HOW DO YOU DO?

Makoto Akai
National Institute of
Advanced Industrial Science and Technology (AIST)

- **Background:** *Nuclear Engineering*
- **Research Area:**
  - *Two Phase Flow Dynamics; MHD; etc.* 1990
  - *CO_2 Sequestration; H_2 Energy System*
  - *Technology Assessment*
    - *Energy Modeling; Life Cycle Assessment; Externality*
  - *Public Communication*
- **Other Activities:**
  - *R&D Projects under METI*
  - *International Collaboration*
    - *IEA: Technology Assessment; Hydrogen Agreement; GHG Prog.*
    - *IPCC*
    - *CSLF*

Global Environmental Policy
Lecture Plan

- **May 24: Overview**
  - **International aspects**
    - **Background**
    - **The Road to Kyoto and Beyond**
    - **Recent topics**
- **May 31: Challenge towards Deep GHG Reduction**
- **June : ???**

Questionnaire

From what you know about global warming, which of the following statements comes closest to your opinion?

• Global warming has been established as a serious problem and immediate action is necessary.	
• There is enough evidence that global warming is taking place and some action should be taken.	
• We don't know enough about global warming and more research is necessary before we take any actions.	
• Concern about global warming is unwarranted.	
• No opinion	

Assuming that global warming is a problem, what do you think the Japan is likely to do about it?

• I believe that firms and government researchers will develop new technologies to solve the problem.	
• I believe we will have to change our lifestyles to reduce energy consumption.	
• I believe we will learn to live with and adapt to a warmer climate.	
• I believe global warming is a problem but the Japan won't do anything about it.	
• I believe global warming is not a problem therefore Japan (US) won't do anything about it.	
• No opinion	

Have you heard of or read about any of the following in the past year?

×：I don't know it at all. △：I have heard of or read about it.
○：I know it to some extent.

• More efficient appliances	
• More efficient cars	
• Hydrogen cars (Mainly Fuel-cell vehicle)	
• Nuclear energy	
• Biomass energy (Energy which uses agriculture, forest, and livestock residues)	
• Carbon sequestration by afforestation	
• Solar energy	
• Carbon capture and storage	
• Wind energy	
• Carbon absorption by iron fertilization of oceans	

How do you feel we can best address the issue of global warming as it relates to electricity production?

• Do nothing. We can live with global warming.	
• Invest in research and development. A new technology will solve global warming.	
• Continue using fossil fuels but with capture and storage of carbon dioxide.	
• Expand nuclear power.	
• Expand renewables (solar and wind power).	
• Reduce electricity consumption, even if it means lower economic growth.	
• Do nothing. There is no threat of global warming.	

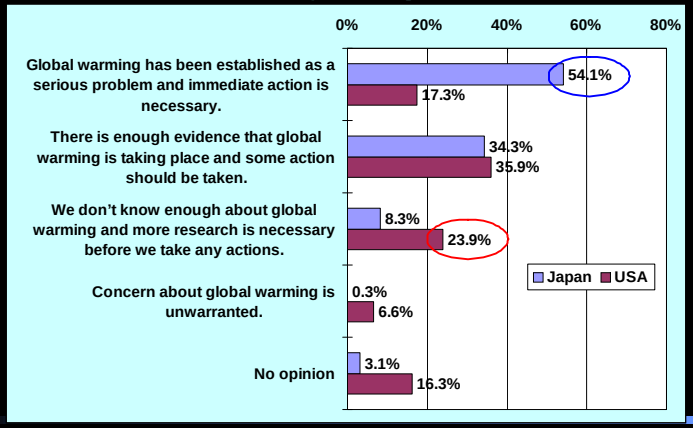
Public Perception on Global Warming Mitigation Measures

US-Japan Study

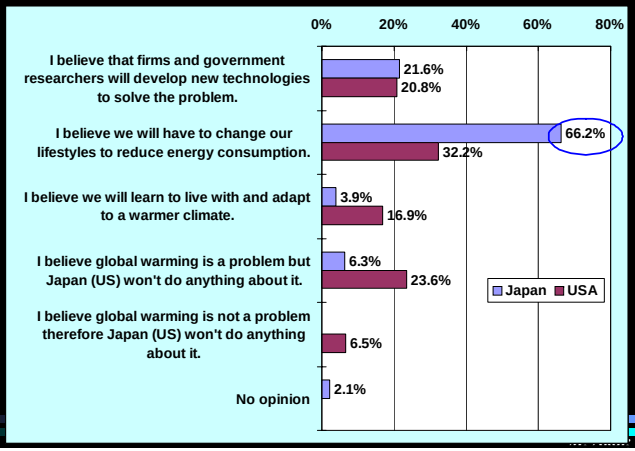
Summary of the Survey

	Japan (AIST)	USA (MIT)
Survey period	Dec. 2003	Oct. 2003
Sample size	1006	1205
Female percentage	50.6%	Average
Average age	47.3	Average
Place of residence	Tokyo (50%) & Sapporo (50%)	Nation wide
Response rate	64%	70%

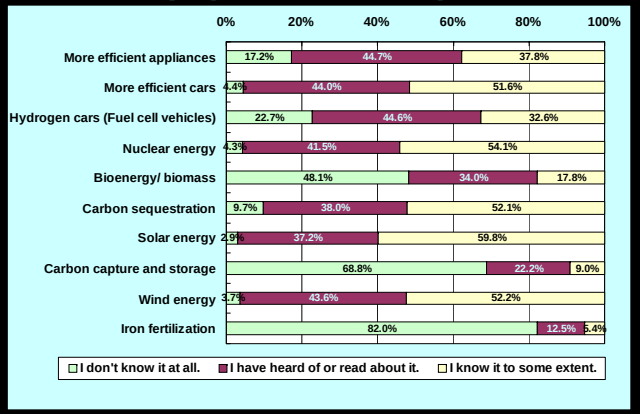
From what you know about global warming, which of the following statements comes closest to your opinion?



Assuming that global warming is a problem, what do you think the Japan (US) is likely to do about it?

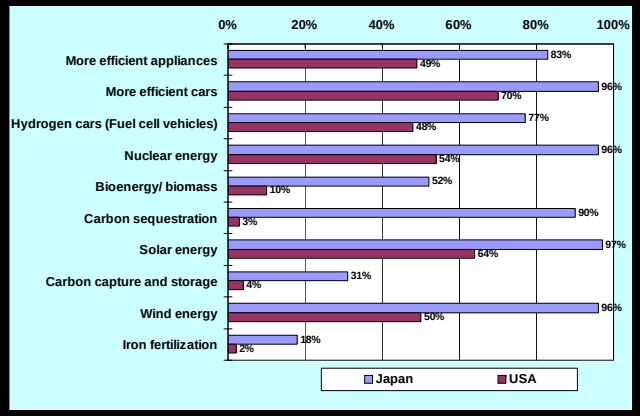


Have you heard of or read about any of the following in the past year? (Japanese Results)



Comparison of Recognition for Global Warming Mitigation Measures

("I've heard of or read about it" + "I know it to some extent")



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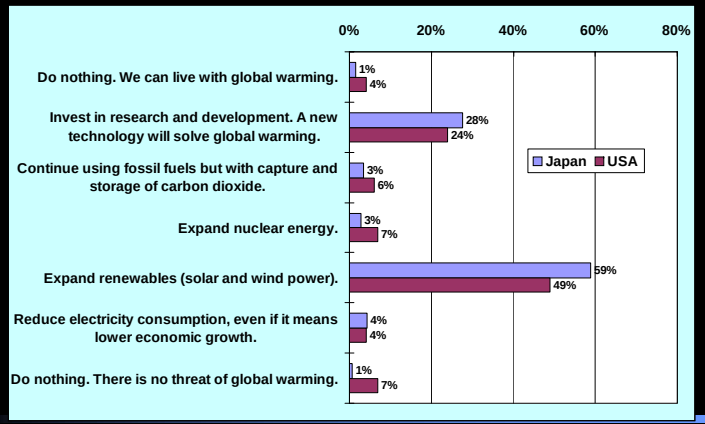


Background

Recent Findings on Climate Change

IPCC TAR Suggestions

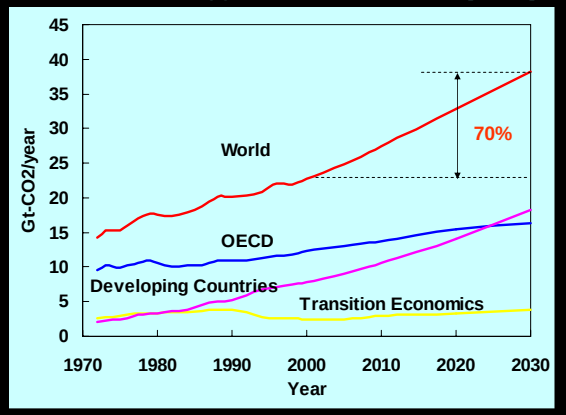
WG1:Scientific Basis-SPM

- An increasing body of observations gives a collective picture of a **warming world** and other changes in the climate system,
- There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to **human activities**,
- Human influences **will continue** to change atmospheric composition throughout the 21st century.

IPCC TAR Recommendations
WG3:Mitigation-SPM

- **Earlier actions**, including a portfolio of emissions mitigation, technology development and reduction of scientific uncertainty, **increase flexibility** in moving towards stabilization of atmospheric concentrations of greenhouse gases,
- **Rapid near-term action** would decrease environmental and human risks associated with rapid climatic changes.

Energy-Related CO_2 Emissions by Region
World Energy Outlook 2002 (IEA)



Findings - World Energy Outlook 2002

- Fossil fuels will continue to dominate the world's energy mix over the next decades.
  - Hence, even under the international climate policies, emissions of GHGs from the energy sector are expected to continue growing, reaching 38 billion tones-CO_2 by 2030.
- Emissions will shift from the industrialized countries to the developing world.
  - The developing countries' share of global emissions will jump from 34% now to 47% in 2030, while the OECD's share will drop from 55% to 43%.

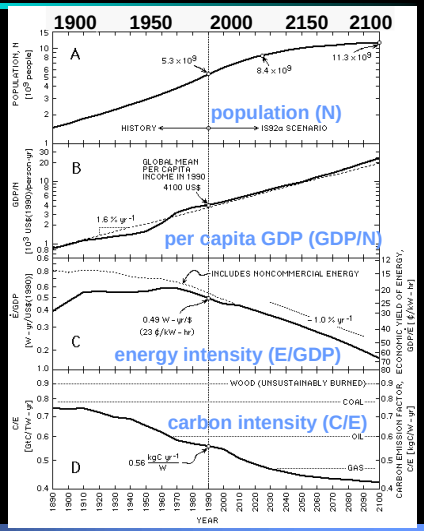
The Kaya equation

- $C = N \times (GDP/N) \times (E/GDP) \times (C/E)$
  - C carbon emissions
  - N population
  - GDP/N per capita GDP
  - E/GDP energy intensity of economic productivity
  - C/E carbon intensity of primary energy

CO_2 emissions

= N x (GDP/N) x (E/GDP) x (C/E)

IPCC IS92a
"Business as usual"
scenario assumptions



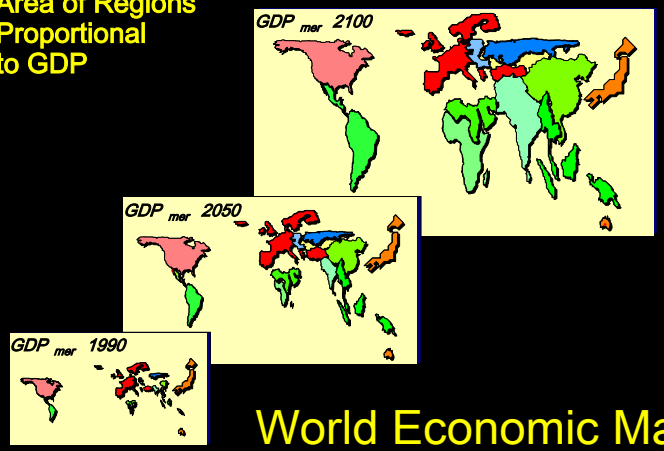
Hoffert et al., 1998

World Economic Map

Areas of Regions Proportional to 1990 GDP

Naki Nakicenovic

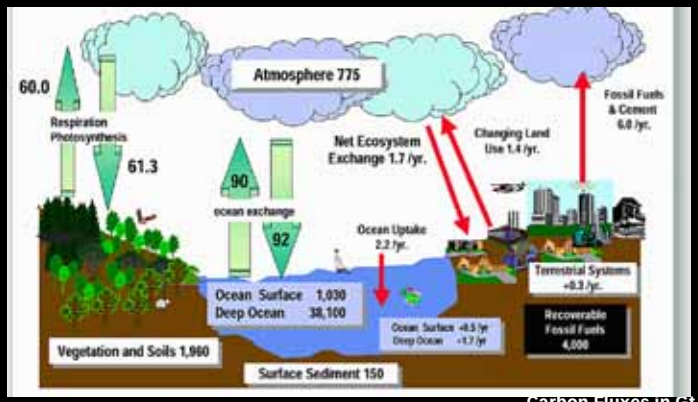
Area of Regions Proportional to GDP



World Economic Map

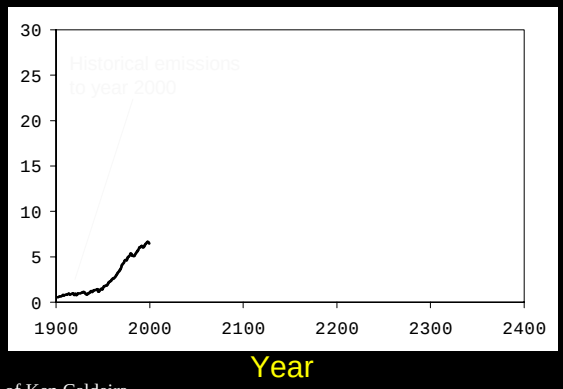
Naki Nakicenovic

Global Carbon Cycle



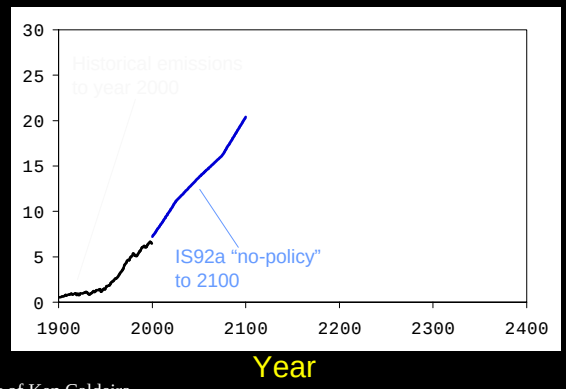
Carbon Fluxes in Gt

What happens if we do nothing?



Courtesy of Ken Caldeira

What happens if we do nothing?



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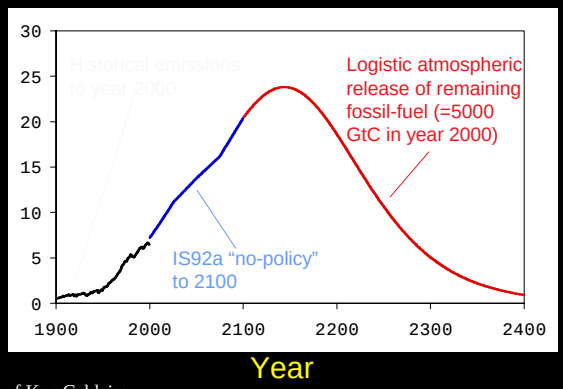
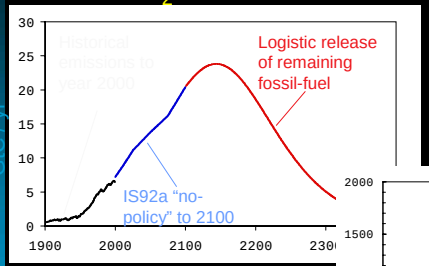


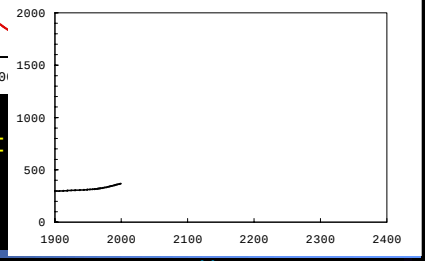
Courtesy of Ken Caldeira

What happens if we do nothing?

CO_2 emissions



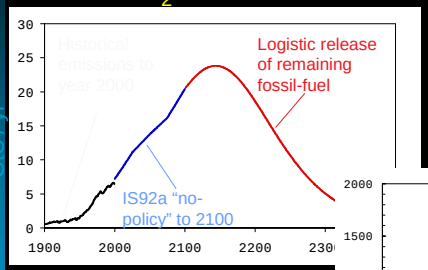
Atmospheric CO_2



Courtesy of Ken Caldeira

What happens if we do nothing?

CO_2 emissions



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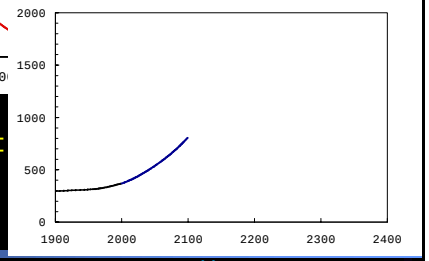

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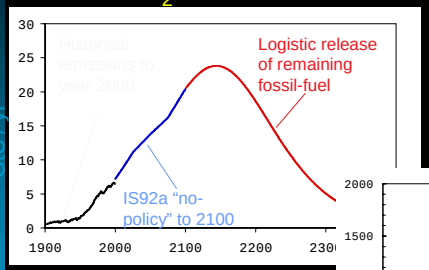
CO_2 emissions



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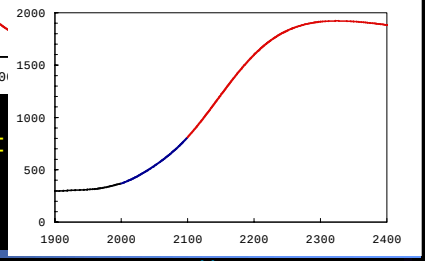

Courtesy of Ken Caldeira

"stabilization of greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system"

What is an acceptable amount of climate change?

Uncertainty in climate sensitivity

What is an acceptable amount of anthropogenic radiative forcing?

Uncertainty in carbon-cycle, aerosols, etc.

What is an acceptable rate of greenhouse gas and aerosol emissions?

Uncertainty in engineering, environmental sciences, social systems, etc.

What is an acceptable system of energy production and consumption?

The Road to Kyoto

History of Global Warming (1/2)

1827	French mathematician Jean-Baptiste Fourier suggests the existence of an atmospheric mechanism keeping the Earth warmer than it would otherwise be. He likens it to a greenhouse.
1863	Irish scientist John Tyndall publishes a paper describing how atmospheric water vapor could contribute to this mechanism.
1890s	Swedish scientist Svante Arrhenius and American P.C. Chamberlain independently investigate the potential problems that could be caused by carbon dioxide (CO_2) building up in the atmosphere. They both suggest that burning fossil fuels could lead to global warming, but neither suspect the process might already have started.
1890s - 1940	Average surface air temperatures increase by about 0.25 C. Some scientists see the American Dust Bowl (a devastating, persistent drought in the 1930s) as a sign of the greenhouse effect at work.
1940 - 1970	Global temperatures cool by 0.2 C. Scientific interest in global warming declines. Some climatologists predict a new ice age.

History of Global Warming (2/2)

1957	U.S. oceanographer Roger Revelle warns that people are conducting a "large-scale geophysical experiment" on the planet by releasing greenhouse gases. Colleague David Keeling establishes the first continuous monitoring of atmospheric CO_2. He rapidly confirms a regular year-on-year rise.
1970s	A series of studies by the U.S. Department of Energy increases concerns about possible long-term effects of global warming.
1979	First World Climate Conference adopts climate change as major issue and calls on governments "to foresee and prevent potential man-made changes in climate".
1985	First major international conference on global warming in Villach (Austria) warns that average global temperatures in the first half of the 21st century could rise significantly more than at any other time in human history. Warmest year on record. The 1980s is the warmest decade on record, with seven of the eight warmest years of the century.
1987	Global temperatures cool by 0.2 C. Scientific interest in global warming declines. Some climatologists predict a new ice age.

Road to Kyoto

1988	•Heat wave in U.S. granary •Testimony by Dr. Hansen •Toronto Conference •Establishment of IPCC
1990	•IPCC First Assessment Report
1992	•Earth Summit ⇒UNFCCC
1995	•COP-1 (Berlin) ⇒Berlin Mandate •IPCC Second Assessment Report
1996	•COP-2 (Geneva)
1997	•COP-3 (Kyoto) ⇒Kyoto Protocol

1988 - Year of Breaking Out

- Dr. Hansen testified before the U.S. Senate
  - 99 percent sure ... the greenhouse effect has been detected and it is changing our climate now.
- *World Conference on the Changing Atmosphere: Implications for Global Security (Toronto)* called for 20 % cuts in global CO_2 emissions by the year 2005
- WMO and UNEP established the Intergovernmental Panel on Climate Change (IPCC).

Road to Kyoto

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Earth Summit

UN Conf. on Environment and Development

- The centerpiece was the ratification of the UNFCCC and was signed by 154 nations.
- UNFCCC does not contain binding targets for GHG emission reductions, but recognizes the importance of reducing GHG emissions in order to prevent "dangerous interference" with the climate system.

UNFCCC

- Sets an initial target for industrialized countries to reduce their GHG emission to 1990 levels by the year 2000.
- Demanded each industrialized nation to submit national communication on GHG emission inventory, and to provide financial and technical assistance to developing countries for the reporting.
- Came into force on 21 March 1994.

Road to Kyoto

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COP-1

Conference of the Parties on its First Session

- **Berlin Mandate**
  - To initiate a process to enable Governments to take appropriate action for the period beyond 2000, including a strengthening of developed country commitments.
  - The work should be completed as early as possible so that the results can be adopted at COP-3 in 1997.
  - Developing countries are explicitly exempted from these new commitments.

Road to Kyoto

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Kyoto Protocol to the UNFCCC

- **38 developed countries agreed to reduce their emissions of six GHGs by a total of 5.2% between 2008 and 2012 from 1990 levels**
  - CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
- **Party quantified emission limitation or reduction commitment include (% reduction):**

  Austria (8); Canada (6); Japan (6); Romania (8); Russian Federation (0); Switzerland (8); USA (7); UK (8);

Kyoto Mechanisms

- **Kyoto Protocol provided the basis for mechanisms to assist Annex I Parties in meeting their targets cost effectively, i.e.**
  - Emissions trading system,
  - Joint implementation (JI) of emissions reduction projects between Annex I Parties,
  - Clean Development Mechanism (CDM) to encourage joint projects between Annex I and non-Annex I Parties. However,
  - It was left for subsequent meetings to decide on most of the rules and operational details that will determine how these cuts in emissions are achieved, measured and assessed.

Towards Effectuation of Kyoto Protocol

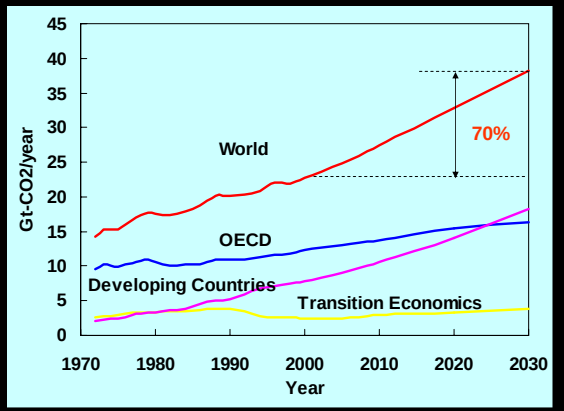
- In order for the Kyoto Protocol to enter into force, it must be ratified by 55 Parties to the UNFCCC, including Annex I Parties representing at least 55% of the total carbon dioxide emissions for 1990.

Kyoto Protocol Ratification Status

Continued Negotiations

- Carbon sink --- What is Kyoto Forest?
  - Land Use, Land Use Change and Forestry (LULUCF)
- Rules and operational details of Kyoto Mechanisms
- Involvement of and assistance to developing countries
- Compliance, etc.

Energy-Related CO_2 Emissions by Region
World Energy Outlook 2002 (IEA)



Indication - World Energy Outlook 2002

Pessimistic with regard to the Kyoto target

- Emissions in those OECD countries that signed the Protocol (including US) will reach 12.5 billion tones in 2010: 2.8 billion tones (29％ above the target)
- Russia, like Central and Eastern Europe, is in a very different situation, with projected emissions considerably lower than its commitments.
  - Under the Protocol, “emissions credits” can be sold to countries with emissions over their target. But this will not suffice to compensate for over-target emissions in other countries.
- Net emissions will be about 15％ above targets in 2010. If US, which does not intend to ratify the Kyoto Protocol, is excluded, the gap falls to 2％.

Questions?

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