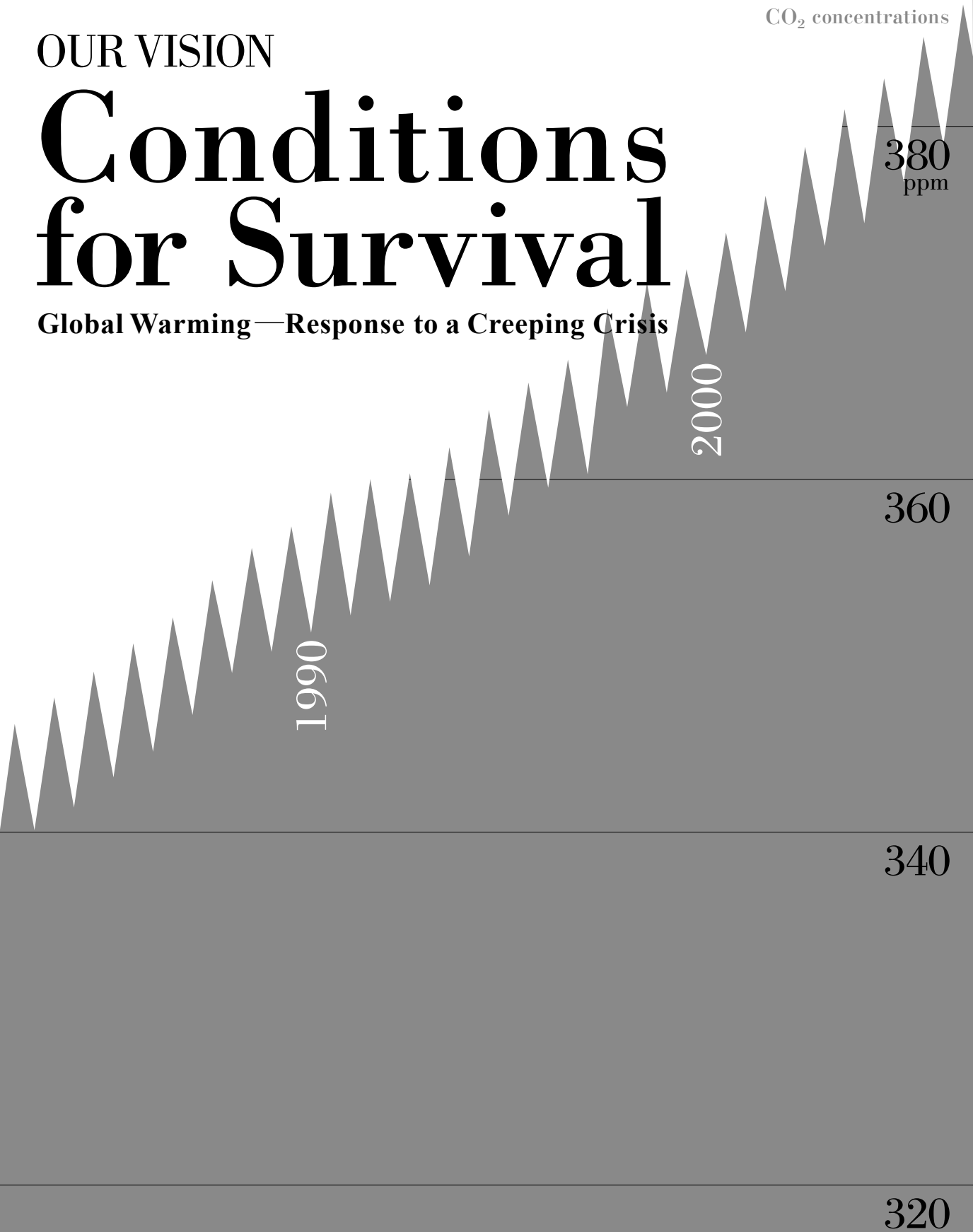


CO<sub>2</sub> concentrations

OUR VISION

# Conditions for Survival

Global Warming—Response to a Creeping Crisis



THE ASAHI GLASS FOUNDATION

Special Round Table Conference on Global Environment Problems

It is almost 40 years since *The Limits to Growth* was published in 1972 by the Club of Rome. Over the years since this publication allowed the world to recognize the finiteness of the Earth, environmental problems have become ever more serious, and show no signs of mitigation. We have already exceeded the limits to growth, and there are even concerns over the survival of humankind. Under these circumstances, the Asahi Glass Foundation established the Special Round Table Conference on Global Environment Problems, comprising 28 directors and councilors who have been debating issues related to humankind, including global environmental problems to date. Based on the results of their discussions, this booklet will give insights into the requirements for a truly sustainable society in “Our Vision,” focusing on the problem of global warming.

The Asahi Glass Foundation was established in 1933 as the Asahi Foundation for Chemical Industry Promotion in commemoration of the 25th anniversary (in 1932) of the foundation of Asahi Glass Co., Ltd. Over most of its first half century, excluding the confused post-war period, the Foundation focused primarily on fostering research in applied chemistry. Subsequently in 1990, the Foundation undertook the overall redesign of its programs, expanding the target of its research grants and establishing its commendation program. At the same time, it changed its name to the Asahi Glass Foundation. Since then, the Foundation has been continuing its activities focusing on [1] the research grant program designed to foster science and technology for future generations and on [2] the Blue Planet Prize program as its two mainstays, with the aim of contributing to the creation of a society and culture that provides a truly rich life to a wide range of people, and including initiatives to solve global environmental problems.





OUR VISION

# Conditions for Survival

Global Warming—Response to a Creeping Crisis



# Introduction

The Earth seen from space is blue and is incomparably beautiful.

Resulting from the accumulation of an incredible number of coincidences, the Earth became a planet where life resides. It is a miraculous planet where air, water, land, and the animals and plants and microorganisms living there together form a complex symbiosis that is invaluable and irreplaceable for all living things, including humankind.

The Asahi Glass Foundation established the Blue Planet Prize and has commended individuals and organizations who contributed to solving global environmental problems. The prize was named after the Earth, shining blue, which is mother to all living things. We have continued to award the prize, in consideration that global environmental problems are the most pressing problems faced by humankind.

We human beings have carried out our activities just to satisfy our own desires, without considering the capacity of the Earth. As a result, the Earth's system has been badly affected and a range of global environmental problems, represented by global warming became significant.

It is now time for us human beings to set bold targets for the survival of all living things on the planet and take action to achieve those targets. We humans are now asked to show our true wisdom.

We would like to ask every one of you to think about global environmental problems and join in the efforts to solve them. The Special Round Table Conference on Global Environment Problems ("the Round Table Conference") comprising the directors and councilors of the Foundation was established for that purpose.

Mankind has made mistakes, but has also become aware of how beautiful a planet the Earth is when seen from space. We have now become aware of the mistakes made and the impending crisis. If we start taking corrective action immediately, I believe we will be able to restore the beauty and riches of the planet and pass them on to future generations.

**Hiromichi Seya**

Chairman of the Asahi Glass Foundation

## Special Round Table Conference on Global Environment Problems

(As of March 31, 2009)

Chairman	Hiromichi Seya	Senior Corporate Advisor, former Chairman, former President, Asahi Glass Co., Ltd.
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	Takeshi Koshizuka	Vice President, University of Tsukuba
	Yukiharu Kodama	President, The Mechanical Social Systems Foundation; Former Administrative Vice-minister of International Trade and Industry
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	Ryoji Noyori	President, RIKEN
	Takashi Miyajima	Professor, Hosei University; Professor Emeritus, Ochanomizu University
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	Shinroku Morohashi	Counsellor, former Chairman, former President, Mitsubishi Corporation
	Hiroyuki Yoshikawa	President, National Institute of Advanced Industrial Science and Technology; Former President, Science Council of Japan
	Michiko Imai	Director, Le Verseau Inc.
	Hitoshi Osaki	Special Advisor to the President, National Institutes for the Humanities; Former Commissioner for Cultural Affairs
	Yohichi Gohshi	Executive Auditor, University of Tsukuba; Former President, National Institute for Environmental Studies; Professor Emeritus, University of Tokyo
	Yuichi Shionoya	Professor Emeritus, former President, Hitotsubashi University
	Niro Shimada	Former Chief Justice, The Supreme Court of Japan
	Tsukasa Shimizu	Chairman, Tokyo Kasei University; Professor Emeritus, former President, Waseda University
	Junjiro Takahashi	Advisor, Academyhills; Professor Emeritus, Keio University
Keiko Nakamura	Director General, JT Biohistory Research Hall; Visiting Professor, Osaka University	
Minoru Makihara	Senior Corporate Advisor, former Chairman, former President, Mitsubishi Corporation	
Nobuo Matsunaga	Vice-Chairman, The Japan Institute of International Affairs; Former Ambassador to the United States of America	
Auditor	Masashi Sakamoto	Former Statutory Auditor, Asahi Glass Co., Ltd.
Former Auditor	Kiyoshi Tazawa	Former Auditor, Asahi Glass Co., Ltd.
Former Councillor	Ryohachi Kusaba	Former Chief Justice, The Supreme Court of Japan

## Prologue

# Departure from *The Limits to Growth*

The book *The Limits to Growth* was commissioned by the Club of Rome and published in 1972. Its authors include Dennis L. Meadows of the Massachusetts Institute of Technology. This book raised questions about the sustainability of the Earth and attracted much public attention. It established a world prediction model and analyzed 12 scenarios on global development over the 200 years from 1900 to 2100. In conclusion, the book warns that if the world population and industrial investment continue to increase, resources will be depleted, the environment will deteriorate, and humankind will reach the limits of growth within 100 years.

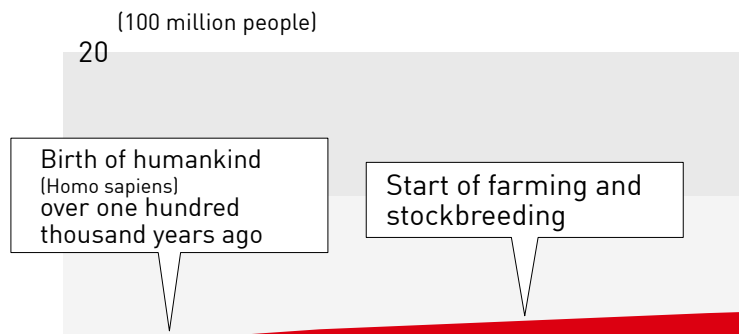
The world population has indeed increased at an exponential rate over the last several tens of thousands of years. The world population was 6.7 billion in 2007, up 5.7 billion or about seven fold on the population at the time of the Industrial Revolution in the 18th century. The production of rice, wheat and corn, and the consumption of fossil fuels have also shown a remarkable rise over the past 100 years, as indicated in *The Limits to Growth*.

Subsequently in 1987, the World Commission on Environment and Development (the Brundtland Commission), which was established within the United Nations, published a report titled *Our Common Future*. In this report, the Commission proposed the concept of “sustainable development” as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The concept of “sustainable development” then spread internationally through the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, the World Summit on Sustainable Development held in Johannesburg in 2002, and other international conferences.

In reality, however, despite the warnings given in *The Limits to Growth*, the world’s population has shown a steady increase, and countries have been continuing economic growth based on mass production, consumption and disposal.

\* Dennis L. Meadows

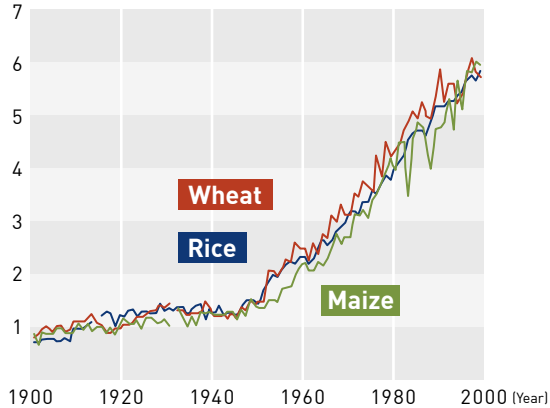
### Trends in World Population (Estimates)



Source: Based on the website of the United Nations Population Fund ([http://www.unfpa.or.jp/p\\_graph.html](http://www.unfpa.or.jp/p_graph.html))

### Trends in World Production of Three Major Cereals

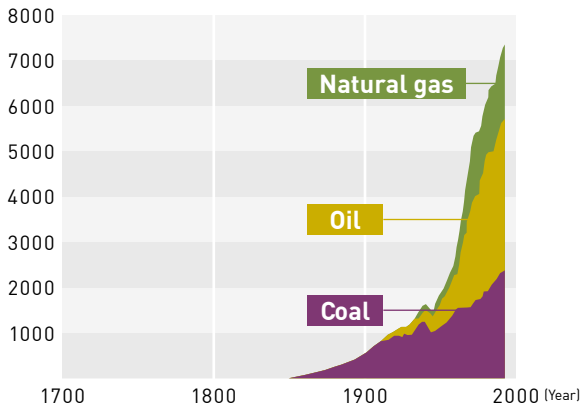
Production: 100 million metric tons



Source: Based on *Annual Report on the Promotion of Science and Technology 2000*, Science and Technology Agency of Japan  
 [Original data: *Chikyu Jizoku-no Gijustu*, book written by Hiroshi Komiyama on global sustainable technology; published by Iwanami Shoten, Publishers]

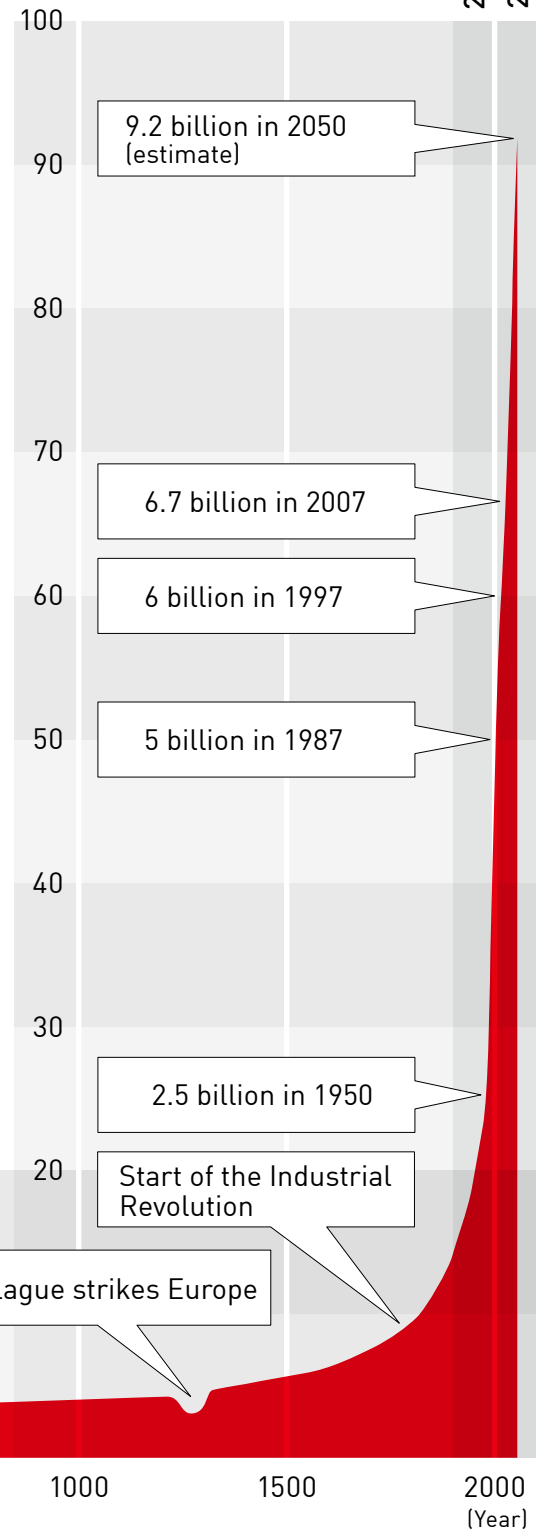
### Trends in World Consumption of Fossil Fuels

1 million metric tons of oil equivalent



Source: Based on *Annual Report on the Environment in Japan 1998*, Environment Agency of Japan

(100 million people)



Development of ancient civilizations

The Plague strikes Europe

Start of the Industrial Revolution

2.5 billion in 1950

6 billion in 1997

6.7 billion in 2007

5 billion in 1987

9.2 billion in 2050 (estimate)

20<sup>th</sup> century  
21<sup>st</sup> century

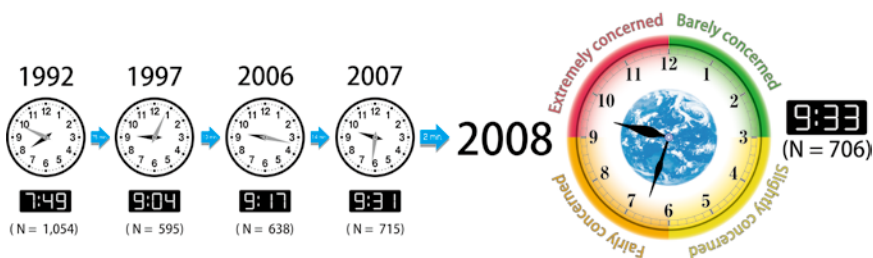
3000 BC ← 0 → AD 500 1000 1500 2000 (Year)

# Prologue: Departure from *The Limits to Growth*

The world's population has been increasing year by year even after the publication of *The Limits to Growth* and has almost doubled over the past 40 years. Energy and food consumption have also been on the rise at a rate exceeding the growth rate of the population. One indicator that we can use to show the global environmental impact of human socioeconomic activities is the ecological footprint (graph on right). According to this indicator, the impact that the world's socioeconomic activities, including those of Japan, have had on the environment exceeded the Earth's ecological capacity to regenerate as early as in the middle of the 1980s. In other words, we are consuming resources faster than they are being regenerated, and so we are exceeding the level of sustainable development. The latest data (2005) indicates that the resources we are consuming have exceeded the amount that the Earth can provide in a sustainable manner by nearly 30 percent. This fact has many implications for our future activities.

The Asahi Glass Foundation conducts an annual survey on the degree of crisis felt by respondents for the survival of the human race in a global environment that continues to deteriorate, targeting experts throughout the world. The Foundation has been monitoring their responses over time as indicated by the hands on the Environmental Doomsday Clock it created. In the first survey held in 1992, the clock showed 49 minutes past seven, and through the years the clock has advanced. In 2008, the clock showed 33 minutes past nine. This implies a strong awareness by world experts of the accelerating deterioration of the global environment. In order to solve global environmental problems, it is essential that ordinary people deepen their understanding of the present global environmental situation and start to involve themselves as important participants in voluntary activities.

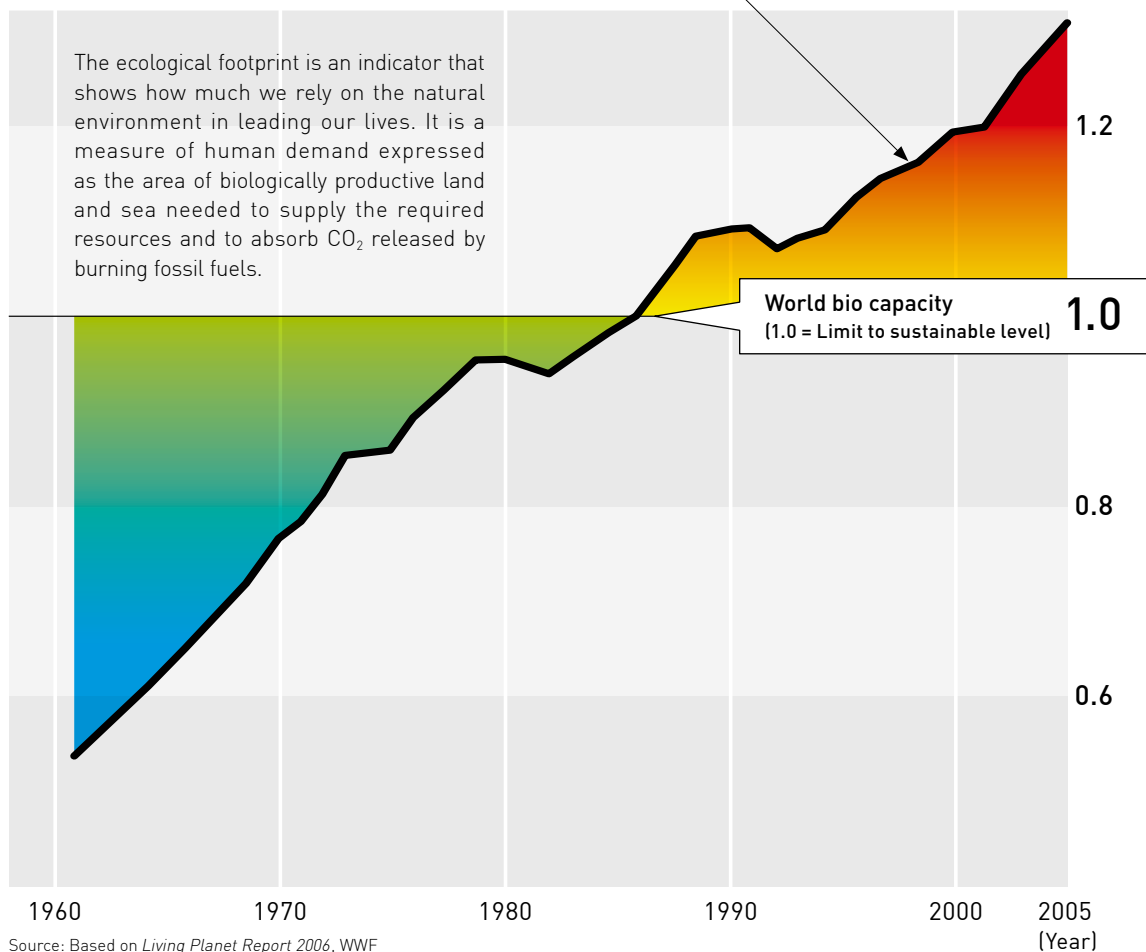
In this booklet, the circumstances surrounding this "creeping crisis" are explained in an easy-to-understand manner with a particular focus on global warming, and the approaches to be taken in response to this crisis are proposed based on the results of discussions held at the Round Table Conference.



Source: The Asahi Glass Foundation



## Trends in the Ecological Footprint of Humankind



## Trends in World Population, Supply of Primary Energy and Consumption of Cereals (1970 onwards)

		1970	1975	1980	1985	1990	1995	2000	2005
Population	1 million people	3,699	4,076	4,451	4,855	5,295	5,719	6,124	6,515
	Average annual growth rate	—	2.5%	2.2%	2.2%	2.2%	1.9%	1.7%	1.6%
Supply of primary energy	1 million toe	5,016	5,776	6,629	7,166	8,120	8,568	9,285	10,537
	Average annual growth rate	—	3.6%	3.5%	2.0%	3.2%	1.4%	2.0%	3.2%
	Per-capita consumption (toe/person)	1.36	1.42	1.49	1.48	1.53	1.50	1.52	1.62
Consumption of cereals	1 million tons	1,108	1,212	1,440	1,553	1,706	1,739	1,859	2,021
	Average annual growth rate	—	1.8%	3.5%	1.5%	1.9%	0.4%	1.3%	1.7%
	Per-capita consumption (tons/person)	0.30	0.30	0.32	0.32	0.32	0.30	0.30	0.31

Source: Based on *World Population Prospectus*, UN, *BP Statistical Review of World Energy 2007* and data on the demand, production and term-end inventory rates of cereals prepared by the Japanese Ministry of Agriculture, Forestry and Fisheries

Notes: — Cereals include rice, maize, wheat and barley. — The average annual growth rate means the average annual growth rate over the previous five years (e.g.: the five years from 1970 to 1975 for the average annual growth rate for 1975).

# Contents

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<b>Introduction</b>	2
---------------------	---

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<b>Prologue</b> <b>Departure from <i>The Limits to Growth</i></b>	4
---	---

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<b>Chapter 1</b> <b>A Creeping Crisis</b>	9
Rapid Increase in Energy Consumption	10
Global Warming	12

---

<b>Chapter 2</b> <b>Responding to the Crisis</b>	17
<b>Roles of Science and Technology</b> Scientifically Clarifying Global Warming, and Energy Innovation	18
1 Scientifically Clarifying Global Warming	19
2 Science and Technology to Seek Benefit for the Earth	21
3 Science and Technology Useful for Industrial Structural Reforms and the Energy Market	22
<b>Creating a Low-Carbon Society</b> Mechanism to Foster Initiatives, and Innovation in Related Systems	28
1 Encouraging Individual Initiatives	29
2 Transforming the Nation's Systems	29
3 Establishing an International Collaboration System	30

---

<b>Final Chapter</b> <b>Our Vibrant Blue Planet</b>	33
A Creeping Crisis	34
We are Social and Biological Beings	34
A Society where Human and Nature Coexist as Entities Full of Life	35
Approaches Toward Realizing a "Blue Planet"	36

---

<b>Special Dialogue</b>	40
-------------------------	----

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<b>Towards Making the Final Proposal</b>	46
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# Chapter 1

# A Creeping Crisis

**British scientist James E. Lovelock,\* proposed the Gaia hypothesis which insists that the biosphere and the hydrosphere, lithosphere and atmosphere interact with each other on the Earth to form a balanced system. This idea regards the Earth or great nature as a single system comprising various elements that interrelate with each other. It can be said that a sound living environment for mankind is maintained thanks to the Earth's homeostasis.**

**Nonetheless, due to global warming and other problems caused by economic growth that heavily depends on fossil fuels, the Earth's homeostasis is now endangered, and as a result, it is predicted that civilization will suffer greatly.**

**If human activity has caused the collapse of the Earth's homeostasis, we must in response make a concerted effort as members of the global community to control the changes made to the system. In this chapter we will examine the situations involved in this "creeping crisis."**

\* James E. Lovelock received the 1997 Blue Planet Prize.



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## Rapid Increase in Energy Consumption

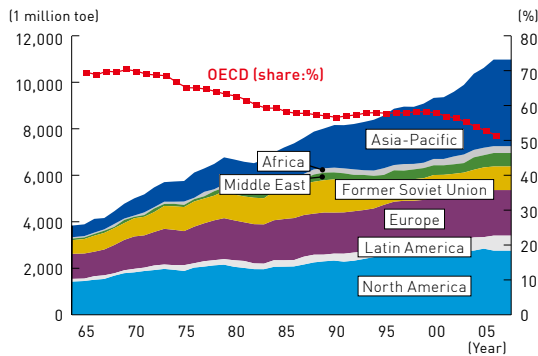
**We must have energy to maintain our civilization. Then how can we reduce our consumption of finite energy resources, while allowing developing regions to continue their economic growth? We are now facing a test of our wisdom.**

### Increasing Consumption of Fossil Fuels

The Industrial Revolution that began in the 18th century has brought about today's economic growth, which centers on industrial production. This economic growth would not have been achieved without the use of natural energy resources such as coal, oil, and natural gas. The world's supply of primary energy has been continuously on an upward trend, having tripled over the past 40 years.

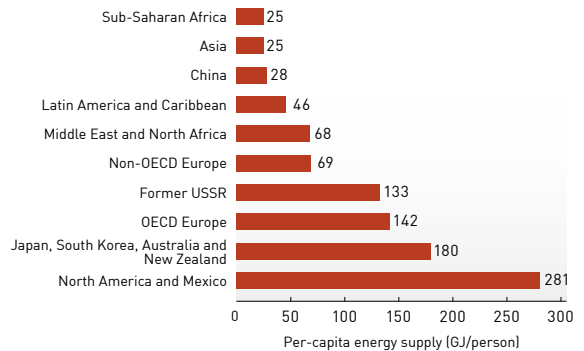
There are, however, substantial regional differences in the rate of growth of this energy consumption. The rate has been declining in developed regions (OECD member states) that have achieved economic growth and where development has matured. In these countries, efforts are being made to conserve energy by changing the industrial structure and increasing the energy efficiency of machinery. On the other hand, the energy consumption growth rate is on the rise in developing regions (non-OECD member states), which still need to grow their economies and establish social infrastructures.

### Trends in World Supply of Primary Energy



Source: Based on BP Statistical Review of World Energy 2007

### Comparison of Per-Capita Energy Consumption in Major Regions



Source: Based on World Energy Assessment 2004 overview, UNDP, 2004

### Increased Energy Consumption in Developing Regions

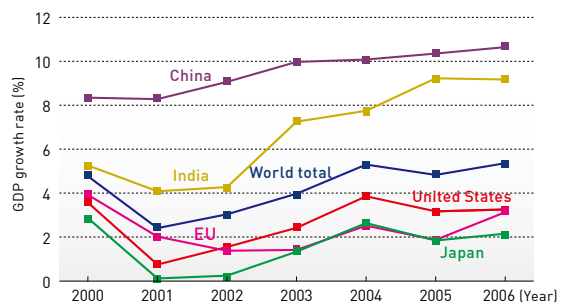
In the Asia-Pacific region in particular, there has been a substantial increase in energy consumption. Increased energy consumption in developing regions is largely attributable to their rapid economic growth. Since 2003, the world GDP growth rate has remained at around five percent, while developing countries in the Asia-Pacific region, as represented by China and India, have been achieving remarkable economic growth in recent years. These countries have been showing a growth rate of around 10 percent, far exceeding the rates in Japan and Western countries.

Per-capita energy consumption, however, is much smaller in developing than developed regions. If, however, developing countries follow the same economic growth path as the developed countries, this will further increase their energy consumption, which could eventually multiply the world's total energy consumption by several times.

### Responsibilities of the Developed Regions

If more energy is consumed mainly through the use of fossil fuels, it will lead to more greenhouse gases being emitted, which will cause further global warming. This could also accelerate the depletion of resources whose reserves are limited. As developing countries achieve more growth, they will use more resources, but the developed countries should not

### Trends in Economic Growth Rates



Source: Based on World Economic Outlook Database for April 2007, IMF

blame the developing countries for this.

Because, in the past, the developed countries consumed a vast amount of energy and emitted high levels of CO<sub>2</sub> in achieving their growth, thus developing countries do have the right to achieve growth in the same manner. Accordingly, in the preface to the United Nations Framework Convention on Climate Change, it states, "Recognizing that all countries, especially developing countries, need access to resources required to achieve sustainable social and economic development, —their energy consumption will need to grow—."

While achieving growth in developing regions, in order to realize a reduction in the consumption of resources and energy, it is essential that the developed regions realize a substantial shift in the fields of energy supply and energy conservation, and support developing regions with the innovative technologies they have developed.





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## Global Warming

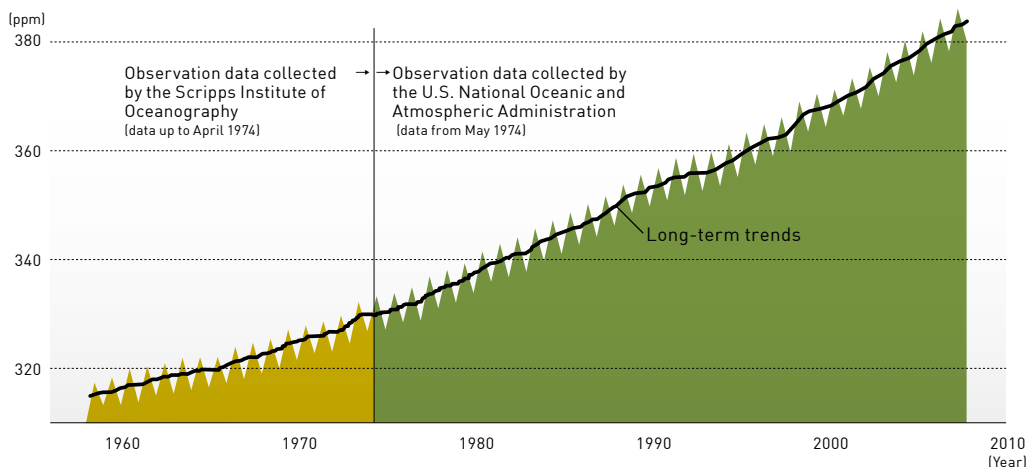
**The world began to recognize the threat of global warming. The causes and effects have been identified scientifically and now countries are implementing various measures to tackle this problem. In this section, we will give an insight into the present level of global warming using the latest data available to us.**

### The Basics of Global Warming

Thanks to a range of research efforts, scientists have made steady progress in clarifying the causes of global warming. In the following, as the first step in dealing with global warming, let's first briefly touch on what global warming is and how it is caused.

The Earth is exposed to radiant heat from the Sun, which warms the ground surface and oceans, but almost the same amount of heat is radiated from the Earth out into space. In the atmosphere, there are gases called "greenhouse gases" such as CO<sub>2</sub> and methane, which absorb a part of the heat radiated from the Earth and emit it back onto the ground surface. As a result, the ground surface temperature is kept at a stable level. However, as the level of atmospheric greenhouse gases increases, the amount of heat emitted back onto the ground surface also increases, and this causes a rise in the temperature of the atmosphere and oceans and raises the average temperatures on Earth. This is global warming.

## Trends in Atmospheric CO<sub>2</sub>



Source: Based on the website of the U.S. National Oceanic and Atmospheric Administration: ([http://www.esrl.noaa.gov/gmd/ccgg/trends/co2\\_data\\_mio.html](http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mio.html))

## Increase in CO<sub>2</sub> emissions from Human Activities

The fact that the atmospheric concentration of CO<sub>2</sub>, which is a greenhouse gas, has been increasing has been demonstrated through a variety of observations. In particular, the precise measurements of atmospheric CO<sub>2</sub> by Charles D. Keeling,<sup>1</sup> a meteorologist, and others are well known. These measurements were made at the U.S. National Oceanic and Atmospheric Administration's Earth System Research Laboratory located in Mauna Loa in Hawaii. The results were presented in a graph called the "Keeling Curve," which demonstrates that, behind the cyclic seasonal changes due to the growth level of plants, CO<sub>2</sub> levels in the atmosphere have been increasing year by year. Dr. Keeling made great efforts to continue his observations at the Laboratory and collect CO<sub>2</sub> data over many years, and his achievements have provided very important information for scientific discussions on global warming.

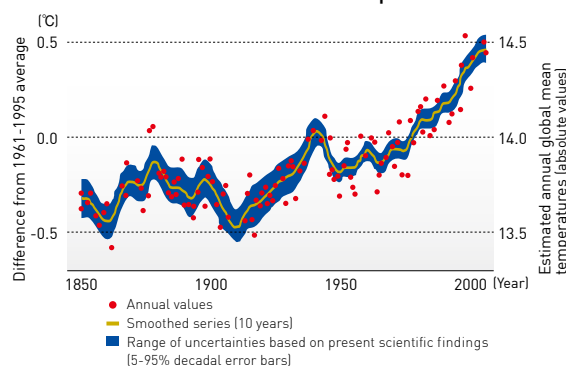
The *IPCC Fourth Assessment Report* announced in 2007 by the United Nations Intergovernmental Panel on Climate Change (IPCC)<sup>2</sup> has concluded that the increase in this greenhouse gas is "very likely" to be attributable to human activity, whereas the *IPCC Third Assessment Report* concluded that it was "likely."

Also, according to the *IPCC Fourth Assessment Report*, the mean global temperatures rose by about 0.7°C over the past century, and in particular, rose at double the pace over the past 50 years compared to the previous 100 years.

\*1. Charles D. Keeling received the 1993 Blue Planet Prize.

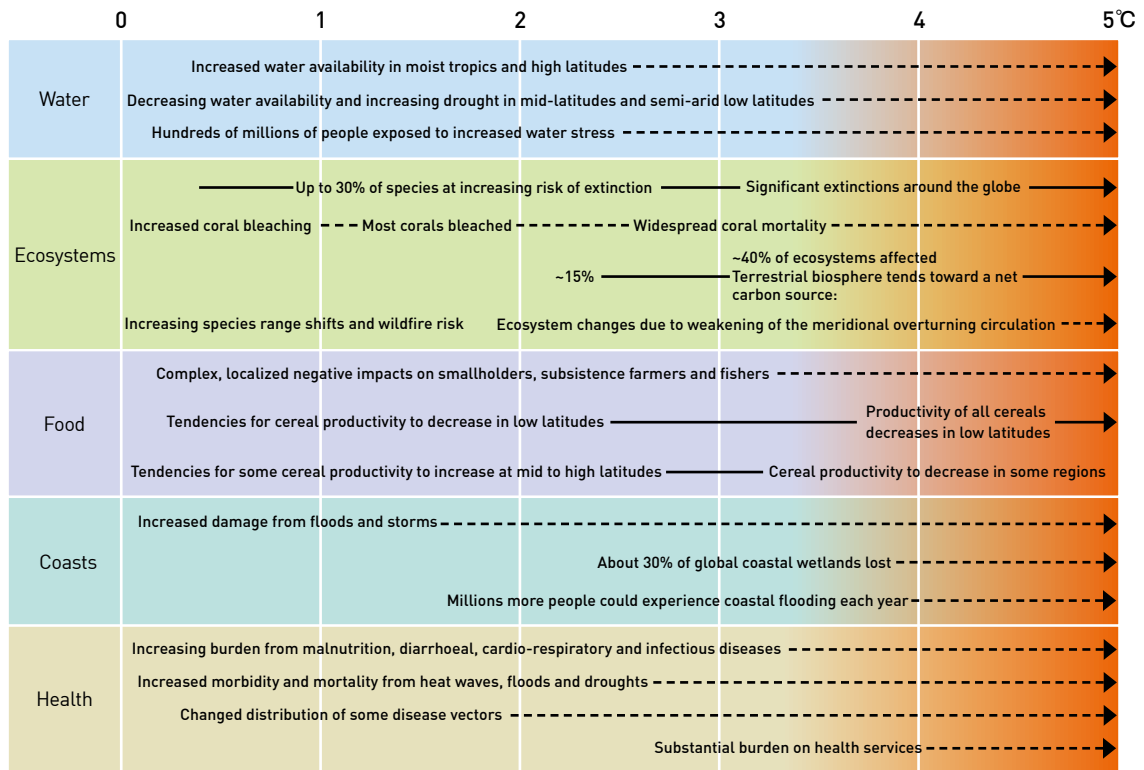
\*2. This panel was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). Researchers participate in the panel from all over the world to make scientific, technological, social, and economic assessments of the global warming caused by greenhouse gases, and the panel, as its primary role, is committed to making the results of their assessments, including knowledge and information, widely available to policymakers and the general public. It is said that about 450 writers and about 800 cooperators from a total of about 130 countries were engaged in preparing the *IPCC Fourth Assessment Report*.

## Trends In Annual Global Mean Temperatures



Source: Based on data available at the website of Japan Center for Climate Change Actions: <http://www.jccca.org/content/view/1730/900/> (Original data: *IPCC Fourth Assessment Report*)

### Examples of Impacts Associated with Changes in the Global Average Temperature



Source: *Climate Change 2007 Synthesis Report*, IPCC

### Predicted Impacts of Global Warming

As for the impacts of global warming, it is predicted that if temperature rises by 2°C or more from the baseline period of 1980 to 1999, one to two billion people on the globe will face a serious shortage of water, and in the ecosystems, up to 30 percent of species will face an increased risk of extinction, unless appropriate measures are taken to deal with the problems. Also, productivity of cereals will decrease at low latitudes and damages from floods and storms will increase in coastal areas. Furthermore, more people will suffer from infectious diseases. Global warming will thus give significant impacts across a range of fields. Moreover, the sea level has been rising due to global warming and it is predicted that the increase will eventually reach 59 cm. Already countries like Tuvalu and the Maldives are facing the danger of being submerged due to global warming.

### Rapid Deforestation: Threat to a Balanced Atmospheric Composition

There are also concerns about deforestation, which might increase emissions of CO<sub>2</sub>. Thanks to forests, oxygen and carbon are well circulated on the Earth: plants help maintain the level of CO<sub>2</sub> in the atmosphere through photosynthesis.

In recent years, there has been rapid deforestation due to conversion to farmland, increase in the area of farmland created by the slash-and-burn method of cultivation, inappropriate commercial logging and frequent outbreaks of forest fires. Emission of CO<sub>2</sub> due to deforestation totaled about six billion metric tons a year in the world, which is equivalent to more than 20 percent of the CO<sub>2</sub> emissions from the use of fossil fuels (26 billion metric tons annually).

This implies that to prevent global warming, it is important to plant trees and prevent deforestation in addition to taking measures to substantially reduce

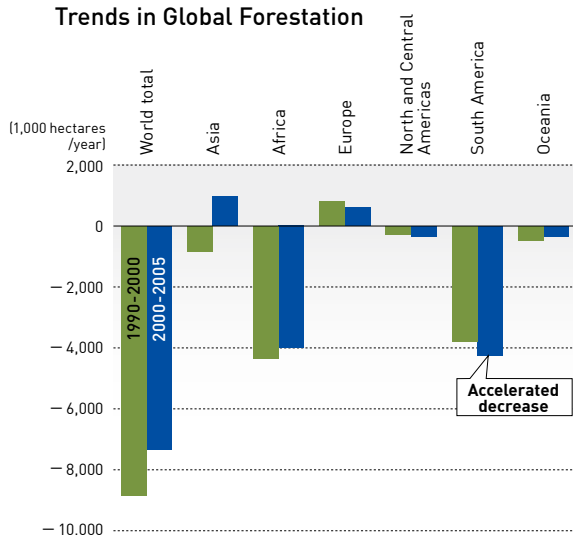
the consumption of fossil fuels. According to the *IPPC Fourth Assessment Report*, CO<sub>2</sub> emissions might possibly be reduced by 1.3 to 4.2 billion metric tons by planting trees and preventing deforestation. At present, however, we cannot say that sufficient measures are being taken for this. In some forests in regions such as South America and Africa, reckless exploitation and logging are still continuing, and the area covered by forests on the globe continues to decline.

Forests play a range of roles: they help prevent desertification of surrounding areas by their water-retaining function, they provide shade, mitigate climate change through transpiration, and provide home for a variety of living organisms. If deforestation continues to progress, some areas will suffer more serious desertification, the atmospheric heat distribution will change, which will in turn change regional and global climates, and the balance of a number of ecosystems will be disrupted. Forests are thus useful in maintaining a balance in the Earth's ecosystems and are indeed important resources that need protecting.



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Trends in Global Forestation



Source: Based on *Annual Report on Trends of Forest and Forestry* (Fiscal 2005), Forestry Agency, Ministry of Agriculture, Forestry and Fisheries of Japan  
 [Original data: *Global Forest Resources Assessment 2005*, FAO]

## Towards Reducing Greenhouse Gas Emissions

The world is reaching a consensus: in order to prevent global warming, it is necessary to substantially reduce global greenhouse gas emissions on a medium- to long-term basis. According to the *IPCC Fourth Assessment Report*, to stabilize the level of atmospheric greenhouse gases at 450 ppm, it is essential to curb greenhouse gas emissions downward in the next 10 to 15 years and halve the 2000 level by 2050. In particular, the Annex I Countries\* are required to curtail their greenhouse gas emissions by 25 to 40 percent of the 1990 level by 2020, and by 80 to 95 percent by 2050.

\* Annex I Countries refer to the Annex I Parties to the United Nations Framework Convention on Climate Change. These countries have numerical emission reduction targets and are listed in Annex B of the Kyoto Protocol. Specifically, they are Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, the Czech Republic, Denmark, Estonia, the European Union, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lichtenstein, Lithuania, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, the United Kingdom and the United States

Under these circumstances, the Council of the European Union basically agreed on a policy to achieve at least a 20 percent reduction (and a 30 percent reduction depending upon international agreements) of greenhouse gas emissions from the 1990 level by 2020.

Also, at the G8 Summit held in Heiligendamm in 2007, participating countries agreed to seriously consider making efforts in cutting global greenhouse gas emissions by half by 2050. At this Summit, Japan introduced the “Cool Earth 50” plan, which encourages the world to set a common target to halve global CO<sub>2</sub> emissions from the present level by 2050. The plan also proposes the following three principles for the formulation of a post-Kyoto Protocol framework:

- 1) All major emitters must participate, moving beyond Kyoto.
- 2) The framework must be flexible and diverse because each country has different circumstances.
- 3) The framework will have to enable compatibility between environmental protection and economic growth.

Despite these initiatives, negotiations have not been successfully concluded regarding the greenhouse gas emission targets after the end of the first commitment period (2008 to 2012) of the Kyoto Protocol, including negotiations made at the 14th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP14) held in Poznan, Poland in December 2008.

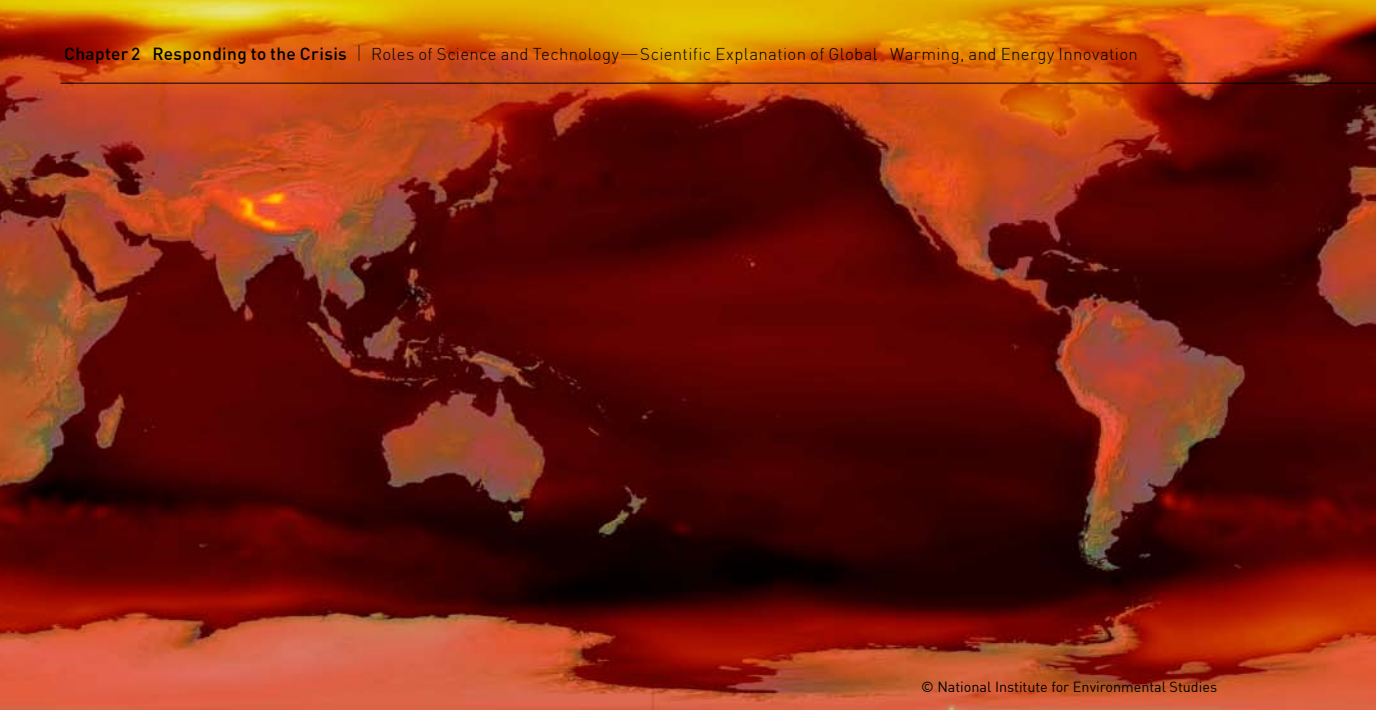


## Chapter 2

# Responding to the Crisis

**Under the United Nations Framework Convention on Climate Change effective since 1994, developed countries set their greenhouse gas emission targets in the Kyoto Protocol, which came into force in 2005. These countries have been implementing measures to attain their respective targets. At the G8 Summit held in Heiligendamm, participating leaders agreed to seriously examine a reduction in global greenhouse gas emissions by at least 50 percent by 2050, as mentioned already in this document. These initiatives represent the activities conducted by the international community to deal with changes made to the homeostasis of the Earth.**

**For the effective implementation of these activities, it is essential for all individuals and companies to participate. The Round Table Conference intensively discussed the requirements to be met by science and technology and social systems to help individuals and companies to take actions based on reasonable decision making. Here, “reasonable” means both “economically reasonable” and “reasonable in terms of the sustainability of the global society.” In this chapter, we set forth desirable directions for science and technology and social systems into the future.**



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## Roles of Science and Technology

### Scientifically Clarifying Global Warming, and Energy Innovation

Today, the reasons that we can lead convenient and comfortable lives lie largely in the development of science and technology. In return for living in comfort, however, we have begun to face the problem of global warming caused by greenhouse gas emissions, which is a negative legacy for humankind.

Fossil fuels such as coal and oil which are the cause of CO<sub>2</sub> increase in the atmosphere but are very useful resources, enabling us to produce energy in an efficient manner. Since the beginning of the Industrial Revolution, we have therefore been heavily dependant on fossil fuels in promoting technological development and building social infrastructure.

Against this backdrop, it was not until recently that we acquired the scientific understanding that our dependence on fossil fuels increased the greenhouse gas emission, which brought about the climate change. We were too proud of our achievements in living comfortably to recognize the gravity of global warming and it took us a long time before we became aware of the negative aspects.

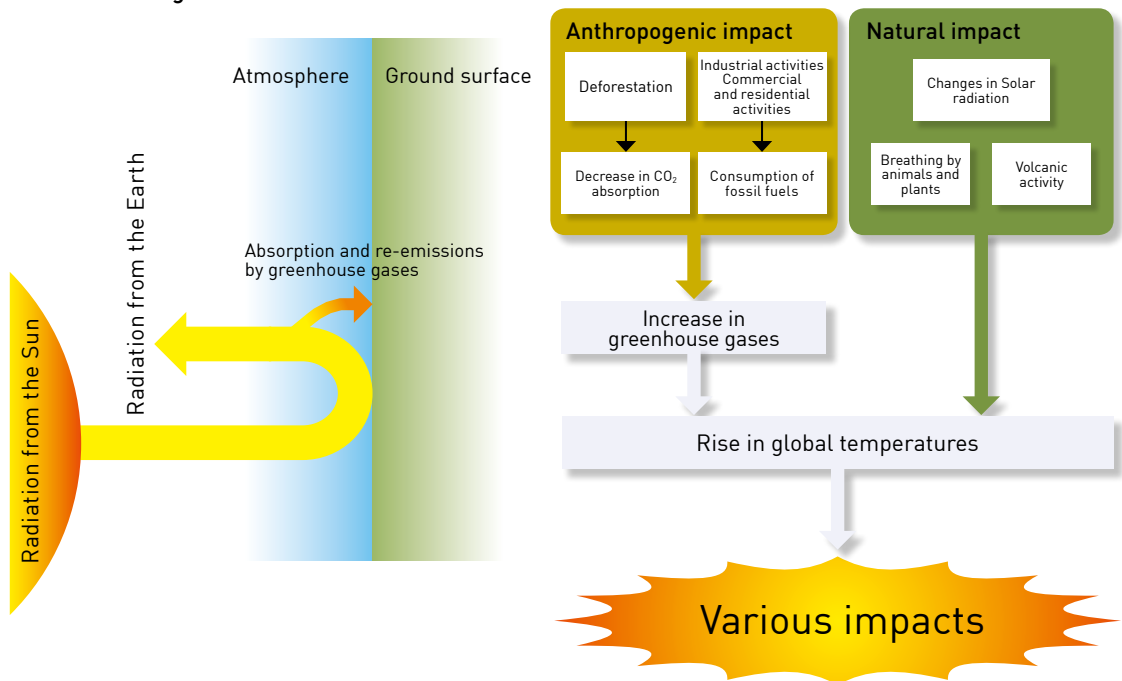
Science and technology have thus indirectly caused global warming, but paradoxically, it has to be

science and technology that can provide solutions to the problem. In order to deal with global warming appropriately, it is necessary to further clarify the mechanism and causes of the phenomenon in a scientific manner. It is virtually a proven fact that global warming has been recently aggravated due to increased greenhouse gas emissions, including CO<sub>2</sub> emissions from human activities. Global warming, however, is a complex phenomenon influenced by a variety of natural factors in the short and long term, and we need to carry out more research to further understand the phenomenon.

Moreover, we need to deepen our understanding of how global warming changes the global climate and what impact it will have on humankind. If science can provide more answers to these questions, more appropriate approaches would become clear to tackle the problem and we will have more versatile options to deal with them.

It is not enough just to follow the current trend in scientific and technological developments to solve the problems of climate change. Innovations that can drastically change our common knowledge in the fields of science and technology are required. In particular, we need to promote fundamental innovation in energy-related technologies in order to help protect the global environment and ensure the sustainable development of human society.

## Global Warming Mechanism



## The Role of Science and Technology 1

## Scientifically Clarifying Global Warming

**The problem of global warming cannot be solved without a scientific understanding of the entire mechanism behind the phenomenon. In light of the fact that global warming involves complex factors and is difficult to clarify, it is essential to collect extensive amounts of data and verify it intensively.**

### Identifying the Impacts of Global Warming

Global warming and climate change are caused by both natural and human factors. Natural factors include changes in the atmospheric circulation pattern, oceanic changes, blockage of sunshine due to an increase in atmospheric aerosol originating from volcanic eruptions and changes in solar activity. Human factors include an increase in CO<sub>2</sub> and other greenhouse gas emissions associated with human activity, an increase in airborne fine particles in the emissions from factories and automobiles, and deforestation. It is thought that these factors combined in a complex manner cause climate change.

According to the IPCC report, recent global warming is determined to be largely due to human factors such as greenhouse gas emissions. In addition, a possibility that climate change might be exacerbated as a result of more complex combinations of multiple factors is also considered.

Then, what activities are necessary to reach a comprehensive and detailed understanding of the global warming mechanism, including the impact of natural factors?

Specifically, we need to accumulate observation data on a continual basis and through the verification of simulation results made based on those data, we need to compile and tabulate the base data on the degree of impact on climate change according to the factors which may be the cause of climate change. In addition, it is necessary to estimate the effects on climate change in total by setting future scenarios on the outcomes of complex interactions between the factors and on the options that we may choose in response to global warming.

Also, in order to implement effective measures

against climate change, it is essential to understand the gravity and impact of the problem in a precise manner. It is important to analyze the impact of global warming on global climate change in total and the impact of climate change on the global community. The IPCC has announced its prediction results regarding the impact of global warming. Specifically, the Panel predicts a rise in sea levels, the occurrence of water shortages in some areas and floods in other areas as a result of the unbalanced distribution of precipitation, outbreaks of infectious diseases and changes in the yield of agricultural products and marine resources. In order to examine specific measures to be taken for each of these problems, we first need to make a more detailed prediction of their impacts.



## The Role of Science and Technology 2

# Science and Technology to Seek Benefit for the Earth\*

**To achieve a low-carbon society that does not depend on fossil fuels, we must pool our deepest wisdom and press forward with research and development that envisage the long-term benefits for the Earth. At the same time, we need to reflect on how to reform our lifestyles and take on the efforts with the collective “wisdom” of all humankind.**

\* Benefits to the Earth refer to the long-term benefits to the biosphere, rather than the short-term benefits to humankind.

## Research and Development with a Long-Range Viewpoint

We should not only look at the technologies that are regarded highly to have the potential for practical use but also those future technologies that are anticipated to be realized in the next hundred or so years, and thus conduct basic research. The technologies that are expected to be developed in the future include technology to use solar energy in cosmic space, nuclear fusion technology, and transmission technology that uses superconductivity.

Technological problems with these technologies are so difficult to resolve that research and development

in those fields will not progress easily, but they should be conducted with a long-range viewpoint for the sustainability of the global society.

In order to break away from dependence on fossil fuels, we must go through significant scientific and technological innovation. To achieve significant innovation, we need to create a science and technology that not only seeks the short-term benefits brought about to industry but also the long-range benefits for the Earth. Market competition might bring an efficient and effective technology in the short term. But science and technology that is useful for the sustainability of the Earth and humankind can be said to be created basically through political decisions to accelerate research and development and evaluations based on long-range viewpoints.

## Sharing All Our Wisdom, Including Expertise in Human and Social Sciences

To formulate and implement highly effective measures to fundamentally solve the global warming problem, it is not sufficient to use the knowledge only in the fields of natural science. It is also indispensable to utilize findings in the human and social sciences, which will in turn promote the effective use of science and technology. For example, in order to predict the impact of global warming on society, devise methods to utilize scientific and technological solutions as core measures against global warming, popularize relevant technologies in society and make social evaluations of the technologies, it is necessary to call for the cooperation of researchers engaged in the fields of the human and social sciences.

In the future, we need to encourage and vitalize creative activities to pioneer new intellectual fields by establishing science and technology seeking benefits for the Earth as the theme and accelerating information sharing and expansion of research networks beyond the framework of disciplinary fields. To this end, it is urgently needed to encourage suitable levels of capital investment, to build good



research environments and to develop the necessary human resources.

## Creating New Lifestyles, and Science and Technology

Even though significant developments in science and technology are expected in the future by promoting “consolidation of wisdom” beyond the boundaries of the natural, human and social sciences, it will take a long time to solve global environmental problems through science and technology.

Along with these efforts, we can immediately begin reviewing our present resource-consuming lifestyles and how our social structures, customs and cultures should be and a lot could be achieved through such reforms. Each and every one of us who is enjoying a comfortable and convenient life, has the responsibility to contribute to solving our global environmental problems.

However, when we engage ourselves in lifestyle reforms, if the idea is to lower our present living standards or to sacrifice convenience in order to conserve energy, many of us will feel discouraged and will be unable to maintain the motivation needed to continue reforms. It is rather better for us to create a new set of value and think about how our lifestyle should be with the idea that we are generating change towards enjoying life.

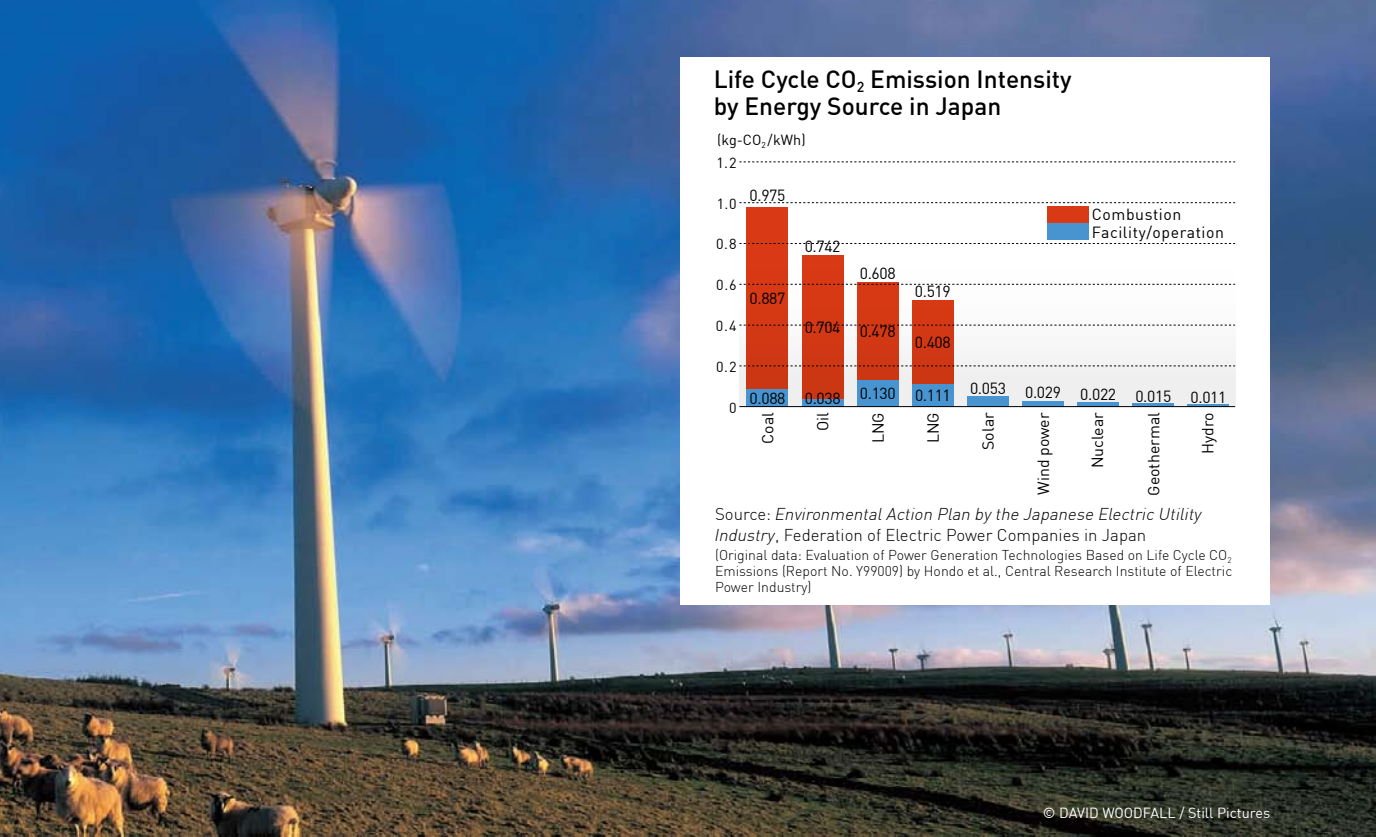
Then it is important to review our way of life by “consolidation of wisdom” not only for scientists and engineers, but including all of us with a drastically new idea that breaks the existing framework. Thence, we need a viewpoint to think about what science and technology that is being considered to support new lifestyles can do.



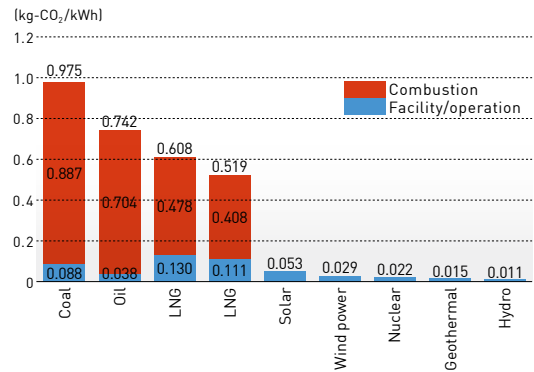
### The Role of Science and Technology 3

## Science and Technology Useful for Industrial Structural Reforms and the Energy Market

**In order to solve global warming and energy-related problems, it is necessary to reform our energy supply and demand structures. To realize a low-carbon society, we need to have technology development strategies and technology design concepts.**



### Life Cycle CO<sub>2</sub> Emission Intensity by Energy Source in Japan



Source: *Environmental Action Plan by the Japanese Electric Utility Industry*, Federation of Electric Power Companies in Japan  
(Original data: Evaluation of Power Generation Technologies Based on Life Cycle CO<sub>2</sub> Emissions [Report No. Y99009] by Hondo et al., Central Research Institute of Electric Power Industry)

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## Shifting to Renewable Energy Sources

At present, a range of renewable energy sources exist, including hydraulic power, wind power, solar power, geothermal heat and biomass.\* Some of these energy sources are already in the phase of practical use and others are still under research and development, but all of them have one merit in common: they do not generate CO<sub>2</sub> in the power generation phase and therefore do not contribute to an increase in atmospheric CO<sub>2</sub>.

Whereas the use of fossil fuels accompany exploitation in remote areas and long distance transportation, power from renewable energy sources can be generated at locations near areas of consumption, which encourages a regional distribution of energy. The use of renewable energy sources thus contributes to the utilization of local natural resources and encourages the local production and consumption of energy.

Renewable energy sources, however, do have disadvantages, including low energy density, present high equipment costs and vulnerability to natural conditions.

Power generation using solar power and wind

power, which are seen as promising renewable energy sources, has been actively introduced mainly in the developed countries. The output, however, varies depending upon the meteorological conditions, including the wind volume and weather. Because of this problem, it is difficult to use renewable energy sources alone to generate power for regular use. It is therefore necessary to combine multiple renewable energy sources and conventional energy sources to ensure a stable supply of electricity, taking into consideration the local characteristics.

In the future, it is anticipated that we will be able to make more effective use of natural energy thanks to further development of technologies, including technologies to store electricity in storage batteries and transfer electricity through the transmission network with lower transmission losses.

\* Biomass refers to resources derived from living organisms. Power generation using resources derived from plants also produce CO<sub>2</sub>, but it is carbon neutral because the same amount of CO<sub>2</sub> was absorbed by the plants as they grew. The use of such resources is therefore thought to contribute to a reduction in CO<sub>2</sub> emissions. The same applies to power generation using methane, which is derived from the waste excreted by plant-eating animals.



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## Use of Nuclear Power as an Energy Supply Source

When considering as far ahead as 2050, humankind will not be able to meet all their energy demands from renewable energy sources alone. It is therefore necessary to continue power generation using fossil fuels and nuclear power.

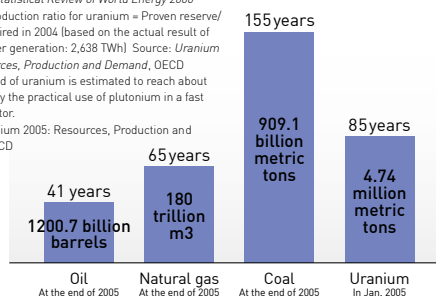
Nuclear power generation does not emit CO<sub>2</sub> and ensures the supply of large amounts of electricity in a stable manner. Moreover, if technology and development for fast breeder reactors further advance, it will enable more effective use of plutonium and in the future, it may have the potential to significantly relax the resource restrictions with the increase in resources recyclability. However, we have to meet many challenges before we can freely encourage the use of nuclear energy. For example, it is necessary to ensure the safety of nuclear power plants, solve problems concerning nuclear waste and ensure the peaceful use of nuclear energy based on the principle of nonproliferation of nuclear weapons. There must also be a deeper understanding of the use of nuclear power among the general public, and countries need to cooperate to ensure the safe and peaceful use of nuclear power, while researchers press forward with the development of next-generation nuclear power generation technologies. What is important is to foster comprehensive research and the development of human resources for the safe and peaceful use of nuclear power.

It is essential to build a firm foundation for the peaceful use of nuclear power by combining initiatives taken in the fields of both the natural and social sciences.

Here it should be noted that not all members of the Round Table Conference agree with the expanded use of nuclear energy. There are some who are against it, and others who think it necessary to examine carefully the safety and social acceptance aspects of nuclear power.

### World Reserves of Energy

- Reserves/production ratio (for oil, natural gas and coal) = Proven reserve/annual production  
Source: *BP Statistical Review of World Energy 2006*
- Reserves/production ratio for uranium = Proven reserve/ amount required in 2004 (based on the actual result of nuclear power generation: 2,638 TWh) Source: *Uranium 2005: Resources, Production and Demand, OECD*
- The life period of uranium is estimated to reach about 2,570 years by the practical use of plutonium in a fast breeder reactor.  
Source: *Uranium 2005: Resources, Production and Demand, OECD*



Source: Based on the website of the Institute of Applied Energy in Japan: <http://www.iae.or.jp/energyinfo/energydat/data1008.html>  
[Original data: *BP Statistical Review of World Energy 2006* and *Uranium 2005: Resources, Production and Demand, OECD*]

## Technologies that Support Structural Reform

Fossil fuels account for about 80 percent of the present supply of primary energy and will remain important energy sources in the short and medium term. With regard to power generation by the use of fossil fuels, options for the creation of a low-carbon society include improvements to power generation efficiency and the development of carbon capture and storage (CCS) technologies.

In promoting CCS technologies, however, there are concerns about the behavior of stored CO<sub>2</sub> and its impact on the environment, and so it is critical to make deeper studies on the environmental impact and safety of the technologies to improve their social acceptability.





The Sleipner project implemented by Norwegian oil and gas companies in the North Sea Oil Fields is the world's first commercial carbon capture and storage project, where CO<sub>2</sub> contained in natural gas is captured and injected into saline aquifers 1,000 meters under the sea at a rate of 2,800 metric tons a day, using large marine equipment.

## Improving the Efficiency of the Energy Utilization System

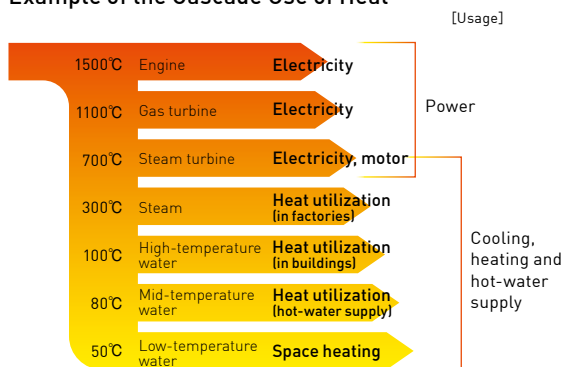
To conserve more energy, it is important to boost the efficiency of the entire energy utilization system, in addition to improving the efficiency of individual machineries. To this end, we need to build the systems for the cascade\* use of energy and resources, and foster energy conservation through highly functional manufacturing. We must also diversify energy supply methods according to the quality of energy required by different devices, including IT devices that need a stable supply of high quality electricity. Moreover, end users are requested to make efforts to conserve energy, which will help reduce the total energy consumption.

It is essential in using limited energy resources effectively to enable the cascade use of thermal energy, including both high-temperature and low-temperature energy. For example, natural gas cogeneration systems use high-temperature energy derived from the combustion of utility gas as the driving force for power generators, and utilize the waste heat from the process for steam and hot

water, thereby achieving the highly efficient use of heat. Also, heat pump technology has recently been attracting much attention as a highly efficient technology that uses atmospheric heat to produce energy that is several times larger than the input.

\* A cascade usually means a series of small waterfalls, but in the environmental field, it means to use the lower-quality resources and energy wasted in the use of high-quality resources and energy for other purposes.

### Example of the Cascade Use of Heat



Source: Based on the website of the Japanese Ministry of Land, Transport, Infrastructure and Tourism: <http://mlit.go.jp/common/000018919.pdf>

Amory B. Lovins\*, who is an energy scientist, insists on the importance of energy conservation by consumers at the “downstream end,” which will help improve resource efficiency and contribute to the optimization of the entire supply system and enable more economical operation. For example, in the supply of electricity, most of the electrical energy is lost before it reaches the end user, and if the end user consumes the electricity delivered to them in a more efficient manner, it will lead to substantial energy conservation across the entire supply system. By saving electricity and contributing to improving the system efficiency, consumers will also increase their awareness of the importance of resource conservation.

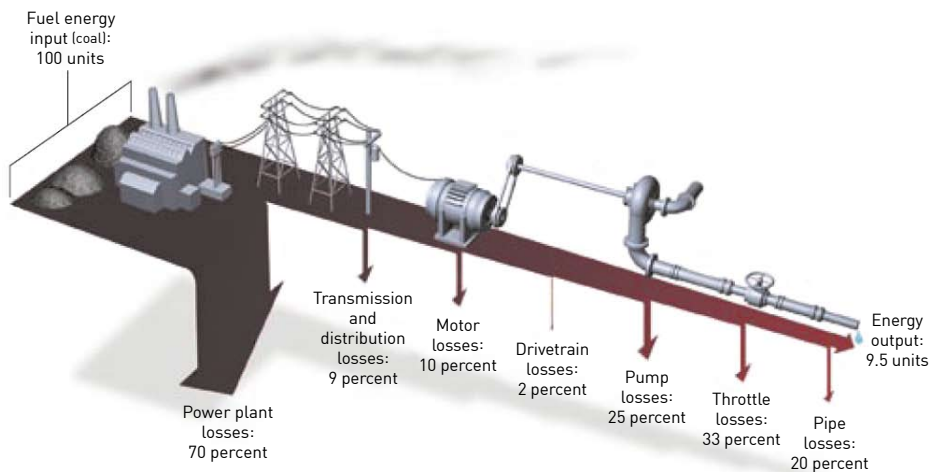
\* Amory B. Lovins received the 2007 Blue Planet Prize.

## Global Popularization of Energy Conservation Technologies

It is also important to popularize energy-efficient machines and systems effectively. In most developed countries, the energy consumption efficiency of machineries has been improved through technological innovation. In particular, Japan’s Top Runner System is highly evaluated as a very effective means of promoting technological development. It is desirable that similar systems be introduced on a global scale to encourage private sector companies to compete in the development of energy conservation technologies.

Across the world, there is still much room to improve energy efficiency. However, to achieve this, excellent technologies possessed by the developed countries must be transferred to the developing regions. The Japanese manufacturing industry

### Losses at Each Stage in the Supply System



#### Reference: Effect of Higher Efficiency at the Downstream End by Dr. Amory B. Lovins

From the power plant to an industrial pipe, inefficiencies along the way whittle the energy input of the fuel—set at 100 arbitrary units in this example—by more than 90 percent, leaving only 9.5 units of energy delivered as fluid flow through the pipe. But small increases in end-use efficiency can reverse these compounding losses. For instance, saving one unit of output energy by reducing friction inside the pipe will cut the needed fuel input by 10 units. The effect of saving at the downstream end is thus huge. Also, it becomes possible to make all the upstream components smaller and simpler.

Source: Based on a lecture given by Dr. Amory Lovins at the time he received the 2007 Blue Planet Prize

has particularly outstanding energy conservation technologies, and the use of these technologies in countries and regions with lower energy efficiency could lead to great results.

To this end, problems regarding intellectual property rights and cost sharing must be solved, and then the infrastructure should be established in the developing countries to which the technologies will be transferred for the development of necessary human resources, organizations and systems. If the developing countries do not have the technological and economic abilities to use the transferred technologies in a well-managed manner, the effect of the transfer will be significantly limited.

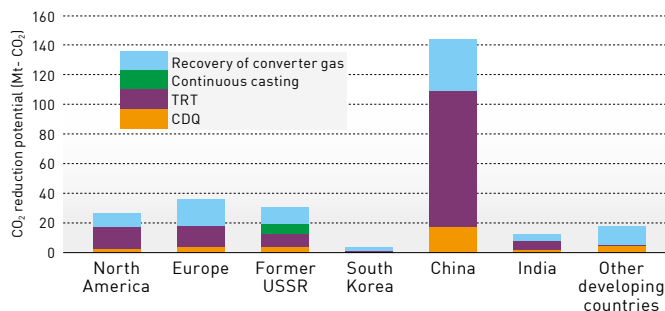
### Achieving Energy Conservation Effects through the Top Runner System

Product	Improvement rate (actual results)
Air conditioners	<b>67.8%</b> (From fiscal 1997 to fiscal 2004)
Electric refrigerators	<b>55.2%</b> (From fiscal 1998 to fiscal 2004)
Electric freezers	<b>29.6%</b> (From fiscal 1998 to fiscal 2004)
Gasoline-powered passenger cars	<b>22.8%</b> (From fiscal 1995 to fiscal 2005)
Diesel-powered trucks	<b>21.7%</b> (From fiscal 1995 to fiscal 2005)
Automatic vending machines	<b>37.3%</b> (From fiscal 2000 to fiscal 2005)
Fluorescent lamps	<b>35.6%</b> (From fiscal 1997 to fiscal 2005)
Copiers	<b>72.5%</b> (From fiscal 1997 to fiscal 2006)

Source: Based on reference materials (No. 3, dated May 2008) prepared for the fourth joint meeting of the groups on the reuse and recycling of home electric appliances between the Committee on Waste Management and Recycling of the Japanese Central Environment Council and the Waste Prevention and Recycling Subcommittee of the Japanese Industrial Structure Council's Environment Committee



### Reducing CO<sub>2</sub> Emissions by Using Current BAT Technologies in the Steel Industry



(Estimation method)

**Global CO<sub>2</sub> reductions potential in 2020**

= Σ [Energy conservation basic unit x production in 2020 x (targeted BAT diffusion rate - current BAT diffusion rate) x CO<sub>2</sub> emission per energy consumption]

Production in 2020 is estimated by assuming the GDP growth rate for the year and multiplying it by the production in 2004.

Source: Based on reference materials (No. 6, dated October 2005) distributed at the meeting of the Expert Committee to Study Future Framework of the Global Environment Subcommittee, the Environment Committee of the Japanese Industrial Structure Council  
 Note: BAT stands for best available technology.





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## Creating a Low-Carbon Society

### Mechanism to Foster Initiatives, and Innovation in Related Systems

A low-carbon society cannot be achieved simply through progress in science and technology. All parties involved, including individuals, companies and governments must change their ways of thinking and fundamentally change their ways of doing things in order to carry out activities in ways that take the environment into account.

Global environmental problems, represented by global warming, provide a serious challenge, but the threats posed are not clearly visible in our daily lives. It is therefore important to “visualize” how our individual lives are interrelated with global warming and other problems to encourage all the parties involved to take stronger actions to solve the problem.

Each and every citizen must make effective use of this “visualized” information to achieve results in

their lives. They should raise their environmental awareness and take action to build a sustainable society. Concerted efforts made steadily by everyone will greatly contribute to attaining this ambitious goal.

Governments, on the other hand, should build the necessary systems to encourage people to be more environmentally aware and reform their attitude to the environment. The role of governments must be to exert strong leadership to establish incentive systems (tax breaks and subsidies) and systems that promote the use of renewable sources of energy.

It is also important to have bilateral and multilateral cooperation between governments to solve global environmental problems. As for anti-global warming measures, rules have already been established to urge each country to take specific actions, as represented by the rules set out in the Kyoto Protocol. Also for energy problems, governments should make moves towards better international cooperation. Specifically, they need to build an international resource management system for the protection and effective use of limited resources and to establish an international framework for the joint development of new energy technologies.

## Creating a Low-Carbon Society 1

# Encouraging Individual Initiatives

## Educating Individuals Who Can Make the Judgment

In order to prevent global warming, it is indispensable that each and every one of us stack up our efforts to do that. For that, it is important that each individual obtain accurate information on global warming and acquire the ability to make their own independent judgment. We need to study how "environmental education" ought to be so that people could take appropriate actions upon acquiring information on changes in their societal situation and many related matters. It is essential to build an educational system in which all the actors in the global community, including individuals, companies, other organizations and governments can recognize

environmental problems and acquire the skills to contribute to solving those problems.

## Visualizing Invisible Threats

Today, many individuals are already aware of the threats to the global environment, but the causes and outcomes of these threats are not clearly visible in their daily lives. They cannot therefore find the motivation to change their lifestyles, and some even feel reluctant to make such changes.

For individuals to take appropriate action for the environment based on their own judgment, it is important to provide them with appropriate information and enable them to "visualize" invisible environmental problems, which will in turn raise their environmental awareness and their ability to make decisions. It is also important to provide them with appropriate social and economical incentives to support them in their activities to preserve the environment. At the same time, individuals must be able to recognize the impact and effect of their lifestyle on the environment.

## Creating a Low-Carbon Society 2

# Transforming the Nation's Systems

## Building a System to Boost Innovation

At present, it is still costly to use renewable energy sources for power generation, and in expanding the introduction of these energy sources, it is necessary for governments to implement the appropriate political measures. The details and effects of these measures depend upon who will bear the extra costs of using renewable sources of energy.

In Germany, power companies are mandated to purchase the electricity generated by costly power

generation using renewable energy sources at fixed costs, but they can pass the extra costs on to individual and corporate consumers by raising their electricity charges. Because of this system, introduction of solar power generation has been steadily progressing in the country, and now Germany is ranked number one in terms of its use of solar power generation. It is important to note that the general public has accepted this system, in which end consumers have to bear the extra costs. It is said that a national consensus has been reached because of strong political leadership, and people are now expecting that expanding the use of renewable energy sources will make it more economical, and that this will then further accelerate its use. In other words, the German initiative has demonstrated to people the possibility that the expanded use of and advancement of technologies for renewable energy sources will eventually lower



the cost of using these resources. Although situations differ by country, this initiative taken by the German government provides a good example for all countries in promoting the introduction of renewable energy sources.

It is also important for energy consumers to be given the option to use low-carbon energy in preventing global warming. To this end, energy suppliers must make efforts to increase their use of renewable energy sources wherever the local natural and socioeconomic environment makes this possible, and diversify the energy market by facilitating power generation using hydraulic power, wind power, solar power and biomass so that consumers can choose to use low-carbon energy sources.

### **Regional Initiatives to Create Communities in Harmony with Nature**

Our use of science and technology has substantially changed the natural environment. Science and technology have made our lives more convenient and enabled us to expand the scope of our activities. However, this has been at great cost and already the impact it has had on the environment exceeds the Earth's regenerative capacity. It is time we realized that there are limits to what the Earth and we ourselves can cope with and reduce the impact of our activities on the Earth to a level within the regenerative capacity of its environment. For that purpose, we must face nature as a living thing, and we need to understand that implementing measures that are inherent and suited to regional features are vital. We cannot live without the blessings of nature. Each region has its unique natural characteristics and has built up its culture in its own natural environment. We have to reach an understanding of nature around us and live in harmony with it, avoiding inflicting damage on its sound natural mechanisms. To achieve this, it is necessary to take regional initiatives to create communities that are in harmony with nature, rather than creating a system to manage the environment in a centralized manner.



### **Creating a Low-Carbon Society 3**

## **Establishing an International Collaboration System**

### **International Peace Building through Cooperation in the Energy Field**

Looking back on the past, humankind has repeated its history of war and peace, and an important viewpoint in considering building a sustainable society is how we keep peace. In this context, the international community needs to establish





a collaborative system, particularly international peaceful collaborative relationships in the environmental and energy fields.

For example, France is far ahead of other countries in terms of nuclear power generation, and the country is supplying electricity produced by nuclear power plants to neighboring countries. Those countries have thus built relationships of mutual reliance through the supply of energy, and these relationships may contribute to mitigating friction in the military field, providing means to maintaining peace. In Europe, countries have a highly functional regional community, namely the European Union. Similarly in the Asian region, in order to support a peace keeping effort, shouldn't Japan establish cooperative relationships with the countries in Southeast Asia and Northeast Asia in the energy and environment fields?

Such cooperative relationships in the Asian region will help to popularize highly efficient technologies in the region, which will in turn help to create a low-carbon society, prevent regional conflicts and build peace in the whole of Asia.

### **Dialogue to Create a Connection for the Global Society**

The 20th century was the century of market competition. It is true that market competition provided the driving force for socioeconomic development, but it also led to increased competition in individual interests and desires, and the problem of global warming is one of the consequences.

In the 21st century, we need to attribute more importance to cooperation than to competition, and to

this end it is important to create social organizations based on mutual trust, not just on mutual interests. For families and local communities, we can usually build relationships of trust relatively easily through family links and territorial bonding. Local valuable resources, including water resources, forests that offer abundant gifts from nature and beautiful scenery, can be protected and utilized appropriately through mutual cooperation and trust within local communities.

For problems such as global warming that need to be tackled on a global scale, it is difficult to find solutions simply by building local relationships of trust among families and communities as they have different interests among countries and the level of industries. Thus, in order to set conservation of the global environment as a mutual target for humankind, we need to establish a connection between societies to enable the world as a whole to cope with the problem. What is important then is to have dialogue. Dialogue is not intended to defeat others. It is the process of recognizing the relationship in between. It

becomes the communication capability necessary not only among countries but for all societal units.

To solve the problems of global warming, appropriate measures should be studied in the fields of science and technology and policies should be decided with the participation of all, through repeated trial and error. To this end, while establishing the connection for the global society, it is necessary for participating individual and organizations to be confident and make appropriate decisions. And in many situations, dialogue is needed first.



## Final Chapter

# Our Vibrant Blue Planet

**In the preceding chapters, we have discussed the science and technology and social systems that are needed to deal with global warming. In addition to tackling the present crisis, however, we also need the will to open the door to a new age. What kind of society should we aim at for this new age? The Round Table Conference discussed the images of the new society.**





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## A Creeping Crisis

The Industrial Revolution started in Europe in the 18th to 19th centuries and economic development which centered around industries spread across the world. Since the Industrial Revolution, humankind has acquired a life rich in material possessions through the development of science and technology and market globalization. On the other hand, however, emissions of green house gases such as CO<sub>2</sub> have increased rapidly due to the rapid rise in the consumption of fossil fuels.

Nonetheless, humankind has given priority to economic development and remained indifferent to the impact of human activities on nature, which is the principal foundation for our survival. At the end of the 20th century, while some scientists began to ring the bell to say that nature, the foundation of our survival, is being impaired, human society continued to put economic development first, resulting in the crisis of global warming creeping in front of us.

## We are Social and Biological Beings

Human beings are both social and biological beings. A biological being relies for its life totally on nature and it lives its life as a very small part of nature. It only exists as a passive being against the environment. It is our activities from the aspect of being human which form a societal entity that is causing the environmental problems. Humankind has believed that a part of nature could be replaced by artificial things on the premise that we can understand and control nature as an object with our reason. The modernization and industrialization since the 18th century has been driven by human beings exploiting, consuming and wasting natural resources in the pursuit of science and technology.

However, we are part of Nature and cannot live unless we act in harmony with it. In the face of the crisis for the natural environment caused by global warming, we cannot inflict any more damage on nature, which is the foundation to our existence as a biological being. We must recognize the fact that nature provides the foundation for the lives of all living things, and that the human as a biological being will not be able to cross over the boundary out of

nature. Past economic development has lacked such a viewpoint, and that could be said to have caused global warming.

## A Society where Human and Nature Coexist as Entities Full of Life

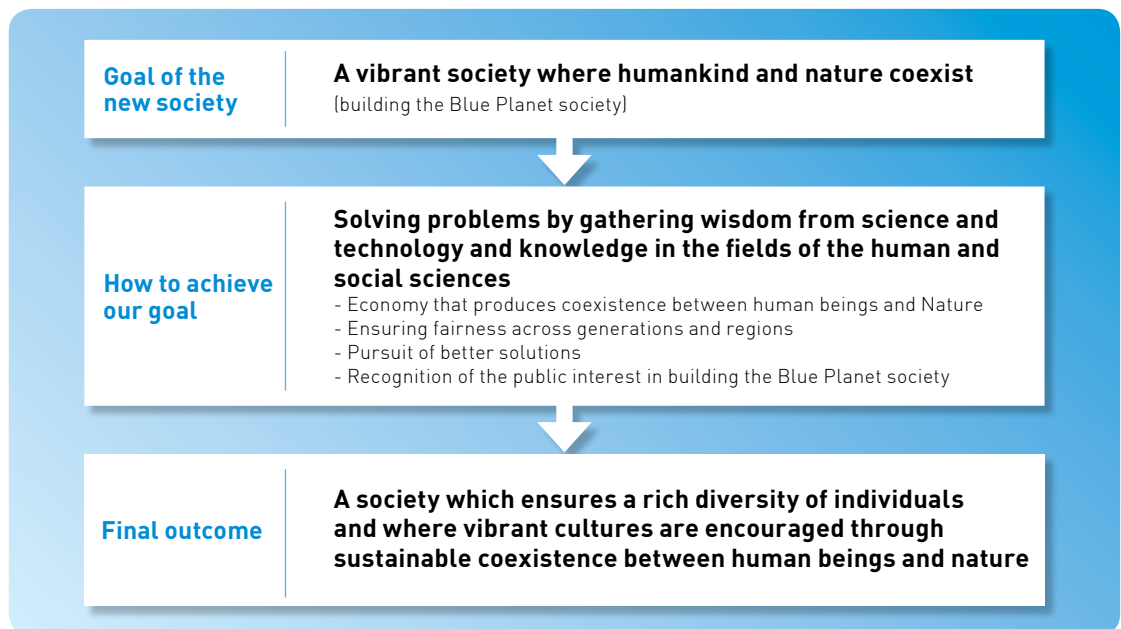
We have pushed forward our economic activities without becoming conscious that the natural environment and resources are limited or that there is a limit to the Earth's regenerative capacity as we lacked the viewpoint that we human beings are also a biological being and that nature is the foundation to all living things. At the same time, in spite of the fact that economy should be a means per se, as the development and use of science and technology advance targeting economical growth itself, people only see the aspects of material riches and convenience, and haven't they ignored considering the existence of humankind itself and the wealth of the spirit?

Therefore, from now on, we should aim at

development which will not damage the reproductive capabilities of nature and resources by targeting sustainable coexistence with nature on a global scale through further clarification of the diverse and complex self-recovery capabilities of the Earth. What is important is to build a society where humans and nature coexist as entities full of life. We have termed such a global society a "Blue Planet." Humankind is an entity existing within nature of the cosmos, the Earth and the region, depending for its life on nature. Thus the recovery of the Nature will lead to the recovery of the vitality of human beings and society. In other words, we need to create a society that respects nature's blessings, and sees the natural environment as the foundation of all life.

The new society created through the realization of a low-carbon society will be a society existing under the coexistence between human beings and nature, where rich diversity and vibrant cultures are ensured for individuals and society.

### Creating a New Society



# Approaches Toward Realizing a “Blue Planet”

**In order to realize a “Blue Planet,” we need to share the societal goal of creating a society where humans and nature coexist as entities full of life and rebuild science and technology and our social systems.**

## **Solving Problems by Gathering Wisdom from Both Science and Technology and Knowledge in the Fields of the Human and Social Sciences**

We have been using science and technology to create more affluent and comfortable lives at the cost of damaging the global environment, which is the foundation for the existence of humankind. From now on, it is vital that we evaluate science and technology taking into consideration environment-related aspects and to try to develop and disseminate new science and technology to conserve the global environment which is the foundation for the existence of humankind. In cases where technology development requires vast amounts of capital and human investments, such as in the development of new energy technologies, special institutional measures based on a long-range viewpoint should be implemented.

In order to reexamine the relationship between human society and nature, not only do we need to consolidate cross-disciplinary wisdom in science

and technology but also to mobilize our wisdom in the fields of human and social sciences. The wisdom in the fields of human and social sciences mentioned here refers to things relating to ethical values and social systems for human beings and nature to coexist. And by systematizing such wisdom, it is necessary to try to solve the problems on a societal scale utilizing wisdom from both science and technology and knowledge in the fields of human and social sciences.

## **Economies that Encourage Coexistence between Human Beings and Nature**

Economies provide the means to acquire affluence for humankind, but pursuing profit leads to unlimited expansion of greed and competition and results in inequality and conflicts between peoples. There were quite a few companies which discharged pollutants and caused pollution by putting the emphasis on short-term economical profits. Global warming can be said to be resulting from the use of fossil fuels beyond the threshold.

We have not counted the environmental cost which is regarded as an “external diseconomy,” in the cost of business activities which includes such costs as labor costs and material costs, and as a result, we have damaged the natural environment and caused global warming. Since the latter half of the 20th century, a number of initiatives to prevent environmental destruction began to be implemented on a local scale. To solve the environmental problems on a global scale, we are required to further establish various social rules and mechanisms. In order to raise affluence and vitality of society, a market economy is thought to function best, but on the other hand, it is necessary to have laws and regimes that lead to building the framework for an economy that can coexist with nature on the premise that the economy is a market economy.





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## Ensuring Fairness across Generations and Regions

According to the report of the Brundtland Commission in 1987, "sustainable development" means "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," and this concept is based on the value of fairness across generations. As humankind fulfills a variety of its needs through nature as the basis of its survival, if nature is damaged by being exploited by the present generation, the basis to fulfill the needs of future generations will be endangered. We therefore must recognize the importance of nature as the basis of survival for future generations and take the responsibility to inherit the rich natural environment which brings spiritual and material blessings.

Also when considering fairness, it is important that we narrow the economic gap between the developed and developing countries. Global warming exerts its most serious effects on developing countries, particularly on poor people living there, and we need to implement countermeasures that take into consideration the huge gaps existing between the developed and developing countries, including gaps in their technological development capabilities and cost sharing abilities. Accordingly, the bodies of the United Nations and the governments of developed countries need to give technological and financial support to developing countries in promoting measures to cope with global warming. The governments of developing countries, however, need to tackle poverty in their countries before they can address global warming. In spite of this disadvantage, they also have an advantage: they can learn a lot from the

experiences of the developed countries regarding economic development and treatment of environmental problems. They can use the lessons learned from the developed countries, including technologies, know-how and expertise, in dealing with their poverty and environmental problems. Cooperation must therefore be promoted between the developed and developing countries in a way that enables the developing countries to make the maximum use of the support given to them by the developed countries. When the developed countries transfer technologies in collaboration with projects in developing countries, they must try to ensure that these initiatives will work together to help the developing countries both solve global warming problems and eliminate poverty.

### **Pursuing Better Solutions**

It has taken several decades for the developed countries to overcome pollution by trial and error, including the years spent in identifying the causes, developing technologies to prevent pollution and establishing the mechanisms to implement anti-pollution measures. Humankind at present is facing a new environmental problem on a global scale, namely global warming. Global warming is far more serious than pollution in terms of magnitude and complexity, and so the problem is thought to take a long time to solve. However, if we are to cope with global environmental problems through the most suitable solution available by completely identifying the cause and establishing a perfect solution, there is a danger that we could be too late and fall into an irrecoverable situation. The crisis requires urgent action.

Therefore to solve global environmental problems, while we make the maximum use of currently available findings and technologies such as assessing risks based on objective data to prevent irreversible damage to the Earth, we need to search for better long-term solutions. As scientific findings, technologies and human ideas change with time, we are required to continually implement long-term solu-

tions, and not become trapped in short-term interests and possibilities.

### **Acknowledging the Public Interest for a Blue Planet**

Solutions to global environmental problems require the efforts of all members of the global society. To this end, the entire global society needs to share the common social target of “sustainable coexistence of human beings and nature.” Namely, concepts such as “a society that relies on the natural environment for its life and honors the blessings” and “a society where human and nature are regenerated as entities full of life” themselves should be the new concepts of what the public means for a global society as a whole.

In order to build such a concept for the general public, it becomes important to raise the awareness of each individual. For individuals to fully comprehend the public interest of a “Blue Planet,” what they need is to ask themselves what enables them to live. If people question the possibility of the survival of humankind on an individual, regional or national level and in schools, companies and organizations, they will come to recognize the fact that humankind cannot live without the blessings of nature. At the same time, people will also learn that in a complex society, they live by interrelating with many others. In doing so, each individual understands that they are entities that have their individual roles to play and becomes aware of the importance of having “consideration for others.” When we say “consideration for others,” it means to respect the independence of others who take different positions. In a society comprising individuals of different genders, ages and abilities, it is only through mutual respect that peace and equality will be maintained.

“Consideration for others” should not only be given to other individuals, but also from one country to another, from present to future generations, and from human beings to nature. And by having consideration for others, initiatives to give mutual assistance arise. In a society where individuals only compete with

each other in the pursuit of their own interests, there can be no such initiatives. The mind and spirit of consideration and mutual assistance arise from relationships of mutual respect. Through mutual respect shall such a society full of diversity and vitality be realized.

### **Establishing a Vibrant “Blue Planet”**

As mentioned before, the Round Table Conference proposes as the image for a new society an image in which “human beings and nature try to coexist as entities full of life” through a low-carbon society, and sends out the message that everyone has to serve their role “to realize a Blue Planet.” Also, through coping with the problems of global warming, in order to cre-

ate a global society where we can deal flexibly with changes made to the Earth’s system which includes both human beings and nature, the Conference would like to make suggestions on how science and technology and social systems should be. Let’s not force each individual into uniform action for a purpose, but by realizing the public value of a “Blue Planet,” let’s aim at creating a vibrant society where the diverse originality and ingenuity of each individual is brought out. The Conference sincerely hopes that a global society which is based on dialogue and peace instead of conflict and war will be realized through reconstructing a foundation on which human beings and nature sustainably coexist with people acting while considering others, other countries, future generations and nature instead of being self-centered.





# Passing Our Blue Planet On to Future Generations

**In the face of impending global warming, what role should the Asahi Glass Foundation play in finding solutions to the problem? Mr. Seya, Chairman of the Foundation talks with Professor Morishima, who is also a Director of the Foundation and chairs the Conference, regarding the mission and vision of the project implemented by the Foundation's Special Round Table Conference on Global Environment Problems.**



## Akio Morishima

Born in 1934, Professor Morishima graduated from the University of Tokyo's Faculty of Law in 1958 and was awarded a Master of Laws (LLM) at Harvard Law School in 1968. He served as a professor and dean of law at Nagoya University and as a professor of law at Sophia University. He is now Professor Emeritus at Nagoya University. After serving as the Chairman of the Board of Directors of the Institute for Global Environmental Strategies from 1998 to 2007 and as the chairman of the Central Environmental Council of the Japanese Government from 2000 to 2005, he has been serving as the chair of the Japan Climate Policy Center since 2005.

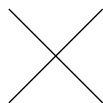
## The Asahi Glass Foundation and Environmental Problems

**Morishima:** Asahi Glass, a company in the private sector, established the Asahi Glass Foundation. And in 1992, the Foundation established the Blue Planet Prize, an international environmental award, to commend those who contributed to solving environmental problems. Moreover, the Foundation established the Special Round Table Conference on Global Environment Problems, a special project towards solving environmental problems. It comprises the directors and councilors of the Foundation. I think that a common thinking lies behind all the initiatives. First, I would like to ask you about this underlying philosophy, in your capacity as former president of Asahi Glass and present Chairman of the Foundation?

**Seya:** Yataro Iwasaki, the founder of the Mitsubishi Group, had a younger brother. And his son Toshiya founded Asahi Glass. Toshiya Iwasaki made strenuous efforts to get the glass manufacturing business off the ground. He even invested his private assets in overcoming various technological difficulties. Asahi Glass celebrated its 25th anniversary in 1933. And to commemorate the anniversary, it established the Asahi Foundation for Chemical Industry Promotion, the present Asahi Glass Foundation. The underlying thinking was that technology provides

# Akio Morishima

Trustee of the Asahi Glass Foundation and  
Chairman of the Special Round Table Conference  
on Global Environmental Problems



# Hikomichi Seya

Chairman of the Asahi Glass Foundation

the basis for the manufacturing sector. He wanted to support Japan's technological progress by granting subsidies for academic research activities. Following such steady activities for about 60 years, the then president of Asahi Glass put forward the idea that "companies that cannot overcome environmental problems will not survive in the future." Then the next president renamed the Foundation as the Asahi Glass Foundation. In 1992, when the Earth Summit was held in Rio de Janeiro, the Foundation launched the Blue Planet Prize award. The program is to commend those people who have contributed to solving environmental problems. In the same year, the Foundation began conducting its Survey on Global Environmental Issues. It was to investigate the sense of crisis felt by environmental experts around the world regarding the present global environment situation. I think that the current special project is also in line with the Foundation's initiatives.

Professor Morishima, we are thankful for your support for the activities of the Foundation since the launch of the Blue Planet Prize. What caused you to engage yourself in environmental problems in the first place?

**Morishima:** It started with a litigation over air pollution. At the end of the 1960s, people in a fishing village near a petrochemical industrial site in Yokkaichi, a city in Mie Prefecture in central Japan,



**Press conference held to announce the establishment of the Blue Planet Prize [June 1992]**

At the United Nations Conference on Environment and Development (Earth Summit) held in Rio de Janeiro, Brazil



## Hikomichi Seya

Born in 1930, Mr. Seya joined Asahi Glass Co., Ltd. in 1954, after graduating from the University of Tokyo's Faculty of Engineering. He became President of the company in 1992 after serving as Director in Charge of Chemical Products, Senior Executive Officer and Senior Executive Vice President. He became Chairman of the company in 1998 and Chairman of the Board in 2002. He has been Senior Corporate Advisor of the company since 2004 and Chairman of the Asahi Glass Foundation since 2000.



*No one in the country seemed willing to take action to address these problems when we should seriously be thinking about what would happen to the Earth if we continue our present lifestyles.*

were suffering from unexplained asthma. When I was involved in the Yokkaichi air pollution lawsuit, one of the first pollution lawsuits filed in Japan, in my capacity as a legal expert, I felt it unreasonable that the plaintiffs had little chance of winning their case due to undeveloped legal doctrine for compensation. The defendants argued that the medical causal relationship could not be proved and that since the number of polluting factories is multiple no factory could be identified as an actual polluter to the plaintiff. At that time I was 33 years old and had just returned to Japan to Nagoya University from studying in the United States. I decided to join the plaintiff lawyers' team as an advisor to apply my legal knowledge. I wanted to use the skill I had just studied in the United States to solve the legal issues in the emerging pollution problems at that time. I continued to get myself involved in a variety of pollution lawsuits and witnessed the expansion of both urban and natural environmental problems from local to global levels. In the course of my career, I became involved in lawmaking and formulating environmental policies. I served as chairperson of the Japanese government's Central Environmental Council.

With such a backdrop, I was appointed a member of the selection committee of the Foundation when it expanded the scope of its research grant program to include the field of social sciences. I was also chosen as a member of the selection committee for the Blue Planet Prize, and have been supporting the Foundation as an expert on law as a social science.

## **Mission of the Round Table Conference**

**Morishima:** The directors and councilors of the Foundation are experts representing a range of fields. Mr. Seya, you took strong leadership in founding the Round Table Conference. What made you do it?

**Seya:** In 1972, the Club of Rome gave us a very strong warning in a book titled *The Limits to Growth*. People had some thoughts about it. Although there have been local wars and serious environmental problems in the world since, currently Japan is peaceful. I felt it is time people seriously thought about the Earth. About whether we can continue our present lifestyles. But no one in the country seemed willing to take action to address these problems. Under these circumstances, I thought I should do something, and took the initiative to found the Conference. The directors and councilors of the Foundation are experts full of experience. I wanted to have them discuss those urgent problems, mainly environmental problems, and send a message to the public.

**Morishima:** *The Limits to Growth* warned the public that if the human race continued its growth in the same way, the resources required to support this growth would be depleted. The situation is more threatening today. I have been engaged in environmental problems from a legal viewpoint. It is my job to listen to the opinions of others in a neutral and objective manner. The directors and councilors of the Foundation have different backgrounds and expertise. It is quite interesting to listen to their free conversation at the meetings of the Foundation.

When I was asked to chair the Conference, I decided to accept the request, thinking that it would be great to bring together the wisdom of the Chairman and other members of the Foundation and communicate their ideas to the public in some form.

**Seya:** What is your impression of the discussions that actually took place at the Conference, as chairperson?

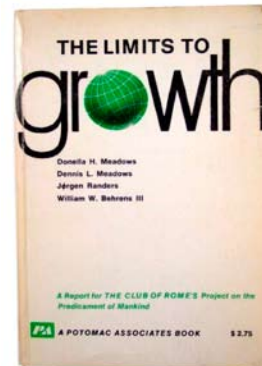
**Morishima:** The members of the Conference have different opinions, but all of them share the same idea. The idea is that they have the so-called Asian way of thinking and not the European way that tends to value self-centered competition in achieving individual goals. The idea is to cooperate with each other as humans and provide mutual assistance. It means that they have an idea that is lacking in current society, that unless we do it that way, society and the environment will not become sustainable. I believe it to be quite meaningful for the Asahi Glass Foundation to communicate the importance of these values to the world from the aspect of environmental problems.

**Seya:** The directors and councilors have a lot to say, and I want their opinions to be heard by people across the world, and let them say “Yes!” to their opinions and then think about what they should do to tackle the identified problems.

**Morishima:** There are still a few researchers who argue that global warming is not caused by human activities. Even if these researchers are right and even if irreversible damage may not be caused to the Earth with 100% possibility, we should prepare for this damage, based on the so-called precautionary principle so long as a high possibility of such risk cannot be denied. The environmental problems including global warming that we are facing today cannot be left unsolved.

**Seya:** I completely agree with you. However, I am afraid that there is some disagreement, even among the members of the Conference. In publishing the opinions of the Conference in the form of a final report in the future, how will you deal with these differences?

**Morishima:** Among the directors and councilors of



**First edition of *The Limits to Growth*** (by the Club of Rome, 1972) This book warned readers that the world population and economic growth would reach their limits in the 21st century due to the depletion of resources and environmental pollution. It shocked the world and raised people’s awareness of global environmental problems.

the Asahi Glass Foundation, no one insists that global warming is not caused by human activities, but they do have different opinions on the size of the impacts that human activities have had on the Earth and about what the important measures to be implemented are. Also, they evaluate the results of national measures and achievements made through science and technology differently. I do not think it necessary to force them to reach a consensus on every topic. Rather, it is necessary to show what measures could be taken against the threat of irreversible damage to the Earth, while clarifying to what extent members agree or disagree on each of these matters.

## Creating a Sustainable Society

**Seya:** Dr. Emil Salim, who received the 2006 Blue Planet Prize, proposed the idea of “Plain living, high thinking.” I also think that one of the possible ways to solve environmental problems is to lead a simple life without wasting resources. This idea, however, might not be compatible with the development of the world economy. How do you think we can find a compromise between the two themes—solutions to environmental problems and economic development? It might be necessary for everyone in the world to try

*We must create a society where people cooperate with and help each other, not a society where they compete with and criticize each other...*



to answer this question.

**Morishima:** To respond to his idea, we need to understand what has caused today's situation in our life. With the market economy system, we have benefited from science and technology to lead high-quality lives, while almost depleting natural resources and increasing greenhouse gases. Now we have to reconsider how we should use energy and what kind of economy and society we should reconstruct. An unbalanced distribution of wealth might cause a further waste of resources and an increase in CO<sub>2</sub> emissions, while the whole of society remains poor. In such a society, security would be endangered.

**Seya:** In what new direction does the Conference think society should move?

**Morishima:** If wealth is redistributed and resources are recycled in a well-organized market economy, high living standards in the whole society can be maintained in a sustainable manner to some extent. We need to create a society where wealth is redistributed giving special consideration to the weak. This is a new vision of society that is completely different from the society we live in today; one in which people value "consideration for others" and "mutual assistance," as explained in the last chapter of this booklet.

**Seya:** Hearing the word "consideration for others," some people might get the impression that we need to return to the thinking of olden days. For example, people may think of the "mutual assistance" mentality they had in old Japanese village communities, where local inhabitants helped each other. However, I think you mean something more by saying "consideration

for others."

**Morishima:** Exactly. It will include such mentality, but on top of that, it means not only to assist, but also to fulfill mutual responsibilities while having respect for others as equal human beings. Specifically, in a future society, wealth should be redistributed in a more organized way, and profit-making should not be regarded as the absolute priority. Developing countries must assume responsibility for their environmental problems and developed countries should redistribute their wealth to the developing countries. We must create a society where people can cooperate with and help each other, not a society where people compete with and criticize each other. This is the basic idea expressed in this booklet, the intermediate report of the Round Table Conference.

**Seya:** In this regard, I believe education must play an important role. In today's Japanese family, I am afraid that children are not educated in the right way. They are not even taught common sense values such as "You must not do wrong," or "You must help other people who are in need." Children experience this "consideration for others" first at home. Parents' consideration for their children provides children with their first lessons on how to build relationships with others in school and in society. Children learn the importance of cooperating with others through their parents. Although things might not be as they want, children should learn to respect others and to be respected by others. We need to teach them that a society only exist with others present and will not exist without having consideration for others.

**Morishima:** What you said applies to everything. In



the world of business too, it is wrong to pursue one's own profit at the expense of others. In social systems, it is wrong to insist on one's own rights without respecting the rights of others. The same is true of technology. Competition should be allowed only under certain rules and within a certain order. The Round Table Conference has been discussing a range of matters taking a broad view, including matters related to politics, technology, education and theory of life, and I think that "consideration for others" and "mutual assistance" are the underlying concepts in all the discussions.

### Urging All the People of the World to Take Action

**Morishima:** What kind of final report would you like the Round Table Conference to produce?

**Seya:** I would like the final report to be easy to read even for junior high school students. I expect the report to be persuasive enough to make its readers to think that they have to do something to reduce CO<sub>2</sub> emissions, while considering the plight of people in developing countries. I want them to take action, to

feel that everyone in the world should do something now.

**Morishima:** I still remember how people voluntarily involved themselves in the aftermath of the Hanshin-Awaji Earthquake in 1995. People really can do something for other people when faced with a real crisis. The threat of global environmental problems is not easy to appreciate in our daily lives, but I am afraid that the threat is a real one and is emerging. I would like the final report to present this fact in an intelligible manner.

We should be aware that it is not our generation, but our children and grandchildren who will live with the serious damage caused by global environmental problems. We must always consider others, including future generations, thinking about the living environment of future generations. Unless the present generation establishes some intergenerational ethics, the human race will not be able to survive on this Earth. I want more people to recognize this fact.

**Seya:** So the final goal of this project is to make everyone feel, "I have to act now to deal with the problem."





# Towards Making the Final Proposal

In recent years, phenomena such as explosive increases in population, global warming, the uneven distribution and lack of water and food, poverty and unbalanced and rapid urbanization have become problems common to humankind and their importance is increasing. In particular, global warming is regarded as a problem that could endanger the existence of humankind and as such, it must be tackled on a global scale. Accordingly, global warming was the main item on the agenda at the Hokkaido Toyako Summit held in Japan in July 2008.

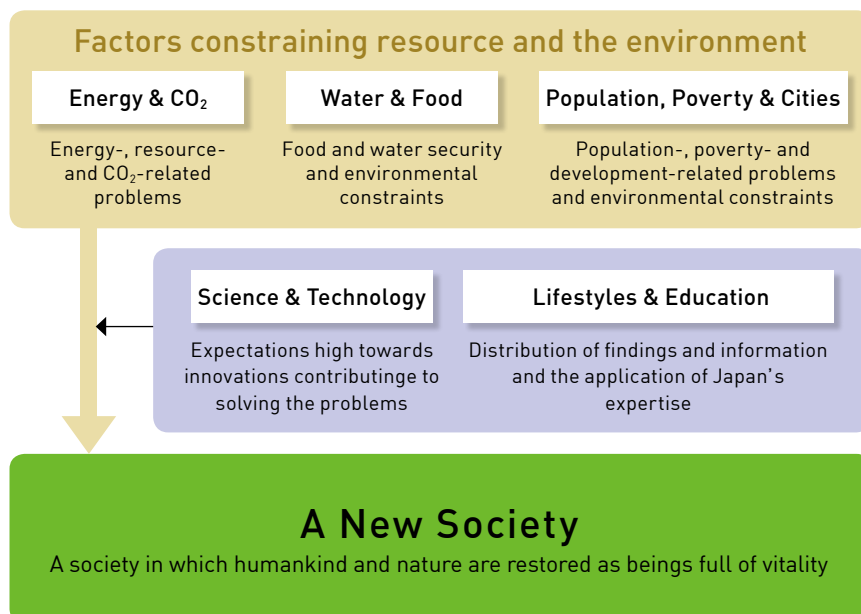
Under these circumstances and in commemoration of the 75th anniversary of its establishment, the Asahi Glass Foundation formed the Special Round Table Conference on Global Environment Problems in December 2006, with the aim of communicating its ideas on global sustainability to the general public. The Conference, which is composed of the directors and councilors of the Foundation, has been discussing a range of global environmental problems and challenges to the whole of the human race. Specifically, the Conference set five discussion themes—“Energy & CO<sub>2</sub>,” “Water & Food” , “Population, Poverty & Cities,” “Science & Technology,” and “Lifestyles & Education.” The members of the Conference have been freely exchanging opinions on these themes from various viewpoints based on their understanding of the present situation and the major problems and discussing important points to be noted and measures to be implemented in the future.

Of the five discussion themes, “Energy & CO<sub>2</sub>,” “Population, Poverty & Cities” and “Water & Food” were selected as problems that need to be dealt with on a global scale, and “Science & Technology” and “Lifestyles & Education” were selected because they help in identifying important solutions to global problems. The Conference meets twice or three times a year and will publish its final report in the spring of 2010.

This booklet constitutes the intermediate report of the Conference and focuses on the results of discussions held on the theme of “Energy & CO<sub>2</sub>.” This report does not give the only possible solutions to global environmental problems or list specific technologies and political measures to be implemented. Rather, it searches for and proposes approaches to be taken to address these problems. We hope that this report will provide the people of the world with the opportunity to reflect on these problems based on their own lives.

**Keiichi Uchida**

Senior Executive Director  
The Asahi Glass Foundation





**Our Vision: Conditions for Survival**  
Global Warming—Response to a Creeping Crisis

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**We are living on this blue planet—a spaceship charting its way through the infinite cosmos with myriad life on board.**

**Are we thinking seriously enough about the destiny of our blue spaceship?**

**As one of the small creatures born on this planet, have we committed ourselves to fulfilling our responsibilities for the Earth—a living spaceship for all organisms? Are we giving enough consideration to the lives and welfare of others?**

**We have designed this project to give you the opportunity to trace the history of the living spaceship Earth and we hope that it provides you with the opportunity to reflect on the future of our blue planet.**



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At 2:30 p.m. on May 19, 1955, Charles David Keeling, who was a chemist, stood alone on a bridge in a Californian forest. He held a five-liter, round-bottomed flask in his hands. Keeling carefully opened the flask, the inside of which had been maintained at a vacuum. The flask was then immediately filled with cold and moist night air. This marked the beginning of scientific research into climate change.

Subsequently, Keeling collected samples of air at various locations and made precise measurements of the traces of CO<sub>2</sub> contained in the atmospheric samples he had collected. The CO<sub>2</sub> amount was a uniform 310 to 315 ppm in all the samples. Based on these results, he concluded that global climate change could be identified by continuing fixed-point observations at a specific location on Earth. In 1958, Keeling actually began making such observations on the top of Mauna Loa in Hawaii.

He continued his observations over many years, and these continued even after he passed away in 2005. In 2007, the level of carbon dioxide in the atmosphere was found to have reached about 385 ppm. This was compared with the level of atmospheric CO<sub>2</sub> in antiquity, which was estimated by analyzing the composition of air trapped in an ice core extracted from a deep layer of the Antarctic ice sheet. This comparison revealed that the level measured in 2007 was the highest in the past 800,000 years.

The results of Keeling's data collection were presented in a graph called the "Keeling Curve," which is shown on the front page of this booklet. The rise in the levels of atmospheric CO<sub>2</sub>, now regarded by everybody as a "creeping crisis," was thus first detected by Keeling, a scientist who made constant efforts to continue his research motivated purely by his interest in science. Keeling received the Blue Planet Prize in 1993 in recognition of his contribution to the launch of scientific debate on the global warming problem.

**af** THE ASAHI GLASS FOUNDATION

