Column We Answer Your Questions about Global Warming

Some erroneous descriptions have given rise to the recent controversy over the credibility of the IPCC Fourth Assessment Report (AR4).

However, these errors concern only a small portion of the AR4 that runs about 1,000 pages and the credibility of the AR4's scientific basis regarding global warming remains intact. Following the recent controversy, the IPCC has commissioned the InterAcademy Council (IAC) to conduct an independent review of the processes and procedures of the IPCC in preparing its reports. The IAC review results will be discussed at this year's IPCC Plenary Session and reflected in the IPCC Fifth Assessment Report (to be released in 2013-2014).

In this column, we explain about questions you might have regarding global warming based on scientific knowledge offered in the IPCC AR4 and other documents.

(1) Is there sufficient evidence that anthropogenic greenhouse gases are the major cause of global warming?

Not only anthropogenic factors such as greenhouse gas emissions but also natural factors including solar activity and aerosols discharged by volcanic eruptions cause changes in the global mean temperature, and a combination of various factors leads to temperature rises or decreases. Around the mid-20th century, there were periods when the global mean temperature stayed flat despite higher atmospheric concentrations of greenhouse gases due to other offsetting factors. The IPCC AR4 noted that based on the results of climatic simulations for 1906-2005, rapid global warming observed in the recent several decades cannot be reproduced without considering anthropogenic increases in greenhouse gas emissions.

(2) The biggest greenhouse effect comes from water vapor. So, isn't it true that a small increase in carbon dioxide emissions has little impact on the environment?

It is true that water vapor has the biggest greenhouse effect (about 60%), but carbon dioxide also plays an important role by contributing about 30% of the greenhouse effect. The amount of water vapor in the atmosphere is determined by exchanges (evaporation and precipitation) between the atmosphere and oceans/land surface. Thus, the amount of water vapor does not increase or decrease significantly due to human activities. Water vapor is believed to grow in amount in the atmosphere if temperatures rise which increasingly accelerates global warming, but much more contributory to temperature rises are carbon dioxide emissions by human activities. In other words, due heed certainly needs to be given to water vapor in that water vapor currently is a factor for the greenhouse effect and has potential to amplify global warming in the future. In order to contain the progression of global warming, however, it is more effective to curb emissions of carbon dioxide and other greenhouse gases.

(3) Isn't it true that the major cause of global warming is animated solar activity, etc. and not the increase in greenhouse gas concentrations?

As noted in (1), not only the increase in greenhouse gas concentrations but also animated solar activity (an increase in radiant energy from the sun) and other factors cause to alter the global mean temperature. However, the latest observation data on the number of sunspots, a good indicator of solar activity, shows that sunspots have stayed almost flat or tended to decrease since the mid-20th century, indicating little possibility of solar activity becoming more vigorous. Cosmic rays (electric atomic nuclei drifting in outer space) that reach the earth's atmosphere are said to form clouds, and there is a theory that cosmic rays decrease when solar activity becomes vigorous and a resultant reduction in the amount of clouds causes temperatures to rise. At present, however, there is no established correlation between cosmic rays and the amount of clouds and the physical mechanism involved has not been elucidated. After assessing scientific discussions concerning natural factors such as solar activity and cosmic rays, the IPCC AR4 has concluded that the increase in global average temperatures in the latter half of the 20th century is very likely due to the increase in anthropogenic greenhouse gas concentrations.

to storm-surge flooding (Western Japan), and ¥119.2 billion in cost of damage due to heat stress (heat stroke) mortality, respectively, is estimated each year in the 2090s.

Section 2 Economic Effects of Measures to Cope with Global Warming

Measures to cope with global warming are believed to have both positive and negative effects on the economy. As specific positive effects on the economy, considerable new business opportunities are conceivable in a diverse range of industries and services. The market for low-carbon energy products is one of fields with considerable potential going forward. Japan must strive to take advantage of these business opportunities.

Measures to deal with climate change may also help eliminate existing inefficiencies. At the corporate level,

the introduction of measures to cope with global warming may lead to cost savings, while at the level of the overall economy, climate policy measures are believed to be likely to lead to improvements in inefficient energy systems.

Furthermore, as secondary benefits of taking measures to deal with climate change, it can also be expected that health damage from air pollution would be reduced or forests that host the bulk of global biodiversity would be preserved.

Lastly, efforts to enhance energy efficiency and diversify energy sources and energy supply as part of measures to cope with global warming will contribute to securing national energy security and is also instrumental in clarifying a long-term energy-related policy framework.

Thus, what is important is the change in our way of thinking to view the promotion of measures to cope with global warming as one of pillars for new growth, instead of focusing only on increased burdens. The "New Growth Strategy (Basic Policies)," adopted by a Cabinet decision in December 2009, regards environment-related markets as sustainable growth areas with potential short-term and long-term demand, and in order to become "an environment and energy power through 'green innovation'," sets the targets of creating over ¥50

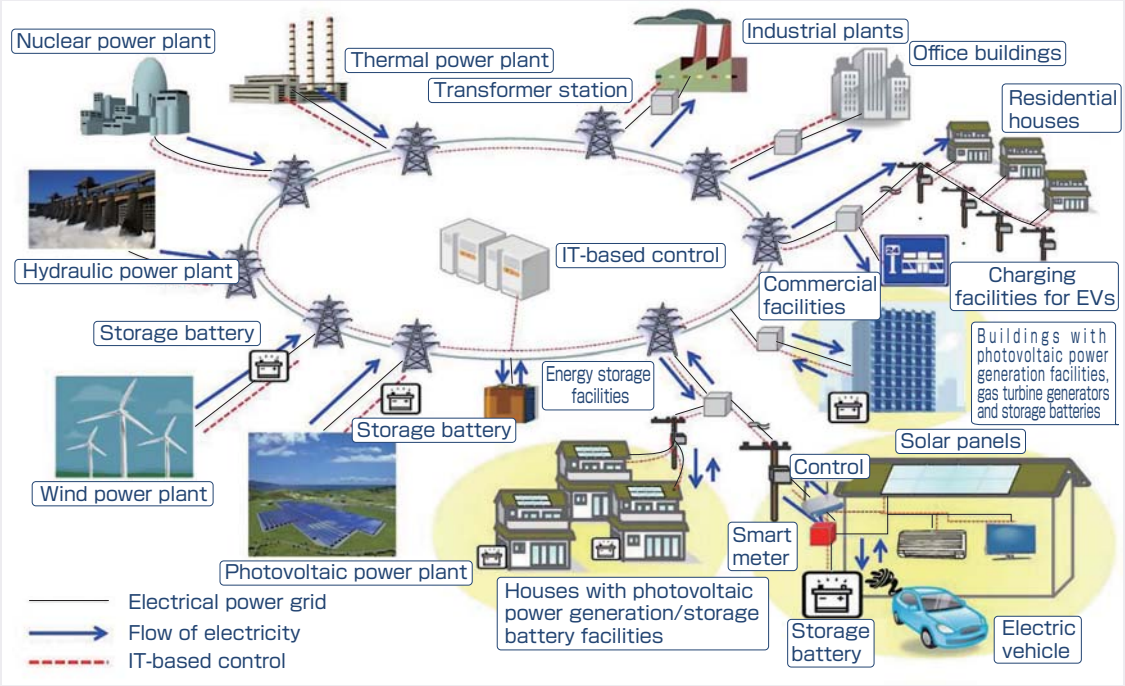
Column Smart Grid

The term "Smart Grid (next-generation power transmission network)" is being used to mean various things. For example, it is used to mean the power transmission and distribution network that incorporates dedicated equipment and software with communication functions and controls the flows of electric power from both the supply and demand sides to optimize them.

The ways in which the so-called "Smart Grid" is visualized differs among countries and regions. In the United States, the Smart Grid has attracted keen attention after the Obama administration placed it as the pillar of the Green New Deal, but appears to be aimed largely at replacing superannuated U.S. power transmission networks. Also in the background is that in the United States, unlike Japan, power demand is expected to keep growing going forward and the necessity is high to upgrade and beef up transmission lines.

In Japan, on the other hand, its power transmission network is known for high efficiency and high reliability. For example, comparison of hours of electric power outage demonstrates that Japan's power supply system is highly reliable. However, if renewable energy such as photovoltaic power generation and wind power generation come to account for a large portion of power supply, as in Europe, due to their vulnerability to weather and climate and unstable output, it will become necessary to take system stabilization measures to ensure the stable supply of electricity. For example, if power supply increases at a time when demand is low, it is necessary to take system stabilization measures such as curbing output of photovoltaic power generation or storing electricity in large stationary storage batteries in order to adjust the power supply and demand balance. In Japan, maintaining the stable supply of power and expanding the introduction of renewable energy are one of the purposes to work on the Smart Grid.

Conceptual Diagram of Smart Grid



source: Ministry of Economy, Trade and Industry, "Toward International Standardization Concerning Next-Generation Energy Systems"

trillion in new environment-related markets and 1.4 million new environment sector jobs by 2020. We describe this in greater detail in Section 4 of this Chapter.

Amid the global recession following the Lehman Shock, various companies, in search of new business, are trying to find opportunities in new fields. In particular, environmental businesses may be described as already expanding with further prospects for growth.

Utilization of natural energy is one area that is likely to increasingly grow in importance globally going forward. Demand for photovoltaic power generation, the typical use of natural energy, according to the International Energy Agency's (IEA) PV Roadmap 2009, is expected to expand about five times the present level by 2020 in terms of electricity generated. For Japan, which has sophisticated technology in photovoltaic power generation, this is the industry sector with growth potential going forward. As Japan plans to introduce measures to support the spread and expansion of renewable energies (solar light, wind, hydroelectric, geothermal, solar thermal, biomass, etc.), such as the creation of the electric power feed-in tariff system, promotion of installation of facilities using renewable energy, promotion of electric power system facilities, and adequate review of regulations, etc., the volume efficiency associated with the spread and expansion at home is expected to help lower manufacturing costs and boost international price competitiveness.

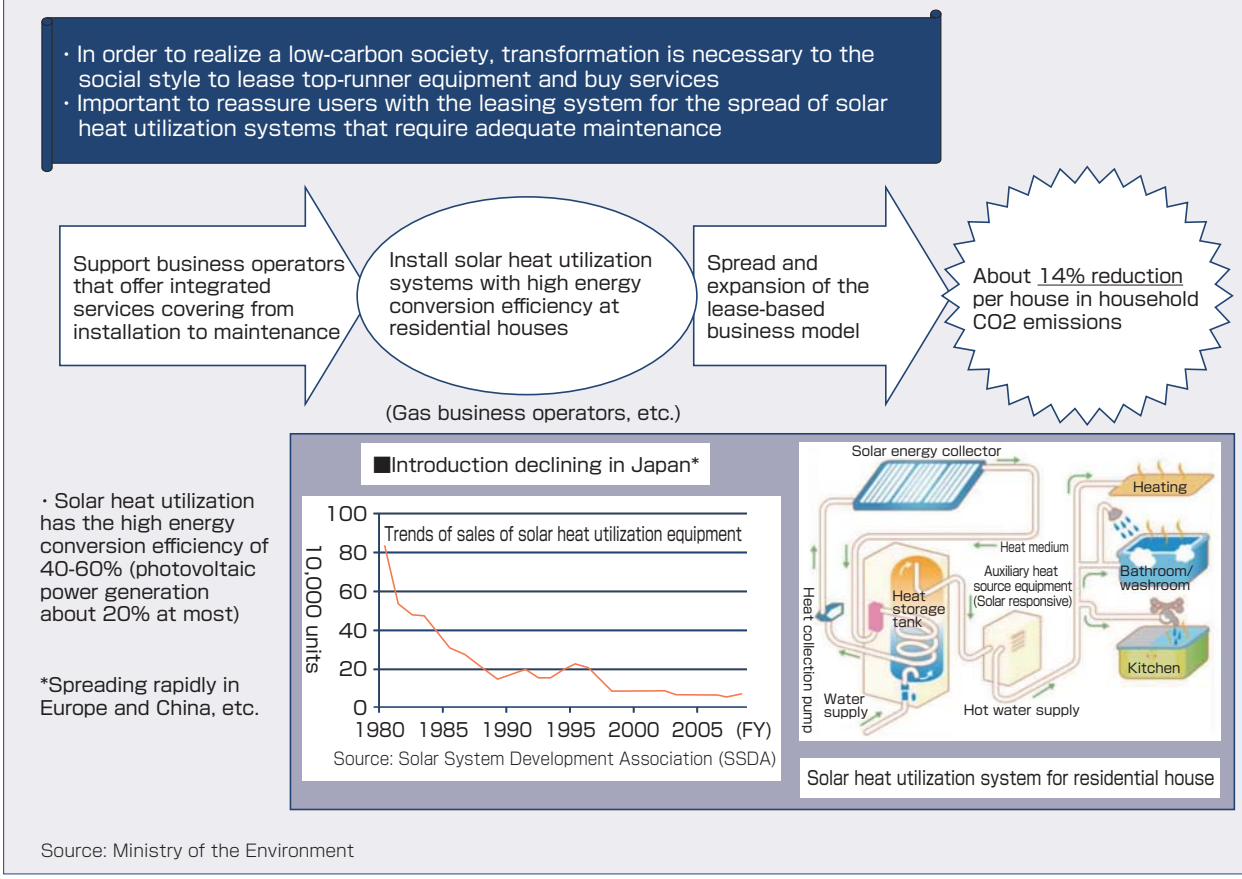
Furthermore, efforts are under way, notably in Europe and the United States, to introduce the "Smart Grid" designed to realize the efficient utilization of renewable energy. Japanese companies are also engaged in active business operations on the strength of their battery technologies, including solar cells and rechargeable batteries.

The Ministry of Economy, Trade and Industry, regarding the Smart Grid business as the next-generation business and in order to support Japanese companies with excellent products and services in going into overseas markets with their systems, established the "Study Group on the International Standardization Concerning Next-Generation Energy Systems" in August 2009 to proactively and strategically contribute to the international standardization of the Smart Grid. In January 2010, the Study Group came up with the "International Standardization Roadmap for Smart Grid," which sorted out and listed 26 important technological elements to be standardized.

In the future, it is also conceivable to develop new services by adding functions to operate security systems and home electric appliances to the Smart Grid.

Other than the Smart Grid, lithium ion and other rechargeable batteries that are a technology essential for electric vehicles, etc. are an area which Japan excels in. The Ministry of the Environment has supported research and development of high-capacity laminate lithium ion batteries, while the Ministry of Economy, Trade and Industry has also been promoting high-performance, low-price innovative storage batteries. Since FY2009, actually, electric vehicles and plug-in hybrid vehicles have been put on the market on a full scale, and going

Figure2-2-1 Concerning Acceleration of the Spread of Household Solar Heat Utilization Systems



Source: Ministry of the Environment

forward, electric vehicles mounted with high-capacity laminate lithium ion batteries are also set to be commercialized. Thus, rechargeable batteries have become an element indispensable for the development of next-generation environment-friendly products.

Measures to cope with global warming will reduce lighting and heating expenses at households. As an example of usage of energy from sunlight, solar heat utilization systems such as water heaters have a high energy efficiency of 40-60% and are also relatively cheap. Solar heat utilization systems are rapidly spreading in Europe and China, etc., and Japan is trying to develop a mechanism under which such systems can be used without safety concerns by spreading them mainly under lease contracts, which helps eliminate maintenance troubles (Figure 2-2-1).

Furthermore, when photovoltaic power generation, high-performance insulation and high-efficiency water heaters are introduced to single-family houses and at the same time electric appliances are replaced with energy-saving ones, for example, despite the costs of introducing these systems and new electric appliances, reductions in heating and lighting expenses can be expected. High-performance insulation of houses will also produce the secondary effect of creating a comfortable and healthy living space that is cool in summer and warm in winter.

Column The Stern Review

The "Stern Review: The Economics of Climate Change" is the report on economic impacts of the climate change problem the British government commissioned to the former World Bank Senior Vice President Nicholas Stern following the Group of Eight Summit in July 2005, which was released in October 2006. The Stern Review analyzed the economic costs of the impacts of climate change, and the costs and benefits of action to reduce the emissions of greenhouse gases using the following three different ways.

(i) Approach to considering individual factors

This is the approach of analysis to consider the physical impacts of climate change on the economy, on human life and on the environment using disaggregated techniques, and examine the resource costs of different technologies and strategies to reduce greenhouse gas emissions.

The Stern Review first made an analysis using integrated assessment models to estimate the overall impact of climate change in monetary units. The Stern Review also used models that makes it possible to examine the risks of most uncertain impacts using probabilities, and it estimated that "the monetary impacts of climate change are now expected to be more serious than many earlier studies suggested."

The Review estimated "the total cost over the next two centuries of climate change associated under BAU (business as usual) emissions involves impacts and risks that are equivalent to an average reduction in global per-capita consumption of at least 5%." Further, including direct impacts on the environment and human health (so called "non-market" impact) and weighting appropriately the disproportionate share of the climate-change burden falling on poor regions of the world, it is estimated that the total cost of BAU climate change would be increased to "the equivalent of around a 20% reduction in consumption per head, now and into the future."

(ii) Approach to using economic models

This is the approach of analysis that uses economic models, including integrated assessment models that estimate the economic impacts of climate change, and macroeconomic models that represent the costs and effects of the transition to low-carbon energy systems for the economy as a whole.

Assuming the following four ways to reduce greenhouse gas emissions:

- Reducing demand for emissions-intensive goods and services
- Increased efficiency, which can save both money and emissions
- Action on non-energy emissions, such as avoiding deforestation
- Switching to lower-carbon technologies for power, heat and transport,

the Review estimated the costs of stabilizing greenhouse gases at levels of 500-550ppm CO_2e in two ways: One is to provide an upper bound on costs by looking at the resource costs of measures in comparison with the costs of the BAU alternative, and the second is to use macroeconomic models to explore the economic system-wide effects of the transition to a low-carbon energy economy. As a result, on the basis of these two methods, it is concluded that "stabilization of greenhouse gases at levels of 500-550ppm CO_2e will cost, on average, around 1% of annual global GDP by 2050." A broad range of macro-economic model estimates led to an important corollary that "there is a high price to delay." The Stern Review also issued a warning: "Weak action in the next 10-20 years would put stabilization even at 550ppm CO_2e beyond reach – and this level is already associated with significant risks."

(iii) Approach to comparing costs

This is the approach of analysis to compare the estimated costs of mitigation with the estimated costs of climate change without action, and to compare the marginal cost of carbon abatement with the "social cost of carbon."

Introducing the latest knowledge about risks and assuming we remain on a BAU trajectory, the Stern Review estimated that "the social cost of carbon today … is of the order of $85 per tonne of CO_2." This number is well above marginal abatement costs in many sectors. Comparing the social costs of carbon

on a BAU trajectory and on a path towards stabilization at 550ppm CO_2e, the Stern Review estimated "the excess of benefits over costs, in net present value terms, from implementing strong mitigation policies this year, shifting the world onto the better path: the net benefits would be of the order of $2.5 trillion."

The Stern Review also states that "innovation driven by strong policy will ultimately reduce the carbon intensity of our economies, and consumers will then see reductions in the prices that they pay as low-carbon technologies mature."

The Stern Review, summarizing the results of analyses based on these three approaches, presented a simple conclusion: the benefits of strong, early action on climate change considerably outweigh the costs."

There is criticism of the Stern Review that the "discount rate" applied to economic model estimates has been set too low and this might have resulted in an overestimation of long-term impacts of climate change. Since many of the preceding economic analyses applied higher discount rates based on the observations of actual behaviors of people, certain researchers consider the Stern Review inappropriate. In contrast, in the Stern Review, Lord Stern argued that the discount rate should be set low and the long-term benefits should be given greater importance regarding the natural system affected by global warming and the human system that depends on the former for its subsistence.

Sources: Asia-Pacific Integrated Modeling (AIM) Team and the executive summary of the "Stern Review: The Economics of Climate Change" (translated by the National Institute for Environmental Studies)

Section 3 Global Movement on Climate Change

Damage from Climate Change has already started emerging, and it is necessary to take appropriate measures for mitigation and minimize the cost of damage. But only Japan's efforts cannot halt climate change, even if it sets an ambitious reduction target. No country can deal with this problem alone. Persistent discussions are ongoing in international negotiations, where the short-term interests clash between developed and developing countries, among developed countries or among developing countries.

1 The International Community's Responses So Far to Climate Change

The Kyoto Protocol adopted at the third session of the Conference of the Parties (COP3) to the United Nations Framework Convention on Climate Change (UNFCCC) in 1997 based on the UNFCCC committed developed countries to embark on international efforts to reduce greenhouse gas emissions and set numerical targets for greenhouse gas emission cuts by developed countries during the first commitment period (2008-2012). However, the Kyoto Protocol, which the United States does not ratify and developing countries are not subject to reduction targets, covers only about 28% of total global emissions of carbon dioxide from energy sources as of 2007. Global emissions of greenhouse gases are expected to continue to increase in tandem with economic development of developing countries with no reduction obligations. Under these circumstances, in order to reduce emissions of greenhouse gases effectively in the future, it is necessary to strive for measures to address climate change by the entire world, including the United States, which is yet to ratify the Kyoto Protocol, and China and other emerging economies whose energy consumption is expected to increase.

Regarding international negotiations on the post-2012 framework, the COP13 held in Bali, Indonesia, in December 2007 adopted the Bali Action Plan and decided to finalize the post-2012 framework by COP15 in 2009 with the participation of all parties to the UNFCCC.

Meanwhile, at the Group of Eight (G8) Hokkaido Toyako Summit held in 2008, the G8 leaders reached common understanding that they seek to share with all Parties to the Framework Convention on Climate Change the vision of, and together with them to consider and adopt in the UNFCCC negotiation, the goal of achieving at least 50% reduction of global emissions by 2050. At the G8 Summit in L'Aquila, Italy, in July 2009, the G8 leaders reaffirmed the goal of reducing global emissions by at least 50% by 2050, and as part of this, supported a goal of developed countries reducing emissions of greenhouse gases in aggregate by 80% or more by 2050 and also recognized the broad scientific view that the increase in global average temperature above pre-industrial levels ought not to exceed 2 degrees Celsius. Subsequently, then Prime Minister Yukio Hatoyama announced in a speech at the Summit on Climate Change in September 2009 that "For its mid-term goal, Japan will aim to reduce its emissions by 25% by 2020, if compared to the 1990 level, consistent with what the science calls for in order to halt global warming," which is premised on the establishment