1. Understanding of Energy Situation

It was in the era of Industrial Revolution of 18th century that man began to consume a huge quantity of energy. In the period of Industrial Revolution, not only an energy source for iron manufacturing was changed from charcoal to coal but also the hydraulic power, wind power and animal power etc. used as a power source for industry and transportation were replaced by steam engines utilizing coal as a fuel. Furthermore, the rapid increase of production brought about by the industrialization produced great cities, resulting in new consumption of household use energy, mainly coal energy, by city residents. Namely, the prior type of energy could not correspond to the rapid increase of energy demand resulted from the increase of population of city residents and a new type of energy "coal" having an enormous potential appeared to fulfill the new increasing energy demand. On the other hand, at the same time with the appearance of all elements of energy economy such as mass production, transportation and market establishing of coal, the energy turned to be deeply related to the problems of resources and environment.

Thereafter, large scale development, transportation and utilization of oil resource were started and consequently, in the 4th quarter of 19th century, secondary energy or conversion energy such as city gas or electric power turned to be used in a practical way. Further, an enlargement of utilization of neutral gas resource and a peaceful utilization of atomic power were realized and after a system of mass production, transportation and consumption of energy was established worldwide, today's energy situation was resulted. In 1970s, the oil crises were triggered off twice by political affairs in the Middle East, thereby the price of energy such as oil etc. was raised so that energy saving effort was enforced and alternation of energy from oil to nuclear power, natural gas, coal etc. was accelerated. In 1972, just before the first oil crisis, the Club of Rome warned in its "Limit of Growth" that an inconsistancy of economical growth with limitedness of resources and environment conservation, if the situation is continued as being, will produce a disastrous situation.

From the last half of 1980's when the period for reconditioning the second oil crisis ended, the increase of energy demand was accelerated by the enlarging world economy. At the same time the problems of acid rain or global warming were brough up in the international context. At the beginning of August 1990, the oil price was raised rapidly by the occurence of Iraq invasion into Kuwait and the world economy (mainly US) has entered into an reconditioning (downwards) stage from the long lasted expansion stage.

How the following three major issues, (1)continuous economic growth (2)global scale environment conservation (3)stable supply of energy, shall be solved simultaneously, is a main theme given to us towards 21st century.

2. Economic Growth and Energy Demand

In the high economic growth period during 1950s and 1960s, the energy demand in Japan grew at a rate exceeding the economic growth rate. Thereafter, during the decade from 1973 to 1983, the energy demand showed little growth but slightly decreased due to the oil crises encountered twice. The real gross national product (GNP), however, increased by 1.45 times (equivalent to annual growth rate
of 4.5%). Why such a phenomenon happened? That is because of a progress in energy saving and a change in industrial structure (a shift to mechanical industry and electronics industry which bring about higher added values with less energy consumption.). Behind this was a progress in technologies of efficient energy utilization and in information related technologies which realize the increase of the added value with less energy consumption.

For the past four years from 1987 to 1990, the energy demand grew annually at a rate of 5% and GNP grew also at 5% annually. Therefore, the value of energy elasticity (the growth rate of energy demand devided by real GNP growth rate) was about 1 which represents a highly energy-consuming growth and is equivalent to the value that Japan experienced during the past high economic growth period. This was resulted from the stagnation of energy saving (or energy consuming trend seen partly) and from the recovery of highly energy-consuming type heavy industries (e.g. iron and steel industry, chemical industry etc.) The progress in energy saving technology and in technologies with high productivity per energy has not ceased completely but the cost of energy (Japan depends on overseas resources for over 80% of its total energy) has declined due to oil price slump and strong Yen and hence, less incentive for energy saving and more emphasis on labor saving have resulted and the productivity per energy has declined.

According to the report "Long-Term Energy Demand and Supply Forecast (1988-2010)" issued in June 1990 by the Advisory Committee for Energy, an advisory organization to the Ministry of International Trade and Industry, a considerable energy conservation is prospected by estimating an annual real economic growth rate of 3.5%, an annual energy demand growth rate of 1.5% and an energy elasticity value of 0.4. This means that 2.0%, the difference between 3.5% and 1.5%, shall be covered by energy conservation. In addition, the report pointed out that it is necessary to limit the energy demand growth at such a low level in order to limit the emmission of carbon dioxide (CO2) generated by the combustion of fossil fuel (coal, petroleum, natural gas etc.) for the prevention of global warming.

3. Energy Consumption and Global Environment Problem

As the energy consumption grows, it has become necessary to take a number of countermeasures for pollution problems and environmental problems. In particular, the coal, petroleum and natural gas, which are originated from fossil of animal and vegetation, will pollute the air or pollute water by the emitted sulfer oxides (SOx) and/or nitrogen oxides NOx so that countermeasures for removing SOx and/or NOx at the stages of production and consumption have been taken. In Japan, since 1970s, the countermeasures have been actively taken and the Japanese environmental regulations have now been severest in the advanced industrialized countries. In the developing countries or the socialist countries the countermeasures for removing SOx and/or NOx are rather future tasks so that the problems of acid rain caused by those substances have becoming more and more serious over national boundaries or even in Western countries. Since mid 1988, a great importance has been placed on the problem of global warming resulted from CO2 emission, which was first posed by some specialists, at various international meetings and in the stage of international politics. Although the cause and effect relationship has not been fully scientifically clarified yet, a policy to limit the CO2 emission from fossil fuel to the present level or below by the 21st century is proposed in European countries and in Japan. In order to attain the target, it will be necessary to promote or accelerate the energy saving and the shift to non-fossil energy (nuclear power, solar energy etc). This, however, will not be so easy.
4. Condition for Enforcing Energy Conservation

Either in the source problem or in the environment problem, the energy conservation is a key for solution. There seems to be limited expectation on nuclear power and new energy such as solar energy because the sense of uneasiness of the residents and general people may not be easily eliminated for the nuclear power, and the economic feasibility and progress of the new energy technology may not be fully materialized. In order to accomplish the energy conservation, it is necessary to unite all kinds of intelligences and ideas from various viewpoints such as change of economical and social structure, re-structuring of traffic systems and cities, review of life style for aiming real human satisfaction, recycle of wastes and combination of various and multiple technologies.

The most important scheme for energy saving is to give incentives which will induce or promote activities of device, improvement and innovation. For this purpose, it is required to make an advanced drastic investment for the welfare of human being in 21st century.