources Development Co (Ltd.) to be handled collectively as part of its business activities.

However, in order to develop the pilot plant and the demonstration plant in earnest in the future under the premise of utilization, establishment of a strong and flexible development system which is capable of coordinating the capabilities and the vital forces of various organizations which are capable of carrying out the trial-and-error research development and of utilizing the results as well as the manpower overseas by carrying out the overseas joint venture development becomes indispensable. In October this year, a Consolidated New Energy Development Organization was established as a body to push forward the development of new energy and to carry out the functions mentioned above. In addition to carrying out technological development, it also promotes overseas coal and geothermal technology development by coordinating and assisting their activities.

(3) Beginning of a New Energy Foundation

To develop new energy technology and popularize it, it goes without saying that in addition to a powerful government policy, there must be serious support and cooperation on the part of the industry which must carry the burden of developing it into an enterprise and utilizing it. Frankly, the leading role of development and popularization must be played by the private sector, the energy user. Without positive participation by the private sector, the so-called technological development plan can be reduced to a painting on the wall.

Assuming that the government is to implement the policies described in (1) and (2) above, the private sector has expressed its participation in and positive support for the new energy development in the form of an official announcement on 17 September of the establishment of a New Energy Foundation. In addition to the technological development activities carried out by this organization, the foundation provides from the private sector support and cooperation to various activities related to the development of new energy technology carried out all over this country and straightens the course of action of technological development in this country by offering timely and necessary suggestions. In order to help new energy get a good foothold in this country, the foundation will consolidate various necessary conditions for the utilization and popularization of these technologies which have already been developed. Therefore, the foundation will promote coalition of the concerned enterprises interested in the development of new energy. Moreover, the foundation will serve as a private base to carry out exchange overseas.

Furthermore, by carrying out various business activities to promote activities in the private sector to develop medium and small scale hydropower, geothermal power, and local energy, the foundation is carrying out the function of a center on the private level to promote the development and introduction of the petroleum-substitute energy into this country.

(4) Legislation of Laws Promoting Development and Introduction of Petroleum-Alternate Energy

In order to aggressively carry out the development and introduction of petroleum-alternate energy including the new energies, cooperation and agreement between government and people are indispensable. This law prescribes the organization and the business responsibilities of the Consolidated New Energy Development Organization which is the nuclear driving force of the activities related to the development of the new energy. The law also makes it very clear that the goals of petroleum alternate energy development, or the "supply goals," are to be established by the Minister of Commerce and Industry through cabinet meeting, and that an "introduction guideline" to guide the private sector in introducing the petroleum alternate energy will be prepared and published. The future measures and direction of action are clearly prescribed by the law. Both government and people should exert their efforts according to what the law prescribes.

Thus, a system involving both government and people has been organized for the express purpose of pursuing the development of new energy technology. We must all work together within this framework toward the realization of depetroleumization--to capture the assurance of Japan's economic security.

[By Iwao Okayama, Research and Development Officer, Sunshine Plan Drive Headquarters, Institute of Industry and Technology: "New Energy--Development Plan for the Whole Project"]

Geothermal Energy--Establish New Exploration Technology In Order To Expand Utilization

This country is one of the prominent volcanic countries of the world so that it is considered to be endowed with a very rich geothermal energy resource. Namely, there are 65 volcanoes in this country and more than 200 so-called geothermal zones including these volcanoes. An estimate based on the data available from some 50 zones, the total geothermal energy reserve amounts to approximately 30 million kilowatts (kW).

Investigations carried out in the past were limited to local investigation of the telltale signs on the surface of the ground. A nationwide geothermal resource general inspection which was launched in 1980 and was to last 3 years is expected to provide a more reliable figure for the total reserve in the future.

There are six geothermal power generating stations in operation in Japan today, generating a total of 12,000 kW, and a 50,000 kW capacity station is under construction. Although there has not necessarily been sufficient development so far, according to a tentative perspective of the long-range energy demand and supply published by the consolidated energy investigation committee in August last year, development is expected to reach 10,000 kW by 1985; 35,000 kW by 1990; and 70,000 kW by 1995. This perspective is based on an assumption that geothermal power generation will become more and more economically competitive as the price of oil continues to rise and that the investigation of promising geothermal zones has advanced so much so that exploitation activities by the private enterprises have become very active.

As part of the geothermal energy utilization, power generation technology may be said to have reached the level of practical application. However, as a result of the Sunshine Plan and various activities related to the nationwide geothermal resource investigation together with the newly developed technologies, utilization of the geothermal energy is expected to increase by leaps and bounds.

To promote the development of alternate energy, a special accounting system was introduced in 1980 and the Consolidated New Energy Development Organization was established as the driving parent body of the system. Since then, the budget for the geothermal energy investigation and the technological development has increased from 3.576 billion yen in 1979 to 8.607 billion yen in 1980, and activities related to geothermal energy utilization including investigation and technological development have picked up speed.

The 1980 Work Plan

The 1980 business that can be carried out with the general account amounts to a total of 2.599 billion yen and consists of the following three parts.

The first part is the research and development work carried out continuously by the various laboratories belonging to the Institute of Industry and Technology. For example, development of exploration technology is carried out by the Geological Investigation Office; development of materials for geothermal application, by Tohoku Industrial Laboratory; and the high-temperature rock power generation technology and the drilling technology, by the Pollution Resources Research Institute. Each laboratory does its work aggressively by expanding its range of research work.

The second part is the research work entrusted to and carried out by the private enterprises. Work is entrusted to the individual private enterprises having superior technological power and special research and development qualifications. The technologies developed in this field include, for example, development of cement and mud for the geothermal application, development of the measurement technology used inside the geothermal well, study of the reduction mechanism of underground hot water, feasibility study of high-temperature rock power generation technology, technology for removal of hydrogen sulfide, and scale prevention technology.

The third part is international cooperation. We are involved in two international cooperation projects. The first project is one sponsored by IEA (International Energy Agency) concerned with evaluation of the new system and economic feasibility of artificial geothermal energy system (high-temperature rock).

The other one is participation in the Fenton Hill Project sponsored by the U.S. Department of Energy. This project, which is part of the Japanese-American Science and Technology Cooperation Agreement (signed in May 1979), is a serious joint development project following the nuclear fusion and coal liquefaction projects. The project is sponsored by the U.S. Department of Energy and is to last 5 years from 1980 to 1984. Its goals include demonstration and test of a high-temperature rock power generation system which is to extract 20,000-50,000 kW of geothermal energy by artificial means from the high-temperature rock. The project is to be carried out at Los Alamos Laboratory in New Mexico. The total cost of the project is approximately 15 billion yen, one-half of which is alloted to the U.S. while Japan and West Germany share one-fourth each. The cooperation agreement with the U.S. is being negotiated now.

The five projects which will be carried out under a special account have a total budget of 6.008 billion yen. These are large projects to be carried out according to the plan over several years under the new organization. The outlines of these projects are as follows.

Outlines of the Major Projects

(1) Nationwide General Investigation of Geothermal Resources

The newest and most advanced exploration techniques including exploration using space- and air-borne instruments will be employed. The investigation activities will be concentrated over the 3 years from 1980 to 1982 and the topographical structure, the geological structure, and data concerning the geothermal energy such as underground temperature distribution over the entire nation will be inclusively investigated in order to get a hold on the macrostate of the nationwide reserve of geothermal resources and to construct a nationwide "geothermal basic map," and also to carry out a general evaluation of the geothermal reserves.

As to the aerial exploration technique, a radar image method developed in the U.S.A. will be used to grasp in minute detail the rift structure over the surface of the earth and the Curie point method will be used to determine the depth distribution of a temperature of approximately 550 degrees in the bedrock.

Employing a space exploration technique, the LANDSAT images will be analyzed in order to identify the ring structure characteristic of a geothermal zone and also the thermal deterioration of the earth's surface. The underground structure will be made clear by a gravity investigation technique. These investigations will be carried out under the new organization; but the "national geothermal basic map" will be constructed by the Geological Investigation Office based on the newly gathered data as well as old data.

(2) Investigation to Verify the Geothermal Exploration Technology

The typical geothermal zones of this country such as "Seniwa area" (in Akita and Iwate Prefectures) and "Kurikoma area" (in Miyagi Prefecture) are to be used as the subjects of a study which will last 4 years from 1980 to 1983. In this study, a consolidated investigation of the earth's surface will be carried out by concentrating various known methods of exploration. A boring investigation will also be carried out, and the two groups of data thus obtained will be compared and their correlations will be studied in an attempt to systematize an exploration technology so that the probability of a reserve at a depth may be ascertained from study of the surface features.

In order to analyze the various data obtained from the surface investigation and from the boring investigation, and to understand the underground structure, a full-fledged analytical technique employing a large-scale computer will be developed by the Geological Investigation Office for the purpose of carrying out the actual data processing.

(3) Development of Power Generating Station With Hot Water Utilization

In order to utilize the hot water which always accompanies the steam used for geothermal power generation, development of binary cycle power generation technology, in which heat of hot water is used to generate a high pressure vapor from a medium having a low boiling point and its vapor is used in turn to generate electricity, will be promoted. Development of total-flow power generating plants, in which steam and hot water are utilized simultaneously in generating electricity, is also to be pursued.

The binary cycle power generation technology, in particular, has already been successfully tested with a 1,000 kW capacity plant built over 1977-78 actually using geothermal energy. Presently, technology for a practical 10,000 kW capacity plant is being developed.

(4) Development of Deep Strata Hot Water Supply System

Aiming at the development of stable geothermal energy of nonvolcanic origin which exists deep underground in plains for the purpose of space heating and agricultural applications, a demonstration test will be carried out over a period of 4 years from 1980 to 1983 at a site south of Akita City.

[By Hideyuki Hayashi, Research and Development Officer, Sunshine Plan Drive Headquarters, Institute of Industry and Technology]

Solar Thermal Power Generation and Solar Photovoltaic Power Generation

Development of Technology for Verification as well as Practical Utilization

Outline of Research and Development of Solar Energy

Solar energy, which is anticipated to be one of the most promising petroleum alternate energy resources, has enormous supply, is free from faulty distribution, and is inexhaustible. It possesses unique characteristics no other energy resources have. Although there are numerous ways of utilizing solar energy, the Sunshine Plan pushes research and development activities centered around the following three fields: application to space heating and cooling and hot water supply system; solar thermal power generation; and solar photovoltaic power generation.

Among these, the field of space heating or cooling and hot water supply system which requires thermal energy at a relatively low temperature of 100°C or so, a portion of the research results including the results obtained from experiment, research, and development of the solar system for private dwelling (newly built as well as existing), collective housing, and large buildings, and the results of material research and development centered around solar collector, have already been commercialized, and more and more homes privately owned, gymnasiums, schools, and business offices are beginning to use these devices of late.

It is estimated that more than 5,000 solar houses have already been built and those equipped with heating and cooling functions have increased significantly in number. Utilization of solar energy in the public welfare items such as space heating or cooling and hot water supply system is entering the stage of popularization today.

Therefore, research and development related to the application of solar energy in the future will put more emphasis on the power generation systems, of which, solar thermal power generation has a pilot system to be used for the verification purposes under construction. It is expected to be completed within this year. More about this system will be described later. From the viewpoint of research and development budget, therefore, we should like to focus our effort, for the moment, on development of technology related to solar photovoltaic power generation.

The budget for research and development of solar energy in the Sunshine Plan is as follows: The total budget for 1980 was approximately 9.5 billion yen. Approximately one-third of which is the construction cost for the solar thermal power generation pilot system.

For 1981, a budget of approximately 8.3 billion yen has been requested for the development of technology centered around application of solar photovoltaic power generation.

As to the research and development system, in addition to the basic research carried out at the national laboratories, various research and development projects are also entrusted to the universities (basic research) and private enterprises (research and development of applied technology and utilization technology). Moreover, we have maintained close cooperation with the Consolidated New Energy Development Organization which was launched on 1 October, letting this organization take charge of the development of system for verification such as demonstration project, and research and development for practical applications such as trial construction of manufacturing plant.

Solar Thermal Power Generation

A solar thermal power generation system is a system which efficiently collects solar energy, which is plentiful but low in density and becomes unavailable at night and in bad weather, stores it, concentrates it, and uses it to generate steam at a temperature higher than 300°C, then uses the steam to drive the turbine to generate electricity. Therefore, the key basic factor in the development is an effective collector and storage which will collect sunlight effectively and convert it into heat through a thermal medium.

Under the Sunshine Plan, research and development of two different systems of collector and storage are pushed forward. The first is the tower collector (concentration type). The sunlight shining upon a large site is reflected by a number of flat mirrors to a focal point near the top of a tower where the light is converted into heat.

The other is the curved surface collector (dispersion type) using both flat and curved mirrors. In this case, a large number of individual collectors are distributed over a site. Under the Sunshine Plan, one collector unit consists of five subunits and each subunit consists of a curved mirror which focuses light reflected from 20 flat mirrors arranged in a row.

In order to study the feasibility of these two methods applied to the solar thermal power generation experimentally, a pilot plant is being built today at Nio-cho, Sanho-gun, Kanagawa-ken. It is expected to be completed by the end of 1980. Each system has a capacity of generating 1000 kW of electric power. Being the first of the megawatt class pilot stations, their progress is closely watched by those concerned here as well as abroad.

Our future plan of action includes, in addition to the verification of function and performance from the test runs, various data, both technical and economic, which will be gathered and analyzed in order to identify points for improvement and to explicate various improvement measures. These activities are tied in with the future development and construction of the large scale plant for practical applications.

On the other hand, in order to achieve efficient utilization of thermal energy, basic research into compound thermo-electric supply system is also being carried out simultaneously. Construction of a pilot plant for the compound thermo-electric supply system is also under plan.

Solar Photovoltaic Power Generation

The solar photovoltaic power generation is a method of converting sunlight directly into electricity through a solar cell. Since this device does not have any moving parts, it is easy to maintain and manage. It is capable of generating electricity on site and can be made into module form so that it can respond to the demand easily. Because of these superior characteristics, its importance and potential have been recognized since the early stage of its development. However the solar cell is still very expensive so that today its applications are limited to unmanned lighthouses and radio relay stations.

Therefore, under the Sunshine Plan, our goal is to lower the price of solar cell to the order of 50-100 yen per watt by around 1991 and to popularize it to the order of 3 million kW. For the long-range goal, the price is to be further lowered. Therefore, the research and development plan consists of three pillars: reduction of cost; system technology for utilization; and standardization.

In order to lower the cost of solar cells, we have pushed the development of new methods of manufacturing solar cell elements (such as ribon crystal, membrane, and compound semiconductor) to substitute for the conventional silicon single crystal pull-up method. However, in addition to the costdown for silicon, automation and rationalization of solar cell manufacturing process too must not be neglected in order to achieve reduction of cost. We plan to construct test plants in the future and carry out development of technology related to this subject.

At present, our plan for 1981 activities includes construction of low-cost silicon refining plant of 10-ton capacity (high purity silicon of IC grade is used as raw material today) and construction of a solar cell assembly line having an annual production capacity of 500 kW. In addition to these, we also plan to push in earnest the development of amorphous solar cell which is said to be the favorite of the future solar cells and also possesses great potential for a significant costdown.

As to the development of system technology required for the utilization of solar cells, a few problems remain to be solved, such as interconnection with the existing power system and the tracking function in response to sudden changes in the weather conditions. Therefore, we plan to carry out various demonstration projects at residential homes, schools and factories in order to test and verify the effectiveness of the system (construction expected to be finished by 1982). In addition to these, we also plan to develop a system in which power is generated centrally (power station format).

On the side of standardization, it is our plan at the moment to develop a high performance solar simulator and to establish a foundation on which to unify the various disjointed methods of conducting evaluation of solar cell performance practiced today.

[By Ichiro Okada, Research and Development Officer, The Sunshine Plan Drive Headquarters, Institute of Industry and Technology]

Coal Gasification and Coal Liquefaction

From Understanding the Reaction Conditions to the Pilot Plant Stage

One of the links of the Sunshine Plan involves effective utilization of abundant coal resource as clean energy as a means of relaxing the energy crisis. By converting a solid fuel coal cheaply into a gas or a liquid, utilization of coal can be significantly simplified. At the same time, substances that pollute the environment can be removed from coal during the process of its phase conversion process. Research and development of coal gasification and liquefaction technologies in order to obtain clean and fluid fuel from coal have been going on for 7 years.

So far, the gasification and liquefaction reaction conditions have been made clear through the basic research related to the mechanism and catalytic action of gasification and liquefaction processes together with the elemental technology research related to the reactor and solid-liquid separator and various engineering problems related to the plant development are being solved today. We can say that research and development of technologies related to coal gasification and coal liquefaction are now at the stage of pilot plant.

Coal Gasification Technology

(1) High Calorie Gas Manufacturing Method

A process of manufacturing high calorie gas, which may be used as city gas or as an industrial fuel, by means of pressurized fluidized bed was developed in 1977 and 1978. Today, a pilot plant having a capacity of 7,000 m^3/day is being constructed. The future plan includes completing the plant in 1981, followed by test runs, and then operational research will be carried out in earnest in 1982.

As the next step from the pilot plant stage, a 50,000 m^3/day demonstration plant will be developed and, by 1990, a commercialized plant having a capacity of as much as 350,000 m^3/day is planned to be built.

(2) Low Calorie Gasification Power Generation Technology

A compound power generation system, which incorporates a technology of low calorie gas manufactured from coal and used for the purpose of power generation, is to be established. Today, operational research is being carried out at a plant having a capacity of treating 5 tons of coal a day. At the same time, another plant having a capacity of treating 40 tons of coal a day is being built. The future plan includes completing construction of the 40 ton/day plant during 1980, carrying out test runs, and beginning operational research with the plant in earnest in 1981.

As the next step from this study, a gasification demonstration plant having a capacity of 1,000 ton/day which is to be used in conjunction with a gas turbine of 100,000 kW capacity will be developed. On the other hand, high efficiency gas turbine of 100,000 kW class will also be developed and, by 1990, a practical combined gasification and power generation plant having coal treatment capacity of 40,000 ton/day and gas turbine power output of 4 million kW is to be developed.

Coal Liquefaction Technology

Development of a technology to convert coal into a liquid fuel similar to crude oil or petroleum has been pushed forward by the research of three different processes: the solvent extraction liquefaction process; the solvolysis liquefaction process; and the direct hydrogenation liquefaction process. At present, all three processes have progressed to the stage of bench scale plant handling 1-2 tons of coal a day.

The goal set for the development of coal liquefaction technology is to realize development of a practical plant by 1990. Yet, today we are only at a stage dealing with plants handling 1-2 tons of coal a day. A significantly accelerated drive will be required in the future.

(1) Solvent Extraction Liquefaction Technology

This is a method in which the soluble portion of coal is extracted by means of heat-treating a mixture of coal and coal-base solvent at a high temperature and a medium pressure. A bench scale plant capable of treating 1-2 tons of coal a day is being built today. The construction is expected to be finished by 1980 and then trial run will begin.

As the next step from the bench scale plant, conceptual design of a pilot plant capable of treating 250 tons of coal a day will be carried out.

The future plan includes the following based on the results obtained from the 1 ton/day plant: development of a 250 ton/day pilot plant and development of a commercialized plant of 25,000 ton/day capacity.

(2) Solvolysis Liquefaction Technology

This is a uniquely Japanese method in which coal is liquefied by means of heat-treating a mixture of coal and asphalt at a high temperature and a normal pressure.

At present, a process involving fused coal has been established and verification work using a bench scale plant handling 1 ton of coal a day has been completed. Extension of the process to micro-fused coal and reduction in the amount of asphalt used and other research to reform the process are being carried out today. Based on the results of these activities, reform of a 1 ton/day plant will be carried out in 1981 and development of new processes will be carried out in earnest.

The future plan includes, if the new process becomes established, development of a pilot plant capable of treating 40 tons of coal a day as the next step, followed by the development of a demonstration plant of 3,000 ton/day capacity and eventually development of a commercialized plant of 15,000 ton/day capacity.

(3) Direct Hydrogenation Liquefaction Technology

With this method, coal is liquefied by heat-treating a mixture consisting of coal, tar, and a mixed oil such as heavy oil in a paste-state at a high temperature and a high pressure. A bench scale plant capable of treating 2.4 tons of coal a day is being built today. The work is expected to be finished by 1981 and then test runs will be carried out.

The future plan includes, based on the results obtained from the 2.4 ton/day plant, development of a pilot plant having a capacity of treating 250 tons of coal a day, and then development of a commercialized plant having a capacity of 25,000 ton/day.

Research and Development System

Development of coal gasification and liquefaction technologies has been pushed forward since 1974 aiming at the long-range goals. However, in order to cope with the tense energy situations here and abroad, under the Sunshine Plan and in cooperation with the consolidated energy policy, the emphasis of the development plan has been shifted to supplying a considerable amount of energy by 1990.

Among various development themes studied so far, those new energy resources which appear promising and capable of supplying a large quantity of new energy quickly are singled out and specific goals for their practical application are established. Special emphasis is placed on the research and development of these key technologies in order to accelerate their progress. Development of coal gasification and liquefaction technologies is one of these key projects.

Therefore, we are charged with an important mission to develop before 1990 some practical plants. Yet, as described above, we have just begun to develop the pilot plant. We expect that we will have many difficulties to overcome in the future.

This plan is so enormous in scope that neither government nor any single enterprise alone can accomplish it. The government and people must work together in order to accomplish this important project.

Fortunately, luck is running high in the private sector, and since the Consolidated New Energy Development Organization was organized in October to push forward research and development jointly by government and people, the development system is now complete and ready. We expect that the activities related to research and development will pick up speed soon.

[By Koji Yoshino, Research and Development Officer, the Sunshine Plan Drive Headquarters, Institute of Industry and Technology]

Hydrogen--Staking the Dream of Technological Development on the Ultimate Energy for Mankind

Through its recorded history, mankind began to use wood and charcoal as fuel, then coal and petroleum, and in more recent years, natural gas. These are all hydrocarbons with progressively smaller carbon content. The activity as fuel seems to increase with a decreasing carbon content.

Liquid hydrogen used as rocket fuel in recent years may be regarded as a hydrocarbon fuel containing no carbon component.

From the changes in fuel over the years, we can see that hydrogen possesses the qualities to be called an ultimate fuel. The characteristics of hydrogen are as follows: (a) There is no limit to the supply of its raw material. The raw material for the production of hydrogen is the boundless water which can be obtained easily and at low cost. (b) It is essentially a clean fuel. (c) It does not upset the natural circulation. Hydrogen which is produced from water returns to water after burning and is instantly assimilated by the environment. (d) This energy can be transported and stored easily.

If hydrogen is generated at the site of a conventional power plant by means of electrolysis of water and the hydrogen thus produced is then transported via a pipeline (ground transport) or by a liquefied hydrogen tanker (marine transport), the energy can be transported more efficiently and economically. For long distance transportation (more than 500 kilometers), hydrogen is said to be more economical than electric power even if the extra cost for the electrolysis is taken into consideration.

It also enables storage of off-peak electric power of a nuclear power generation or electric power generated intermittently from solar energy, wind power, or wave power. Namely, such electric power may be converted into hydrogen and stored, or, supply and demand of the electric power can be regulated from a combination between the electrolysis of water and the fuel cell.

(e) Hydrogen has a broad spectrum of applications. It can not only substitute for petroleum as heat source in every field of application, but also be used as chemical raw material or in the fuel cell to generate electricity directly.

As described above, hydrogen is extremely versatile. When hydrogen can be produced cheaply in large quantity, a great change will take place in the existing energy system. It is expected that a hydrogen economy which is comparable to the electric power economy of today will be established in the 21st century.

Research and Development Plan and the Present Status

Research and development of hydrogen energy is being carried out as one of the links of the Sunshine Plan which was launched in 1974. This year was the last year of the first 7-year period and considerable results have been achieved.

The long-range research and development plan for hydrogen energy under the Sunshine Plan is as shown in Fig. 1 while Table 1 summarizes the budget for research and development of hydrogen energy technology invested so far. Fig. 2 illustrates the hydrogen energy research relationship system.

(1) Hydrogen Manufacturing Technology

Traditionally, hydrogen is manufactured mainly from naptha and natural gas by means of steam reforming process or as a byproduct of electrolysis of sodium chloride as a process of manufacturing caustic soda.

(a) Electrolytic Method

Electrolysis of water is a method of manufacturing hydrogen well known from very early days. It used to be the major process of manufacturing hydrogen until a method of obtaining hydrogen more cheaply from naptha was introduced. However, as the price of petroleum continues to rise, manufacturing hydrogen from electrolysis of water has caught the attention once again. More will be expected of this process when hydrogen is viewed as a medium for storing the off-peak electric power of a nuclear power generation and the electric power which is generated intermittently from such energy sources as solar energy and wind power.

At present, when electric power is obtained mainly from fossile fuels, hydrogen manufactured by means of electrolysis cannot compete. Therefore, the goals of research and development consist of significant improvement in the efficiency of electrolysis of water, reduction in the size of equipment, and reduction in cost. Therefore, research activities related to the improvement of electrode and diaphram, and raising the pressure as well as the temperature of the process are aggressively pursued.

Specifically, development of an electrolytic plant to carry out the process at 120°C and 20 atmospheres (conventional process: 80°C and normal pressure) and the related elemental research are being pursued.

An experimental plant having a capacity of 4 Nm^3/h was completed in March this year. It is being test run and evaluated now. Based on the results of this test, construction of a pilot plant having a capacity of 20 Nm^3/h will be planned.

Research on electrolysis of water using solid electrolyte is also being pursued. This method of electrolysis employs an organic polymer solid electrolyte membrane (such as NAFION by DuPont) which is a kind of ion exchange membrane. Use of membranes enables the device to be made compact. However, there are other problems which require solution such as the material used and development of electrode and catalyst and the method of attaching them on the membrane which is strongly acidic.

A device for electrolysis of water having a diameter of 200 mm is under construction today based on the experience gained in the past.

(b) Thermo-chemical Method

In an electrolysis process, production of hydrogen from an energy source involves three stages of energy conversion; namely, from thermal energy to mechanical energy, to electrical energy, then to hydrogen. Therefore, the overall conversion efficiency comes to only about 30 percent. In order to raise this efficiency, one of the methods of direct conversion from thermal energy to hydrogen energy employs a combination of several chemical reactions involving alkaline earth metals, iron, sulfur, and halogens at a temperature under 1,000°C and produces hydrogen in effect by the reaction $H_2O=H_2+1/2O_2$ while these materials are recycled and used repeatedly.

Research work related to this method was started at the end of 1960 as a link of the nuclear furnace heat utilization project by the European Nuclear Power Co-op. Since then, research on thermo-chemical method has been carried out extensively and numerous thermo-chemical cycles have been proposed.

The thermo-chemical method is still at the basic research stage; many years and months must pass before we can see its practical application. At Ispura Institute, cyclic operation is already being tested in a glass apparatus. Under the Sunshine Plan, four kinds of cycles are under study, but they are all at the stage of basic research.

(c) High Temperature Direct Thermal Cracking Method

In this method, water is dissociated into hydrogen and oxygen (approximately 50 percent) at a high temperature in the range of 2,500-4,000°C and hydrogen is swiftly separated from oxygen. Nuclear furnace and solar furnace are considered as the source of heat for this process. The method is also at the stage of basic research. However, generation of hydrogen was confirmed in a high temperature xenon arc image furnace simulating the solar furnace. There are many problems related to this theme that must be solved including development of materials that can withstand such a high temperature and establishment of a gas separation technology.

(2) Technologies Related to Transportation and Storage of Hydrogen

At present, transportation and storage of hydrogen are carried out in bombs (gaseous hydrogen) and cryogenic containers (liquid hydrogen). These means are disadvantageous because special treatment and containers are required.

On the other hand, hydrogen has a high tendency to combine with metals and form metal hydrogen compound. The occlusion rate is very high, as high as the density of liquid hydrogen. Research into promising metals and various systems of transportation and storage using these metals is being carried out.

Most recently, transportation and storage of hydrogen using microballoons have caught the attention of those concerned.

(3) Utilization of Hydrogen

(a) Combustion Technology

The combustion temperature of hydrogen is very high, and its combustion rate is very fast so that there are problems related to formation of NO_x and backfire. Nevertheless, it is anticipated that basically no difficulties will be encountered in its practical application in the future.

At present, research and development activities centered around catalytic combustion of hydrogen most suitable for kitchen and space heating applications are being pursued.

(b) Fuel Cell

The principle of the fuel cell is the reverse of electrolysis of water. The chemical reaction between hydrogen and oxygen is converted into electric energy and utilized. It involves a simple conversion from chemical energy into electric energy, so that electric power generation at an efficiency much higher than that attainable by the thermal power generation (approximately 40 percent) can be realized theoretically.

Other application technologies that are studied include a study of prime mover. Just like combustion technology, prevention of backfire and generation of NO_x are the main problems that remain to be solved. So far some success has been achieved with a single cylinder engine by introducing a third valve.

International Cooperation

Hydrogen has, not only in Japan, also caught the attention of the European countries as the ultimate fuel of mankind.

In "the Third World Hydrogen Energy Conference" held in Tokyo in June this year, 480 delegates representing 25 countries presented numerous theses and exchanged information among themselves.

A Hydrogen Work Panel was organized under the international organization dealing with the energy problem, i.e., IEA, and an "association to carry out research and development plan related to manufacturing of hydrogen from water" was signed in October 1977. Japan, jointly with nine European countries, has also joined this association in order to participate in this international cooperation in research.

At present, the cooperation is mostly limited to exchange of information. If the cooperation can be pushed one step further to include such activities as joint research effort, exchange of researchers, and divided tasks, development of hydrogen energy technology may be able to achieve results more rapidly.

[By Tsutomu Makino, Research and Development Officer, the Sunshine Plan Drive Headquarters, Institute of Industry and Technology]

Ocean and Wind Power

From the Stage of Basic Research to the Stage of Practical Application

The consolidated research under the Sunshine Plan not only has a system of constantly gathering new academic and technological information but also searching to discover seeds of energy technology which have not yet been systematically researched. Basic and experimental research works and investigative works on promising seeds have been carried out in order to promote their growth. As a result of past research, a number of seeds are found to germinate in recent years.

"Ocean temperature differential power generation" utilizing ocean energy and "wind power generation" utilizing wind energy belong to this category. In its interim report concerning the strategy for accelerated drive of the Sunshine Plan presented in November last year by the New Energy Technology Development Group belonging to the Industry and Technology Council which is an advisory agency to the Minister of Commerce and Industry, these two subjects were picked up together with the four themes discussed above as the focal points of future effort.

Ocean Temperature Differential Power Generation

Ocean temperature differential power generation utilizes a temperature differential of 20°C or so that exists between the warm sea water near the surface of the ocean and the deep cold sea water to generate power by means of a thermal cycle. The estimated total power generation potential due to ocean temperature differential power generation in Japan's economic waters (within 200 miles) is said to be approximately 100 trillion kW-h/yr. This resource may be considered boundless so that the selection of location in response to the demand and according to the technology and economic condition is the only remaining problem.

Furthermore, combination between the warm water discharged from the thermal power or nuclear power station and the deep cold sea water or utilization of solar pond can also be considered. Although the efficiency is low because the temperature differential is only 20°C or so, it is characterized by the boundless amount of energy which enables steady continuous operation. According to an estimation, a several megawatt class generator can compete with a diesel generator used in the offshore islands, and a 100-megawatt class practical plant can compete with a conventional power plant.

So far, development of heat exchanger and study of its characteristics in the oceanic environment, research of corrosion and biological pollution of its structural elements, investigation of oceanic conditions, construction of resource distribution map, and conceptual design of experimental and practical scale plants have been carried out. Beginning in 1980 or 1981, evaluation of the security of power generating system (closed system), investigation of ocean environment, and research and development of new power generating cycles (thermal power generation method) and the structural elements will be emphasized. Consolidating the results achieved in the past and the results which will be achieved by these efforts, a feasibility study of a 1,000-kW class pilot plant will be carried out and the course for future design and construction will be charted by the results of these studies.

Although the Sunshine Plan aims at the development of large capacity ocean-based installation, there are also small capacity land-based power stations. For example, construction of a 100-kW unit on the Nauru Island designed by the Toden, and a 50-kW unit of land-based installation on the Tokunoshima designed by the Kyushu Electric Power are being planned. In addition to these, the Saga University conducted a mid-ocean experiment last October off the shore of Shimane, while an experiment is being carried out with an experimental plant built at Imanri.

The efficiency of this cycle is inherently low because a temperature differential of only 20°C or so is utilized and the true efficiency will be even lower because a considerable amount of power is consumed in pumping the sea.water. Therefore, one of the future research effort will be the development of technology to improve the cycle efficiency. There is scale merit to the construction cost, so that a large scale installation of 100-megawatt class must be built in order to reach the economic base of the conventional electric power plant. Development of a large scale installation may be beneficial to the fishing industry, because the nutritional salt component of the deep is brought to the surface. However, its environmental impact must be carefully assessed before any action is taken.

Wind Energy Power Generation

Wind energy power generation is a method of generating power by converting wind energy by means of a windmill into a rotating power which drives a generator. The wind energy resource of this country is quite abundant; as much as 7,000 trillion kW-h/yr, and according to an estimate, approximately 5,000 power generating windmills of 1,000 kW class can be installed. The possible power generating capacity will be even larger if the mid-ocean locations are also included.

Wind energy is characterized by its low density (on average, 150-200 W/m^2) and large fluctuations. Therefore, the main theme of research and development consists of how these problems may be overcome and how the energy may be utilized effectively. The cost for power generation of 100 kW class unit is said to become competitive with the diesel power generation unit used on the offshore island and the cost of 1,000-3,000 kW class practical unit will be comparable with the conventional method of power generation.

In this country, research and construction of a small scale system of several kW class have been carried out under the Wind Topia Plan sponsored by the Science and Technology Office. However, we lack the experience of constructing large capacity installations. Therefore, under the Sunshine Plan, research and development of elementary technology, investigation of wind data, and conceptual design of large capacity installations have been carried out by various research institutes and private enterprises since 1978. As a result of these efforts, the feasibility of large scale wind energy power generation in Japan has been established and research and development of 100 kW class wind energy power generating system will begin in 1981.

At the same time, construction of a wind energy power station of the same class on Miyake Island was under consideration by the Tokyo Power Co. Therefore, these two projects were combined and reorganized into a single plan and it was decided that further research and development activities would be carried out under the Sunshine Plan.

The future schedule includes manufacture and factory testing of various elements in 1981, construction in 1982, trial runs including link-up with the power system in 1983-4, and research and development of even larger capacity installations based on the results obtained from these activities.

The research topics of the future include the solution of technological problems related to improving the equipment efficiency and responsiveness to the load condition of a system which utilizes the low density and variable wind energy, development of various technologies to handle the unique wind characteristics including turbulence created by the mountains and typhoon, reduction of noise and electric wave disturbances, and thorough environmental assessment to prevent destruction of scenery.

Other Ocean and Wind Energy Utilization

Research related to desalination of sea water utilizing the ocean temperature differential to vaporize sea water under reduced pressure, then condense it is being carried out by Nagasaki University. They successfully carried out a small scale mid-ocean experiment this July.

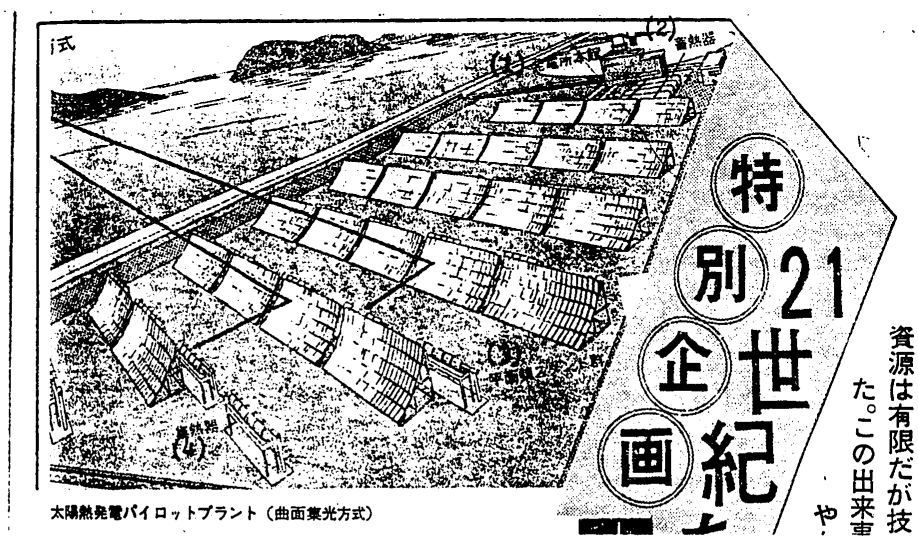
Various small scale devices for generating power utilizing wave energy have been developed since about 10 years ago and actually used as the power source for illuminating lighthouses and buoys by the Maritime Safety Agency. Aiming at development of large scale equipment, the Ocean Science and Technology Center constructed an experimental ship "Kaimei" carrying on board nine air turbine generators and carried out various experiments over a period of 2 years from 1978 to 80. They found that the stern generator was able to generate a maximum of 300 kW with an average of 50 kW. They have also successfully carried out experimental transmission of power ashore.

In addition to these, research activities related to the development of various forms of wave energy power generation are also being carried out by many private enterprises. Furthermore, tidal power generation utilizing the range of the tide and ocean current power generation utilizing the kinetic energy of the ocean current and other ideas are also being studied.

Concerning utilization of wind energy, there are plans to develop other forms of application besides power generation such as converting wind energy into thermal energy or dynamic energy and utilize it directly, or stored for future usage.

Japan is a small country ranking 51st in the world in land area. However, its economic waters have an area which is 12 times its land area, so that when these are counted together, it ranks 10th in the world. Ocean energy and wind energy are both a form of solar energy, so that the total amount of energy obtainable over this vast area is enormous.

As the Middle East situation grows tenser and tenser and the supply of petroleum becomes less and less stable, the need to put these clean and renewable energies to good use becomes more and more urgent. Both government and the private sector must work together to cultivate a few new energy technologies such as ocean temperature differential power generation and wind energy power generation which have germinated from the seeds into splendid young trees today. This is our urgent task.



Solar thermal power generation pilot plant (curved curface focusing format) (p 66)

Key: (1) Power station building
(2) Thermal energy storage
(3) Cluster of mirror stands
(4) Heat collector

研究開発所要資金見通し

(1) 55～65年度研究開発所要資金	2兆4,000億円	公的資金	1兆6,000億円	
		民間資金	8,000億円	
(2) うち55～60年度	〃 7,000億円	公的資金	5,800億円	
		民間資金	1,200億円	

(3)(単位：億円)

	51～54	55～60	61～65	55～65
(4) 太陽	90	700	300〈2,000〉	1,000〈2,000〉
(5) 地熱	110	700 〈600〉	200 〈800〉	900〈1,400〉
(6) 石炭	60	4,000 〈600〉	8,500〈4,000〉	12,500〈4,600〉
(7) 水素	20	100	300	400
(8) 総合研究等	30	200	900	1,200
(9) 計	310	5,800〈1,200〉	10,200〈6,800〉	16,000〈8,000〉

(10)(注) 1. 〈 〉内は民間資金で外数である。
2. 公的資金はデモンストレーションプラント開発段階までであり，実用化1号プラントの開発は民間資金によるものとした。
3. 以上の研究開発費の他に普及する助成資金が別途必要である。

サンシャイン計画が発足し、実施 技術を中心として
移されている。 西暦二〇〇〇年ま

Perspective of Funds Required for Research and Development (p 67)

Key: (1) 1956-65 fund required for research and development: 2.4 trillion yen (Public fund = 1.6 trillion yen; Private fund = 0.8 trillion yen)
(2) 1955-60 fund as part of (1) above: 700 billion yen (Public fund = 580 billion yen; Private fund = 120 billion yen)
(3) Unit: 100 million yen
(4) Solar
(5) Geothermal
(6) Coal
(7) Hydrogen
(8) Consolidated research
(9) Sum total
(10) Note: 1. Figure inside 〈 〉 is private fund and so is an external figure. 2. Public fund covers up to the stage of demonstration plant development. Development of practical application No 1 plant is to be covered by the private fund. 3. In addition to the funds for research and development enumerated above, some subsidiary funds will be needed for the purpose of popularization.

太陽エネルギー研究開発予算 (1)(単位：100万円)

	(2) 55年度	56年度(要求額)	(3) 主要なプロジェクト
(4) 太陽熱発電	6,678	1,624	熱発電プラントの運転研究など
(5) 太陽光発電	2,288	6,090	デモンストレーションシステムの開発，光発電システムの開発，低コスト・シリコン精製実験プラントの開発，太陽電池製作，実験プラントの開発，アモルファス太陽電池の開発など
(6) 冷暖房・給湯	510	533	長期蓄熱技術の研究開発，産業用ソーラー・システムの技術開発など
(7) その他	77	77	
(8) 合計	9,553	8,324	

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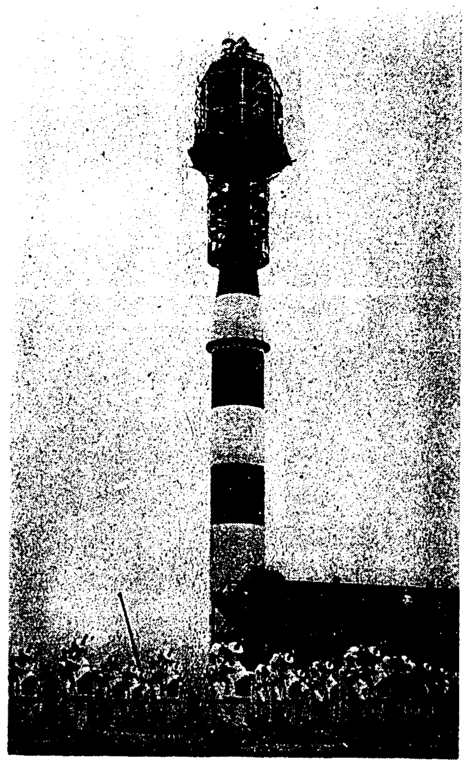
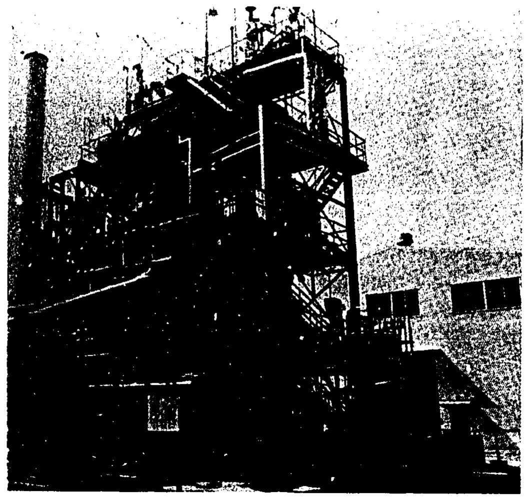
Budget for Research and Development of Solar Energy (p 73)

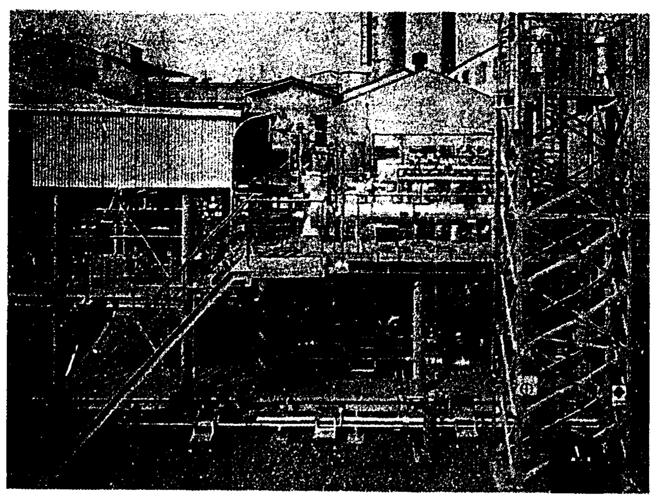
Key: (1) Unit: million yen
(2) 1955 1956 (requested amount)
(3) Major projects
(4) Solar thermal power generation: Operational research of thermal power generating plant
(5) Solar photovoltaic power generation: development of demonstration system; development of photovoltaic power generation system; development of low cost silicon refining experimental plant; construction of solar cell; development of experimental plant; and development of amorphous solar cell.
(6) Space heating and cooling and hot water supply: research and development of long term heat storage technology; development of industrial solar system technology
(7) Other
(8) Sum total



A 1,000 kW Tower Focusing System under construction (Nio-cho, Kanagawa-ken) (p 73)



A coal Liquefaction Plant, capacity 1 ton/day (Nagasaki-ken) (p 75)



A Hydrogen Manufacturing Test Plant, capacity 4 Nm^3/h (p 77)

水素エネルギー技術研究開発予算 (1)(単位：100万円)

(4) テーマ \ (2) 年度	49	50	51	52	53	54	55	(3) 合計
(5) 1. 製造技術	138	201	224	325	381	482	719	2,470
(6) 2. 輸送・貯蔵技術	39	48	37	51	53	55	64	350
(7) 3. 利用技術	100	136	109	87	77	75	90	674
(8) 4. その他	55	78	84	57	76	78	78	506
(9) 合計	332	463	454	520	590	690	951	400

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たがって、技術開発によって

Budget for Research and Development of Hydrogen Energy Technology (p 79)

Key: (1) Unit: million yen
(2) Year
(3) Sum
(4) Theme
(5) Manufacturing technology
(6) Transportation and storage technology
(7) Utilization technology
(8) Other
(9) Sum total

図 1. 水素エネルギー技術研究開発長期計画図

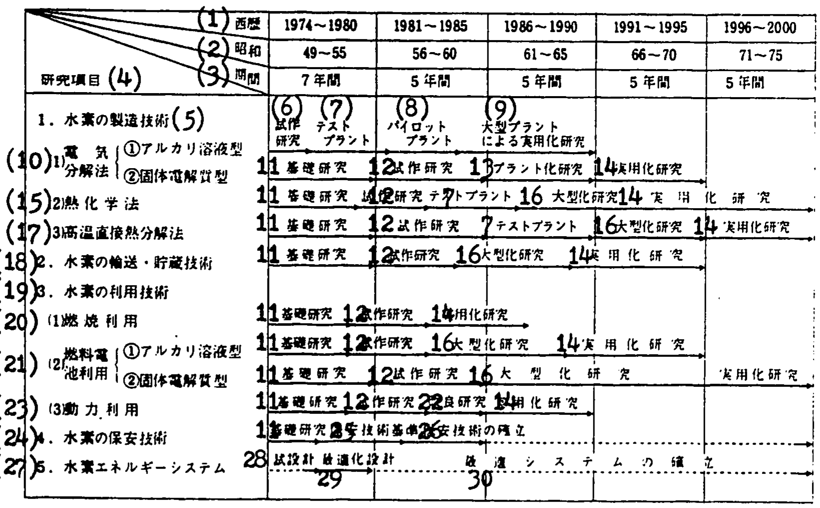

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Fig. 1 Long-range Research and Development Plan for Hydrogen Energy Technology (p 79)

Key: (1) A.D.
(2) Showa
(3) Period
(4) Research items
(5) Hydrogen manufacturing technology
(6) Trial manufacture research
(7) Test plant
(8) Pilot plant
(9) Application research using large scale plant
(10) Electrolysis: 1. Alkaline solution; 2. Solid electrolyte
(11) Basic research
(12) Trial manufacture research
(13) Plant research
(14) Utilization research
(15) Thermo-chemical method
(16) Large scale research
(17) High temperature direct thermal cracking method
(18) Hydrogen transportation and storage technology
(19) Hydrogen utilization technology

(20) Combustion utilization
(21) Fuel cell application: 1. Alkaline solution type; 2. Solid electrolyte type
(22) Improvement research
(23) Power utilization
(24) Hydrogen safety technology
(25) Safety technology standard
(26) Establishment of safety technology
(27) Hydrogen energy system
(28) Trial design
(29) Optimization design
(30) Establishment of optimum system

図 2. 水素エネルギー研究開発体系

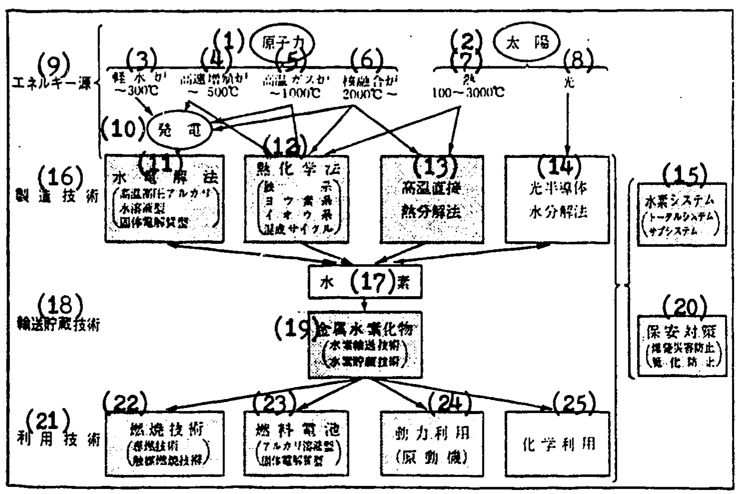

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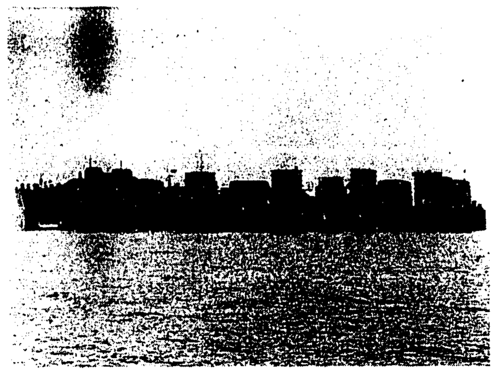
Fig. 2 Hydrogen Energy Research and Development System (p 79)

Key:
(1) Nuclear energy
(2) Solar energy
(3) Light water furnace
(4) High speed breeding furnace
(5) High temperature gas furnace
(6) Nuclear fusion furnace
(7) Thermal
(8) Photovoltaic
(9) Energy source
(10) Power generation
(11) Electrolysis of water (high temperature, high pressure alkaline solution or solid electrolyte)
(12) Thermo-chemical method (iron, halogen, sulfur, mixed cycle)
(13) High temperature direct thermal cracking method
(14) Photovoltaic seconductor hydrolysis method
(15) Hydrogen system (total system, subsystem)
(16) Manufacturing technology
(17) Hydrogen
(18) Transportation and storage technology
(19) Metal hydrogen compound (hydrogen transportation and storage technology)
(20) Safety measure (prevention of explosion and hydrogen brittleness)
(21) Utilization technology
(22) Combustion technology (special combustion technology, catalytic combustion technology)
(23) Fuel cell (alkaline solution type, solid electrolyte type)
(24) Power utilization (prime mover)
(25) Chemical application



Experimental ship "KAIMEI" carrying on board air turbine power generators (p 81)

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SCIENCE AND TECHNOLOGY

NEW TECHNOLOGICAL FIELDS OF GENETIC ENGINEERING, MICROCOMPUTERS ADVANCING

Tokyo MAINICHI SHIMBUN in Japanese 5 Jan 81 p 15

[Interview with Huga Saito, Professor of Tokyo University, interviewed by Kenji Makino, Editorial Staff; Ryoichi Mori, Professor of Tsukuba University, interviewed by Hideo Hisano, Editorial Staff]

[Text] Two technologies appear to have unlimited potential today--biotechnology and electronics. In particular, the genetic engineering and microcomputer fields are making rapid advances. Research and development in these areas are very competitive. How far will they advance and what will they bring to our lives? We have asked two scientists to speak about the outlook for the respective technology fields.

Interviewers:

Genetic Engineering--Editorial Staff, Kenji Makino

Microcomputer--Editorial Staff, Hideo Hisano

Genetic Engineering

Toward Development of Yeast and Bacillus Subtilis Utilization

[Interviewer] Through genetic engineering it would appear that we can make useful materials that are not obtainable by any other method.

[Saito] The currently most advanced technology is the injection of a certain human gene into coli bacteria to obtain that gene's primary product. This primary product is protein--a small amount of which is physiologically effective and which has a high additional value.

Some are already at the test production stage: a variety of hormones called stomatostatin, insulin, growth hormone, interferon. All these are results achieved in genetic engineering led by the Genentech Corporation (U.S.)

Eli Lilly Company, for instance, is culturing coli bacteria in 1 and 2 ton capacity tanks for insulin production. Clinical testing of the product has already been started and it might become commercially available perhaps even within this year. It is development that has taken a shorter time than anyone anticipated.

Others under research include: vaccines for cattle disease--prunella (hoof and mouth disease), influenza, type B hepatitis and enzyme called urokinaze which dissolves thrombus. Switzerland's Biogen Corporation appears to be the leader in type B hepatitis vaccine development and it has already made contacts with the Japanese companies.

[Interviewer] What items appear promising besides the primary products?

[Saito] Improvements in the bacilli which will heighten the desirable basic characteristics of micro-organisms or change them at the convenience of humans. For example, a bacillus called methylophillus which makes protein from methanol wastes energy. Thus the ICI--an English chemical firm--substituted methylophillus ammonia replacement gene with energy saving colitis germs and it has applied for patent for this innovation. The new procedure should yield a 5 percent saving of methanol.

Production of energy materials--foodstuff, cattle feed, ethanol and so on--are possibilities. Seasonings, antibiotics, amino-acids are all produced by micro-organisms now but better products will be obtained through better technology

[Interviewer] Can micro-organisms other than colitis germs be used?

[Saito] Yeast and bacillus subtilis. Yeast is widely used in liquor and bread production and since they are encaryates, we can expect characteristics that are closer to higher organisms. Bacillus subtilis which will be licensed soon has a related bacillus that is used in fermented bean--natto--manufacture and it is also used in industrial production such as amylase. In either case, we have had more experience using them than colitis germs and they are advantageous in that the product is secreted outside the body of the bacillus. This type of micro-organism utilization is what Japan is interested in developing in the future, but in terms of technological development, this field is several years behind the colitis germ technology.

Genetic Treatment, Still Realm of Fantasy

[Interviewer] Setting aside single cell micro-organisms for the moment, what about betterment of multi-cell animal and plant life?

[Saito] For plants, I think it would be relatively easy because it is possible to build an individual plant from one somatic cell. And if that cell's genes are manipulated, it is possible to introduce a characteristic of say, high resistance to blight and harmful insects. In the United States, such research, being conducted by seed companies and the like, is in a quite advanced stage. In this field, Japan has its own technology that it has developed as well and the results will emerge by the by.

But when it comes to animals, as of now, an individual animal life can only be created from an embryo--a collection of several cells. And when the object of creation is human.... We are not yet in a position to predict the time when genetic treatment will become a daily, routine function.

[Interviewer] What do you think about the current "mood" which can perhaps be described as "genetic engineering fever"?

[Saito] Although the general impression appears to be one of great gain with very little effort, I think the situation will calm down hereafter. All kinds of genetic engineering primary products will become commercially available in 3 to 4 years. Improvement of micro-organism species will take longer. For that, comprehensive biotechnology is necessary. Therefore although more than 60 firms are actively pursuing biotechnology now, only about 20 will survive. I remember when commercial production of penicillin began in 1948. At that time 70 firms undertook to manufacture it. After 1 year, only four companies survived the competition. Of course, the technology developed along the way did pave the way for modernization of Japan's zymotechnology. In England and France genetic engineering enterprises are assisted by the government. This is probably a reflection of their long-range strategic planning in this field.

Theoretical Aspects and Safety Factors Ought To Be Scrutinized

[Interviewer] How will genetic engineering progress in the future?

[Saito] There will be continued development into the 21st century. It can be seen as the basic technology that will revolutionize all of the biological industry and nearly all segments of the chemical industry. There will also be contributions in food and energy sectors through the use of bio mass [transliteration]. For example, I think there will be a development of a micro-organism that can dismantle the wood cellulose efficiently and turn it into food and energy.

[Interviewer] Are such applications possible by applying the technology we have on hand or do we need new technological breakthroughs in order to obtain them?

[Saito] Extension of present-day technology will probably be sufficient to bring about the changes described. The difficulties associated with genetic regrouping technology have remained pretty much unchanged from the beginning (initial predictions). As a result of the increased number of researchers in this field, the pace of progress, if anything, has quickened. Of course, new obstacles will arise. For example, there has been a chance discovery that the genes of organisms having a true cell nucleus is not connected on a single DNA chain but are found in bits and pieces; but such problems can be conquered.

[Interviewer] As technology advances, are there things we should be careful of?

[Saito] Genetic engineering ought to be practiced but it includes a number of topics which we should be well aware of. Genetic treatment of humans involve philosophical issues. Utilization of pathogenic bacteria and toxin producing bacteria, manipulation of cancer causing genes, mass culture of improved micro-organism species are some additional controversial topics. With regard to cancer causing genes, the result of research has informed us that rather than dealing with cancer causing virus, reliance on the DNA based process will be much less dangerous. U.S. businesses are forerunners in safety research concerning genetic engineering.

[Interviewer] Would you comment regarding Japan's research capability in the genetic engineering field?

[Saito] Let us compare the number of research applications related to genetic regrouping--between Japan and the United States. In the United States, there were approximately 600 applications to the National Institute of Health last year; and this year, there will be about 800 filings. In Japan, there were 94 applications to the Ministry of Culture last year and about 170 are expected this year. However, the guidelines (manual or experiments) are much looser in the United States and it has more research which does not require permit application, so the differential is probably more like 10 to 1. The question is how far this gap can be closed.

Microcomputer

Prospects: Peak in 30 Years

[Interviewer] The topic on which we would like you comments is computers, especially how the microcomputer and its application--which is making rapid progress--will advance in the future.

[Mori] With regard to the microcomputer, there is a prediction made by Mr Fargin who established Zilog Inc (U.S.). This man is known as one of those who developed the 280--an excellent microcomputer. He predicted how far the micro-electronics technology could go, given the current pace of development. According to his prognosis, gate number will go up to 100 million and power consumption per gate will go down from the current $\frac{1}{5000}$ watts per gate to $\frac{1}{100,000,000}$ watts per gate.

[Interviewer] A typical value now is about 5,000 gates, is it not?

[Mori] Yes. Gate number ought to be regarded as logic capacity rather than memory capacity. Some 10,000 gate machines are being test produced now. So the prediction is that the microcomputer of the future will be about 10,000 times more sophisticated.

[Interviewer] When will that be realized?

[Mori] Plotting the rate of progress and the time frame thus far on a graph and continuing the direction into the future gives us 100 million gate machine around the year 2007. By maintaining the current speed of development, about 30 years from now.

Weight of Human Existence Will Be Demonstrated

[Interviewer] It has been 35 years since the first computer (ENIAC) came into being. The Computer sector is still on the upward swing, development-wise.

[Mori] It may be that the momentum will slow down in the future. But microcomputer development will not stop for a while. At least during our children's life time, the microcomputer field will continue to progress.

[Interviewer] If computer technology advances that far, would it not equal the human brain in its capability?

[Mori] Regardless of how far the computers may advance, the choice of whether or not to accept or reject the computer will be man's. In the first place, there is no comparison between a computer and a human being. In relation to recent super LSI development, there has arisen a comparison about so many super-LSI equalling a human brain cell; but it is a big mistake to equate the number of computer's transister-like elements with the number of human brain cells.

[Interviewer] Why?

[Mori] Human brain cells are said to number about 14 billion. Two hundred fifty-six kilo-byte IC memory has already been developed in Japan; and the availability of 1 mega byte (1,000,000) memory is near at hand. In terms of numerical comparison, if there are 14,000 one mega byte memories, that should equal a human brain. But does that give you the feeling that memory can function as well as a human brain?

[Interviewer] With 14,000 one mega byte memories........No, I don't think so.

[Mori] A single human cell contains so many fantastic functions such as heredity and correcting body malfunction and so forth. None of its functions can be copied by the currently available super-large computers. When I translated human logical capability into a numerical value according to a certain formula, the result was 10^{26}. In contrast, the present day large computer's logical capability is 10^6 to 10^8. In the case of a microcomputer, it is 10^4 to 10^6. Even if we ascribe a maximum value to computer, human brain is superior by 10^{18} or 100 kyo (a unit 10,000 times 1 trillion).

[Interviewer] Truly it is an astronomical difference.

[Mori] Therefore, so long as advancement and diffusion of computer technology continues, we become more and more aware of how unsophisticated the current machines --including calculators--are in comparison to a human "machine." Conversely, we come to realize the enormity of human existence.

Super-LSI Technology and Use of Voice

[Interviewer] Our talk has expanded to an astronomical scale, so to pull it back down to earth, tell us about the future perspective for microcomputer application.

[Mori] Within the next 5 years, the machines will have a mouth and ears. At least, "a machine that talks" will become commonplace in 5 years at the latest.

Introduction of voice will have a very important role in conversation between man and the machine. Voice can be used in exchange of information in limitless fashion. Moreover, this kind of job is perfectly suited for microcomputer.

[Interviewer] How is that?

[Mori] There are some who question whether or not there will be demand for super-LSI which is being developed now. But super-LSI technology is just the right thing for synthetic voice chip making. Software for synthetic voice chip is relatively simple and as much as possible, it should be incorporated into the hardware. Hardware may become complex in proportion but then, super-LSI technology can be applied here. And as I stated before, the field of voice application is virtually limitless; thus the demand will be great; and mass production will bring the cost down.

[Interviewer] There is something like a talking electronic dictionary. In order to increase the number of words, all one has to do is increase the super-LSI memory....

[Mori] That is about the size of it. Moreover, as the talking aspect advances, the need for "listening" ability will increase also.

[Interviewer] But I heard that voice recognition would be much more difficult than voice synthesizing.

[Mori] It is indeed difficult to recognize undefined language, but if we use defined language, it is possible to do quite a bit. Although it is based on a limited number of words, a voice recognition facility which has 90 percent plus recognition ratio to an unspecified human voice has already been developed in Japan. A while ago, information input/output vis a vis a machine depended on a punch card and a line printer. Today, it is based on a keyboard and CRT which closely resembles a TV picture tube. And in the future, I think the microphone and the speaker will take their place.

[Interviewer] When a voice typewriter which can handle a mixture of Chinese ideograph and Japanese syllabary becomes a reality, a newspaper reporter's job will be facilitated because we would no longer need to take copy on the telephone....

[Mori] Data processing in Japanese is the current goal for Japan's computer development. That would be the start of a real computer age [in Japan]. Computer use began with numerical calculation. Then moved to machinery management and now we are at the stage of voice synthesization. Next will be voice recognition. And as this voice synthesization and recognition become coupled, data processing in Japanese will advance. All this will take time but unless we accomplish these tasks, we cannot claim to be in a true computer age.

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END