

## Environmental Technology and Policy Making

- Overview (June 7)
  - Background
  - The Road to Kyoto and Beyond
  - Toward Deep Reduction of GHGs
- Environmental Policy in Japan (June 21)
  - Including R&D policy
- Global Challenge towards Climate Change & Recent Topics (July 12)

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## Development of Environmental Policy

### “Environmental Policy”

- The term in contemporary sense has been used since early 1970s, particularly after the establishment of Environmental Agency in 1971.

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## History of Environmental Administration Local to Global

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## History of Environmental Topics and Administration (1/4)

1880's	Spread of mine pollution at Ashio copper mine
1897	Forest Law
1911	Factory Law
1955	Itai-itai (ouch-ouch) disease became in issue (Cd)
1956	Outbreak of Minamata disease (Hg)
1957	Natural Parks Law
1958	Law Concerning the Preservation of Water Quality in Public Waters Law Concerning Regulation of Industrial Effluent
1961	Air pollution and marine pollution in Yokkaichi-city
1962	Publication of “Silent Spring” Law Concerning the Emission Control of Smoke and Soot
1965	Outbreak of Minamata disease in Niigata
1968	Outbreak of Kanemi Oil Poisoning Symptoms (PCB) Air Pollution Control Law and Noise Regulation Law

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## History of Environmental Topics and Administration (2/4)

1969	Osaka Airport Pollution Suit Law Concerning Special Measures for the Relief of the Pollution-related Patients First “Annual White Paper on Environmental Pollution”
1970	Outbreak of health damage caused by photochemical smog
1971	Inauguration of the Environmental Agency Offensive Odor Control Law
1972	United Nations Conference on Human Environment (Stockholm) Nature Conservation Law
1973	Pollution-related Health Damage Compensation Law
1975	Hexavalent chromium pollution issue
1979	Convention on Wetlands of International Importance Especially as Waterfall Habitats (Ramsar Convention) Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington Convention)

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## History of Environmental Topics and Administration (3/4)

1984	Law Concerning Special Measures for the Preservation of the Water Quality of Lakes and Ponds
1988	Establishment of IPCC Vienna Convention for Protection of Ozone Layer Law for the Protection of the Stratospheric Ozone Layer
1989	Establishment of Council of Minister for Global Environmental Conservation
1990	Planning of the Action Program to Arrest Global Warming
1991	Law for the Promotion of Utilization of Recyclable Resources
1992	UN Conference on Environment and Development (Adoption of “Rio-Declaration on Environment and Development “ “Agenda 21”)
1993	Basel Convention on the Control of Trans-Boundary Movement of Hazardous Wastes and Disposal Convention on Biological Diversity

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## History of Environmental Topics and Administration (4/4)

1994	Effectuation of UNFCCC
1997	Environmental Impact Assessment Law COP3
1998	Law Concerning the Promotion of the Measures to Cope with Global Warming
1999	Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management Law Concerning Special Measures for Dioxins Control
2000	Basic Law for Establishing Recycling-Based Society Law on Promoting Green Purchasing Law for Promoting Effective Use of Resources Construction Waste Recycling Law Food Waste Recycling Law
2001	Inauguration of the Ministry of the Environment <i>M. Akai, AIST</i>

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## Japan's Domestic Approach Government

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## Road to Kyoto

1988	<ul style="list-style-type: none"> <li>• Heat wave in U.S. granary</li> <li>• Testimony by Dr. Hansen</li> <li>• Toronto Conference</li> <li>• Establishment of IPCC</li> </ul>
1990	• IPCC First Assessment Report
1992	• Earth Summit & UNFCCC
1995	<ul style="list-style-type: none"> <li>• COP-1 (Berlin) &amp; Berlin Mandate</li> <li>• IPCC Second Assessment Report</li> </ul>
1996	• COP-2 (Geneva)
1997	• COP-3 (Kyoto) & Kyoto Protocol

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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<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs, SF<sub>6</sub>
- 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);
  - Australia (+8%)**

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## Action Program to Arrest Global Warming

Decision made by the Council of Ministers for Global Environment Conservation  
(October 1990)

- The action program covers the period from 1991 to 2010 with 2000 set at the intermediate target year.

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## Action Program

### Target

- The emissions of CO<sub>2</sub> should be stabilized on a per capita basis in the year 2000 and beyond at about the same level as in 1990
- Efforts should also be made to stabilize the total amount of CO<sub>2</sub> emission in the year 2000 and beyond at about the same level as in 1990

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## Action Program

### In Reality...

- The emissions of CO<sub>2</sub> should be stabilized on a per capita basis in the year 2000 and beyond at about the same level as in 1990
  - ▷ 00/90 = +7.2%
- Efforts should also be made to stabilize the total amount of CO<sub>2</sub> emission in the year 2000 and beyond at about the same level as in 1990
  - ▷ 00/90 = +10.2%

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## 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.

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## After Kyoto

1998	<ul style="list-style-type: none"> <li>• COP-4 (Buenos Aires)</li> <li>• The warmest year in the warmest decade of the warmest century of the millennium.</li> </ul>
1999	• COP-5 (Bonn)
2000	• COP-6 (The Hague)
2001	<ul style="list-style-type: none"> <li>• COP-6 Part II (Bonn)</li> <li>• COP-7 (Marrakesh)</li> <li>• IPCC Third Assessment Report</li> </ul>
2002	<ul style="list-style-type: none"> <li>• COP-8 (New Delhi, Oct 23-Nov 1)</li> <li>• Rio + 10: World Summit on Sustainable Development (Johannesburg, Sep 2-11)</li> </ul>

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## Guidelines of Measures to Prevent Global Warming

June 19, 1998

- Decision by “Global Warming Prevention Headquarters” chaired by Prime Minister
- Establish the basic policy to meet with the Kyoto Protocol

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## The Guidelines

### Energy Related Reductions

- In order to achieve a 6% reduction targets stated in the Kyoto Protocol:
  - Regarding CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions, a 2.5% reduction will be achieved through steadfastly promoting measures relating to both energy supply and demand focusing on promoting **energy saving**, introduction of **new energy** and the construction of **nuclear power** plants with rigid nuclear safety measures, introducing **innovative technologies**, and accelerating the efforts of each social actor.

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## The Guidelines - Summary - GHG reduction target of Japan for 2010

-2.5%	Emission reduction of CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O ±0%: Energy related CO <sub>2</sub> -0.5%: CH <sub>4</sub> and N <sub>2</sub> O -2.0%: R&D and introduction of innovative technologies, and effort of each citizen
+2.0%	CFC alternatives, etc. (HFC, PFC and SF6)
-3.7%	Sinks of Japan's forests
-1.8%	The balance: utilization of international mechanisms

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## Reinforcement of Existing Law

### - Top Runner Approach -

- Introduced as part of a package to further strengthen the Law Concerning the Rational Use of Energy.
- Promotes energy efficiency in consumer products, by setting a product of the **highest energy efficiency** as a standard in its product category, e.g. television, and establishing that as a goal for industry to come up with.

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## 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.

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## Statement by Global Warming Prevention Headquarters after COP-7

November 12, 2001

- Japanese Government has decided to take the necessary measures and actions in order to ratify the Kyoto Protocol in FY 2002.

▷ Ratified in June 2002

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## Research and Development

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## R&D Policy on Global Warming in Japan (FY2002)

- In September 2001, the Council for Science and Technology Policy established "**Promotion Strategy in Prioritized Area based on the Science and Technology Basic Plan**"

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### *Global Warming Research Initiative*

Above programs will be conducted in an integrated manner with the cooperation of Ministries.

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## Global Warming Research Initiative

- The Initiative includes the following programs (FY 2002: 219.6 billion yen)
  - Global warming monitoring program
  - Global warming prediction and climate fluctuation research program
  - Global warming effects and risk evaluation program
  - GHG fixation(sequestration) and utilization program
  - Global warming prevention policy research program
  - New & renewable energy and energy conservation technology development programs

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## Technological Options for Reduction of GHG Emissions

- Improvement of energy efficiency
- Switching to lower carbon fuels, e.g. coal to natural gas
- Use of non carbon fuels, e.g. renewables, nuclear
- Enhancement of natural sinks for CO<sub>2</sub>, e.g. forestry
- Capture and sequestration of CO<sub>2</sub>.

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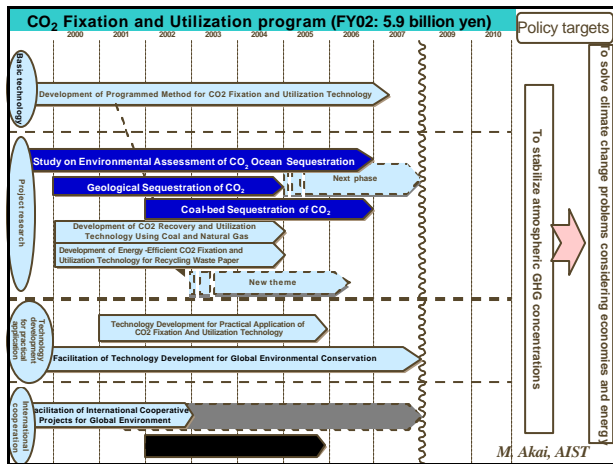
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## R&D Program by METI

- New R&D programs from FY 2002
  - *R&D Program for Innovative Technologies to Prevent Global Warming* which includes 21 specific projects for the technologies that have a certain level of contribution in GHG reduction by 2010, and,
  - *R&D Program for CO<sub>2</sub> Fixation and Utilization* which deals with mid- and longer term technologies, including CO<sub>2</sub> sequestration technologies.

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## CO<sub>2</sub> Capture and Sequestration (Storage) - Status -

- Fossil fuels can be part of the energy mix
- Capture and storage of CO<sub>2</sub> enables deep reductions in emissions
- Cost (\$40-60/tCO<sub>2</sub> avoided) is no greater than large-scale application of other deep reduction measures
- It is not expected that all fossil reserves will be exploited
- This is a transition strategy to a different energy system – it is a means of gaining time

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## CO<sub>2</sub> Capture and Sequestration - Aspects to be considered -

- CO<sub>2</sub> Capture
- CO<sub>2</sub> Transmission
- CO<sub>2</sub> Sequestration
  - Geological
  - Ocean
- CO<sub>2</sub> Utilisation
- Terrestrial sequestration

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## CO<sub>2</sub> Capture

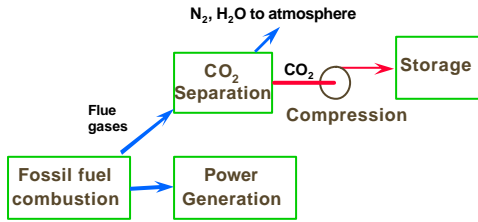
- 3 options
  - Post-combustion capture
  - Pre-combustion decarbonisation
  - Oxyfuel combustion

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## CO<sub>2</sub> Capture

- **Post-combustion capture**
  - Chemical solvent scrubbing

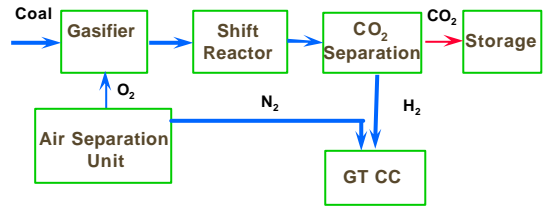


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## CO<sub>2</sub> Capture

- **Pre-combustion decarbonisation**
  - Physical solvent scrubbing

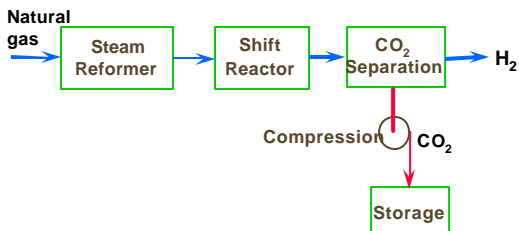


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## H<sub>2</sub> from Natural Gas

- **CO<sub>2</sub> capture and sequestration towards hydrogen economy**

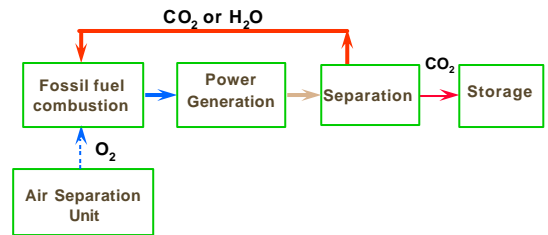


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## CO<sub>2</sub> Capture

- **Oxyfuel**



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## CO<sub>2</sub> Capture

- **Costs comparable with other deep reduction options**
  - All 3 approaches would capture CO<sub>2</sub> at costs of \$30-50/t CO<sub>2</sub> avoided in large scale application
  - To reduce costs further will need radical changes in approach e.g. gas turbine with CO<sub>2</sub> as working fluid
  - Novel ideas needed to re-optimize the process of generating power without release of CO<sub>2</sub>

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## CO<sub>2</sub> Transmission

- **Established technology**
  - Areas for improvement
    - Limited
  - Action being taken
    - Industry assembling performance data on high pressure behaviour of captured CO<sub>2</sub>

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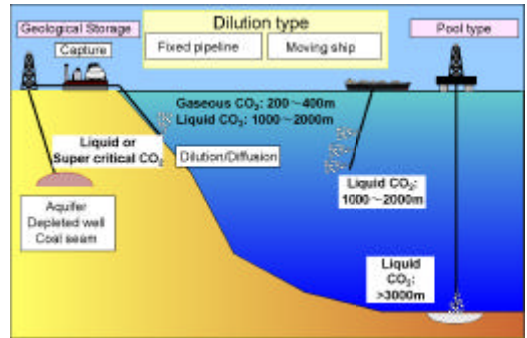
## CO<sub>2</sub> Sequestration - Options -

- **Geological**
  - Depleted oil and gas fields
  - Unminable coal measures
  - Deep saline reservoirs
- **Deep ocean**
- **Cost typically \$10/t CO<sub>2</sub>**
  - In some cases may generate offsetting income

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## Concept of CO<sub>2</sub> sequestration



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## Is there sufficient capacity?

- **PNNL Simulation results:**
  - Total amount of CO<sub>2</sub> to be captured 1990 - 2095
    - Coal-based scenario: 1230 Gt CO<sub>2</sub>
  - Estimated reservoir capacities:
    - Deep saline reservoirs 400 - 10000 Gt CO<sub>2</sub>
    - Disused oil and gas fields 920 Gt CO<sub>2</sub>
    - Unminable coal measures >15 Gt CO<sub>2</sub>
    - Deep ocean 4000 Gt CO<sub>2</sub>

Battelle Memorial Institute

Pacific Northwest National Laboratory

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## CO<sub>2</sub> Sequestration

- **All options should be considered**
- **Areas for improvement**
  - Demonstrate CO<sub>2</sub> can be stored safely and securely
  - Verify amount stored (monitoring)
  - Environmental impact – demonstrate minimal leakage and other possible impacts
  - Build confidence with public and NGOs

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## Terrestrial sequestration

- **Options**
  - Afforestation, reforestation and land use changes
  - Popular
  - Allowed in Kyoto protocol
  - Significant potential in near term
  - Issue: security of storage
  - Warning: quoted costs often not on basis comparable with capture/storage

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## CO<sub>2</sub> Utilisation

- **Enhanced recovery of hydrocarbons**
  - Established use
  - Result = storage of CO<sub>2</sub>
- **Chemical fixation**
  - More CO<sub>2</sub> released than stored
  - Quantities not material to solving problem
- **Biological fixation**
  - Vast areas of land required
  - Radical improvements needed in biology

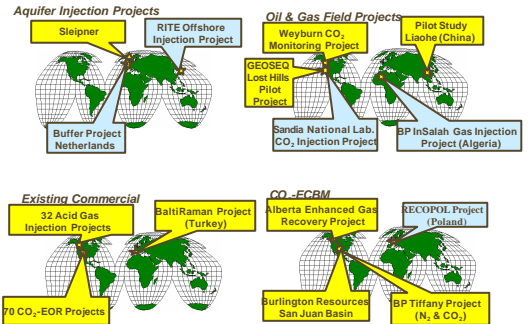
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## METI's Project Geological Sequestration of CO<sub>2</sub>

- FY2000 - FY2004
- Objectives:
  - Accumulation of the data to assure the safety of underground storage of CO<sub>2</sub> through a small-scale field injection test and laboratory experiments.
  - Study on the social and economic aspects of the technology.
- Small-scale liquid CO<sub>2</sub> injection test will be conducted at an onshore gas/oil field until 2004.

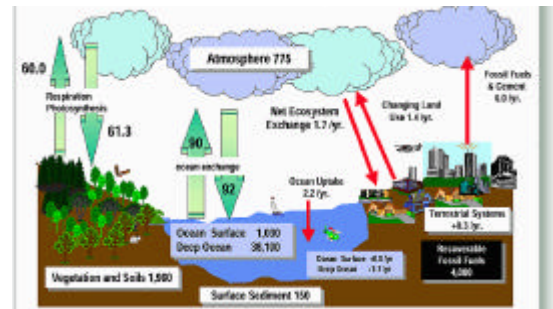
## Geological Sequestration Projects



## METI's Project Study on Environmental Assessment of CO<sub>2</sub> Ocean Sequestration

- FY1997 - 2001 (Phase-1)
- FY2002 - 2006 (Phase-2)
- Goal: Development of a generic assessment model for describing and predicting CO<sub>2</sub> behavior from a discharge point to the ambient open sea and the resulting biological impact.
  - to provide necessary information to formulate international understanding/agreement on the technology

## Global Carbon Cycle

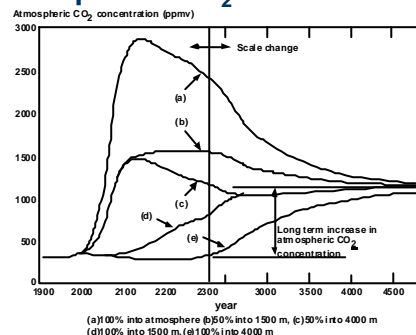


## Ocean Sequestration - Background

- It is predicted that 80 - 85% of the CO<sub>2</sub> from fossil fuels will eventually be absorbed by the deep ocean, which currently contains ~38 trillion tonnes of carbon.
- CO<sub>2</sub> is accumulating in the air due to the slow rate of transfer between the surface and deep ocean:
  - Of the CO<sub>2</sub> emitted into the air today
    - 6% will be absorbed by the ocean in 1 year
    - 29% will be absorbed in 10 years
    - 59% will be absorbed in 60 years
    - 84% will be absorbed in 360 years

"Atmospheric Chemistry & Physics: from Air Pollution to Climate Change"

## Ocean Sequestration and Atmospheric CO<sub>2</sub> Concentration





**Questions?**

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