Japanese Energy Efficiency Policy and the 25% Greenhouse Gas Reduction Target: Prime Minister Takes on Mission Impossible?

Chiharu Murakoshi, Hidetoshi Nakagami, Takahiro Tsurusaki, and Mikiko Nakamura, Jyukankyo Research Institute

ABSTRACT

Japan has announced to the world a goal of reducing greenhouse gas emissions 25% from 1990 levels by 2020. This amounts to a 30% reduction from 2005 levels, a very high target. However, the scientific basis enabling such reduction is not clear, and industry has raised objections. The government's target will be extremely difficult to achieve, requiring not only an Action Plan, but also bold government initiatives.

Energy efficiency policy of Japan is based on the Energy Conservation Law (ECL), its related standards, and additional programs. The ECL was revised in 2002, 2005, and 2008, with regulations strengthened each time. Major energy efficiency standards include Top Runner Standards targeting equipment, standards for factories and workplaces targeting the industrial and commercial sectors, two types of standards targeting buildings, and standards for shippers targeting the transportation sector. To attain these standards, programs have been implemented to encourage introduction of energy efficiency and renewables.

In this paper, we discuss energy efficiency standards and major programs to encourage energy efficiency and renewables in Japan. Policy recommendations to attain the 2020 emissions target are not yet available. We report on the state of policy development to attain the 25% reduction.

Introduction

Pursuant to the Notification to the Parties from the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change (UNFCCC), 55 nations and regions were to inform the UNFCCC Secretariat of 2020 greenhouse gas (GHG) emissions reduction targets by January 31, 2010. These countries and regions represent 78% of world GHG emissions. Targets for 2020 of major developed nations include a 25% reduction from 1990 levels for Japan; a 20% reduction from 1990 levels for the European Union (EU, 27 countries); from 5 to 25% reduction from 2000 levels for Australia; and a 17% reduction from 2005 levels for the US. Among developing nations, China and India announced targets for reducing CO_2 emissions per unit of GDP in 2020 from 2005 levels by 40 to 45%, and 20 to 25%, respectively. Japan's target amounts to a 30% reduction from 2005 levels, which stands out as the most ambitious goal in the world from current levels, and will be very difficult to achieve.

To implement emissions reductions, it will be necessary to strengthen regulations and develop policies to encourage high-efficiency equipment. It is also important to understand current energy efficiency policies. In this paper, we first explain current energy efficiency policies of Japan. Then, we discuss ways that Japan can reach its emissions reduction target.

Energy efficiency policy of Japan includes many kinds of standards and programs, based on the Energy Conservation Law (ECL). The ECL was revised and strengthened in 2002, 2005, and 2008. In FY2008, part of these regulations were revised. Other systems, such as use of a benchmark system, are currently under consideration. Below, we discuss Japan's various energy efficiency standards and programs to encourage introduction of renewable energy.

The reduction target of Japan was not a result of technical analysis. Rather, it was a political target announced by the new administration. In August 2009, the Democratic Party of Japan (DPJ) succeeded the Liberal Democratic Party (LDP), which had held power essentially continuously in the postwar era. Some DPJ policies were taken directly from the DPJ manifesto, used to gain power, while other policies are being revised and then implemented. The reduction target greatly exceeds the former administration's target, and comes straight from the manifesto.

The government is currently investigating forecasts of emissions reductions from energy efficiency and renewables, as well as prospects for Clean Development Mechanism (CDM) procurement from overseas. There are not yet final results of these investigations. We discuss their state as of April 2010.

Overview of the Energy Conservation Law

The Law on the Rational Use of Energy (short name, Energy Conservation Law, ECL) was promulgated in 1979, as Japan had faced the two oil shocks of the 1970s and their serious economic impacts. From that time on, the ECL has advanced energy efficiency policies for the industrial, transportation, and commercial sectors. After many revisions, the existing law was again revised in May 2008, to strengthen policies targeting the consumer (commercial and residential) sector, due to its recent trend of rising energy consumption. With this ECL revision, the range of targets of regulation has expanded.

There are four major areas addressed by the ECL. They are factories and workplaces, transportation, housing and other buildings, and equipment. Groups targeted in each area are:

- Factories, etc.: managers of factories and workplaces (including office, retail, restaurant, hospital, hotel, school, and other service sector workplaces)
- Transportation: transport companies and consigners (who have freight transported)
- Housing, buildings: at time of construction, owners/developers; at time of addition or structural alteration, building owners and managers; also, home building companies;
- Equipment and appliances: producers and importers of equipment and appliances

In addition, there is a system to certify Qualified Energy Managers (QEM) and Energy Managers (EM). QEM are certified by a national exam, while EM are recognized after receiving specific training. Facilities above a certain size must employ these energy management professionals, who prepare reports of energy consumption and submit plans to the government.

The scope of regulations for factories and workplaces, housing and other buildings broadened in FY2008. For factories and workplaces, until the recent revision, regulations applied to large-scale facilities above a fixed size, but now the regulations target enterprises normalized by units of business. Companies with multiple facilities which include franchise business, must report annual energy consumption (in crude oil equivalent) for the whole enterprise (headquarters, factories, branches, sales offices, etc.). Those with total usage of 1,500 kL COE or above are subject to the regulations.

For buildings, a new provision requires small- and medium-sized buildings above a fixed size to report on energy efficiency measures (EEMs), and housing developers are now subject to somewhat strict energy efficiency standards. Also, recommendations for energy efficiency performance labeling have been added.

Standards for EEMs in each area were announced in a Minister's bulletin. For cases in which EEMs are strikingly inadequate, advice and guidance will be given, extending to instruction, public disclosure, and administrative orders. Energy efficiency standards in Japan can be difficult to understand, as seen in "cases in which EEMs are strikingly inadequate" in the ECL. Standard values have been set for energy efficiency performance and methods, but, apart from the Top Runner Standards and the requirement that large-scale workplaces are to improve energy efficiency performance by 1% each year, firms that do not meet the standards do not actually receive guidance and regulation.

Energy Efficiency Standards

Energy efficiency standards in Japan are set forth in the ECL and address the following main areas: factories and other worksites, equipment, buildings, transportation, and QEM. Standards for equipment are regulatory, while standards for other areas are partly regulatory and partly voluntary. For example, for facilities with total annual energy consumption above 3,000 kL COE, submission of mid-range and long-range plans showing annual improvements of 1% in energy efficiency is mandatory, but for facilities with annual consumption between 3,000 and 1,500 kL COE, only reporting of annual consumption is required. Another example is that owners of 300 m^2 or larger buildings must submit reports at time of construction, major expansion or remodeling, but the standards to be attained are voluntary standards.

Besides those standards mentioned above, the government requested that each industry prepare their own action plan, and many industry groups have set energy efficiency targets in their long-term action plans. Also, benchmark standards for each sector are in the process of being set. Below, we discuss the contents of each kind of standard.

Standards of Judgment for Specified Equipment (Top Runner Standard), on the Rational Use of Energy

Standards for judgment of energy efficiency for equipment listed in the ECL began in 1979. At first, standards addressed electric refrigerators, air conditioners, and passenger vehicles. In 1994, five products, fluorescent lights, televisions, copy machines, computers, and magnetic disk units, and in 1996, VCRs, were added

With the ECL revision of 1998, the method of setting standards of judgment for specified equipment was changed to the Top Runner method. This method involves setting the standard value based on the most energy efficient products currently on the market. Also, to show consumers each product's degree of attainment, a labeling system was introduced concurrently.

Targeted equipment has been added sequentially. In 2002, electric toilet seats, vending machines, transformers, gas and kerosene appliances (space heaters, cooking appliances, water heaters), in 2005, microwave ovens and electric rice cookers, and in 2009, routers and network switches, were added. As of February 2010, 23 equipment categories are targeted (Table 1).

The Top Runner Standard (TRS) has had good results. All target efficiency improvements have actually been exceeded as of now (Table 2). Between 2003 and 2005, most equipment reached its target year and entered the second or third period of improvement (Table 3).

Table 1. Top Runner Standard Specified Equipment

Type	Machinery / Equipment
Electrical Equipment	Air Conditioners, Fluorescent Lights, Electric Refrigerators, Electric Freezers, Electric Rice Cookers, Microwave Ovens, TV Sets, Video Cassette Recorders, DVD Recorders, Electric Toilet Seats, Computers, Magnetic Disk Units, Routers, Network Switches, Copying Machines, Vending Machines, Transformers
Gas and Kerosene Appliances	Space Heaters, Gas Cooking Appliances, Gas Water Heaters, Oil Water Heaters
Vehicles	Passenger Vehicles, Freight Vehicles

Table 2. Energy Efficiency Improvements Due to Top Runner Standard

Machinery / Equipment	Index	Base Year	Target Year	Energy Efficiency Improvement	
				Expectation	Result
Air Conditioners (Room Air Conditioners, ≤ 4kW)	COP	1997	2004	66.1%	67.8%
Fluorescent Lights	lm/W	1997	2005	16.6%	35.6%
Electric Refrigerators	kWh/year	1998	2004	30.5%	55.2%
Electric Freezers	kWh/year	1998	2004	22.9%	29.6%
TV sets (CRT)	kWh/year	1997	2003	16.4%	25.7%
Video Cassette Recorders	W	1997	2003	58.7%	73.6%
Computers	W/MTOPS	1997	2005	83.0%	99.1%
Magnetic Disk Units	W/GB	1997	2005	78.0%	98.2%
Copying Machines	Wh/h	1997	2005	31.0%	72.5%
Vending Machines (Drinks)	kWh/year	2000	2005	33.9%	37.3%

Source: METI, ECCJ. Jan 2008. Top Runner Program (revised edition). p.9. and METI. 2005-2009. Reports by Energy Efficiency Standards Subcommittee of Advisory Committee, Agency for Natural Resources and Energy.

Table 3. Examples of Current Energy Efficiency Standards

Equipment	Index	Base Year	Target Year	Target Value (Weighted Average) [1]	Energy Efficiency Improvement
Air Conditioners (Room Air Conditioners, ≤ 4kW)	APF	2005	2010	6.0	22.4%
Fluorescent Lights	lm/W	2006	2012	91.2	7.7%
Electric Refrigerators	kWh/year	2005	2010	452	21.0%
Electric Freezers	kWh/year	2005	2010	421	12.7%
TV sets (LCD, PDP)	kWh/year	2004	2008	120.5	15.3%
TV sets (LCD, PDP)	kWh/year	2008	2012	103.0	37.0%
DVD Recorders	kWh/year	2006	2010	68.3	20.5%
Vending Machines (Drinks)	kWh/year	2005	2012	1131	33.9%

Source: METI.2005-2009.Reports by Energy Efficiency Standards Subcommittee of Advisory Committee, Agency for Natural Resources and Energy.

Note: 1. The weighted average target value is calculated under the assumption that the distribution of types of models shipped stays constant. It is possible that the efficiency target values could be attained for individual models but the actual weighted average efficiency could be exceeded due to increases in equipment size, etc.

Many TRS values are set as a function of equipment size. While there should be an effect to reduce GHG emissions, the standards do not prevent increases in energy consumption due to choosing larger models with higher function. However, recently, encouragement of market transformation has been seen. For example, with the 2005 fluorescent lights standard, because the specialty high frequency fluorescent lamp had its own category, there was no need to try to increase its market share, but for the 2012 target year standard, it is categorized with the regular fluorescent lamp. It will be difficult to attain the weighted average target value without shifting sales toward the specialty high frequency lamp.

Standards of Judgment for Factories, etc., on the Rational Use of Energy

Energy efficiency standards of judgment for factories and other business operators focus on energy management. Fundamentally, they apply to all workplaces, but in particular, certain facilities defined in the ECL are listed as Designated Energy Management Factories and Workplaces (DEMF) and are subject to the following requirements.

Type 1 DEMF, using above 3,000 kL COE annually, must assign a responsible energy manager, submit medium- and long-term plans, report on energy consumption, and improve energy efficiency by 1% or more annually. If standards are not met, the government may instruct the operator, and if instruction is not followed public disclosure may occur.

Type 2 DEMF, using above 1,500 kL COE annually, must assign a responsible energy manager, report on energy consumption, and improve energy efficiency by 1% or more annually. If standards are not met, the government may make recommendations to the operator.

The standards for factories, etc., focus on management, measurement and record keeping, preservation and maintenance, and EEMs used in new construction. Targeted equipment includes combustion equipment such as boilers, steam boilers, industrial furnaces, heating, cooling, and air conditioning equipment, water heating equipment, waste heat recovery and utilization, power generation, co-generation, electricity transmission equipment and transformers, electric motors, electric furnaces, lighting equipment, elevators, and office equipment. In addition to energy consumption, business operators must periodically report a calculation of unit energy consumption (UEC, energy consumption per unit of activity) which is used to evaluate whether energy efficiency improves by 1% annually.

The unit of activity used for the UEC denominator varies according to the type of industry and facility. For producers, it is the quantity produced. For commercial buildings various indexes can be used, such as floor area, conditioned floor area, conditioned floor area multiplied by hours conditioned, sales floor area, business hours, and capacity utilization ratio. Consideration of factors having a major influence on energy consumption, such as temperature change, have also be recognized.

In the 2008 ECL revision, the energy efficiency standards for factories, etc., the facilities targeted expanded. Before, facilities were classified as DEMF based on their energy consumption, which meant that, even if they belonged to a large company, small-scale factories and small buildings belonging to a large landlord were not subject to the standards, nor were large retail or restaurant chains with small-scale individual locations. In contrast, the 2008 ECL revisions have greatly expanded the range of facilities subject to the standards by considering whether the annual energy consumption of the whole enterprise exceeds 3,000 or 1,500 kL COE.

Standards for Building Energy Efficiency, on the Rational Use of Energy

Building energy efficiency standards were first set in 1980, and sequentially strengthened in 1993 and 1999, and further strengthened with the 2008 ECL revision. One revised part of the standards that took effect from 2009 is "Standards of Judgment for Construction Clients, etc. and Owners of Specified Buildings" (METI, MLIT 2009, Bulletin No. 3). At first, the standards only applied to office buildings, but hotels, hospitals, retail stores, restaurants, schools, assembly halls, factories, and others are now included.

The building energy standards have two parts, performance standards that use the Perimeter Annual Load (PAL) and Coefficient of Energy Consumption (CEC), described below, and the prescriptive standards with specifications for buildings and equipment that becomes the basis for judgment.

Performance standards are defined by two numerical indexes. One, PAL, relates to the plan and the design of the envelope's thermal insulation performance (windows, insulation thickness, etc.). The other, CEC, relates to the energy performance of equipment in the building. PAL is an index to evaluate the resistance to heat loss of the outer walls, windows, etc.

PAL = perimeter zone annual heat load (MJ/y)/perimeter zone floor area (m^2)

CEC is an index to evaluate efficiency of energy used by equipment furnished with the building. It is split into five indexes, for heating and cooling (CEC/AC), ventilation (CEC/V), lighting (CEC/L), water heating (CEC/HW), and vertical transport, or elevator (CEC/EV) equipment. However, the ventilation equipment in CEC/V is for unoccupied, unconditioned zones, such as mechanical rooms, parking garages, and toilets. Equipment for ventilation due to circulation of conditioned air in occupied zones is evaluated with CEC/AC. Each standards is evaluated as "annual energy consumption / annual estimated load", for example, CEC/AC = annual heating and cooling energy consumption / annual estimated heating and cooling load.

The prescriptive standards (called the "point method,") apply to buildings with floor area of 5,000 m^2 or less. For each category to be evaluated, a specified number of points is awarded according to the content of EEMs used, and if the total is 100 or higher it is considered equivalent to having met the energy efficiency performance standards. Major categories for evaluation are essentially the same as in the performance standards.

$$\text{points} = \sum(\text{points for each category}) \quad + \quad \text{correction points}$$

Residential Energy Efficiency Standards, on the Rational Use of Energy

Residential energy efficiency standards were revised in 2009, but there was little change in thermal performance characteristics. Rather, parts of the Standards of Judgment for Owners of Residential Buildings, and Design and Construction Guidelines were clarified and simplified.

Energy efficiency standards for general housing. Residential energy efficiency standards regulate things like thermal performance and solar radiation attenuation. Standards of Judgment for Owners of Residential Buildings regulate performance required at time of construction, while the Design and Construction Guidelines specify actual EEMs that should be used.

There are four methods set forth in the Energy Efficiency Standards for Owners of Residential Buildings. There are different standards for each evaluation method for the various geographic regions. Types A, B, and C are performance standards, while Type D is a prescriptive standard, a point method for building owners and others at the time of planning and construction. Choice of any of Types A, B, C, or D is allowed, but Type D is essentially always used. Type A evaluates annual heating and cooling loads. Types B and C are evaluation methods that use factors such as the heat loss coefficient (Q value) and the summer solar heat gain coefficient (μ value). Type D evaluates according to EEMs such as those used to improve thermal performance of envelope components like external walls, measures to decrease leakage area, and measures to attenuate solar radiation in summer. The following three categories are required for Type D:

- thermal resistance for each part of the frame (U value, R value, EEMs)
- thermal resistance for openings (windows, doors, etc.; U values, EEMs)
- attenuation coefficient for openings (η value, EEMs)

Energy efficiency standards for housing developers. For companies that build single-family houses to sell (developers of detached housing), additional energy efficiency standards have been set, from April 2009. Standards are for total annual primary energy consumption by heating and cooling, mechanical ventilation, lighting, and water heating equipment. Considering the diffusion in recent years of solar electric generation, the effectiveness of such measures is included in the evaluation. The standard for houses with PV systems is set 10% higher than the standard for general houses.

Because building energy efficiency standard levels have not been revised in ten years, standard values are relatively low when compared with those in Europe and North America, in contrast to the high levels of the Top Runner Standard. Insulation performance of the existing building stock is low so in order to greatly improve energy efficiency of buildings, costly retrofits of existing buildings will be required. In April 2010, METI and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) agreed to revise existing energy efficiency standards for buildings, with a goal of making them mandatory five years later.

Voluntary Standards of Industry

Each Japanese industry has its own reduction targets and energy efficiency and CO_2 reduction plans. These plans are targets for efforts within each industry, and are not regulatory, but are likely to be implemented effectively.

In 1997 the Nippon Keidanren took the initiative with their Voluntary Action Plan on the Environment, with a goal to limit CO_2 emissions in 2008 to 2012 at or below 1990 levels. In 2010, 62 industries and enterprises are participants in the Keidanren Action Plan, comprised of 34 industrial and energy conversion industries, 15 commercial sector enterprises, and 13 transportation industries. The 34 participating industries in the industrial and energy conversion sector cover 45% of CO_2 emissions of Japan, and 84% of that sector's overall CO_2 emissions.

From 2008 on, the government instructed industry groups unaffiliated with the Keidanren to make their own voluntary action plans. As a result, another 53 industries have made plans and are working to achieve their CO_2 emissions reduction targets. By industry, there are 21 industrial and energy conversion industries, 28 commercial sector enterprises, and 4 transportation industries. With the Keidanren members, this is a total of 115 industries and enterprises, covering essentially all the Japanese industrial, commercial, transportation, and energy conversion sectors.

Incentives to Encourage Energy Efficiency and Renewables

Financial incentives to encourage energy efficiency and renewables in Japan are mainly subsidies. Subsidies are offered by METI, the Ministry of the Environment (MOE), and MLIT. Also, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) offers a program aimed at schools.

Besides subsidies, there are tax reduction and subsidized interest payment programs, but they have hardly been used. Here, we explain the major subsidies that are meant to encourage energy efficiency and renewables. We also explain the Feed In Tariff program, which is a system to allow purchase of solar electricity at a fixed price that began in 2009.

Incentives for Subsidized Projects

The major subsidies for energy efficiency and renewables are shown in Table 4.

Table 4. Major Subsidy Programs for Energy Efficiency and Renewables

Ministry	Sector	Example of subsidized facilities / equipment	(Typical) rate of subsidy	Budget in FY2009 (million US$)
Ministry of Economy, Trade and Industry (METI)	Industrial	High-efficiency industrial furnaces, Next-generation coke ovens, Industrial complex cooperation	1/3～1/2	330
	Residential Commercial	High-efficiency water heaters, High-efficiency air conditioners, Renewable energy systems, Insulation	1/3～1/2	214
	Institutional Commercial	Large scale photovoltaic generation systems (“Mega Solar”)	1/3～1/2	404
	Residential	Photovoltaic generation systems	Flat ($778/kW)	523
	Residential	Fuel cell cogeneration systems	1/2 of the difference	68
	Transport	Electrical vehicles, (Plug-in) Hybrid vehicles, Natural gas vehicles, Clean diesel vehicles, LPG vehicles	1/2 of the difference	48
Ministry of the Environment (MOE)	All	Renewable energy systems, Fuel cell, LED lights, Bio ethanol fabrication, DME vehicles, waste power generation	1/3～1/2	116
Ministry of Land, Infrastructure and Transport and Tourism (MLIT)	Residential Commercial	Low CO_2 emission buildings	1/2 of the difference	78
	Transport	Low emission vehicles	1/2 of the difference	14
METI, MOE, MOC (Ministry of Internal Affairs and Communications)	Residential	High-efficiency appliances (Air conditioners, Refrigerators, TV s) (Eco-point system)	3,000 – 36,000 points (yen)	5852
METI, MLIT	Transport	High-efficiency vehicles (Eco car subsidy)	Flat	7012
MLIT, METI, MOE	Residential	Energy efficiency retrofits, Energy efficient new houses (Eco Point system)	2,000 – 300,000 points (yen)	1111

Source: METI, MOE, MLIT. 2009

In most cases, the rate of subsidy is set at one third to one half of either the total cost or the difference between the regular and the high-efficiency equipment or facility. A large appropriation for several subsidy programs was in a supplementary budget for FY2009. These include a program to give Eco-points to consumers who purchase high-efficiency air conditioners, refrigerators, and TVs (the points can be exchanged for other efficient products or gift cards) and a program to subsidize purchases of high-efficiency vehicles. These programs also serve as economic stimuli, and are temporary measures. The second supplementary budget appropriation of FY2009 funded an Eco-point system to reward energy efficiency home retrofits and energy efficient new houses.

Program for Purchasing Solar Electricity at a Fixed Price

The Renewable Portfolio Standard (RPS) began in 2003, and in 2009 announced a goal of purchasing 17.33 TWh by 2016. This corresponds to a relatively low portion, somewhat less than 2%, of total electric generation in Japan. Furthermore, with the goal of increasing solar electric generation by a factor of 10 by 2020 and 40 by 2030, in 2009, METI began the Feed In

Tariff (FIT) program, to purchase solar electricity at a fixed price. Before the FIT program was introduced, electric utilities had their own voluntary programs to purchase solar electricity, and the purchased electricity was reflected in their RPS. The purchase price for generated electricity (the surplus electricity, after the user's own consumption) was then 21.6 cents/kWh.

In 2009, the utility programs were suspended, and became a government program. The electricity subject to purchase is surplus electricity, after the generator's own use. The current price is 43.2 cents/kWh for PV systems of less than 10 kW (mostly from houses) and 21.6 cents/kWh for systems between 10 kW and 500 kW (mainly from businesses), but it is planned to decrease the price for new contracts each year. Electric utilities subtract 6 cents/kWh in avoided costs from the purchase price, and charge all customers an equal surcharge to recover the remainder. Thus, this solar generation is not reflected in the RPS. At the time of contract execution, PV system owners receive a fixed price over 10 years. By decreasing the price for newly installed systems each year, in addition to relieving some burden of the surcharge that would grow with increased system penetration, it provides an incentive to install systems earlier. The purchase price for solar electricity was set under the assumption that the cost of the PV system should be recovered in ten years.

In order to strengthen this program, the DPJ administration, elected in 2009, requested a study of a system to purchase all the solar electricity generated. In contrast to the current program, which purchases the electricity after the owner's own consumption, this is a proposal to purchase all the electricity generated. METI is currently studying whether it is reasonable to buy all the electricity, and what the price would be. If the total electricity purchase plan were implemented, the diffusion of PV systems would probably increase faster, but the surcharge burden would increase greatly, so it is important to carry out such a program in a balanced way.

Greenhouse Gas Reduction Targets of Japan

The 2020 GHG emissions reduction target of Japan is 25% below 1990 levels. Major nations setting appropriate reduction targets is a condition, but incredibly, no concrete policy for reaching the 25% reduction exists. It is helpful to understand the political context of this target.

In August 2009 the DPJ won the lower house election, ending the Liberal Democratic Party (LDP) administration, in power almost continuously since 1950. For the August election, the DPJ put their new policies in a manifesto, and one of these was a pledge to reduce GHG emissions 25% from 1990 levels (including CDM) by 2020, which would be a 30% reduction from 2005 levels. It is said that Japan has a government of bureaucrats because, instead of political parties having their own affiliated think tanks, the administration performs this function. That is to say, the party in power uses the administration's think tank function and can carry out various studies, while parties out of power have trouble doing the same. The DPJ is trying to build a system where policy initiatives are lead by politicians rather than bureaucrats. But it cannot be said that the DPJ's GHG reduction target resulted from sufficient study.

The government is presently investigating concrete policies to realize the 25% reduction. Below, we consider the reduction target based on results available as of April.

DPJ Government Policies

In setting its target, the DPJ considered the IPCC midterm recommendation for 20 to 40% reductions for developed countries, and having major concern about global climate change, took the position that Japan should take the initiative and set a high target. They also insisted that to be an international leader, Japan must set a high target. Critics point out that simply setting a target does not enable international leadership. A network, cooperation, and a determined strategy are also necessary. Another claim is that in building a low-carbon society, environmental business will grow, creating jobs. This has been likened to President Obama's Green New Deal, but critics point out that it is necessary to balance effects on existing domestic industries, with growth of new industries. Already, in implementing the existing reduction target, there could be great damage done to industry, and due to industry moving overseas, there would be leakage.

Global Warming Countermeasures Task Force

Just after the new administration began, a cabinet ministers' task force was organized. A number of think tanks participated, carrying out multifaceted modeling studies, with results announced in a November 2009 report. However, for reasons such as use of different models with various initial assumptions, as well as innovation due to environmental constraints not being sufficiently considered, the conclusion was that separate, detailed studies are needed.

Macroeconomic assumptions were the following: real GDP growth of 1.3% annually, population of 122 million in 2020, nominal crude oil price of \$56/bbl in 2005 and \$121/bbl in 2020, crude steel production of 113 million tons in 2005 and 120 million tons in 2020, and nuclear generation of 437.4 TWh in 2020. For this case, GHG emissions in 2020 are 1,397 $MtCO_2$/year, and 10.8% increase over 1990 emissions of 1,261 $MtCO_2$/year.

Because the models used by different research groups differ, we cannot directly compare their results, but results of impact analysis of economic indicators, such as 2020 GDP, and marginal cost of reductions are shown in Table 5. For example, at the 15% reduction level, we can see the impact on real GDP of -1.3 or -1.4%, real employee compensation of -5.2 or -2.0%, and real disposable income of -2.0 or -1.8%. Also, there is a big gap in the marginal cost estimates of \$244 and \$114 per tCO_2. Overall, the National Institute for Environmental Studies (NIES) results are much more optimistic about the economic impact.

Table 5. Task Force Economic Impact Analyses

2020 domestic GHG reduction from 1990 levels		10%	15%	20%
Japan Center for Economic Research	Real GDP (%)	-0.8	-1.3	-2.1
	Real Compensation of Employees (%)	-2.9	-5.1	-7.9
	Real Disposable Income (%)	-1.2	-2.0	-3.0
	Real Household Expenditure (%)	-1.2	-1.9	-2.9
	Real Capital Spending (%)	-0.3	-0.3	-0.4
	Marginal Cost ($/tCO_2$)	118	243.8	434.2
National Institute for Enviromental Studies	Real GDP (%)	-0.9	-1.4	-2.9
	Real Compensation of Employees (%)	-1.2	-2.0	-3.5
	Real Disposable Income (%)	-0.6	-1.3	-3.1
	Real Household Expenditure (%)	-1.1	-1.8	-4.4
	Real Capital Spending (%)	-0.6	0.1	-0.2
	Marginal Cost ($/tCO_2$)	96.4	113.9	265.2

Source: Ministers' Committee on Global Climate Change Issues. Nov 2009. Task Force Interim Report.

Table 6. Task Force Scenarios for Introducing Energy Efficiency and Renewables

Research Organization		National Institute for Enviromental Studies			The Institute of Energy Economics, Japan	
Domestic GHG reduction rate		10%	15%	20%	8%	15%
Solar Electric Power	stock	20 x 28 GW	25 x 37 GW	55 x 79 GW	20 x 28 GW	40 x 56 GW
High-Efficiency Vehicles	flow	44%	53%	88%	50%	100%
	stock	20%	24%	37%	20%	40%
New Housing	Ultra-high efficiency standard (*1)	NA	20%	30%	NA	NA
	Compliance with energy efficiency standards	80%	80%	70%	80%	100%
Retrofit of Existing Housing	Compliance with 1992 standards	NA	10%	10%	NA	100%
High-Efficiency Water Heaters	flow	60%	80%	100%	--	--
	stock	50%	70%	80%	80% of Multi Family	90%
Proportion of Nuclear Power		45%	45%	45%	44%	51%
Proportion of Renewable Energy		7%	10%	17%	5%	10%
Total Investment over 10 years (Billion USD)	Total	450	675	882	468	1458
	Industry	27	27	27	NA	NA
	Housing	198	342	360	81	720
	Business	99	117	126	NA	NA
	Transport	54	72	90	108	126
	Renewable	81	126	279	72	135
Reduction in Utility Costs (Billion USD/year)	From Energy Efficiency	NA	NA	NA	25.2	39.6
	From Decrease in the Price of Oil	NA	NA	NA	30.6	27.9

Source: Ministers' Committee on Global Climate Change Issues. Nov 2009. Task Force Interim Report.
Notes: 1. Energy consumption at around 20% of the current heating and cooling energy efficiency standard.
2. Energy consumption at around 120% of the current heating and cooling energy efficiency standard.

Results for studies of policies and investment amounts for curbing GHG emissions are shown in Table 6. Results vary greatly with the organization, but here also, the NIES results appear most optimistic. We can see that, for example, at the 15% reduction level, it is necessary that solar electric generation increases by a factor of 25 or 40, the diffusion of high-efficiency passenger vehicles is 24% or 40%, compliance with energy efficiency standards for new housing is mandatory, thermal performance retrofit of existing housing brings either 10% or 100% of the stock into compliance with 1992 standards, and, diffusion of high-efficiency water heaters (latent heat recovery, heat pump water heater, and cogeneration) reaches 70% or 90%. In other words, the present levels of efficiency must be greatly exceeded.

The amount of investment required over 10 years is estimated as $675 billion or $1,458 billion. To realize the 25% reduction, even assuming that we can reduce domestic emissions by 15% and provide a 10% reduction via the CDM, audacious controls and enormous incentives or loads borne by the private sector will be needed. We cannot do a simple comparison, but considering reductions through the CDM, for the necessary 451 $MtCO_2$ at $20/$tCO_2$ it would cost $9 billion/year, or at $50/$tCO_2$ $22.5 billion/year, a large difference.

Medium Range Roadmap and Basic Energy Plan

As 2010 began, MOE and METI began investigation of concrete policies for reaching the 25% GHG reduction target in 2020. Main policies of MOE are shown in Table 7, while those of METI are shown in Table 8. Their contents vary somewhat, but MOE has announced their understanding that the 25% reduction can be reached. The bold array of measures needed to do so include making building energy efficiency standards mandatory, and further making all buildings Zero Energy Houses or Zero Energy Buildings in 2050, and greatly increasing the penetration of high efficiency water heaters, solar electric generation, and high efficiency vehicles. The cost involved in doing this by 2020 is $898.2 billion, calculated on the assumption that costs can generally be recovered within 10 years. A 25% GHG reduction amounts to 315 million tCO_2 and if recovered in 10 years would cost $285 per tCO_2. From energy efficiency retrofit cost of $200 to $500 per tCO_2, if we assume use of renewable energy and investment in the newest technology, there is concern that the costs will exceed the estimates.

The industrial sector has announced its doubts that this plan can be implemented. Also, there is major concern that extensive use of measures like a carbon tax or environment tax, cap and trade system, and feed-in-tariffs that are under consideration in order to implement the plan, would pose big loads on citizens.

At any rate, Japan's climate change countermeasures plan has changed significantly with the change to the DPJ administration. However, the time needed for studies has been a brief few months, and considering that the plan does not have sufficient scientific backing, it has not yet reached the level of national consensus.

Table 7. Main Policies of MOE's Medium-Long Range Roadmap

Sector	Measure	2020	2050	Cost until 2020 (Billion $)
Industrial Sector	Main Industries	Expand diffusion of advanced technology	NA	25.2
	CFC Alternatives, etc.	Emissions reduction	NA	
Residential Sector	Thermal performance	Flow: mandatory standards (with 30% stricter than the standards)	NA	186.3
		Stock: 80% energy efficiency retrofits (500,000 units per year)	Stock: 100% ZEH	
	High-efficiency water heaters	EcoCute:16 million units (32-fold increase)	NA	106.2
		CB: 25 million units (125-fold increase)	NA	
		SHW: 10 million units (2.9-fold increase)	NA	
	High-efficiency household appliances	AC COP: 4-6 (now: 3-4)	NA	56.7
		Lighting efficiency: x1.8	NA	
		Other efficiency: x1.35	NA	
Commercial Sector	Building energy efficiency performance	Flow: mandatory standards	(2030 Flow ZEB mandatory) Stock: 100% ZEB	54.9
	SHW	SHW 1.96 million m^2(5.8-fold increase)	NA	13.5
	Other	High-efficiency electric motors	NA	32.4
Transport Sector	High-efficiency vehicles	50% of flow	Flow: possible to choose high efficiency vehicles for all vehicle types	45.9
	fuel efficiency improvements	NA	NA	28.8
Energy Transformation	PV	25 GW (22-fold increase)	NA	203.4
	Wind Power	NA	NA	22.5
	Other	NA	NA	106.2
Non Energy	Waste, CFC Alternatives, etc.	NA	NA	16.2
Total				898.2

Source: MOE. Mar 2010. Medium-Long Range Roadmap for Climate Change Countermeasures.
Notes: ZEH: Zero Energy House or ZERO Emission House; EcoCute: CO_2 refrigerant heat pump; CB: Condensing Boiler; SHW: solar hot water system; ZEB: Zero Energy Buildings; PV: Photovoltaic.

Table 8. Main Measures of METI's Basic Energy Policy

Sector	Measure	2020	2030
Industrial Sector	Main industries	Expand diffusion of advanced technology	NA
Residential Sector	High-efficiency water heaters	EcoCute:10 million units	NA
		Fuel Cell:1.4 million units	NA
	Fuel cells	1.4 million units (now: 10,000 units)	NA
	High-efficiency lighting (LED)	Flow: 100% LED	Stock: 100% LED
Commercial Sector	Building energy efficiency performance	Flow: public buildings ZEB	Flow: 100% ZEB
	High-efficiency lighting (LED)	Flow: 100% LED	Stock: 100% LED
Transport Sector	High-efficiency vehicles	50% of flow	NA
	Biofuels	develop technology and set up infrastructure	NA
Energy Transformation	promote nuclear power	8 additional reactors	NA
	thermal power	Introduce cutting edge technology	NA
	renewable energy	FIT	NA

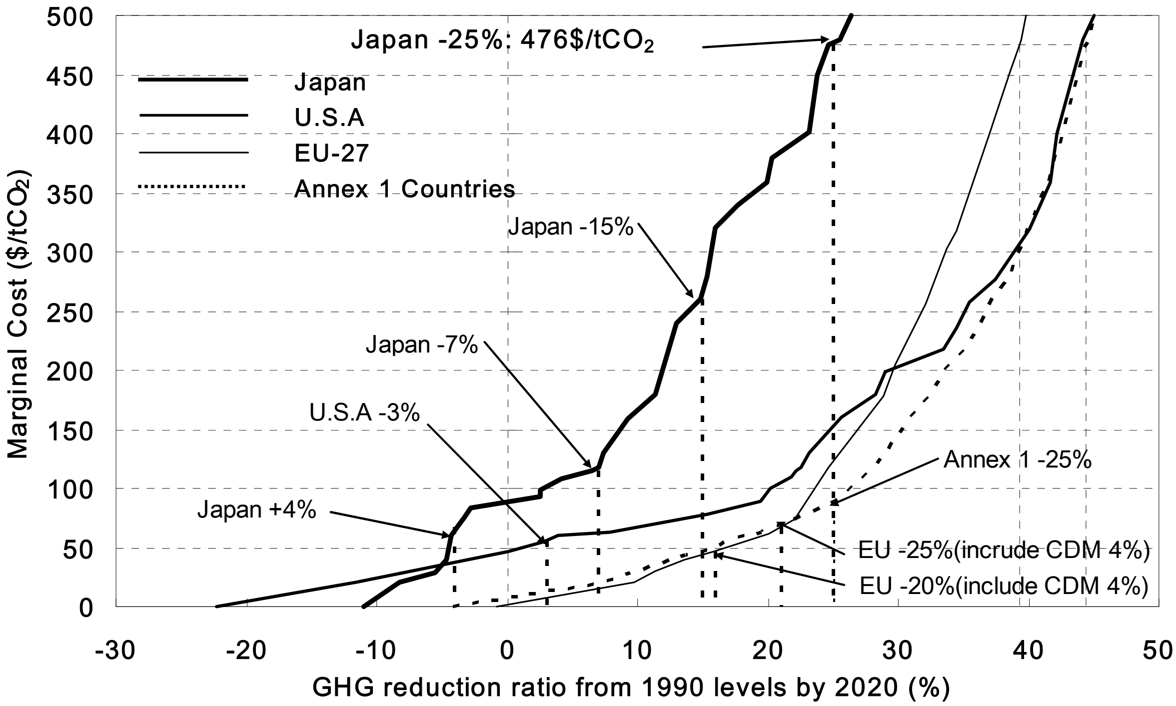
Source: METI. Apr 2010. Draft report of Basic Energy Plan.

Marginal Costs of GHG Reductions

Japan has one more major issue when compared with other nations. Since the first oil shock, Japan has been thorough about energy efficiency, due to the need to build an effective system for economic growth while having few resources of its own. In particular, the industrial sector has received guidance and regulation over energy efficiency from long ago, and energy consumption has hardly grown. Accordingly, the marginal cost of GHG reduction is much higher than in most other countries. According to analysis by the Research Institute of Innovative Technology for the Earth (RITE), the marginal cost to reduce emissions to 1990 levels is \$90/tCO_2 in Japan, \$50/tCO_2 in the US, and \$3/tCO_2 in the EU (27 countries). For a 15% reduction from 1990 levels, the marginal costs are \$285/tCO_2 in Japan, \$81/tCO_2 in the US, and \$45/tCO_2 in the EU. Considering the marginal costs to reach their announced target reduction from 1990 levels, the marginal costs are \$476/tCO_2 for Japan at 25%, \$56/tCO_2 for the US at 3%, and \$46/tCO_2 for the EU. The marginal cost to reach its target is 8.5 to 10 times that for the US and Europe. Even with the assumption that 10% of Japanese reductions are via the CDM, the marginal cost would be 5 to 6 times higher.

The fraction of the 25% reduction target that should come from domestic sources has not yet been decided, but it is clear that even to reduce emissions to around 1990 levels, compared to the US and Europe, there will be a high cost. It will be very difficult to achieve the target.

Figure 1. Marginal Costs of GHG Reductions



Source: Keigo Akimoto. Feb 2010. "Global Warming Countermeasures toward Major Emissions Reductions."RITE

Conclusion

Japan has essentially no energy resources. Policies encouraging energy efficiency after the first and second oil shocks were indispensable to growth. This was the background of the 1979 ECL, which has been revised many times, to the present day. First came regulations for the industrial sector, and from 1995 on for the residential, commercial, and transport sector regulations were strengthened. In this paper, we have introduced each regulation based on the ECL, and their standard values, in addition to the newly introduced FIT program.

Japan has set a target of a 25% GHG reduction from 1990 levels by 2020. This originated with the DPJ manifesto for the general election of 2009, and soon after taking power was taken up as policy, and announced to the world. The new administration is very concerned about climate change, and since Japan cannot stop global warming alone, has raised it as an issue with which international society should grapple. By acting on its own, setting a stricter target than others, it could be a global leader. At the same time, by encouraging environmental business, it also puts forth a vision to improve Japanese technological strength and realize economic growth.

To achieve such a bold target, it will be necessary to refine delicate, strategic policy measures, while also making utmost use of domestic and overseas networks. But concrete policies for reaching the 25% reduction target are still under study. There are many areas in which major improvements must be made: technology and PV system acquisition increased by factors of several tens, energy efficiency standards for housing and other buildings made mandatory, retrofits of existing housing aggressively implemented, nearly all passenger vehicles replaced by high-efficiency ones. However, the economic impact is much too large to be ignored. Because energy efficiency has progressed to a high degree in Japan, compared to the US and EU, the marginal cost of GHG reductions is extremely high. To reach the 25% reduction target Japan will need to pay 5 to 10 times as much as the US or EU. Given this situation, it seems that Prime Minister Hatoyama is taking on Mission Impossible.

Acknowledgement

We appreciate Barbara Litt's help in translating this paper from Japanese.

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