HOW DO YOU DO?

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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 11: Overview**
  - **International aspects**
    - **Background**
    - **The Road to Kyoto and Beyond**
    - **Recent topics**
- **May 18: Energy and Environmental Policies**
  - **Japan, US, etc.**
- **May 25: Challenge towards Deep GHG Reduction**

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.**

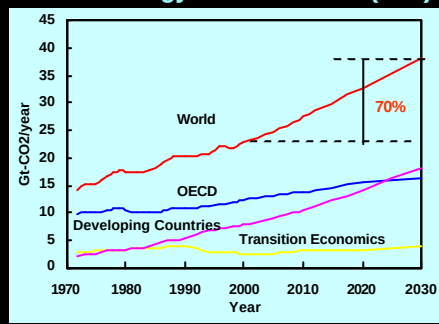
IPCC TAR Recommendations

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

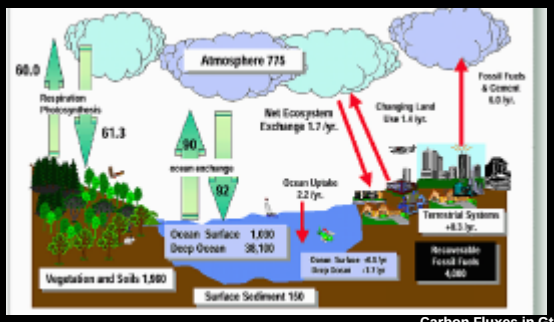
World Energy Outlook 2002 (IEA)



Findings - World Energy Outlook 2002

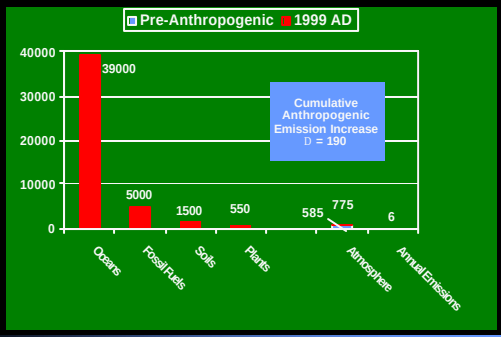
- Fossil fuels will continue to dominate the world's energy mix over the next decades.
  - Hence, even under the international climate policies, emissions of GHGs from the energy sector are expected to continue growing, reaching 38 billion tones-CO_2 by 2030.
- Emissions will shift from the industrialized 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%.

Global Carbon Cycle



Carbon Fluxes in Gt

Carbon Reserves and Flows
(GtC = 10^9 Tonnes C)



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 Þ UNFCCC
1995	•COP-1 (Berlin) Þ Berlin Mandate •IPCC Second Assessment Report
1996	•COP-2 (Geneva)
1997	•COP-3 (Kyoto) Þ 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).

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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.

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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.

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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);

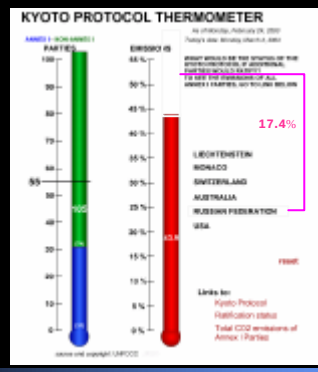
Kyoto Mechanisms

- 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.

IPCC Special Report on LULUCF - SPM -

1. Introduction
2. Global Carbon Cycle Overview
3. Issues Associated with Definitions
   - 3.1. Forests, Afforestation, Reforestation, and Deforestation
   - 3.2. Additional Activities
4. Carbon Accounting
5. Methods for Measuring and Monitoring
6. Estimates of Average Annual Carbon Stock Changes /Accounted for ARD Activities and Some Additional Activities
   - 6.1. Afforestation, Reforestation, and Deforestation
   - 6.2. Additional Activities
7. Project-Based Activities

Energy-Related CO_2 Emissions by Region
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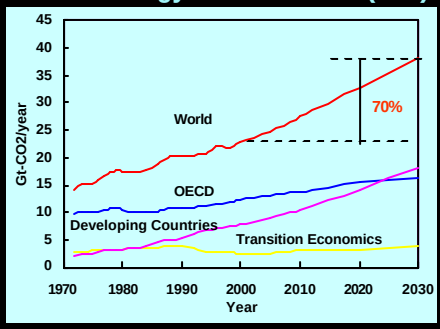


Indication - World Energy Outlook 2002
Pessimistic with regard to the Kyoto target

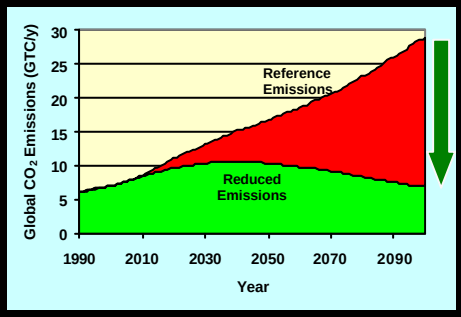
- Emissions in those OECD countries that signed the Protocol (including US) will reach 12.5 billion tones in 2010: 2.8 billion tones (29% above the target)
- Russia, like Central and Eastern Europe, is in a very different situation, with projected emissions considerably lower than its commitments.
  - 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%.

U.S. Climate Change Technology Policy

President's Key Policy Addresses:

- June 11, 2001
  - Committed U.S. to Work Within UN Framework
  - Directed U.S.G. to Develop Flexible, Science-Based Response
  - Supported UNFCCC to Stabilize GHG Concentrations
  - Established National Climate Change Technology Initiative
  - Established Climate Change Research Initiative
- February 14, 2002
  - Reaffirmed Long-Term UNFCCC Central Goal
  - Established U.S Goal to Reduce GHG Intensity by 18% by 2012
  - Encouraged Business Challenges and Voluntary Reporting
  - Directed Improvements to the EPACT Emissions Registry
  - Supported Transferable Credits
  - Valued GHG Avoidances by Supporting Financial Incentives

Global Climate Change – The Role for DOE and New Technology



Technology Pathways

#1: Closing the Loop on Carbon
- Introduction of Carbon Sequestration and Hydrogen Technologies Augment the Standard Suite of Energy Technologies

#2: Renewables and Nuclear Succeed
- Major Technological Advances in Renewable and Hydrogen Technologies are Coupled with a New Generation of Nuclear Reactors

#3: Beyond the Standard Suite
- Dramatic Breakthroughs in "New and Advanced Technologies – e.g., Fusion, Bio-X" – Create a Fundamentally Changed Energy System

Current Climate Change Technology R&D Initiatives

- FreedomCAR
- FreedomFuel
  - Hydrogen Technology
  - Nuclear-Based Hydrogen Initiative
  - Large-Scale Hydrogen Production From Fossil Fuels
- Fuel Cell Systems
- Regional Carbon Sequestration Partnerships
- Carbon Sequestration Leadership Forum
- Nuclear Power Generation IV
- Nuclear Power 2010
- International Thermonuclear Experimental Reactor (ITER)
- National Climate Change Technology Initiative Competitive Solicitation Program

Significance of CCTP

- Leadership in climate change science can:
  - Reduce uncertainty
  - Illuminate risks and benefits
  - Guide and pace strategy
- Leadership in climate change technology can:
  - Create a robust set of technological options
  - Improve their performance and reduce costs
  - Facilitate society's ability to effect change

U.S. Initiatives for International Activities

- Carbon Sequestration Leadership Forum (CSLF)
- International Partnership for the Hydrogen Economy (IPHE)

Carbon Sequestration Leadership Forum

- CSLF is an international climate change initiative that is focused on development of improved cost-effective technologies for the separation and capture of CO_2
- The purpose is to make these technologies broadly available internationally; and to identify and address wider issues relating to carbon capture and storage.
- This could include promoting the appropriate technical, political, and regulatory environments for the development of such technology.

The First Ministerial-level Meeting
June 23-25, 2003

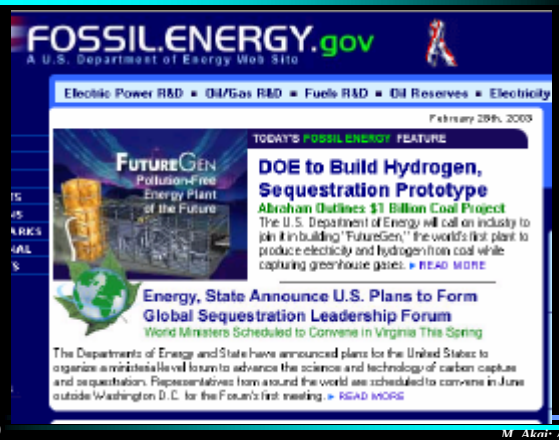
- Attended by delegations from 16 countries and the European Commission.
- The CSLF charter was signed by representatives of 13 countries and EC.
  - Stay in effect for 10 years
  - Additionally, Germany and South Africa have joined

CSLF Activities

- Framework for international cooperation in research and development for the separation, capture, transportation and storage of CO_2.
- The activities will be conducted by:
  - Policy Group
    - Governing the overall framework and policies of the CSLF
  - Technical Group
    - Reviewing the progress of collaborative projects and makes recommendations to the Policy Group on any needed actions.

CSLF Collaborative Projects
Review by Technical Group

- Information exchange and networking,
- Planning and road-mapping,
- Facilitation of collaboration,
- Research and development,
- Demonstrations,
- Public perception and outreach,
- Economic and market studies,
- Institutional, regulatory, and legal constraints and issues,
- Support to policy formulation, or
- Other issues as authorized by the Policy Group.



FutureGen – Goals (1/2)
A Sequestration and Hydrogen Research Initiative

- Design, construct, and operate a nominal 275MW (net equivalent output) prototype plant that produces electricity and H_2 with near-zero emissions. The size of the plant is driven by the need for producing commercially-relevant data, including the requirement for producing one million metric tons per year of CO_2 to adequately validate the integrated operation of the gasification plant and the receiving geologic formation.
- Sequester at least 90 % of CO_2 emissions from the plant with the future potential to capture and sequester nearly 100 %.

FutureGen – Goals (2/2)
A Sequestration and Hydrogen Research Initiative

- Prove the effectiveness, safety, and permanence of CO_2 sequestration.
- Establish standardized technologies and protocols for CO_2 measuring, monitoring, and verification.
- Validate the engineering, economic, and environmental viability of advanced coal-based, near-zero emission technologies that by 2020 will: (1) produce electricity with less than a 10% increase in cost compared to nonsequestered systems; (2) produce hydrogen at $4.00 per million Btus (wholesale), equivalent to $0.48/gallon of gasoline, or $0.22/gallon less than today's wholesale price of gasoline.

International Partnership for the Hydrogen Economy (IPHE)

Purposes:

- To serve as a mechanism to organize and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies.
- To provide a forum for advancing policies, and common codes and standards that can accelerate the cost-effective transition to a global hydrogen economy to enhance energy security and environmental protection.

Questions?

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