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VOLUNTARY OR REGULATORY? COMPARATIVE BUSINESS ACTIVITIES TO MITIGATE CLIMATE CHANGE

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Abstract

The purpose of this paper is to make clear the historical significance of voluntary business activities to mitigate climate change. Roughly speaking, there are two main approaches: one based on regulations by the government of each country, and the other based on voluntary activities by the private sector. In Japan, we have been able to observe both approaches since the oil crises of the 1970s.

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. Unless this tradeoff mechanism is eliminated, global warming countermeasures cannot be expected to make any progress. 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 of 1997 because they feared that the establishment of such targets might interfere with efforts to realize affluence in their countries.

The tradeoff between affluence and global salvation can only be resolved by promoting energy conservation. 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 that in Japan. In this paper, we will make clear the historical reasons why and how Japan has been able to achieve such a high level of energy conservation.

I. *Introduction*

In November 2013, the government of Japan announced that the greenhouse gas reduction target based on the 1997 Kyoto Protocol (a reduction of 6% compared to 1990 levels) had been achieved. According to the announcement, the actual annual average for greenhouse emissions in the 2008–2012 commitment period had risen by 1.4% compared to 1990 levels, but a reduction of 9.7% had been achieved through the so-called Kyoto Mechanism (3.8% reduction through absorption by forests and 5.9% reduction through emissions trading including investment in energy-efficient projects overseas) for an overall reduction of 8.2%, which

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exceeded the target.

The Environmental Voluntary Action Plan, which was formulated in June 1997 by the Japan Business Federation, the central business association for the industrial sector in Japan (reorganized as the Keidanren in May 2002; hereinafter abbreviated as "Keidanren"), played an important role in the process of reaching the Kyoto Protocol targets. Supported by the Environmental Protection Foundation, the four rapporteurs for this paper have pursued joint research with the added element of an academic assessment of Keidanren's Environmental Voluntary Action Plan. As well as outlining the outcomes of the joint research by the four rapporteurs, this paper also looks back at the history of Japan's unique experiments in resolving global environmental issues.

In 1997, Keidanren formulated the Environmental Voluntary Action Plan, and launched voluntary initiatives aimed at developing a recycling-oriented society and global warming countermeasures. This initiative differs from the methods of other countries where the focus is on emissions-trading structures and environmental taxation. It is a unique initiative that attempts to conserve energy and reduce greenhouse gas (GHG) emissions through voluntary action by each industrial sector with industry associations playing a key role, and with the use of credits playing no more than a supplementary role. With Keidanren's Environmental Voluntary Action Plan as the driving force, Japan has met its obligations to reduce GHG emissions in the first commitment period (2008–2012) of the Kyoto Protocol. Based on the outcomes of the Environmental Voluntary Action Plan, Keidanren formulated and announced its Commitment to a Low Carbon Society in January 2013. The Commitment develops and expands the initiatives under the Environmental Voluntary Action Plan, and seeks to contribute to achieving the target set by the international community of halving GHG emissions by 2050.

The theme for our joint research is to evaluate the Voluntary Action Plan compared to the emissions-trading system and other methods. The purpose of the research is to add an academic assessment dimension to the Environmental Voluntary Action Plan, the voluntary initiative formulated by Keidanren in June 1997, with the aim of developing a recycling-oriented society and global warming countermeasures. Compared to structures that enforce emissions trading and environmental taxation, the academic record of research on such voluntary initiatives is sparse. Therefore, this research places emphasis on verifying the outcomes of voluntary initiatives.

The members of the joint research team are:

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For this research, we focused on interviews and fieldwork as well as a review of the literature. Specifically, we interviewed nine types of industry that are implementing Keidanren's Environmental Voluntary Action Plan and the Commitment to a Low Carbon Society, and we also carried out fieldwork in the paper industry. The interview subjects were the Japan Paper Association, Japan Iron and Steel Federation, Japan Chemical Industry Association, Japan

Cement Association, the four electrical and electronic associations, Japan Automobile Manufacturers Association, Inc., Japanese Ship-owners' Association, Scheduled Airlines Association of Japan, and Real Estate Companies Association of Japan. For the interviews, each association briefed us on the outcomes of the Environmental Voluntary Action Plan and the Commitment to a Low Carbon Society at the organizations concerned before we proceeded with a carefully structured question-and-answer session. On this occasion, we sought to verify cross-sectional perspectives with international versatility (for example, the Top Runner Program, life cycle assessment, and sector-based approach).

With the cooperation of the Japan Paper Association, we visited the Oji Paper Kasugai Mill to tour the mill and interview employees of Oji Paper for the fieldwork. At the mill, we were given a tour of the pulp-receiving facility, the shipment facility, the paper-making and coating facility, and the biomass turbine facility. Positive developments at the company include the use of RTF, waste tires, and a range of other materials for biomass power generation, which accounts for a high proportion of power consumption at the mill.

We also conducted an interview with Masayo Wakabayashi, research scientist at the Central Research Institute of the Electric Power Industry, to inquire about the features of the Environmental Voluntary Action Plan and how they compare with those of other methods.

Through a series of surveys, this research has confirmed the following:

(1) Compared to emissions trading, environmental taxation, and other methods, the voluntary method adopted for the Environmental Voluntary Action Plan has produced a variety of creative approaches, resulting in outcomes with continuous and international potential.
(2) The significance of the initiatives and the methods of measuring and explaining the outcomes have evolved in the course of executing the Environmental Voluntary Action Plan.
(3) All industry associations have played a central role in promoting the Environmental Voluntary Action Plan, which can be regarded as a new social function for industry associations. In the course of executing the Environmental Voluntary Action Plan, the unique division of roles between the private sector and the government has functioned efficiently with the private sector acting as the entity that leads the progress and the government continuously checking the progress.
(4) The Top Runner Program, life cycle assessment, and sector-based approach are some of the new methodologies that have come out of Japan in the process of evolving from initiatives under the Environmental Voluntary Action Plan to the Commitment to a Low Carbon Society.

II. *Historical Overview: Japan's Challenge to Cool the Earth*

1. Energy Conservation: The Only Way to Overcome the Paradox Confronting Humankind

This chapter shows a historical overview of the unique experiments that Japan has undertaken in order to resolve global environmental problems.

The biggest obstacle to implementing global warming countermeasures is that the initiatives can contradict the desires of people in pursuit of "affluence." In this case, a structure is formed where "affluence" and "saving the planet" are in a trade-off relationship, and unless we break through this structure, it is not possible to expect genuine progress with measures to prevent global warming. China, India, and other emerging economies have not participated in the country-based framework for GHG emission reduction targets set out in the Kyoto Protocol because of the risk that the targets would obstruct "affluence" in their countries.

The only way to resolve the tradeoff between "affluence" and "saving the planet" is to promote energy conservation. This is perfectly clear if you compare primary energy consumption per unit of gross domestic product (GDP) for the principal countries and regions in the world with data from the International Energy Agency (IEA) published in 2009. Specifically, we have divided the oil equivalent for primary energy consumption by GDP converted into U.S. dollars to try to calculate the numerical values for each country and region. It then becomes clear that even the European Union (EU), where energy conservation is fairly advanced, consumes 1.8 times more energy than Japan to produce GDPs of a similar scale. For Britain, the ratio is 1.2, for Germany 1.6, for France 1.8, for the United States 2.0, and for Australia 2.5. For Korea and Canada, the ratio is 3.1, for the United Arab Emirates 5.2, for Thailand 6.1, for Saudi Arabia 6.5, for China (excluding Hong Kong) 7.4, for India 7.9, and for Indonesia 8.0. Russia uses 16.8 times the energy of Japan, and the average value for the whole world is 3.2 (2012 White Paper, Agency for Natural Resources and Energy, METI).

These facts are ample proof that if countries and regions worldwide were to achieve energy conservation standards equal to Japan, it would be possible to make significant reductions in energy consumption (this would also indicate a significant reduction in GHG emissions) while maintaining and expanding "affluence." Promoting energy conservation is in itself the only way to resolve the tradeoff between "affluence" and "saving the planet."

2. The First Methodology out of Japan: The Top Runner Program

As "a country where energy conservation is advanced," Japan has a major role to play in developing countermeasures against global warming on an international scale. It is definitely no exaggeration to say that promoting energy conservation is the most significant of the international contributions that Japan can make in the twenty-first century.

However, this absolutely does not mean that Japan can be satisfied with the current energy conservation standard. Here, we must not overlook the historical fact that it was persistent efforts to pursue technical innovation and institutional reform that provided the driving force for building Japan into a country where energy conservation is advanced.

After the oil crises, Japan not only vitalized energy conservation initiatives in the industrial sector, but progress was also made with institutional reforms to promote the initiatives. In 1979, the Act on the Rational Use of Energy (the Energy Conservation Law) was enacted, establishing energy conservation guidelines for factories and buildings as well as guidelines for efficient energy consumption by machinery and appliances (automobiles, air conditioning units, etc.). The guidelines for machinery and appliances featured advanced content and were linked to the Top Runner Program introduced in 1999.

The concept behind the Top Runner Program is to establish fuel consumption standards for automobiles and energy conservation standards for electrical appliances at a level that is above

the performance of the best commercially developed product at a specific point in time. The Top Runner Program is currently attracting international interest as a unique energy conservation measure originating in Japan.

Since the Top Runner Program was introduced in Japan, some equipment (automobiles, electric products, etc.) has already reached its target year. Many of the targets have been exceeded and the assessment of the Top Runner Program is that it has made a significant contribution to improving energy consumption efficiency for all equipment. Chapter 3 by Akira Itagaki discusses the Top Runner Program in detail in the context of examples from the automotive industry.

3. The Second Methodology out of Japan: The Sector-based Approach

To significantly reduce GHG emissions for the whole planet, it is definitely not sufficient to only use market mechanisms such as introducing and expanding emissions trading. We must implement breakthrough technical innovations that rapidly promote energy conservation and the use of renewable energy.

As a framework for facilitating such breakthrough technical innovation, the sector-based approach has recently been attracting great attention. The sector-based approach is a concept that attempts to make significant reductions in GHG emissions and strives to drastically improve energy efficiency across national borders for each sector (industry or field) where GHG emissions are high. The Japanese government has a track record of encouraging all countries to adopt the sector-based approach.

The advantage of the sector-based approach is that it closes a loophole in the framework of the Kyoto Protocol, which established reduction of obligations for GHG emissions on a country-by-country basis. If all the main GHG emitters participated in the framework of the Kyoto Protocol, the loophole may never have developed. However, the reality is different.

China (the world's No. 1 emitter of greenhouse gases in 2007), India (No. 4), and other developing countries are not participating in the country-based framework for GHG emission reduction obligations provided by the Kyoto Protocol for fear of hindering "affluence" in their own countries. Meanwhile, the United States (No. 2) withdrew from the Kyoto Protocol framework because it perceived non-participation by developing countries to be "unfair." As a result, total GHG emissions from those countries that have shouldered the responsibility for their own reduction obligations under the Kyoto Protocol account for no more than 28% of GHG emissions worldwide. (Since the first commitment period for the Kyoto Protocol is 2008–12, these calculations are based on the results for 2007, the immediately preceding year).

The fact that only some of the principal GHG emitters are participating in the country-based framework of obligations to reduce GHG emissions in line with the Kyoto Protocol has increased the odds of the so-called carbon leakage problem occurring. Carbon dioxide (CO_2) makes up the core of greenhouse gases. Where countries with emissions reduction obligations imposed on them coexist with countries that have no such obligation, as is the case with the Kyoto Protocol, energy-intensive industries and sectors transfer from the former to the latter countries. As a result, the problem of increased CO_2 emissions for the whole world arises. This is the carbon leakage problem. This phenomenon arises because a country (for example, Japan) that ships out its energy-intensive industries and sectors has had emissions reduction obligations imposed on it and, generally, has a higher level of energy efficiency than a receiving country

with no such obligation (for example, China). This "carbon leakage problem" is the most serious loophole in the framework of the Kyoto Protocol.

In the case of the sector-based approach, there are no issues with carbon leakage because the emissions reductions for CO_2 and other greenhouse gases are devised by sector and not by country. If the sector-based approach is employed, energy-intensive industries and sectors stay in countries with good energy efficiency (where emissions reduction obligations have been imposed) while technologies that contribute to improved energy efficiency are transferred to the same industries and sectors in countries with low energy efficiency (where emissions reduction obligations have not been imposed). The important point here is that when energy-intensive industries and sectors stay in countries with good energy efficiency, it is not only possible to control CO_2 emissions worldwide at present, but it also increases the probability of developing technical innovation that will bring even higher levels of energy efficiency in the future.

The concept behind the sector-based approach is to try to significantly reduce GHG emissions and strive for radical improvements in energy efficiency across national borders for each sector (industry or field) where GHG emissions are high. The steel industry is the most enthusiastic proponent of the sector-based approach. Chapter 4 by Izumi Okubo discusses the sector-based approach in the steel industry in more detail.

Although international initiatives have not progressed as far as the steel industry, there is another sector worthy of special mention in terms of the potential effect of the sector-based approach. It is the coal-fired thermal power sector.

Japan has the highest standard of thermal efficiency in the coal-fired thermal power sector in the world. If the technologies were transferred internationally, it would be possible to immediately make significant reductions in CO_2 emissions. With respect to thermal efficiency in the coal-fired thermal sector, an internationally important source of power, Japan, surpasses Germany, the United States, China, and India with a world-class performance equal to that of Northern European countries. Consequently, if the best practices (most efficient power generation methods) of Japan's coal-fired thermal power stations were rolled out to other countries, this alone would result in a significant reduction of CO_2 emissions worldwide.

The calculations have been made by the Agency for Natural Resources and Energy based on IEA data ("Promoting the Introduction of High-Efficiency Thermal Power Generation," Agency for Natural Resources and Energy, METI, April 2013) shows the following amazing facts: simply rolling out the best practices (maximum efficiency) of Japan's coal-fired thermal power generation would reduce annual CO_2 emissions by 811 million tons in China, 361 million tons in the United States, and 292 million tons in India for a total reduction in CO_2 emissions of 1,464 million tons for these three countries (2009 performance standard).

This figure of 1,464 million tons corresponds to 116% of 1,261 million tons, which was the volume of GHG emissions in Japan in 1990. If the best practices of Japan's coal-fired thermal power generation were rolled out to China, the United States, and India, there would be no need to wait until 2020 for a GHG emission reduction that is 4.6 times the "25% reduction target" set out by former prime minister Hatoyama Yukio in 2009 and withdrawn by Prime Minister Abe Shinzo in 2013; it could be attained here and now. Based on this fact, it is definitely no overstatement to say that Japan's coal-fired thermal power technology is the "trump card" for preventing global warming.

4. The Third Methodology out of Japan: LCA

In addition to the Top Runner Program and the sector-based approach, there is another trump card that Japan can transmit to the world in order to significantly reduce GHG emissions for the whole planet. The third trump card is the concept of life cycle assessment or analysis (LCA).

LCA is a method of assessing the impact of a product on the environment by considering the entire process from obtaining the raw materials and fuel via processing, sales, and consumption to disposal.

From the standpoint of LCA, the chemical industry can be cited as an example of an industry that is tackling CO_2 reduction on an international scale. According to LCA, the use of chemical products enables significant reductions in GHG emissions in a range of fields including insulation, lighting, packaging, marine antifouling coatings, synthetic textiles, automotive weight reduction, low-temperature detergents, engine efficiency, piping, wind power, district heating, green tires, and solar power. A report released by the International Council of Chemical Associations (ICCA) to coincide with the L'Aquila Summit in Italy in July 2009 concludes that GHG emission reductions enabled by the chemical industry correspond to 2.1–2.6 times the emissions from the same industries, and that the reduction potential by 2030 will reach 4.2–4.7 times this figure (*Life Cycle Analysis* report, International Council of Chemical Associations, 2009).

Table 1 shows the details of eight product categories (102 examples of products) where ICCA estimates that the LCA method has a reduction effect on CO_2 emissions. Even if CO_2 is emitted during the process of manufacturing chemical products, it is possible to realize CO_2 emission reductions on a scale that exceeds emissions from the manufacturing process, if we consider the scale of CO_2 emission reduction that these products bring to the stages of use, consumption, and disposal. This is a global warming prevention measure that incorporates the LCA method proposed by the chemical industries.

The restrictions on CO_2 emissions by means of the country-based approach, which was introduced to prevent global warming, are often implemented by linking them with industry-based emission controls. Basically, the initiatives implemented to achieve the GHG emissions reduction obligations agreed under the Kyoto Protocol have taken the form of setting targets by industry and pursuing those targets. When this method is applied uniformly to the chemical industry, the manufacturing scale of the chemical industry is reduced according to the logic of industry-based CO_2 emission controls. Reductions in the manufacture of chemical products have a negative impact on estimates for global warming prevention measures that incorporate the LCA method. In order to prevent this kind of negative connection, ICCA published a report at the time of the L'Aquila Summit.

The Japan Chemical Industry Association plays a central role in the LCA initiatives taken at ICCA. In 2011, the Japan Chemical Industry Association published a report entitled "Innovations for Greenhouse Gas Reductions: Life Cycle Analysis of Chemical Products in Japan." In this report, the Japan Chemical Industry Association proposes the concept of c-LCA (carbon-life cycle analysis), which adapts the LCA methods to the issue of CO_2 emissions.

On the one hand, the use of fossil fuels makes the chemical industry a major GHG emitter, but the industry also provides large numbers of components to other industries. The c-LCA assessment method focuses on CO_2 emitted when using the products of other industries that

Table 1. Details of the Eight Product Categories for Which ICCA Used the LCA Method to Calculate the CO_2 Emissions Reduction Effect

Transportation	(19) Automotive weight reduction, lubricants, lower friction, engine efficiency, aviation weight reduction, marine fuel reduction
Insulation	(19) Building insulation, fridge insulation
Building	(10) Construction material, piping, windows
Agriculture	(17) Feed supplements, fertilizer and crop protection, preservation, food production efficiency
Packaging	(13) Food packaging, shopping bags
Consumer goods	(18) Electronic components, house ware, service wear, textiles, low-temperature detergents
Power	(4) District heating, solar power, wind power
Lighting	(2) CFL (compact fluorescent lamp) lighting, LED (light-emitting diode) lighting

Source: ICCA, *Life Cycle Analysis* report, 2009
Note: The figures in brackets ( ) indicate the number of products covered by the estimates.

incorporate these components. It looks at finished products that use chemical components with the same functionality and finished products that do not use any chemical components so as to compare CO_2 emissions across the life cycles. If no chemical components are present, the difference is seen as an increase in CO_2 emissions and calculated as a net contribution to CO_2 emissions. Chapter 5 by So Hirano looks in more detail at the LCA initiatives in the chemical industry in Japan.

5. Japan Will Lead in Stopping Warming if CO_2 is Reduced Overseas

Here, we would like to question the assertion that even if Japan were to reduce domestic GHG emissions by 25% compared to 1990 levels as in the international commitment announced by former prime minister Hatoyama Yukio, the contribution to stopping global warming would not be that large. This is the issue of the limitations of an approach that attempts to reduce GHG emissions by setting targets by country (the so-called country-based approach).

Carbon dioxide emissions from energy sources account for most GHG emissions (approx. 60% for the world and approx. 90% for Japan). The proportion by country (or region) of CO_2 emissions from energy sources in 2010 indicates that CO_2 emissions in Japan account for a little less than 4% of worldwide emissions (in 2010, CO_2 emissions worldwide were 30.3 billion tons while CO_2 emissions for Japan were 1.1 billion tons).

In short, even if Japan achieved the 25% target for CO_2 emission reductions by 2020, worldwide CO_2 emissions would only be reduced by a little less than 1% (less than 4% x 25% = less than 1%). This is the reason why "the degree of contribution to stopping global warming would not be that high" even if Japan were to achieve the 25% target.

So, is Japan not capable of taking a leading role in stopping global warming? She most decidedly is; i.e., if Japan employs an appropriate method, there is no reason why she cannot take a leading role in stopping global warming.

What is an appropriate method for Japan? As we have highlighted in this paper, it is to transmit to the world the three trump cards of (1) the Top Runner Program, (2) the sector-based approach, and (3) LCA to reduce overseas CO_2 emissions.

In terms of reducing GHG, the Top Runner Program is highly effective in the private sector and the operational sector. The sector-based approach works particularly well in the industrial sector, the power generation sector (energy conversion sector), and the transportation

sector. And all of these sectors are deeply engaged with LCA. To make real progress with stopping global warming, it is extremely important to use these three trump cards. By using these approaches, Japan can take an internationally leading role in stopping global warming.

III. *Top Runner Program: The Case of the Automobile Industry*

1. Introduction to this chapter

This chapter shows a consideration of voluntary carbon dioxide (CO_2) emission controls implemented by automobile manufacturers. There are several reasons for choosing automobile industry. This chapter focuses on CO_2 emission controls based on the Japanese government's Top Runner Program for comparing voluntary controls with other types of restrictions. Automobiles are subject to this program. And automobile industry is a leading sector among key manufacturing industries in the cost of capital investment, research and development expenses and working population. Therefore automobile industry is an appropriate target for this study.

This chapter is structured as follows. First, this chapter shows automobile industry's approaches to achieve the standard that was set by the Voluntary Action Plan and the Action Plan for a Low-Carbon Society. As the first step to examining this point, this chapter shows outline of the Voluntary Action Plan and examples of effort by automobile industry and its results. As the second step, this chapter shows the same points in the case of the Action Plan for a Low-Carbon Society. Then this chapter shows similar consideration of the Top Runner Program. Finally, with the above-mentioned consideration in mind, this chapter shows significance of self-regulation and the Top Runner Program by comparing them each other.

2. Voluntary Action Plan

Under the Voluntary Action Plan, automobile industry set a target of reducing CO_2 emitted in a production process at their plants and advanced efforts towards achieving this.

In 1997, the Japan Automobile Manufacturers Association, Inc. (JAMA) and the Japan Auto-Body Industries Association Inc. (JABIA) set the target to reducing CO_2 emission by 10% of FY 1990 level.[1] JAMA and JABIA revised their targets to a five-year average for the period of FY2008–FY2012 and raised the target value in 2007 based on a Keidanren policy. JAMA, which had used a fixed coefficient (t-CO_2/10,000kwh) set in FY1990 adopted a coefficient of variation based on the results for each fiscal year in 2007. Accordingly, the target value for 2007 fell by 21.1% from the FY1990 result. However, this figure is equivalent to a fixed coefficient reduction of 12.5%. In 2008, JAMA and JABIA consolidated their approaches and raised their unified target to a 22% cut from the FY1990 level. Ultimately, in 2009, they raised their CO_2 emission control target to a 25% cut from the FY1990 figure.

I aim to confirm the basis for calculating these target values in the following, with the

[1] Japan Automobile Manufacturers Association, Inc. and Japan Auto-Body Industries Association Inc. (December 12, 2013), *Jidosha seizogyo ni okeru chikyu ondanka taisaku no torikumi* (Initiatives for addressing global warming in the automobile-manufacturing industry).

target value for FY2008, a 22% reduction from the FY1990 level, as a point of reference.[2]

To start, we can find the business-as-usual projection ("BAU projection") for respective fiscal years based on manufacturing plans for FY2008–FY2012 and planned CO_2 increase factors, with CO_2 emissions in FY2007 as an intensity target. We can then arrive at a five-year average based on the calculated BAU projection.[3] More precisely, the average BAU projection for five years in FY2008–FY2012 comes to 7.72 million tons. This figure consists of 6.61 million tons of CO_2 emitted in FY2007, 800,000 tons emitted for increasing production (total 720,000 tons attributable to expanded production at existing manufacturing plants and 80,000 tons owing to a parts production increase), 290,000 tons for facility buildup (total 240,000 tons emitted for building new plants, adding manufacturing lines, manufacturing parts for overseas clients, and maintaining production at new plants, and 50,000 tons for summertime measures and automation), and 20,000 tons emitted for environmental response. JAMA and JABIA set the target figure of 6.59 million tons of emission cuts by subtracting 1.02 million tons attributable to electricity coefficient improvement and 113,000 tons reduced with self-help efforts from the average BAU projection.

JAMA and JABIA arrived at 113,000 tons of CO_2 emissions reduced with self-help efforts by summing up three figures—the volume of reduction planned for achieving targets announced by respective companies, volume of reduction by investment items that had been introduced or will be introduced reliably in medium-term plans, and volume of reduction presented in medium- and long-term plans prescribed in the Act on the Rational Use of Energy. More specifically, JAMA and JABIA set the CO_2 emission reduction target for self-help efforts by adding up figures for (1) measures taken on the energy supply side (totaling 24,000 tons of CO_2 emissions reduced), (2) measures taken on the energy consumption side (33,000 tons), (3) sophistication of energy supply methods and operation and management technologies (27,000 tons), (4) line consolidation and concentration (13,000 tons), and (5) fuel conversion, Energy Service Company (ESCO) Project, and other initiatives (15,000 tons).

To achieve these targets, the automobile-manufacturing industry advanced measures in four broad categories— (1) facility measures, (2) measures for improving productivity, (3) fuel conversion, ESCO Project, etc., and (4) energy-saving effects in cooperation with supply chains, etc.[4]

As a result of these measures, the average volume of CO_2 emissions reduced in the five years of FY2008–FY2012 reached 35% of the emissions in FY1990, substantially greater than the 25% set as the target.

[2] I (Itagaki) referred to *2008-nendo jishu kodo keikaku hyoka kensho kekka oyobi kondo no kadai nado* (Results of the evaluation and inspection of the FY2008 voluntary action plan, future issues, etc.), which the Global Environment Subcommittee under the Environment Committee of the Industrial Structure Council released on December 16, 2008 as the basis for establishment of all standards cited in this chapter.

[3] Estimates based on the most recent results are used for the production plans of respective companies because they keep such plans secret.

[4] Japan Business Federation, *Kankyo jishu kodo keikaku (ondanka taisaku-hen) foroappu kekka* (Results of follow-ups on the voluntary environmental action plan [focused on measures against global warming]) (editions for respective fiscal years).

3. Action Plan for a Low-carbon Society[5]

Automobile industry took part in the Action Plan for a Low-Carbon Society as well. They are currently working to reduce CO_2 emissions under this plan.

The automobile industry's CO_2 emission target under the plan is to bring total emissions in FY2020 to 7.09 million tons, or 28% less than FY1990 emissions. I aim to confirm the method of setting this target value in the following in the same way as the target under the Voluntary Action Plan. First, we can forecast total CO_2 emissions for FY2020 by multiplying the predicted 11.7 million automobiles produced in that year by the per-vehicle CO_2 intensity target for FY2005. In doing so, we must add a volume of CO_2 that was emitted in production process of next-generation automobiles occupying the ratio of 18% in the whole amount of production to the total CO_2 emissions since such automobiles emit 20% more CO_2 through their production compared with existing models. JAMA and JABIA set a target of 7.09 million tons for CO_2 emission cuts by subtracting the 820,000 tons reduced through electricity coefficient improvement and the 830,000 tons cut with self-help efforts from the calculated total of 8.74 million tons.

JAMA and JABIA set CO_2 emissions to be reduced with self-help efforts at 830,000 tons by adding up the volume of reduction with six measures—(1) facility improvement on the energy supply side (totaling 130,000 tons reduced), (2) facility improvement on the energy consumption side (250,000 tons), (3) improvement in operation and management (130,000 tons), (4) fuel conversion (90,000 tons), (5) revolutionary technological development (180,000 tons), and (6) energy-saving efforts made in offices and research institutes (50,000 tons).

The Action Plan for a Low-Carbon Society also mentions contributions to such a society through automobile fuel economy improvement and development and practical implementation of next-generation automobiles. In other words, the plan mentions a contributions to reduce CO_2 emissions in the transport sector through improvement of automobile fuel economy and introduction of next-generation automobiles such as hybrid models and fuel cell vehicles. JAMA and JABIA calculate they can cut CO_2 emissions by 22–26 million tons in the ten years from FY2010 with such steps.

JAMA and JABIA have not, however, set specific numerical targets for CO_2 emission reduction with the development and sales of next-generation automobiles. They have not done so because the volume of CO_2 that automobiles emit depends greatly on traffic condition and driving method, and this tendency makes it hard for manufacturers to set a target for reduction with self-help efforts.[6]

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[5] For information presented in this section, I referred to *Sankoshin jidosha WG shiryo* (Materials for the Automobile Working Group of the Industrial Structure Council) prepared by the Japan Automobile Manufacturers Association, Inc. and Japan Auto-Body Industries Association Inc. and to *Teitanso shakai jikko keikaku* (Action plan for a low-carbon society) released by the same two associations unless specified otherwise.

[6] According to Keidanren-sponsored interviews with members of the Japan Automobile Manufacturers Association, Inc. (conducted on December 12, 2013).

4. Government-imposed Restrictions on the Automobile Manufacturing Industry

(1) Restrictions through the Top Runner Program

An example of government-imposed restrictions on automobile manufacturers is energy consumption controls applied to specific types of equipment through the Top Runner Program. The program is designed to establish standards in consideration of the performance of a product with the highest energy efficiency among those currently on the market and the future outlook for technological development. It covers twenty-six types of equipment, including air conditioners and televisions, in addition to passenger automobiles and cargo trucks.[7]

A standard for the fuel economy of gasoline passenger automobiles was originally established in December 1979 based on the Act on the Rational Use of Energy (the Energy Conservation Law) enacted that June. In the subsequent period, the standard and applicable vehicles were revised many times. In March 1999, a new standard was established with the Top Runner Program as its basis.

First, standards, etc. in the program are deliberated and determined at the judging standard subcommittee for respective types of equipment (or working groups in their preparatory stage. As the second step, the Energy Efficiency Standards Subcommittee deliberates and determines standards and so on. Finally, standards, etc. are determined by the deliberations of the Advisory Committee for Natural Resources.[8] In the case of the automobile's fuel economy standards for FY2020, the Subcommittee on Automobile Judgment Standards was set up under the Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy. The subcommittee held joint meetings with the Automobile Fuel Economy Standards Subcommittee established at the Automobile Transport Task Force under the Land Transport Subcommittee of the Council for Transport Policy under the Ministry of Land, Infrastructure, Transport and Tourism to discuss new fuel economy standards.[9] Seven meetings were held from June 28, 2010 to October 20, 2011 to deliberate on the new standards. Participants in the meetings decided on the standards in consideration of interviews conducted with automobile and other manufacturers (whose results were presented at the second meeting on September 13, 2010) and public comments received for an interim report. With particular regard to establishment of specific standards, they "listened to information including management strategies, etc. such as the presented state of and outlook for the development of various fuel economy improvement technologies and the prospects for the popularization of next-generation automobiles in consideration of the degree of acceptance by consumers who is conscious of this cost." "From technical viewpoints they reexamined and reas sessed the rate of fuel economy improvement by engine improvement, auxiliary machinery loss reduction, and driving system improvement and rate of future popularization of automobiles in FY2020 while referring to the information from manufacturers. And they estimate fuel economy improvement

[7] Agency for Natural Resources and Energy (March 31, 2014), *Toppu rannaa seido ni tsuite seido gaiyo* (Outline of the Top Runner Program) (http://www.enecho.meti.go.jp/policy/saveenergy/data/tr-seido.pdf).

[8] Agency for Natural Resources and Energy and the Ministry of Economy, Trade and Industry (March 2010), *Top Runner Program: Developing the World's Best Energy-Efficient Appliances*, p. 10.

[9] Ministry of Economy, Trade and Industry (June 2010), *Shoenerugii kijun bukai jidosha handan kijun shoiinkai no secchi ni tsuite* (Establishment of the Subcommittee on Automobile Judgment Standards under the Energy Efficiency Standards Subcommittee).

rate of top-runner vehicles."[10] These actions suggest that opinions and information on the manufacturing side have great significance.

(2) Tax Systems and Environmental Labels

Tax reduction systems such as eco-car tax reduction, special treatment for used automobiles, and special treatment for green vehicles play the role of complementing the Top Runner Program. These systems reduce taxes such as automobile acquisition tax and automobile weight tax in accordance with an excess rate of fuel economy standards. Tax reduction increases in amount as the excess rate rises. This is a policy aimed not only at achieving standards but also giving companies the motivation to develop more fuel-efficient automobiles by stimulating competition among them, in addition to encouraging consumers to buy automobiles that offer high fuel economy.

The Sticker for Cars that Achieved Fuel Economy Standards, a type of environmental label, is also assumed to be performing the role of promoting competition for further development of such automobile models. This is a system for putting stickers on automobiles that have achieved or surpassed fuel economy standards according to their levels of standard achievement. The Ministry of Economy, Trade and Industry and Ministry of Land, Infrastructure, Transport and Tourism introduced the Sticker with the aim of "raising the interest and understanding of general consumers regarding the fuel efficiency performance of automobiles and promoting popularization of high-fuel-economy automobiles through the choices of general consumers."[11] Through information provision, the Sticker is playing the roles of promoting the purchase of high-fuel-economy automobiles and encouraging companies to develop such models.

The efficiency of applicable equipment has improved greatly in part due to these regulation.

5. Summary of Controls under the Two Action Plans and Comparison with Restrictions through the Top Runner Program

As stated above, voluntary controls by automobile manufacturers produced a certain level of effects. As a result of steps taken through the Voluntary Action Plan, CO_2 emitted for production declined drastically. The comparison of the Voluntary Action Plan with the Action Plan for a Low-Carbon Society shows that the target of CO_2 emissions decreased sharply with self-help efforts. Probably it is certain that the Voluntary Action Plan experience proved effective in the self-imposed control that followed.

Taishi Sugiyama and Masayo Wakabayashi stated that an advantage of voluntary controls is that information is accumulated on the control-setting side. And they stated that this

[10] Ministry of Economy, Trade and Industry (October 2011), *Sogo shigen enerugii chosakai shoenerugii kijun bukai jidosha handan kijun shoiinkai kotsu seisaku shingikai rikujo kotsu bunkakai jidosha bukai jidosha nenpi kijun shoiinkai godo kaigi saishu torimatome (an)* (Final report [draft] on joint meetings by the Subcommittee on Automobile Judgment Standards under the Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy and the Automobile Fuel Economy Standards Subcommittee under the Automobile Transport Task Force of the Land Transport Subcommittee of the Council for Transport Policy), p. 19.

[11] Ministry of Land, Infrastructure, Transport and Tourism (March 4, 2013), *Nenpi kijun tasseisha sutekka no tenpu ni tsuite* (Attachment of sticker for cars that achieved fuel economy standards) (http: //www.mlit.go.jp/common/ 000208143.pdf).

advantage enhances effect of regulation because this advantage enabled (1) quick response, (2) a cross-product approach, and (3) flexible response.[12]

With regard to these three points, Japanese government regulations are assumed to compare unfavorably with voluntary controls. Japanese government regulations has imposed on the automobile-manufacturing industry show a historical government tendency to establish standards with consideration given to factors such as technological development by manufacturers and economic conditions.[13] For this reason, officials took time for hearing of opinions from automobile companies before enforcing restrictions. As a result, government regulations tend to compare unfavorably with regard to (1) quick response. As an example, the Subcommittee on Automobile Judgment Standards was set up under the Energy Efficiency Standards Subcommittee in June 2010 to establish fuel economy standards for FY2020. Yet the standards were finalized one year and four months later, in July 2011. In the meantime, looking at the process of formulating the Action Plan for a Low-Carbon Society, plans for nine key industries were published in November 2010, eleven months after Keidanren announced its intention to draw up and promote the plan in December 2009.[14] In addition, with regard to (2)a cross-product approach, when a new product is born, it is necessarily to determine which the product becomes a target of the regulation or not. And if the product become the target, it is necessarily to set new standard. Because the Top Runner Program is regulation for specific types of equipment. Also, (3) with regard to flexible response, in some cases, the time for implementing regulation may be postponed and standards may be relaxed considering the state of manufacturers' technological development. However, such response needs time and expense due to the problem stated in (1). The same goes for the tightening of regulatory standards.

Meanwhile, voluntary controls also have their limits. For example, the scope of controls and the appropriateness of standards are problems. With regard to the scope of controls, automobile manufacturers make effort actively to improve fuel economy of their products, but they dose not set numerical standards of their products in the Voluntary Action Plan and the Action Plan for a Low-carbon Society. They did not establish such standards because the fuel economy would significantly depend on the product users. However the original meaning for the regulation is to reduce CO_2 emissions for the global environment. Therefore it is necessary that automobile industry commit to reducing CO_2 emissions in the transport and home sectors more.

With regard to the latter, It is difficult for the industry to set adventurous limit values as regulatory standards. Values whose achievability is doubted will be difficult to establish. The industry has been enthusiastic about voluntary controls because effort to reduce CO_2 emissions

[12] T. Sugiyama and M. Wakabayashi (2013), *Ondanka taisaku no jishuteki torikumi: Nihon kigyo wa do kodoshitaka* (Voluntary initiatives for measures against global warming: How have Japanese companies acted?), *Energy Forum*, March 2013, p. 51.

[13] A. Itagaki (2011), *Sengo Nihon no tai jidosha sangyo kisei seisaku no tokucho to sono igi: Haigasu anzen kisei wo chushin ni* (Characteristics of control policies for the automobile industry in postwar Japan and their significance: With a focus on exhaust controls and safety regulations], Ph. D. University of Tokyo.

[14] *2013-nendo iko no sangyokai no jishuteki torikumi* (*teitanso shakai jikko keikaku*) *ni kansuru sakutei jokyo oyobi kongo no kadai nado (an) (gaiyo)* (State of formulation concerning voluntary industry controls [action plan for a low-carbon society], future issues, etc. in and after FY2013 [draft] [summary]), (materials on the proceedings at joint meetings of the Global Environment Subcommittee under the Environment Committee of the Industrial Structure Council and the Voluntary Action Plan Follow-up Specialist Subcommittee under the Global Environment Committee of the Central Environment Council), March 2013.

bring the industry advantages such as cost reduction and higher profit through improved fuel economy. Yet the other side of the coin is that the industry avoids controls whose costs exceed their advantages. This means that awareness of response to environmental issue, the original purpose of the regulation, is pushed into the background. Of course it is natural for an actor engaging in corporate activities to take such behavior. Because of this, the existence of objective regulator, that judge the original purpose of the regulation and the conditions of regulated side , is needed.

Japanese government regulation play the role of supplementing voluntary control that are limited. In the reference cited, Sugiyama and Wakabayashi positioned voluntary controls as controls that supplement government regulations.[15] it is certain that government regulations also play the role of supplementing voluntary controls.

Among government regulations, the Top Runner Program encourages standard achievement more than the others because it facilitates competition among companies and gives them the incentive to work on regulations by functioning in combination with tax reduction systems. However, the program has the three limits explained above because it is a government-imposed restriction. This remains a fact. It is important to increase the supplementation of voluntary controls and government regulations and build systems for this purpose while making the most of their characteristics.

IV. *Sector-by-Sector Approach: The Case of the Iron and Steel Industry*

1. Introduction to This Chapter

The theme for this chapter is to look back, from a historical perspective, on measures that the Japan Iron and Steel Federation (JISF), an iron and steel industry organization in Japan, has taken to combat global warming. With the exception of the electric power industry, which belongs to the energy conversion sector, iron and steel is the Japanese industry that discharges the greatest volume of carbon dioxide (CO_2), which forms the core of greenhouse gases. For this reason, JISF has worked on measures to fight global warming most aggressively among the many industrial organizations that exist in Japan. I (Okubo) outline such JISF initiatives in this chapter.

I first examine the activities of JISF related to the Environmental Voluntary Action Plan (the "Voluntary Action Plan"). Then, I look back on the historical progress of measures JISF has taken to fight global warming. Finally, I introduce JISF's initiatives in connection with the Commitment to a Low Carbon Society, which are expected to enter into full swing from here forward.

2. JISF's Activities related to the Voluntary Action Plan

In the Voluntary Action Plan, JISF adopted a 10% reduction from the FY1990 energy consumption level, the benchmark year used in the Kyoto Protocol, as its target.[16] It then

[15] Ibid. Sugiyama and Wakabayashi, p. 16.

[16] The Japan Iron and Steel Federation (JISF), (December 12, 2013), *Tekkogyo no chikyu ondanka taisaku eno*

achieved this target, reducing energy consumption by an average rate of 10.7% from FY2008 to FY2012, the first commitment period. It also realized a 10.5% cut in CO_2 emissions in the same period. JISF thus used no credit based on the so-called Kyoto Mechanism.[17]

As a nation, Japan made the most of the Kyoto Mechanism to achieve a total greenhouse gas emission reduction of 6% from the FY1990 level, a goal set in the Voluntary Action Plan. JISF's activities could be called a model among initiatives taken in different industries. It played a leading role in promoting global warming countermeasures in Japan by proposing a sector-by-sector approach and taking other steps.

3. Historical Progress of JISF's Global Warming Countermeasures

The Japanese iron and steel industry has achieved energy conservation of the world's highest level since the oil crises in the 1970s with initiatives such as process omission and interconnection, introduction of waste heat recovery facilities, their reinforcement and efficiency improvement, recovery of by-product gases and their effective use, and expansion of the ratio of slightly caking coal used and resource recycling. The energy efficiency of the iron and steel industry in respective countries shows that the Japanese iron and steel industry boasts the world's highest energy efficiency level.[18] An international comparison of potential for reducing CO_2 emissions, assuming that the energy efficiency of the Japanese iron and steel industry is transferred and diffused, indicates that such potential exists in countries such as China, the United States, Russia, and India, on a considerably large scale.[19]

How has the Japanese iron and steel industry achieved energy conservation of such a high level? We can read the answer in the context that shows the historical progress of energy-saving technologies used in the industry.

The recovery of waste heat and fuel reduction accounts for the high ratios of principal energy conservation technologies employed in the industry.[20] The following section introduces initiatives that the Japanese iron and steel industry has taken in connection with coke dry quenching (CDQ) facilities, which produce the highest energy-saving effect among waste heat recovery facilities, and the Super Coke Oven for Productivity and Environmental Enhancement toward the 21st Century (SCOPE21), which brings together technologies for increasing the ratio of non-slightly caking coal. These represent vital technologies for the recovery of waste heat and reducing fuel.

CDQ facilities recover waste heat from coke ovens and use it for electricity. Japan introduced technologies for their prototype from the defunct Soviet Union in 1973 and subsequently improved on them. The Japanese iron and steel industry introduced the first CDQ

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torikumi: Jishukodo keikaku jisseki hokoku [Initiatives the Japanese iron and steel industry has taken against global warming: Report on the achievements of the voluntary action plan].

[17] Energy consumption and CO_2 emissions of total steel producers were estimated based on" Current Survey of Energy Consumption" . CO_2 emissions are calculated by using electric power coefficients after reflecting emission credits.

[18] Ibid. JISF (2013).

[19] The Japan Iron and Steel Federation (JISF), (February 25, 2008a), *Nippon tekkogyo no enerugii koritsu ni tsuite* [Points regarding the energy efficiency of the Japanese iron and steel industry].

[20] The Japan Iron and Steel Federation (JISF), (1993), *Ikkan seitetsujo no shoenerugii taisaku to sono seika* [Energy conservation measures taken at integrated ironworks and their achievements].

unit incorporating improved technologies in 1976. After that, it increased the number of CDQ units installed in step with technological improvement. The diffusion rate of CDQ facilities resultantly reached approximately 60% in 1990 and 100% in 2012.[21] Inprovement of CDQ technologies and a rise of the number of CDQ units installed were the main causes of growth in recovered waste heat energy in 1975–1990.[22] Japanese iron and steel manufacturers raised the ratio of recovered energy to spent energy by improving the technologies further from 38% in FY1990 to 44% among FY2008-2012 (average rate).[23]

SCOPE21[24] is a new coke oven model that adopts new technologies. A coke oven is a facility that carbonizes coal and produces coke. Coking belongs to the uppermost stream of the ironmaking process. It is a process strongly associated with technologies for reducing fuel. Technologies related to coke ovens are extremely important because coking process accounts for 13% of energy consumption in the ironmaking process. The development of SCOPE21 began in 1994, with the first SCOPE21 installed in 2008. Japan constructed a total of 48 coke ovens from the 1960s to 1970s. A new coke oven model that incorporates the latest technologies had been sought because the useful lives of old coke ovens in Japan are scheduled to end in the near future. SCOPE21 uses the latest technologies for increasing the ratio of non-slightly caking coal and it has CDQ technologies in combination.

SCOPE21 realized greater efficiency and energy conservation by dividing the coke-manufacturing process into three stages: (1) advanced coal processing, (2) carbonization, and (3) heating by CDQ. Advanced coal processing became a major technology for SCOPE21. Advanced coal processing technologies raise the ratio of low-quality coal used, improve the quality of coke, and lead those changes to energy conservation by reducing moisture contained in coal. Japanese iron and steel manufacturers have improved their technologies from the traditional moist coal method to coal moisture control (CMC) technologies introduced in 1983 to dry-cleaned and agglomerated precompaction system (DAPS) technologies realized with an actual machine in 1992. They improved the ratio of low-caking coal used from 10% to 50% by SCOPE21. The carbonization period was shortened from 17.5 hours to 7.4 hours and productivity rose 2.4 times as a result. They achieved a 21% cut in energy used and reduced CO_2 emissions by 400,000 tons/year.

In addition to those mentioned above, we can cite waste-recycling technologies as important energy-saving technologies the Japanese iron and steel industry introduced after conclusion of the Kyoto Protocol. According to JISF materials, the effective use of plastics and other waste grew in the first five years of the twenty-first century.[25] Their effective use has since remained at a high level.

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[21] Ibid. JISF (2013).

[22] The Japan Iron and Steel Federation (JISF), (1992), *Ikkan seitetsujo no miriyo enerugii* [Unused energy at integrated ironworks].

[23] Ibid. JISF (2013).

[24] The following arguments on SCOPE21 are based on Nippon Steel Corporation (2008), *Jisedai kokusu seizo gijutsu SCOPE21 ga honkaku kado* [Next-generation coke-manufacturing technology SCOPE21 starts operating at full scale], *Nippon Steel Monthly*, 182, pp. 1-8.

[25] Ibid. JISF (2013).

4. Sector-By-Sector Approach Advocated by JISF

With regard to the Commitment to a Low Carbon Society, JISF has adopted the following four as its key approaches:

(1) Eco-processes (further boosting energy efficiency, which is already at the world's highest level, by timing the introduction of technologies developed in recent years to the renewal of decaying facilities)
(2) Eco-solutions (contributing to CO_2 emission reduction on a global scale by transferring energy conservation technologies to offshore locations centered on developing countries and popularizing their use)
(3) Eco-products (contributing to CO_2 emission reduction at the stage of end-product use through the supply of high-performance steel)
(4) Development of a revolutionary ironmaking process (reduction of iron ore using hydrogen and separation and recovery of CO_2 from blast furnace gases)

Among the four, Approach 2 corresponds to the so-called sector-by-sector approach. This is an approach that drastically raise energy efficiency and substantially cut greenhouse gases across national boundaries in sectors (industries or fields) that produce greenhouse gases in large quantities. The Japanese iron and steel industry is working on this sector-by-sector approach with great enthusiasm.

JISF set up a task force under the Asia-Pacific Partnership on Clean Development and Climate (APP), and investigated the state of diffusion about representative energy-saving and environmental technologies from 2006 to 2008 at ironworks in six APP participants: Japan, the United States, China, India, South Korea, and Australia. The investigation covered energy conservation technologies for operations such as the recovery of by-product gases from blast furnaces, coke ovens, and converter furnaces, CDQ, power generation using top-pressure recovery turbines ("TRT power generation"), coal moisture control, pulverized coal injection (PCI), waste heat recovery from sintering, hot blast stoves, converter furnaces, and pellet-manufacturing processes, and scrap preheating for electric furnaces. Environmental technologies for operations such as desulfurization of coke-oven gases, desulfurization and denitration of gas emissions from sintering, and desulfurization and denitration of gas emissions from pellet-manufacturing plants were also subject to the investigation.

Based on the findings of this investigation, APP's iron and steel task force and JISF concluded that energy conservation and environmental technologies of the world's highest level could reduce CO_2 emissions by 127 million tons/year[26] even if production is kept at the level as of the investigation point if and when such technologies are transferred from ironworks in Japan to their counterparts in the six countries and disseminated among those facilities. This reduction volume amounts to more than 10% of the 1.261 billion tons of greenhouse gases Japan emitted in FY1990. As is widely known, Japan repeated great efforts to achieve the target made compulsory under the Kyoto Protocol, that is, to cut average greenhouse gas emissions for the period of FY2008–FY2012 by 6% compared with the FY1990 level. The scale of greenhouse gas emission cuts that Japan is needed to accomplish under the Kyoto Protocol can

[26] The Japan Iron and Steel Federation (JISF), (October, 2008b), *Tekkogyo no chikyu ondanka taisaku eno torikumi* [Initiatives the Japanese iron and steel industry has taken against global warming].

be achieved immediately in excess if and when existing energy conservation technologies of the highest level, which the Japanese iron and steel industry has actualized, can be popularized among other APP participants.

The amount of possible CO_2 emission reduction as of 2008 country by country, assuming that the iron and steel industry in each country can achieve the same energy efficiency as its Japan's efficiency, indicates that CO_2 emissions will be reduced substantially in countries centered on China, the United States, and Russia, and that the possible CO_2 emission reduction for ten countries will add up to 250 million tons when this situation becomes reality.[27] Japan has reached the highest level in terms of energy efficiency of the iron and steel industry, and there is a huge disparity among nations regarding energy efficiency in this sector. The CO_2 emission reductions become possible just by applying the current energy efficiency of the Japanese iron and steel industry internationally because such disparity is present.

Among the four approaches that JISF adopts with regard to the Commitment to a Low Carbon Society, the eco-products in Approach 3 correspond to life cycle analysis (LCA). As an example, JISF is working to reduce CO_2 emissions substantially at the stage of iron and steel use by supplying high-hardness, high-performance iron products. It is aiming to take a leadership role in LCA, in addition to the sector-by-sector approach.

5. Conclusion of This Chapter

Global crude steel production increased further in the twenty-first century and reached 1.55 billion tons, the largest volume ever, in 2012. Increased crude steel production in China was a main reason for this result. Crude steel produced in China grew by more than ten times in 1990–2012. China's crude steel output accounts for almost 50% of global steel production today.[28]

Such crude steel production growth is the backdrop to the rising importance of the sector-by-sector approach. China, where crude steel is now produced in large volumes, and India, where greater crude steel production is forecast, display particularly high potential for diffusion of energy conservation facilities. Technological transfers are essential for their diffusion.

International cooperation that supports the sector-by-sector approach in the iron and steel industry became active as the twenty-first century began. Bilaterally, such cooperation has been advanced between Japan and China mainly by the Meeting for Exchanging Advanced Environmental Protection and Energy Conservation Technologies since 2005, and between Japan and India by the Public and Private Collaborative Meeting since 2011. With regard to multilateral cooperation, the APP task force in iron and steel industry above aggressively engaged in activities for such collaboration in 2006–2010. The GSEP working group and other bodies, have also proactively applied the sector-by-sector approach to their activities since 2010.

Here, we see again CO_2 emission-reducing effects of the technologies that Japanese companies had popularized to overseas by FY2012. CO_2 emissions totaled approximately 46.92 million tons/year among China, India, South Korea, Russia, Ukraine, and Brazil by this period. The total CO_2 emissions from these countries are anticipated to rise to 70 million tons in

[27] Ibid. JISF (2008a).
[28] Ibid. JISF (2013).

FY2020.[29]

According to data published by the International Energy Agency (IEA), CO_2 emission cuts will reach 340 million tons/year[30] when energy conservation and environmental technologies of the highest level are transferred and disseminated to worldwide. This reduction volume equals 27% of the greenhouse gases Japan emitted in FY1990. This means Japan will cut its CO_2 emissions more than 25% from its FY1990 level, that is a goal prime minister Hatoyama Yukio set in 2009, ahead of FY2020.

V. *Life Cycle Analysis: The Case of the Chemical Industry*[31]

1. Introduction to This Chapter

The purpose of this chapter is to examine past initiatives and future developments concerning greenhouse gas (GHG) reductions in the chemical industry in Japan.

The chemical industry in Japan was already promoting energy reduction in manufacturing (energy conservation) before reducing GHG became an international issue. As a result, carbon dioxide emissions per production output in Japan is low even when compared to advanced countries. As Japan is not rich in fossil resources, these efforts to conserve energy have progressed because of the economical demand triggered by the oil crisis to reduce the use of fossil fuel. If we look at the production of ethylene, which is a core product in the manufacture of petroleum products, we find that by 1990 energy consumption per unit of output was approximately half the previous level. Assuming Japan is 100, a comparison of current energy efficiency at ethylene plants indicates a score of 110 for Europe and 130 for North America, which suggests that production in Japan is efficient even for an advanced country and that carbon dioxide emissions per unit of output are proportionally lower.

When GHG emissions reduction became the international agenda, the nature of these efforts changed from being problems to be addressed by individual firms to issues that were proactively and extensively promoted through Japan Bussiness Federations (Keidanren) and industry organizations. The chemical industry embarked on a Voluntary Action Plan for reducing GHG in 1997. The industry also engaged with the Commitment to a Low Carbon Society in fiscal 2013. The latter action, the Commitment to a Low Carbon Society, proposes measures for reducing CO_2 emissions based on life cycle assessment (LCA), a concept that differs from previous initiatives.

After first presenting an overview of the Environmental Voluntary Action Plan, the remainder of this chapter will examine the Commitment to a Low Carbon Society, which is the initiative for the future that incorporates the new LCA perspective.

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[29] Ibid. JISF (2013).

[30] The Japan Iron and Steel Federation (JISF), (August 30, 2012), Nihon tekko renmeiteitanso shakai jikko keikaku [Action plan for a low-carbon society of JISF].

[31] Unless otherwise noted, the descriptions in this paper are based on the Japan Chemical Industry Association data (2012, 2013) and interviews with the stakeholder.

2. GHG Reduction Efforts in the Chemical Industry: The Environmental Voluntary Action Plan

In its Environmental Voluntary Action Plan, the chemical industry set a target of reducing energy per unit of output to 90% of 1990 levels by 2010. This target was established after surveying approximately 100 chemical companies in 1996 and considering the prospects for energy conservation efforts at each company. On this occasion, energy per unit of output was adopted as the indicator instead of CO_2 emissions for the following reason. The chemical industry is a basic materials industry and production output is dependent on demand in downstream industries that the industry itself can not control. Therefore, even if the industry makes efforts to conserve energy, emissions will increase when demand increases, and conversely, emissions will decrease when demand contracts even if the industry makes no effort at all. Consequently, it is not possible to use emissions as an indicator to reflect the efforts in the industry, so energy usage per unit of output (= CO_2 emissions) was selected instead.

Initiatives to reduce GHG in the chemical industry have achieved the expected target. The Voluntary Action Plan was launched in 1997 and the target was achieved as soon as fiscal 2002 when energy consumption per unit of output was at 90% of 1990 levels. Therefore, the chemical industry set a new target for energy consumption per unit of output at 80% of 1990 levels (87% in the case of emergence of external adverse factors) and, as of fiscal 2007, the target was changed to an even more ambitious one. Unfortunately, the financial crisis that emerged with the collapse of the Lehman Brothers bank in 2008 manifested itself in external adverse factors that caused a sharp drop in demand for chemical products. In this context, the chemical industry lowered energy consumption per unit of output to 85% of 1990 levels for the period 2008 to 2012, achieving this revised target as well. From fiscal 1997 to fiscal 2012, cumulative investment in GHG reduction rose to 554.5 billion yen with the cumulative reduction effect reaching a crude oil equivalent of 4.77 million kiloliters. In annualized terms, this equals average energy savings of 1.1% every year over a period of sixteen years.[32]

This reduction in GHG was realized through:

(1) Improved operating methods (changes in pressure, temperature, flow rate, and other manufacturing conditions, reducing the number of machines in operation, shortening hours, sophisticated controls, etc.);
(2) Recovery of emitted energy (using and improving hot and cold emissions, etc.);
(3) Rationalization of manufacturing processes (process rationalization, catalyst changes, changes in manufacturing methods, etc.);
(4) Improved efficiency of equipment and machinery (efficiency improvements by updating machinery and materials, installing highly efficient equipment, etc.);
(5) Other (product changes, etc.).

The report of the Japan Chemical Industry Association (JCIA), "Initiatives to Counter Global Warming at the Japan Chemical Industry Association" (2013), gives a summary of the number of investment projects, investment amounts, reduction effect, and investment effect (cumulative totals for fiscal 2008 to 2012). Improved efficiency of equipment and machinery

[32] Japan Chemical Industry Association (JCIA), (2013), "Initiatives to Counter Global Warming at the Japan Chemical Industry Association."

contributed the most to the reduction. And improved operating methods had the highest investment effect. This highlights the importance of updating deteriorating equipment to reduce GHG and it also becomes clear that making small-scale improvements in, for example, operating methods is a small investment with major impact.

The corporations in the chemical industries have not achieved these emission reductions by their own efforts alone. In Japan, the chemical factories is not alone in coastal areas, but there are also areas where the factories of corporations in the oil refinery industry, steel industry, power industry, and other heavy industries are concentrated in close proximity (in Japan, this is referred to as a "Kombinat," or an industrial complex). In these industrial complexes, different types of industry and different corporations have reduced GHG by lending each other their resources. For example, in the Sakai district in Osaka, oil refineries (Tonen General Sekiyu and Nippon Petroleum Refining) and chemical companies (Mitsui Chemicals) use previously discarded LNG cool energy from the adjacent Osaka Gas to reduce CO_2 emissions by 64,400 tons per year. Such initiatives are underway at industrial complexes in all areas of Japan.[33]

3. Future Initiatives: Commitment to a Low Carbon Society

Following the Environmental Voluntary Action Plan, the chemical industry has embarked on initiatives to reduce GHG by 2020 based on the new Commitment to a Low Carbon Society. The target of this Commitment is to reduce CO_2 emissions from activities by 1.5 million tons under the business-as-usual scenario (BAU) as of 2020. Based on presumption production in fiscal 2020, calculations indicate CO_2 emissions would be 67.28 million tons and when this is reduced by 1.5 million tons, the target is 65.78 million tons.

Since the chemical industry in Japan already has the highest level of energy efficiency in the world, there is little margin for future reductions, but the industry is aiming for further levels of efficiency by disseminating BPT (best practice technologies). Specifically, the industry believes it is possible to reduce energy consumption by a crude oil equivalent of 151,000 kiloliters by introducing energy-saving technologies for ethylene crackers, and 515,000 kiloliters by introducing energy-saving technologies for other chemical products.

At the same time, the industry is examining the following measures for further reduction potential:

(1) Cooperation with interested groups: With LCA (described below), eight target products have the potential to reduce CO_2 emissions by 120 million tons.
(2) International contributions: Spreading out Japanese manufacturing technologies worldwide (for example polycarbonate-manufacturing technologies that use CO_2 for raw material, state-of-the-art production facilities for terephthalic acid, etc.); rolling out materials and products worldwide (seawater desalination technologies using reverse osmosis membranes, control devices for air conditioner DC motors), etc.
(3) Developing innovative technologies (medium to long term): Developing new processes (innovative naphtha catalytic cracking process, etc.) and manufacturing processes for chemical products that do not use fossil fuels.

[33] For details, see Kazuya Inaba, Takeo Kikkawa, and So Hirano (2013), "Konbināto tōgō" (Integration of industrial complexes), *The Chemical Daily*.

Among these potentials, the development of technologies that use CO_2 as a raw material for chemical products, and manufacturing processes that do not use fossil fuels, have made steady progress[34] (Hirano 2013). For example, Mitsui Chemicals has already built a demonstration plant to develop a technology for synthesizing methanol from carbon dioxide. Kuraray has developed liquid rubber from a raw material made by fermenting cane sugar. The advantage of this rubber is that it is not petroleum-derived, which, depending on the application, reduces costs by 10–30% compared to the case of using fossil resources.

4. Summary and Examples of Life Cycle Analysis (LCA)

This section provides a detailed discussion of CO_2 emission reductions based on the life cycle assessment (LCA) described in the Commitment to a Low Carbon Society.

LCA focuses not only on the amount of CO_2 emitted when manufacturing a product, but on the total amount of CO_2 emitted during the entire product's life cycle from extraction of the raw materials for the product through manufacture, distribution, consumption, and use to recycling, disposal, and incineration.[35]

In addition, the contribution of the chemical industry to reducing CO_2 emissions is sought through the following process. To start with, find the total amount of CO_2 (α) emitted during the entire life cycle when using finished products made with chemical products, and similarly, find the total amount (β) when using finished products made with a comparison product. The difference between α and β ($\beta - \alpha$) is regarded as an increase in emissions when no chemical products are present, and is treated as a "net contribution to reducing emissions." There is a slight increase in emissions from raw material extraction, manufacture, distribution, and disposal in order to produce more of the chemical products that contribute to CO_2 reduction. However, when we look at emissions over the whole life cycle, total CO_2 emissions shrink through major reductions at the stages of consumption and use.[36]

Here, I will consider aircraft as an example that is easy to understand. In recent years, manufacturers have started to use carbon fiber[37] in the bodies of aircraft. When using carbon fiber, it is possible to substantially reduce weight while maintaining the same strength and safety. As a result, a Boeing 787 (commissioned in November 2011), which is designed to save weight by using approximately 50% carbon fiber and composite materials in the body, improves fuel consumption by 20% compared to the current Boeing 767.[38] The ratio of carbon fiber used

[34] So Hirano, (2013), "*Kagaku sangyō no kōken*" (Contributions of the chemical industry), Briefing Papers for the Spring Annual Meeting of the Chemical Society of Japan.

[35] Japan Chemical Industry Association (JCIA) (2012), "Innovations for Greenhouse Gas Reductions: Life Cycle Analysis of Chemical Products in Japan."

[36] Ibid. JCIA (2013).

[37] Fiber made from carbon. Carbon fiber is manufactured by heating organic fiber such as polyacrylonitrile (PAN) fiber or pitch fiber in an inert atmosphere until the non-carbon atoms are expelled. Lightness and strength are its special features. The specific gravity of carbon fiber is 1.8, or about one quarter that of iron (7.8). Carbon fiber is a significantly lighter material even when compared to aluminum (2.7) and glass fiber (2.5). In addition, it has excellent strength and elasticity with specific tensile strength (tensile strength divided by specific gravity) approximately ten times that of iron, and a specific tensile modulus (tensile modulus divided by specific gravity) approximately seven times that of iron. (Please refer to http://www.torayca.com/aboutus/abo_001.html for information about Toray carbon fiber.)

in the current Boeing 767 does not exceed 3%, but if, for argument's sake, the 767 had the same ratio of carbon fiber as the 787, the weight of the body structure could be reduced from 60 tons to 48 tons. As a result, a plane that has so far only been able to fly 103 km per kiloliter of jet fuel would be able to fly 110 km. In the case of a service age of ten years and 2,000 annual flights of 500 miles (equivalent to the distance between Tokyo and Sapporo in Japan), CO_2 emissions per aircraft would be reduced by 27 kilotons. This breaks down into a 0.2-kiloton rise in emissions when manufacturing carbon fiber from raw materials, but emissions are expected to shrink by 0.8 kilotons during assembly and by 26.3 kilotons during use (flights) for a reduction of 27 kilotons across the whole life cycle.

After examining ten cases based on LCA, the Japan Chemical Industry Association concluded that the cases in question would facilitate a reduction in CO_2 emissions totaling 130.57 million tons. These calculations seek the extent of CO_2 emission reductions across the whole life cycle compared to the case of not using chemical materials in products manufactured in 2020, the base year for the calculations. The aforementioned case of aircraft is one of these preliminary calculations. Among the cases considered, the nine cases of solar power, wind power, automobiles, aircraft, automotive tires, LED lighting, insulation for residential use, air conditioners, and piping materials are included in the Commitment to a Low Carbon Society, and would account for approximately 120 million tons. Similar to the example of aircraft, detailed preliminary calculations of CO_2 emissions are available for each of these cases.[39]

The following comments apply to the most important cases:

(1) If it were possible to generate power with solar energy without using fossil fuels, there would be significant reductions in CO_2 emissions compared to the conventional power generation methods that use fossil fuels.
(2) Similarly to the case of the aircraft mentioned earlier, the use of carbon fiber in automobiles would improve fuel consumption and reduce CO_2 emissions.
(3) Switching from regular automotive tires to fuel-efficient tires would improve fuel consumption and reduce CO_2 emissions by cutting rolling resistance to the road surface when driving.
(4) Compared to conventional incandescent light bulbs, LED light bulbs have a higher luminous efficacy as well as a longer service life. Therefore, CO_2 emissions are lower across all phases from extracting raw materials to manufacture and assembly, use, and disposal.
(5) By improving airtightness and insulating properties in residential homes, insulation materials save energy used by coolers and heaters. At present, 55% of residential housing in Japan has no insulation, so there is still much leeway for reducing CO_2 by increasing the use of insulation in housing.

5. Summary: Issues for the Future and LCA in Other Industries

While the LCA concept is an attractive one, it is difficult to incorporate it directly into the targets for reducing GHG emissions. The reason is that it is difficult to obtain contributing

[38] *Nihon keizai shimbun*, September 22, 2011.
[39] For details, see Ibid. JCIA (2013).

ratios and to identify what percentage of reduced emissions is due to the chemical industry. For example, in the case of aircraft, the reduction in fuel and CO_2 emissions due to the use of carbon fiber in the aircraft body is attributable to the chemical industry that manufactured the carbon fiber components, but it is also attributable to the aircraft industry initiatives that introduced the components. It is difficult to decide what proportion to attribute to which entity.

Based on our interview survey, we found that understanding of LCA among users of chemical products is not sufficiently advanced. For example, the Scheduled Airlines Association of Japan is introducing aircraft that use carbon fiber composites as a first measure for reducing CO_2 emissions. However, no mention is made of the chemical industry, in the plan of the Airlines Association of Japan. They think that the emissions reduction by introducing the carbon fiber to the aircraft are own contribution as a matter of course.[40] At the present time, the Japan Chemical Industry Association does not allocate such contribution ratios.

Despite these problems, other industries have incorporated the LCA concept into the Commitment to a Low Carbon Society.[41] For example, the Flat Glass Manufacturers Association of Japan calculates that by expanding the use of multi-glazing with high insulation properties and other eco glass, it is possible to reduce CO_2 by 68 million tons when renovating existing buildings, and 64 million tons for new-builds. The Japan Cement Association suggests that changing from asphalt pavements to concrete would contribute to CO_2 reductions by reducing rolling resistance for heavy vehicles and improving fuel efficiency. In either case, the thinking is that it is possible to reduce emissions across the whole life cycle even though manufacturing more of these products would increase CO_2 emissions at the manufacture, distribution, and disposal stages.

The Commitment to a Low Carbon Society limits the amount of CO_2 reduction through LCA to the portion used in Japan. However, carbon fiber, fuel-efficient tires, LED light bulbs, and many other products can be used (spread) overseas as well as in Japan. Consequently, the potential for reducing CO_2 emissions through LCA is extremely high. Therefore, to avoid a situation where the manufacture of products with potential to reduce CO_2 emissions stagnates as a result of imposing reduction obligations on emissions during manufacturing only, a policy issue for the future is to build structures that encourage the manufacture of these products.

VI. *Conclusion: The Role and Responsibilities of Japan as a Country Where Energy Conservation Is Advanced*

As "a country where energy conservation is advanced," Japan has a major role to play in developing countermeasures against global warming on an international scale. It is certainly no exaggeration to say that promotion of energy conservation is the most important international role that Japan can play in the twenty-first century.

However, this absolutely does not mean that Japan can be satisfied with the current energy conservation standard. Here, we must not overlook the historical fact that it was persistent efforts to pursue technical innovation and system reform that was the driving force behind building Japan into a country with advanced energy conservation.

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[40] Scheduled Airlines Association of Japan (2014), "About the Commitment to a Low Carbon Society."

[41] Japan Business Federation (2013), "Commitment to a Low Carbon Society."

For example, immediately after the oil crises in the 1970s when energy prices rose sharply, the steel industry in Japan focused on continuous processes and abbreviated processes. Then, in the 1980s, coke dry quenching equipment (CDQ), top-pressure recovery turbines (TRT), and other large-scale waste heat recovery systems were installed. CDQ is a system for the efficient recovery of the waste heat produced when cooling red-hot coke extruded from a coke oven. TRT is a system for controlling the top pressure in a blast furnace and for recovering blast furnace gas to generate power. With TRT, it is possible to recover about 40–50% of blasting power. Since the 1990s, the steel industry has also tackled the efficient use of waste products.

From the 1970s to the 1980s, the Japanese cement industry phased out wet kilns and started to develop dry processes for kilns (introducing SP/NSP systems). Kilns that use SP/NSP systems optimize the cement-firing process by passing the raw materials through a pre-heater that uses waste heat from the rotary kiln, and then sending the raw materials to the rotary kiln. As a result, the kilns can deliver energy consumption reductions of approximately 30%. Subsequently, the cement industry has proactively introduced vertical mills with excellent pulverization efficiency and pre-pulverizers to produce energy consumption reduction results.

After the oil crises, Japan not only vitalized energy conservation initiatives in the industrial sector, but progress was also made with institutional reforms to promote the initiatives. In 1979, the Act on the Rational Use of Energy (the Energy Conservation Law) was enacted, establishing energy conservation guidelines for factories and buildings as well as guidelines for efficient energy consumption by machinery and appliances (automobiles, air conditioning units, etc.). The guidelines for machinery and appliances featured advanced content and were linked to the Top Runner Program introduced in 1999. When the Energy Conservation Law was revised in 1993, it clearly spelt out active engagement in energy conservation from the perspective of measures to counter global warming in addition to the conventional perspectives of energy safety guarantees.

It is clear from these facts that Japan's emergence as a nation with advanced energy conservation has not come about overnight, but has been built up over a long period of time through unceasing efforts aimed at technical innovation and institutional reform. There are hints that Japan's status as a country with advanced energy conservation will waver unless such efforts are multiplied in the future. Japan's industrial sector and government must wake up to the roles and responsibilities of a country where energy conservation is advanced and continue with the improvements.