"Japan's Contribution to Cool Earth"

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I. Introduction

On May 24, 2007, then Japanese Prime Minister Shinzo Abe announced the "Cool Earth 50" Plan at an international conference titled "Asian Future." The plan presented a long-term strategy to cope with global warming issues, and upheld the following two purposes:

(1) Cutting global greenhouse gas emissions to half the current level by 2050, and
(2) Presenting a long-term vision for developing innovative technologies and building a low-carbon society.

The Cool Earth 50 Plan also proposed three principles for establishing a post-2013 (i.e. post Kyoto Protocol) framework, as follows.

(a) All major emitters must participate, thus moving beyond the Kyoto Protocol, to achieve global reduction of emissions;
(b) The framework must be flexible and diverse, taking into consideration the circumstances of each country; and
(c) The framework must achieve compatibility between environmental protection and economic growth by utilizing energy conservation and other technologies.

Despite changes in prime ministers, the Japanese Government holds fast the two purposes and three principles of the Cool Earth 50 Plan even today. This paper focuses on the following two points:

(i) How compatibility between environmental protection and economic growth could be made, and
(ii) How Japan should contribute to "Cool Earth" on a long-term basis.

In regard to point (i), this paper makes clear the validity of energy conservation and technological innovation in sections II and III. One of the most important innovations is CCS (Carbon Dioxide Capture and Storage) / EOR (Enhanced Oil Recovery) technology.

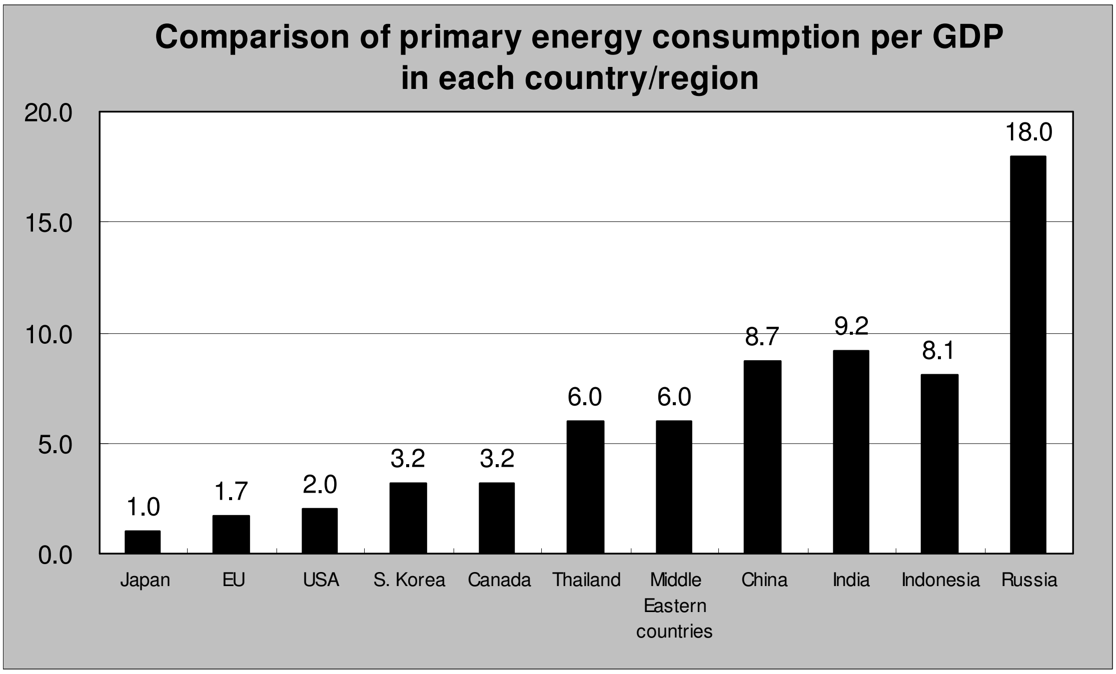
In regard to point (ii), this paper introduces two unique Japanese methods for cutting global greenhouse gases, the "Top Runner Program" and the "Sector by Sector Approach," in sections IV and V. The former is effective in the residential, commercial, and transportation sectors, and the latter is valid in the industrial sectors.

II. Energy Conservation

To address global warming in earnest requires a clear vision. The vision should be founded on a good balance between "affluence" and "global salvation," which may be achieved by promoting energy conservation.

The greatest issue in implementing global warming countermeasures is to avoid initiatives that may conflict with people's desire to attain affluence. Such initiatives create a "tradeoff" between affluence and global salvation, so to speak. Unless this tradeoff mechanism is eliminated, global warming countermeasures cannot be expected to make any progress. The reason why newly developing countries such as China and India did not participate in the framework for establishing country-specific greenhouse gas emission reduction targets under the Kyoto Protocol, is because they feared that the establishment of such a target may interfere with efforts to realize affluence in their countries.

The tradeoff between affluence and global salvation can only be resolved by promoting energy conservation. The figure eloquently illustrates this point.



Note: Figures have been obtained by dividing primary energy consumption (equivalent to tons of oil) by GDP (converted to US dollars) and adjusting them in reference to Japan as represented by a value of 1.
Source: Agency of Natural Resources and Energy, Energy Efficiency and Conservation Division, "Report on Energy Conservation Measures" (2007)
Original material: IEA Energy Balance 2006

It shows a comparison of primary energy consumption per GDP (gross domestic product) in the world's major countries and regions, based on data compiled by IEA (International Energy Agency) in 2006. More specifically, the oil equivalent of primary energy consumption in each country and region was divided by GDP converted to US dollars, to achieve a numerical value for that country/region when Japan is given a value of 1. The smaller the value, the more advanced the energy conservation is in the relevant country/region. However, even in the EU (European Union), where energy conservation is generally assumed to be quite advanced, 1.7 times more energy is used to achieve the same level of GDP as Japan. In regard to other countries, the United States consumes 2.0 times more energy, South Korea and Canada 3.2 times, Thailand and the Middle Eastern countries 6.0 times, and Indonesia, China, and India, approximately 8 - 9 times more energy. When it comes to Russia, the country uses 18.0 times more energy compared to Japan.

The figure eloquently shows that energy consumption can be reduced considerably (and in effect, achieve considerable reduction in greenhouse effect gas emissions) while maintaining and expanding affluence, if all countries/regions in the world achieve the same level of energy conservation as Japan. Promoting energy conservation is indeed the sole solution to resolving the tradeoff between affluence and global salvation.

III. Technological Innovation

In order to achieve the long-term target of reducing global greenhouse gas emissions by half by 2050, it is crucial to develop innovative energy technologies that are not an extension of conventional technologies. On March 5, 2008, the Japanese Government announced "Cool Earth—Innovative Energy Technology Program," which identified 21 technologies to be prioritized, as follows:

1. High-efficiency natural gas-fired power generation,
2. High-efficiency coal-fired power generation,
3. Carbon dioxide capture and storage (CCS),
4. Innovative photovoltaic power generation,
5. Advanced nuclear power generation,
6. High-efficiency superconducting power transmission,
7. Intelligent transport system,
8. Fuel cell vehicle,
9. Plug-in hybrid vehicle/ Electric vehicle,
10. Production of transport bio-fuel,
11. Innovative materials production/processing,
12. Innovative iron and steel making process,
13. High-efficiency house and building,

14. Next-generation efficiency lighting,
15. Stationary fuel cell,
16. Ultra high-efficiency heat pumps,
17. High-efficiency information device and system,
18. House/building/local-level energy management system,
19. High-performance power storage,
20. Power electronics, and
21. Hydrogen production, transport and storage.

In these fields, Japan is a global leader, boasting the world's top level energy technologies.

With respect to CCS (third technology in above list), Japan Oil, Gas and Metals National Corporation (JOGMEC) is pursuing efforts to link the technology to EOR (enhanced oil recovery). JOGMEC has been engaging in the technical development of EOR since the 1980s, and has implemented a feasibility study in Kuwait and Abu Dhabi, on the entire process of recovering carbon dioxide (CO_2) that is released from power stations and injecting it to oil layers to increase crude oil recovery. Based on results of the study, JOGMEC is presently utilizing the knowledge it has accumulated through the technical development of EOR (CO_2 injection technology, technology for analysis of fluid behavior in underground oil/gas layers, etc.) to implement technical development and surveys on CCS. In addition to CCS, JOGMEC is also pushing forward with technical development and surveys on general environmental conservation issues relating to oil and natural gas development (treatment of oilfield-produced gas and water accompanying oil and natural gas development, etc.).

IV. "Top Runner Program"

As a leader in energy conservation, Japan plays a large role in implementing worldwide global warming countermeasures. It would not be an exaggeration to say that the promotion of energy conservation is the single most significant theme among Japan's contribution to the international community in the 21st century.

However, this is not to say that Japan may remain content with its current level of energy conservation. It is important to remember the historical fact that the ceaseless effort in pursuing technical innovation and institutional reform was the driving force behind the development of Japan into today's leader in energy conservation.

In Japan in the post-oil crisis era, industries began to actively pursue energy conservation, and advances were made in institutional reforms to promote those efforts. Following the establishment of the "Law concerning Rationalization of Energy Use" (commonly known as the Energy Conservation Law) in 1979, energy conservation guidelines were formulated for plants and buildings, and guidelines on energy consumption efficiency were also compiled for machinery and appliances (automobiles, air conditioners, etc.). The guidelines for machinery and appliances contained advanced concepts that would later lead to the establishment of the "top runner system," which was eventually introduced on a full scale in 1999. Under the top runner system, automotive mileage standards and electrical appliance energy-saving standards are to be set at levels that exceed the performance of the most efficient product on the market at the time, in each product category. The system is presently attracting worldwide attention as a unique energy conservation measure developed by Japan.

A pamphlet titled *Top Runner Program*, issued in January 2008 by Japan's Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI) and the Energy Conservation Center, Japan (ECCJ), describes the top runner system as follows.

> "Expectations regarding the role of energy conservation are increasing due to mounting global environmental problems. As a result, demands that machinery and equipment's energy consumption efficiency be increased to the greatest extent possible are now a reality. The Top Runner Program has come into existence in light of this situation. This Top Runner Program uses, as a base value, the value of the product with the highest energy consumption efficiency on the market at the time of the standard establishment process, and sets standard values by considering potential technological improvements added as efficiency improvements. Naturally, target standard values are extremely high. For achievement evaluation, manufacturers can achieve target values by exceeding target values by weighted average values using shipment volume, the same as the average standard value system. The implication of using weighted average values is the same as the average standard value system, that is, the system is meant to give manufacturers incentives for developing more energy-efficient equipment. Above all, deliberation studies during the value establishment process in this system can proceed smoothly in a shorter period from the start to the final standard determination. While this system gives manufacturers substantial technological and economic burdens, the industry should conduct substantial prior negotiations on the possibility of achieving standard values and adopt sales promotion measures for products that have achieved target values." (pp. 6-7)

Since the introduction of the top runner system in Japan, a number of product categories have reached their target achievement year. The table below shows a summary of the results of the top runner system for those product categories. It is evident from the table that the top runner system has contributed significantly to improving energy consumption efficiency in each product category.

The results of the top runner system by product categories

Product category	Energy efficiency improvement	Period
TV sets using CRTs	25.7%	FY1997～2003
VCRs	73.6%	FY1997～2003
Air conditioners*	67.8%	FY1997～2004
Electric refrigerators	55.2%	FY1998～2004
Electric freezers	29.6%	FY1998～2004
Gasoline passenger vehicles*	22.8%	FY1995～2005
Diesel freight vehicles*	21.7%	FY1995～2005
Vending machines	37.3%	FY2000～2005
Computers	99.1%	FY1997～2005
Magnetic disk units	98.2%	FY1997～2005
Fluorescent lights*	35.6%	FY1997～2005

Note: For product categories marked with *, energy efficiency standard values are defined by energy consumption efficiency (e.g. km/l), while those without * are defined by the amount of energy consumption (e.g. kWh/year). In the above table, values for "Energy efficiency improvement" indicate the rate of improvement calculated based on each standard. (Example: If 10 km/l is developed to be 15 km/l, an improvement rate indicated as 50% [It is not calculated as the improvement of fuel consumption by 33 % from 10 liters to 6.7 liters for a 100 km drive]; and if 10 kWh/year is developed to be 5 kWh/year, the improvement rate is 50 %.)

Source: op. cit., *TOP RUNNER PROGRAM*, 2008.

V. "Sector by Sector Approach"

It is clear that the Cool Earth 50 Plan can in no way be achieved simply by utilizing market mechanisms. To reduce the world's greenhouse gas emissions by half by 2050, a breakthrough technical innovation must occur that would dramatically promote energy conservation and the use of new energy sources, while using nuclear power generation and other "existing tools" to buy time.

A framework which has begun to attract rapid attention in recent years as a key to achieving that breakthrough technical innovation is the "sector by sector approach." The approach aims to reduce greenhouse gas emissions considerably, by making drastic, trans-boundary efforts to improve energy efficiency in each sector (industry, field) that emits significant amounts of greenhouse gases. The Japanese government is actively encouraging all countries of the world to adopt this sector by sector approach.

The advantage of the sector by sector approach is that it can make up for the pitfalls in the framework of the Kyoto Protocol that establishes reduction obligations of greenhouse gas emissions for each country. There would have been no pitfalls, had all major greenhouse gas emitters participated in the Kyoto Protocol framework, but that was not to be.

China (2nd largest greenhouse gas emission country in the world), India (5th largest emission country) and other newly developing countries did not participate in the framework for establishing country-specific greenhouse gas emission reduction obligations under the Kyoto Protocol, for fear that doing so would interfere with efforts to realize affluence in their countries. At the same time, the United States (the largest emission country in the world) withdrew from the Kyoto Protocol framework, claiming "unfairness" of nonparticipation by the newly developing countries. As a result, the countries that agreed to the imposition of reduction obligations under the Kyoto Protocol only accounted for a little over 30% of total worldwide emissions (calculated based on 2004 data).

The participation of only some major greenhouse gas emitters in the framework for establishing country-specific emission reduction obligations under the Kyoto Protocol increased the possibility of "carbon leakage." Carbon dioxide accounts for the largest proportion of greenhouse gases. When countries that have emission reduction obligations exist alongside countries that do not, as under the Kyoto Protocol framework, the transfer of large energy-consuming industries and sectors from the former to the latter may in effect increase worldwide CO_2 emissions. This issue is referred to as carbon leakage. It occurs because large energy-consuming industries and sectors in emigrant countries obligated to reduce greenhouse gas emissions (such as Japan) generally have higher energy efficiency than immigrant countries that have no reduction obligations (such as China). This carbon leakage issue can be said to be a serious pitfall of the Kyoto Protocol framework.

As opposed to the above framework, the sector by sector approach would not cause carbon leakage, because it aims to reduce CO_2 and other greenhouse gas emissions per sector, instead of per country. Under this approach, large energy-consuming industries/sectors would remain in energy-efficient countries (countries with obligations to reduce emissions), but could also contribute to increasing energy efficiency in their respective industries and sectors in less energy-efficient countries (countries with no emission reduction obligations) through technical transfers. It is important that large energy-consuming industries/sectors remain in energy-efficient countries, not only to better control worldwide CO_2 emissions in the foreseeable future, but also to insure high probability of technical innovations that could further increase energy efficiency in the farther future.

Let us examine the effectiveness of the sector by sector approach in major industries that release greenhouse gases. Of the world's total CO_2 emissions from energy sources, 26.0% are released from coal-fired thermal power plants, 6.3% from iron and steel production, 2.9% from cement production, and 17.1% from road transportation. Below is a close-up look at the effects of the sector by sector approach in the electric power and the iron and steel industries.

The Federation of Electric Power Suppliers of Japan, an industrial organization boasting a membership of major electric power companies in Japan, has recently estimated the amount of CO_2 emissions that could be reduced in each country and region by 2030, if the electric power industry were to implement the sector by sector approach on a global scale. According to the estimation, CO_2 emissions would drop considerably, mainly in China, India, and the United States, by as much as 1.87 billion tons worldwide. Since the world's CO_2 emissions totaled 26.69 billion tons in 2005, implementation of the sector by sector approach in the electric power industry would reduce 7% of that total.

The sector by sector approach in the electric power industry consists of the following three initiatives:

(1) Operational improvement in existing thermal power stations

(2) Operational improvement in new thermal power stations

(3) Development and introduction of low-carbon technology.

The first point mainly pertains to coal-fired thermal power stations in developing countries, and hinges on a global horizontal expansion of best practices through exchanges among engineers, a practice commonly known as "peer review." The second refers to the introduction of the highest energy efficiency technology at the time, or BAT (Best Available Technology), to thermal power stations that are planned for construction in the near future. This may perhaps be called the "top-runner system" in the power generation sector. The third point promotes integrated gasification combined cycle (IGCC) and CO_2 capture and storage (CCS) technologies, and promises an extremely large CO_2 emission reduction effect. Electric power companies in Japan are global leaders in regard to the first and second initiatives but are also directing considerable efforts to achieving the third.

Similarly, the Research Institute of Innovative Technology for the Earth (RITE) in Japan has projected the amount of CO_2 emissions that could be reduced by each country at this point in time, if the iron and steel industry in all countries throughout the world achieves the same level of energy efficiency as Japan's iron and steel industry. According to the projection, CO_2 emissions would drop considerably, mainly in China, the United States, and Russia, and as much as 250 million tons of CO_2 emissions could be reduced by the top 10 countries that have the largest steelworks in the world.

In the wake of the oil crisis in the 1970s, Japan's iron and steel industry has achieved the world's highest energy conservation level by abbreviating or merging work processes, recovering and effectively utilizing by-product gases, introducing and reinforcing large-scale waste heat recovery facilities, expanding the usage rate of non-coking or weak-coking coal, and recycling resources. As a result, the energy efficiency (tons of petroleum/tons of crude steel) of Japan's integrated steelworks is a mere 0.59, while that of the United States is 0.74, Canada 0.75, the United Kingdom 0.72, France 0.71, Germany 0.69, Australia 0.79, South Korea 0.63, China 0.76, India 0.78, and Russia 0.80 (2008 survey by RITE). Because of this disparity, a global horizontal expansion of the current level of energy efficiency in Japan's iron and steel industry alone would be able to reduce CO_2 emissions.

Dissemination of existing technologies is not the only reason for implementing the sector by sector approach in the iron and steel industry. Other reasons include the development and introduction of breakthrough technologies, such as CO_2 capture and storage (CCS), hydrogen production and utilization, and electric smelting. Japan's iron and steel companies are particularly concentrating on the development of the CCS and hydrogen technologies.

VI. Concluding Remarks

This paper focuses on the following two points:

(i) How compatibility between environmental protection and economic growth could be made, and

(ii) How Japan should contribute to "Cool Earth" on a long-term basis.

In regard to point (i), this paper makes clear the validity of energy conservation and technological innovation. The former applies to short or medium-term efforts, and the latter, to long-term strategy.

In regard to point (ii), this paper introduces two unique Japanese methods for cutting global greenhouse gases, the "Top Runner Program" and the "Sector by Sector Approach." The former is effective in the residential, commercial, and transportation sectors, and the latter is valid in the industrial sectors.

Finally, it is worth mentioning that Japan did not become a leader in energy conservation overnight, but gradually achieved the status through long years of unrelenting efforts toward achieving technical innovation and institutional reform. This means that the Japanese people must continue to make these efforts to maintain the position as leader in energy conservation. Moreover, to realize the goal of the Cool Earth 50 Plan to reduce the world's greenhouse gas emissions by half by 2050, the Japanese government and industries must fully realize Japan's role and responsibility as an energy conservation leader and continuously strive to develop technical innovations.