論説 Commentary

Giving cautions against hasty anti-global warming measures —Scientists bear grave responsibility

Makoto MISONO
Professor Emeritus at the University of Tokyo / President of Japan Union of Chemical Science and Technology

Scientists and society

Scientists (including engineers, humanity scientists and social scientists), in my opinion, deserve society's respect and job opportunities when they demonstrate their social contributions and ethics. Therefore, it is an essential contribution to society and an ethical obligation and social responsibility for scientists to publicly present their professional judgments and judgmental criteria and to urge society to make the right choices.

In this sense, the global warming issue will provide a good opportunity for scientists to demonstrate their existential value. It is not only because scientists are highly influential on this issue as seen in the reports of the Intergovernmental Panel on Climate Change (IPCC), but also because global warming is such a critical issue that it could determine the future direction of humankind.

Low carbon society: validity of the target

In reality, however, the world has been in a quandary because of misunderstandings (illusions) and controversial points of view even among scientists.

Some people argue that global CO_2 emissions should be halved by 2050 to realize a low carbon society, but their argument does not have enough scientific evidence. No such writing has, of course, been found in any of the IPCC reports, which are not supposed to make any policy recommendations.

According to simulation of future in the IPCC reports, a substantial increase in CO_2 emissions is estimated even in the scenario that envisages about 2 degrees C rise in temperature until the end of the 21st century. Therefore, if global CO_2 emissions as of 2050 can be reduced by approximately 20% from the current level, it seems to me that there would not be such a high rise in temperature until the end of the 21st century.

In this regard, however, the amount of CO_2 emissions, which largely depends on the consumption of fossil energy, would rapidly increase especially in developing countries, if it were not for any regulations. In such a case, even a seemingly moderate target such as restraining CO_2 emissions as of 2050 to the current level would never be easy to achieve. That is because an expansion of production and consumption inevitably results in increased energy consumption in modern civilization, which bases its existence on massive energy consumption. It is also because, for the time being, we will have no choice but to depend on fossil resources as the largest source of energy consumption (presumably about 50% in 2050).

When considering measures, we should avoid causing heavy damages by underestimating the risk of global warming. But at the same time, we should recognize that excessive measures would also have major adverse effects. It would be wise to start with moderate targets and appropriate measures and then to flexibly modify them when the situation demands. This author believes that it will be good to initially focus on the efficient use of fossil resources and energy conservation because these resources will retain their substantial role throughout the 21st century, and then to gradually increase nuclear energy and the old and new renewable energies[1)], although this point of view still needs to be discussed.

Other than the above, a Life Cycle Assessment (LCA), which takes a time axis into account, will also be required. For example, it should be considered that even if CO_2-reduction equipment is installed, it will take time to actually reduce the net emissions because a certain volume of CO_2 was emitted when the equipment was produced.

Cost performance of measures
Are electric vehicles effective for CO_2 reduction?

Let's look at CO_2-reduction technology from the standpoint of cost performance[1)]. Some people seem to think that a low carbon society would be readily achievable if electric vehicles are commonly designed to be driven by solar power generation, but this is a fallacy. They are wrong about the "quantitative relationship" and "time axis." Hereinafter, I am going to prove this point based on some numerical data, and would like to assert that we should make a rational decision on the priority order of anti-global-warming measures. I feel more strongly about it as I have observed the recent trend of praising aggressive targets without any specific measures.

First, let's look at the quantitative relationship. At present, solar power generation accounts for only 0.01% - 0.02% of the total energy consumption in the world, or 0.1% - 0.2% in Japan. Even if it grows multi-tenfold in Japan, that would not amount to a large volume from a global perspective in terms of both the net energy supply and CO_2 reductions. In sharp contrast, over the next 25 years, the aggregated increase in CO_2 emissions in new emerging countries as a whole is estimated to outnumber the total emissions in Japan (slightly below 5% of the world's total) by a one digit difference. The figure shows the relevant cases in China and India in comparison to Japan.

Now let's consider the cost performance. Solar power generation emits 53 g CO_2 per kWh. This is far below 420 g average for electric power generation. In terms of power generation costs, however, the former costs about 45 yen, much more expensive than latter's about 7 yen on average (cf. wind force power generation costs about 12 yen). Accordingly, the required cost for a one-ton reduction of CO_2 is calculated as follows: $(45-7)$ yen $/(420-53)$ g $\fallingdotseq$ 100,000 yen per ton. In addition, when solar power generation becomes widely used, storage equipment will become necessary to level off the power supply. This additional cost is said to be equivalent to the solar power generation cost. If the additional cost is assumed to be half of the power generation cost, it

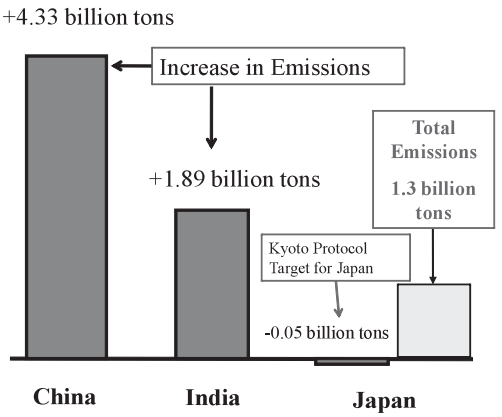

Figure: Increases in CO_2 Emissions in China and India for the Period between 2005 and 2030* and Japan's Reduction Target / Total Emissions
(*Estimated by the Institute of Energy Economics, Japan)

would be about 150,000 yen (= about 100,000 yen + 50,000 yen). In the emissions trading market, the current market price is about 1,500 yen per ton. It means that the additional cost is 100 times as much as the market price. Meanwhile, the cost of nuclear power generation is less expensive than the average cost of electric power generation. It needs to be clarified whether the CO_2 reduction cost, including the costs of hard-to-assess waste processing and reactor decommissioning, would be equivalent to the emissions market price.

As described above, we could wishfully count on the use of solar power in the future, but we have to say that the existing technology has not yet reached such a level as to allow its widespread use. Rather than urging its hasty expansion, we should focus on core technological innovation, aiming at widespread use in the late 21st century.

Next, let's consider i-MiEV as an example of electric vehicles which can be driven only with batteries. A comparable mini vehicle consumes about 5,000-liters of gasoline (about 0.5 million yen for the gasoline) and emits about 12-tons of CO_2 (2.4 kg of emissions per one-liter of gasoline), when it runs for 100,000 km. On the other hand, i-MiEV can reduce both gasoline and CO_2 emissions. However, approximately 4-ton CO_2 will be emitted through the generation of the necessary electric power for an i-MiEV to run 100,000 km. This electric vehicle will be priced at approximately 4.6 million yen. It means an i-MiEV will be more expensive than a comparable mini car by about 3.5 million yen (because huge amounts of lithium-ion secondary batteries need to be installed). Based on the above, the CO_2 reduction cost is calculated at 0.4 million yen or over per ton. That's much more expensive than other reduction means.

In addition to this, we have to take into account CO_2 emissions at the time of production. Judging from the price levels, the emissions volume would be fairly large. About 1.3 billon-tons of CO_2 is emitted for Japan's GDP of roughly 500 trillion yen. So, to put it simply, the 3.5 million yen more expensive price means larger CO_2 emissions by about 9 tons. If this roughly calculated figure is adopted, the i-MiEV would emit a larger volume of CO_2. (If it is compared to the average CO_2 emissions of the manufacturing sector, the gap would be much larger.) At the present stage, judging from the reduction effect as well, the widespread use of electric vehicles cannot be said to be a priority issue. Just like solar cells, it would be better to work on the technological innovation (especially for storage batteries) thoroughly. Storage technology is also essential for the use of natural energy which is inherently variable. In either case, the field of chemistry will play many roles.

By the same token, the CO_2 reduction cost of cheap bioethanol imported from Brazil is estimated at about 40,000 yen per ton, as is the reduction cost of the previous Prius model [1]. Needless to say, these are roughly estimated figures and may become less costly in the future. The cost estimates would also change if these CO_2 reduction measures became much more common and widespread (with the possibility for the costs to change in both directions of increase and decrease).

There remain unanswered questions. For example, "how much cost is considered appropriate to maintain the environment?" or "would it be all right to make a decision only from the viewpoint of economic efficiency?" Nevertheless, it would be better to place a lower priority on an excessively high-cost measure (since CO_2 emissions usually increase along with the cost). It would be beneficial to estimate and compare the CO_2 reduction costs of other relevant measures.

The argument about cost performance would be unproductive if it remained deskbound. Such an argument should be resolved on the basis of track records. Incidentally, an acquaintance of mine installed a photovoltaic facility on the roof of his all-electric house 15 years ago. From what I have heard, the track record of this facility is summarized as follows: Purchased electricity: Generated electricity: Sold electricity ≒ 10 : 3 : 1.

Summary: appropriate measures and responsibilities of scientists

Scientists are responsible not only for contributing to society by creating excellent science and technology but also for publicly presenting scientific information for making decisions and urging society to make the right decisions.

What is important in anti-global-warming measures is to implement long-term effective measures steadily over many years. If the direction is right, we will not have to feel pressured. This is because the IPCC predictions and the sense of crisis on the streets are presumably too much[2], as suggested by the Climate-Gate Scandal and the Himalayan glaciers mistake. On the other hand, new industries cannot be expected to build up their strengths and become independent in a short period of time. I fear that our country might become poor if it made a wrong decision about its anti-global-warming measures.

The global-warming issue is uncertain and complicated, but it is critical. I sincerely hope that all scientists will tackle this issue earnestly to construct a transparent and highly efficient collaboration mechanism and that appropriate measures will be selected, through contributions from science.

1) Makoto Misono, "*Shin Ene Genso*" (Illusion of New Energy), Energy Forum 2010; The Chemical Daily, December 16, 2009.
2) Tadashi Watanabe, CHEMISTRY, March 2010 Issue; Kiminori Itoh, CHEMISTRY TODAY, January 2010 Issue; Also please refer to Juen Asuka et al., "*Chikyu Ondanka Kaigiron Hihan*" (Criticism on Skepticism toward Global Warming), IR3S/TIGS Sosho No. 1, 2009 (disclosed on the web site).

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E-mail: ronsetsu@chemistry.or.jp

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