

Environmental Conservation and Energy

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1. Introduction

As a consequence of the development of civilization, the world energy consumption increased very rapidly and then environmental pollution is becoming serious social problems. The energy consumption is closely related with our daily comfortable life. The world population is expected to increase up to 9 thousand million by the year 2050 and every people in developing and developed countries seek a better life. To satisfy their desire much energy production which closely related with environmental pollution is needed. Thus we fall into dilemma between a better life and comfortable environments. Therefore, we need to compare the environmental aspects of different energy sources such as the coal, oil, gas, nuclear and hydro fuel cycles. Renewable sources of energy that are recently developing, may give less impacts to our environments. For such sources of energy, however, the cost-benefit analysis should be done and its limitations were then considered. In most developed countries, a half of the energy is used as electrical energy. There are a variety of cycles to produce electricity, coal, oil, gas, nuclear fuel, hydro, tidal, geothermal, wind energy etc.

This report will present the general features of electric power production and then discuss the comparative assessment of environmental impacts of some energy sources.

2. Increase of Energy Consumption and Population

In the primitive age people used energy only for obtaining their foods. So their energy consumption per capita was so small that they do not need to think of it. As agriculture and industry progress, the energy consumption per capita was extremely increased. In modern industrialized society, people use more energy for business and transportation etc. than for food obtaining. Therefore, there is big difference in energy consumption per capita between developed and developing countries. About one fourth of world population living in developed countries consume more than three fourth of world total energy generation.

In these 20 years economic expansion is going on in many developing

countries, especially in Asian countries. This means that energy consumption per capita in these countries will increase rapidly. Moreover, since the populations of the developing countries are also increasing, the total energy consumption of the world is significantly increasing.

In the year 1 of Christian era human population is estimated to be 2.5 hundred million. And it took about 1600 year to become double population, 5 hundred million. By contrast, however, it took only about 30 years that 2.5 thousand millions of world population in 1950 reaches double population, 5 thousand million.

According to the United Nations' estimation the world population will increase up to 9 thousand million in the year 2050. This fact is called as population explosion.

Table 1 shows the population for world and major area, 1750-2050. And Table 2 represents the comparison of population between in 1998 and in 2050 for the 20 countries with a large population.

Table1 Population for World and Major Areas,1750-2050
(From World population prospects, United Nations)

| Major area | 1750 | 1800 | 1850 | 1900 | 1950 | 1998 | 2050 |
|-----------------------------|------|------|------|------|------|------|------|
| Population size (thousands) | | | | | | | |
| World | 791 | 978 | 1262 | 1650 | 2521 | 5901 | 8909 |
| Africa | 106 | 107 | 111 | 133 | 221 | 749 | 1766 |
| Asia | 502 | 635 | 809 | 947 | 1402 | 3585 | 5268 |
| Europe | 163 | 203 | 276 | 408 | 547 | 729 | 628 |
| Latin America | 16 | 24 | 38 | 74 | 167 | 504 | 809 |
| and the Caribbean | | | | | | | |
| North America | 2 | 7 | 26 | 82 | 172 | 305 | 392 |
| Oceania | 2 | 2 | 2 | 6 | 13 | 30 | 46 |

3. Environmental Problems Closed in on Mankind

To the Japanese, a people so accustomed to dumping waste into river or air, because streams or wind carry it away as far as the amount of dumping wast is small. However, such old idea has to be corrected when we have suffered from health hazard by air and water pollutions which emerged about from the late 1960s to 1970s. The most serious cases were well-known Minamata and Kawasaki diseases. However, these environmental problems were limited in the local areas, and these problems were overcome by introducing a number of control technologies. The simmlar ongoing problems in Asian countries can be overcome by examining them through Japanese experiences.

Table2 Comparison of Population between 1998
and 2050 for 20 Large Countries

(From World population prospects, United Nations)

(thousands)

| 1998 | | 2050 | | | |
|------|---------------------------|-----------|----|---------------------------|-----------|
| 1 | China | 1,255,698 | 1 | India | 1,528,853 |
| 2 | India | 982,223 | 2 | China | 1,477,730 |
| 3 | U. S. A | 274,028 | 3 | U. S. A | 349,318 |
| 4 | Indonesia | 206,338 | 4 | Pakistan | 345,484 |
| 5 | Brazil | 165,851 | 5 | Indonesia | 311,857 |
| 6 | Pakistan | 148,166 | 6 | Nigeria | 244,311 |
| 7 | Russian Federation | 147,434 | 7 | Brazil | 244,230 |
| 8 | Japan | 126,281 | 8 | Bangladesh | 212,495 |
| 9 | Bangladesh | 124,774 | 9 | Ethiopia | 169,446 |
| 10 | Nigeria | 106,409 | 10 | Dem.Rep. of the Congo | 160,360 |
| 11 | Mexico | 95,831 | 11 | Mexico | 146,645 |
| 12 | Germany | 82,133 | 12 | Philippines | 130,893 |
| 13 | Viet Nam | 77,562 | 13 | Viet Nam | 126,793 |
| 14 | Philippines | 72,944 | 14 | Russian Federation | 121,256 |
| 15 | Egypt | 65,978 | 15 | Iran(Islamic Republic of) | 114,947 |
| 16 | Iran(Islamic Republic of) | 65,758 | 16 | Egypt | 114,844 |
| 17 | Turkey | 64,479 | 17 | Japan | 104,921 |
| 18 | Thailand | 60,300 | 18 | Turkey | 100,664 |
| 19 | Ethiopia | 59,649 | 19 | United Rep. of Tanzania | 80,584 |
| 20 | France | 58,683 | 20 | Thailand | 74,188 |

In recent years several different kinds of environmental problems i.e. the global environmental problems are occurred.

This means that pollution stemming from industrialized nation will spread on an increasingly international scale, because such a pollutant is not so reactive to deposit nearby the emission site.

We should give most careful consideration to the following 5 environmental issues.

1. Acid rain (NO_x, SO_x): forest decaying, ecological change of lake and marsh
2. Greenhouse effect (CO₂, CH₄...): meteorological change, change of sea-water level
3. Ozone-layer destruction (fluorocarbons): increase of skin cancer
4. Dispersion of hazardous chemicals (Dioxins....): health hazard, endocrine disruption
5. Radiations and electromagnetic wave (Nuclear facilities, Communication tools): health hazard

The above environmental problems are all associated with our daily life through which we use a large amount of energy and throw away articles wastefully.

4. Most serious environmental problems.

Among several global environmental problems, I am going to mention about two issues here, 1) a greenhouse effects (global warming) and 2) environmental endocrine disruptors, because they seem to be really serious problems if they actually emerge.

Greenhouse effect is originated mostly from carbon dioxide (CO₂) by the combustion of fossil fuels such as coal and oil. In parallel with the industrial development, the quantity of CO₂ emission was rapidly increased from around 1950s. Total amount of CO₂ emitted in the world is estimated to be 6 hundred million tons (as carbon) as shown in Fig. 1. And as Fig. 2 shows U.S.A., Canada and Russia are the three largest CO₂ emission countries on the per capita basis.

In addition to CO₂, methane, nitrogen oxide and fluorocarbons also contribute to the greenhouse effect at the rates represented in Fig. 3. It is said that average atmospheric temperature rises 2 °C and thus the sea-level goes up 50 cm.

Such being the cases, this subject has been discussed at the Intergovernmental Panel on Climate Change since 1988. In 1997, an international meeting was held in Kyoto to settle the actual plan of warming gas cut-down rate for each country. A part of figures agreed by the countries are shown in Table 3.

The figures means the reduction rate of the warming gas on the basis of 1990 level. Since this regulation is very severe, Japan, U.S.A., Canada, France and some other countries will be difficult to achieve their target levels without adopting prudential policy. On the contrary, Germany, Russia and United Kingdom will be able to achieve it without fail.

Most developing countries did not agree with this international proposal.

With respect to environmental endocrine disruptors, there are so many questionable points remained. More than 15 million chemical compounds are synthesized by man. And about 60 thousands of them are used around our environment. Their chemical toxicity are generally well known.

Environmental endocrine disruption is not chemical toxicity but a different kind of health hazard. A small amount of many chemicals released in to the environment are considered to disrupt the endocrine system in wild animals and humans, and many of which have estrogenic activity by binding to estrogen receptor. At present it is unknown how many chemicals show such a effect. But many research workers suspect that there are at least 200 doubtful chemicals. Among these endocrine disruptors, dioxins are rather widely studied, but more full-scale studies should be done for a number of other chemical in the future.

Fig.1 Change of CO₂ Emissions Since 1950
(From Oak Ridge National Laboratory)

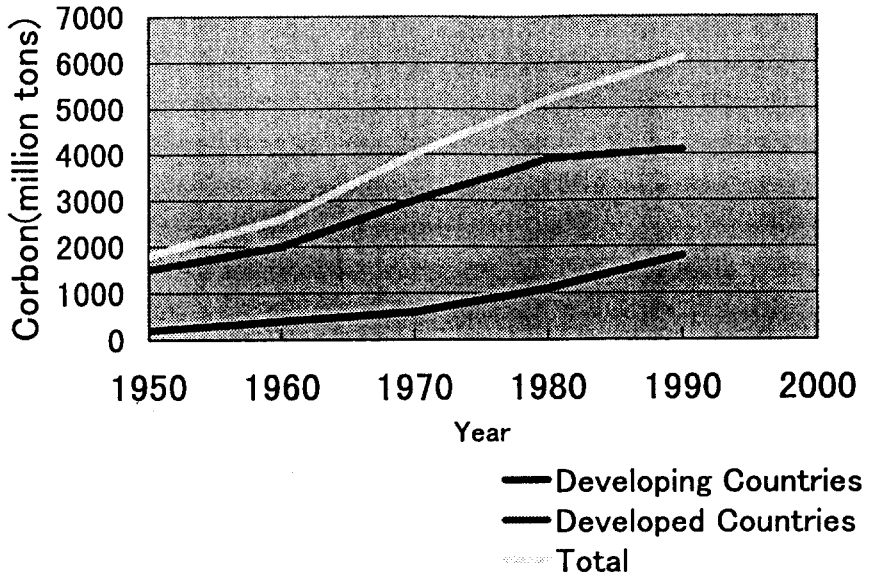


Fig.2 CO₂ Emissions Per Capita from Each Country(1992)
(From World Institute of Resources)

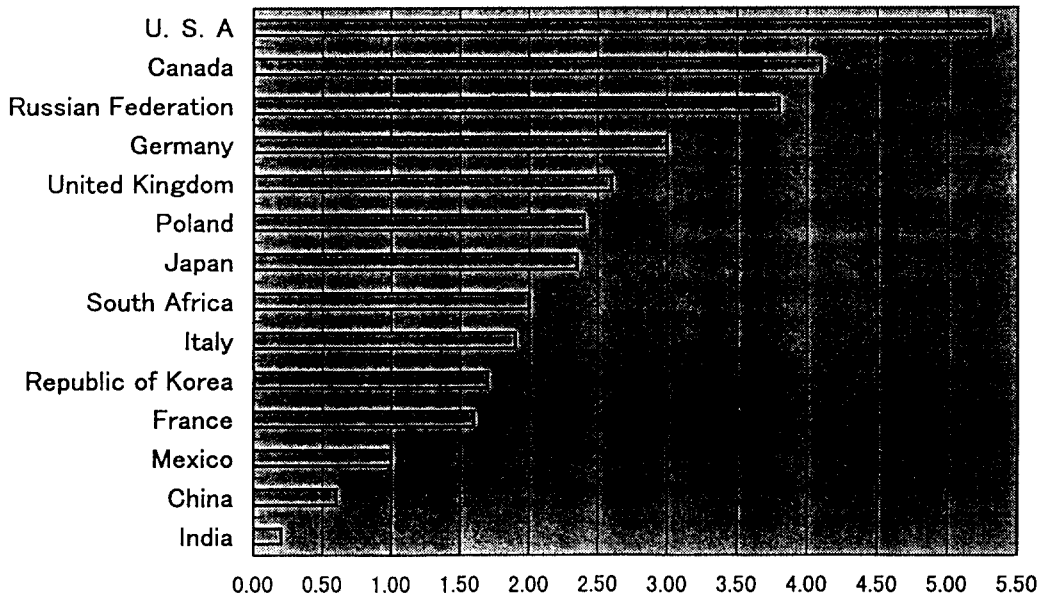


Fig.3 Contribution of Several Gasses to the Greenhouse Effects(1992)
(From IPCC Report 2)

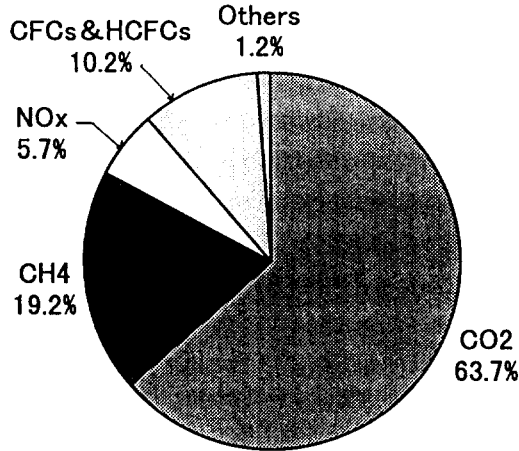


Table3 Target Figures Adopted COP3(Kyoto)

| The Members of Treaty | Reduction rate (%) | The Members of Treaty | Reduction rate (%) |
|-----------------------|--------------------|-----------------------|--------------------|
| Australia | +8 | Italy | -8 |
| Austria | -8 | Japan | -6 |
| Belgium | -8 | Netherlands | -8 |
| Bulgaria | -8 | New Zealand | 0 |
| Canada | -6 | Norway | +1 |
| Croatia | -5 | Poland | -6 |
| Czeek Republic | -8 | Portgal | -8 |
| Denmark | -8 | Romania | -8 |
| Finland | -8 | Russian Federation | 0 |
| France | -8 | Spain | -8 |
| Germany | -8 | Sweden | -8 |
| Greece | -8 | Switzerland | -8 |
| Hungary | -6 | Ukraine | 0 |
| Iceland | +10 | United Kingdom | -8 |
| Ireland | -8 | U. S. A | -7 |

Regarding dioxins they were never synthesized intentionally for commercial use. These compounds were formed as unwanted by-products of some kinds of agricultural chemicals.

Recently however, the potential sources of human exposure to dioxins via foods shifted to product of waste combustion.

The dioxins emitted from incinerators could contaminate animal foods and vegetables. In Japan dioxin issue is now becoming most important environmental problem because we depend 70% of waste disposal on combustions.

Dioxin uptake by humans is regarded to come from food and dust contaminated through flue gas emissions. Many people who live near an incinerator fear that they will be exposed to high level of dioxin and subsequently develop cancer or other health hazard. Atmospheric concentration and intake from food of dioxin are certainly high in Japan. However their levels are still in a permissible exposure level. In any way we have to reduce waste disposal as small as possible and construct a incinerator with high-performans.

5. Characteristics of Electric Power Generation Systems

The energy systems could be classified in electrical, thermal and mechanical energies. Since electrical energy can be safely and easily handled, it is most widely used. Various sources for electrical energy are available. For examples, coal, oil, natural gas, hydro and tidal power, geothermal, solar, nuclear and wind energy. In this report I will describe characteristics of these electric power generation systems.

Coal: Direct coal (or peat) combustion is often used in electricity generation. A huge amount of coal is extracted from surface and deep underground in many countries. In the case of coal combustion, it gives a significantly high ash (more than 50%) and gaseous waste which involves CO₂, NO₂ and SO₂.

In an environmental point of view, its impact is quite high.

However, the use of coal is increasing in several developing countries, because they have large deposit of coal and the cost of the power plant construction is relatively low.

Oil: Oil combustion is most widely used in electricity generation. Oil is extracted continental or off-shore wells.

Crude oil combustion emits CO₂, NO₂, SO₂, but ash wastes are less than for coal. In this electricity generation system, the power distribution is very easily controllable depending on the demand.

Natural Gas: Natural gas receives strong attention as a fuel for generating electricity because it minimize CO₂ emission. Other hazardous gas such as NO₂ and SO₂ are also less than those of coal. As to the greenhouse effect, the advantage may be partly cancelled by release of methane occurring during gas extraction and handling.

Hydropower: Hydroelectricity seems to be attractive supply option because it gives off no emission wastes. However in most cases of hydroelectricity generation, huge dam construction is needed. The construction leads to environmental damage, especially for natural ecology. On the other hand the construction cost is enormous. However, because of its large resources potential, this kind of energy could play an important role, particularly in developing countries.

Geothermal and Wind Energy: These two electricity generation systems raise less environmental impact. As far as these energy sources are concerned, they are so unevenly distributed. Geothermal energy is much used in U.S.A., Phillipine, Mexico, Italy, New Zealand and Japan where the volcanic activity is widely seen. Wind energy is much used in U.S.A., Germany and Denmark. In U.S.A. there is famous windfirm near San Francisco where about 16 hundred thousand kW electricity is produced by using 17 thousand units of wind mills. Even such a fuge plant, it could supply only 15% of electric power demand of San Francisco with population of 8 hundred thousand.

Solar Energy: Solar energy would be most promising resources in the future. Solar energy system of electricity generation emit very little waste. Unfortunately, however, solar energy is very much dispersed spaciouly. Therefore it needs a great size of ground area to receive sunbeams. At present, this energy source is increasing its contribution to wards electricity generation, but it is unlikely to meet a large share of the global electricity demand.

Nuclear Energy: Nuclear energy is able to produce tremendous electric power. It would be only one alternative to fossil fuel energy at present. However, in the case of nuclear energy utilization, there is serious problem of managing and desposing the radioactive wastes.

Nuclear energy has the potential to make a significant reduction of CO₂ emissions. Though its technological, instrumental, operational safely levels are substantially increased, its public acceptability still remains in question. From my point of view, nuclear energy is adapted for the energy source of the developed countries, because it needs a big fund and high-technology in construction and

operation.

Some Other Energy: There are several other energy sources, but their contribution towards total electricity consumption is negligibly small. However, the challenge for new energy utilization is still anticipated.

6. Conclusions

Electric energy is essential to social and global development. Its global demand is rapidly increasing in parallel with the economical development of the developing countries. Where any kinds of energies are being used, there should be unwilling waste emissions which give a variety of environmental impacts. Even in the cases of many renewable energy sources, wastes may arise in construction, manufacturing, transport and dismantling etc.

So we always need be taken into account on the overall impacts to our environments including human health, agricultural land and water, and other ecological systems.

When we choose the electricity generation system, the factors of risk and benefits, and the cost should be first considered. And we will choose several energy sources that fit to the particular country or the local area. We have to find out the ideal case that called "the best mixture."