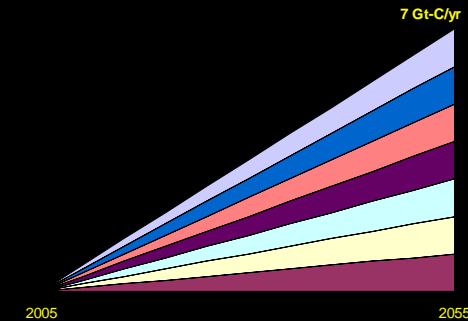


## Global Environmental Policy Lecture Plan

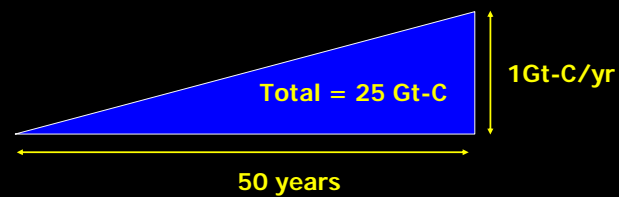
- May 24: Overview
  - International aspects
    - Background
    - The Road to Kyoto and Beyond
    - Recent topics
- May 31: Challenge towards Deep GHG Reduction
- June 14: International energy and global environmental policy

## Seven Wedges to Fill the Triangle



## What is a “Wedge”?

- A “wedge” is an activity reducing the rate of carbon build-up in the atmosphere that grows in 50 years from zero to 1.0 Gt-C/yr.



## Example of a Wedge - Nuclear -

- Displacement of coal fired power plant
  - CO<sub>2</sub> emission from 1GW coal fired plant:
    - Specific emission: 0.887 kg/kWh
    - Availability: 80%
 
$$1 \times 10^6 \times 24 \times 365 \times 0.8 \times 0.887 = 6.22 \times 10^6 \text{ (t-CO}_2\text{/yr)}$$

$$= 6.22 \times 10^6 \times 12 / 44 = 1.70 \times 10^6 \text{ (t-C/yr)}$$
  - To reduce 1Gt-C:
    - $1 \times 10^9 \text{ (t-C/yr)} / 1.70 \times 10^6 \text{ (t-C/yr)} = 590$
- Effort needed to 1 wedge:
  - Add 590 GW that displaces coal (~1.7×current capacity)

## Report Subject

- Develop a wedge with explanation of
  - Estimation procedures
  - Comparison of current market scale, etc.
- Candidate technologies include:
  - CO<sub>2</sub> capture and sequestration,
  - Renewables (Solar, Wind, etc.),
  - Efficiency improvement (Vehicles, etc.),
  - Shifting to low carbon fuel (Natural gas),

5

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## Summary of Reporting

### Technologies assessed:

- Efficiency
  - Power plant: **1**
  - Vehicle: **2**
- Low carbon power generation
  - Coal to natural gas: **1**
  - Coal to solar PV: **3**
  - Coal to wind: **1**
  - Natural gas to renewables: **1**
  - Fossil fuel to biomass: **1**
- Biofuel vehicles: **2**
- Hydrogen vehicles: **1**
- CO<sub>2</sub> capture and sequestration: **1**

6

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## Rough Example – Solar PV

- Annual power generation:
  - ~ 1,000 (kWh/yr)/kWp
- Installation area for 1kWp of PV:
  - ~ 10m<sup>2</sup>/kWp
- Required area to substitute 1GW plant
  - =  $[1 \times 10^6 \times 24 \times 365 \times 0.8] / [1000] \times 10$
  - = 70 km<sup>2</sup>
  - ↔ Inside area of Yamanote-line ≈ 60 km<sup>2</sup>
- To reduce 1Gt-C:
  - 590 x 60 = 35,400 km<sup>2</sup>

7

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## Note for the Report

- Already submitted reports will be send back to you with comments.
- Develop wedges based on your own consideration.
  - Reports should not be a mere copy of Prof. Socolow's paper.
- Formal reports should be submitted via e-mail to Prof. Takahashi.

8

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## Energy and Global Environmental Policies in Several Nations

9

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## United Kingdom

10

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### Key Points in UK Policy (1/2)

- **UK Energy White Paper** : environment issues at heart of Energy Policy - desire to put UK on a path to reduce CO<sub>2</sub> levels by 60% in 2050 (compared to 1990 levels)
- No one single winning technology; broad portfolio approach required
- Clean use of fossil fuels world-wide becoming increasingly recognized as a key transitional issue in getting to a sustainable energy future

11

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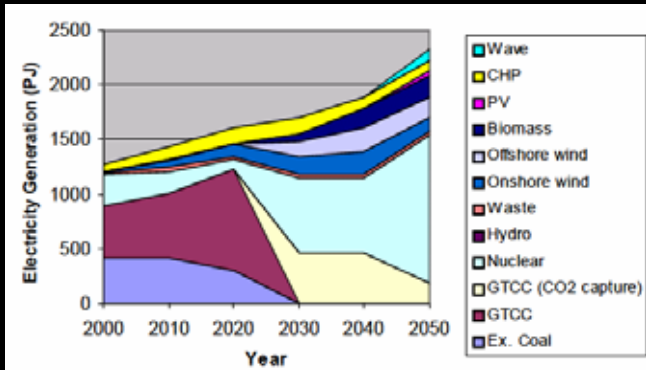
### Key Points in UK Policy (2/2)

- Desire for a Carbon Abatement Strategy that includes fossil fuels
- CCS considered as one key element in such a strategy; recognized link to "hydrogen economy" needs
- International co-operation recognised as an essential element

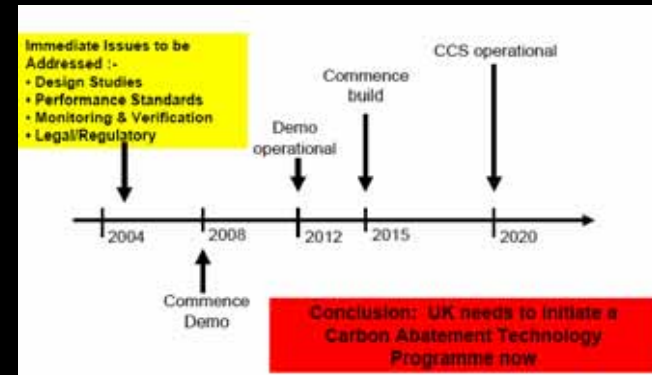
12

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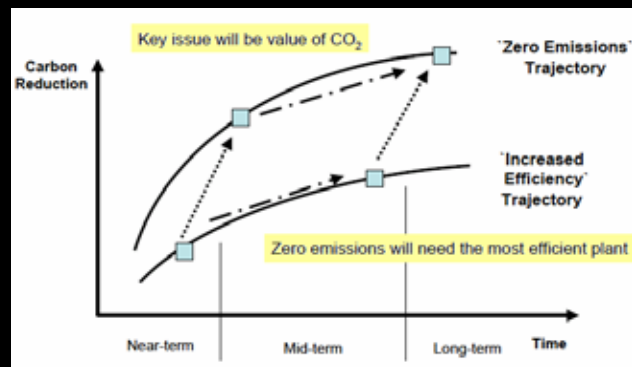
### UK Fuel Mix in Electricity Generation 60% CO<sub>2</sub> Reduction in 2050 (limited Energy Efficiency)



### UK Roadmap for Carbon Capture and Sequestration



### UK Strategy Trajectories



# Canada

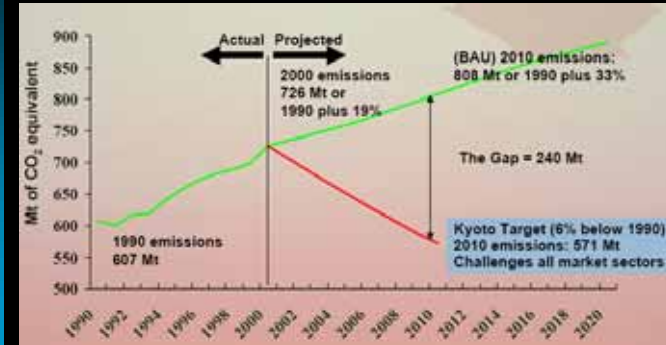
## The Canadian Context

- Canadian energy policy is framed within the context of **Sustainable Development**
- Sustainable development – pursuit of a balanced portfolio of **environmental, economic** and **social** goals
- For energy, sustainable development aims to:
  - Reduce energy use, intensity (and carbon content), emissions
- A major driver is climate change
- CO<sub>2</sub> capture and storage is the natural evolution of leading Canadian initiatives in AGI and EOR in place since the 1980's

17

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## Canada's Kyoto Challenge



18

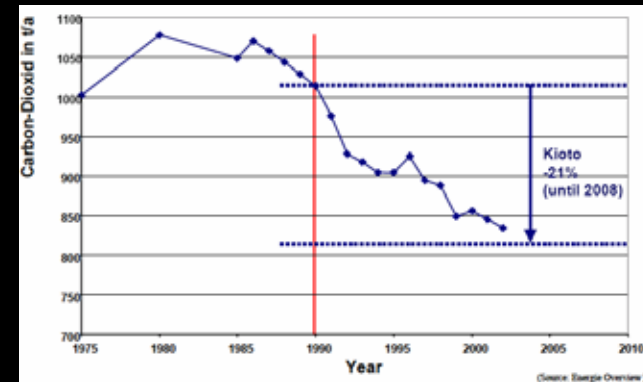
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## Germany

19

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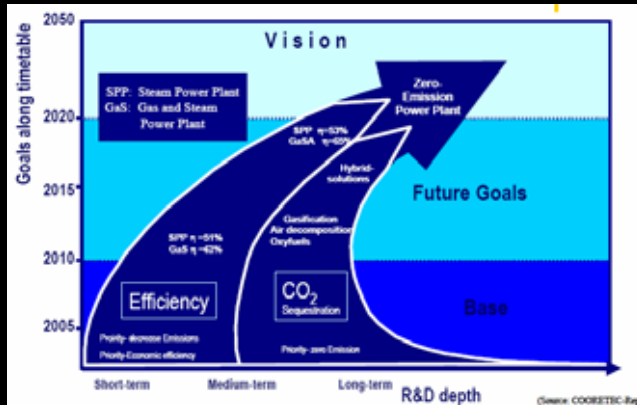
## CO<sub>2</sub> Emissions in Germany



20

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## Emission Reduction Roadmap



Italy

## GHG Emissions in Italy

- Italy committed to reduce its total GHG emissions by 6.5% in 2008-2012 compared to 1990 levels
  - 93 million tonnes by 2010 from the projected level in 2010 without any measures
- Energy-related CO<sub>2</sub> emissions have been growing gradually and were 6.5% above the 1990 level in 2001 reaching 437 Mt-CO<sub>2</sub>
  - Power sector: 155 Mt-CO<sub>2</sub> (1/3 total)
- Italian Carbon intensity: 0.35 kg-CO<sub>2</sub>/\$GDP in 2000 (IEA av. 0.43, EU av. 0.37)
  - ↓
  - Policy measures (voluntary agreements, carbon tax, regulations, international agreements, ...)
  - R&D initiatives

## Three Horses of the “Troika”

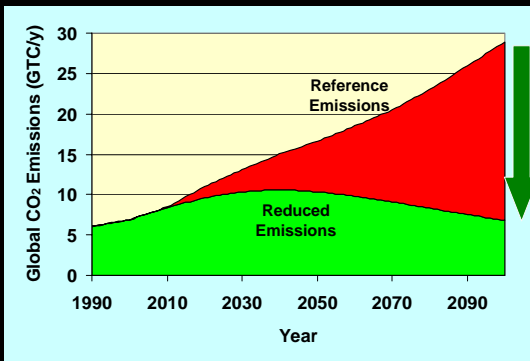
- Energy efficiency
  - Renewable energy
  - Emission free fossil fuels
- ↓
- Carbon Capture and Storage (CCS), is a crucial issue in energy policy: as the third horse of the troika
- Sometimes operate simultaneously

# United States

## 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

29

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## U.S. Initiatives for International Activities

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

30

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## 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<sub>2</sub>
- 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.

31

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## 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, South Africa, France, Norway, The Netherlands have joined

32

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## CSLF Activities

- Framework for international cooperation in research and development for the separation, capture, transportation and storage of CO<sub>2</sub>.
- 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.

33

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## 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.

34

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**FOSSIL.ENERGY.gov**  
A U.S. Department of Energy Web Site

Electric Power R&D ■ Oil/Gas R&D ■ Fuels R&D ■ Oil Reserves ■ Electricity

February 28th, 2003

**TODAY'S FOSSIL ENERGY FEATURE**

**FUTURE GEN**  
Pollution-Free Energy Plant of the Future

**DOE to Build Hydrogen, Sequestration Prototype**  
**Abraham Outlines \$1 Billion Coal Project**  
The U.S. Department of Energy will call on industry to join it in building "FutureGen," the world's first plant to produce electricity and hydrogen from coal while capturing greenhouse gases. [▶ READ MORE](#)

**Energy, State Announce U.S. Plans to Form Global Sequestration Leadership Forum**  
World Ministers Scheduled to Convene in Virginia This Spring  
The Departments of Energy and State have announced plans for the United States to organize a ministerial-level forum to advance the science and technology of carbon capture and sequestration. Representatives from around the world are scheduled to convene in June outside Washington D.C. for the Forum's first meeting. [▶ READ MORE](#)

35

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## 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<sub>2</sub> 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<sub>2</sub> to adequately validate the integrated operation of the gasification plant and the receiving geologic formation.
- Sequester at least 90 % of CO<sub>2</sub> emissions from the plant with the future potential to capture and sequester nearly 100 %.

36

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## FutureGen – Goals (2/2)

A Sequestration and Hydrogen Research Initiative

- Prove the effectiveness, safety, and permanence of CO<sub>2</sub> sequestration.
- Establish standardized technologies and protocols for CO<sub>2</sub> 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.

## Japan

## 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.

# History of Environmental Administration

## Local to Global

## History of Environmental Topics and Administration (1/6)

1880's	• Spread of mine pollution at Ashio copper mine
1897	• <b>Forest Law</b>
1911	• <b>Factory Law</b>
1955	• Itai-itai (ouch-ouch) disease became in issue (Cd)
1956	• Outbreak of Minamata disease (Hg)
1957	• <b>Natural Parks Law</b>
1958	• <b>Law Concerning the Preservation of Water Quality in Public Waters</b> • <b>Law Concerning Regulation of Industrial Effluent</b>
1961	• Air pollution and marine pollution in Yokkaichi-city

## History of Environmental Topics and Administration (2/6)

1962	• Publication of "Silent Spring" • <b>Law Concerning the Emission Control of Smoke and Soot</b>
1965	• Outbreak of Minamata disease in Niigata
1968	• Outbreak of Kanemi Oil Poisoning Symptoms (PCB) • <b>Air Pollution Control Law and Noise Regulation Law</b>
1969	• Osaka Airport Pollution Suit • <b>Law Concerning Special Measures for the Relief of the Pollution-related Patients</b> • <b>First "Annual White Paper on Environmental Pollution"</b>
1970	• Outbreak of health damage caused by photochemical smog

## History of Environmental Topics and Administration (3/6)

1971	• <b>Inauguration of the Environmental Agency</b> • <b>Offensive Odor Control Law</b>
1972	• United Nations Conference on Human Environment (Stockholm) • <b>Nature Conservation Law</b>
1973	• <b>Pollution-related Health Damage Compensation Law</b>
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)

## History of Environmental Topics and Administration (4/6)

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

45

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## History of Environmental Topics and Administration (5/6)

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
1994	• Effectuation of UNFCCC
1997	• Environmental Impact Assessment Law • COP3
1998	• Law Concerning the Promotion of the Measures to Cope with Global Warming

46

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## History of Environmental Topics and Administration (6/6)

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

47

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Approach towards  
Climate Change  
Government

48

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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) ⇒ Berlin Mandate</li> <li>• IPCC Second Assessment Report</li> </ul>
1996	• COP-2 (Geneva)
1997	• COP-3 (Kyoto) ⇒ Kyoto Protocol

49

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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.

50

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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

51

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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%

52

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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>

## 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

## 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.

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

-0.5%	Domestic GHG Emission
-2.0%	Energy related CO <sub>2</sub>
±0%	Energy supply and demand measures
-1.4%	Effort of each citizen
-0.6%	R&D and introduction of innovative technologies
+2.0%	CFC alternatives, etc. (HFC, PFC and SF <sub>6</sub> )
-0.5%	Non-energy related CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O
-3.9%	Sinks such as Japan's forests and land use change
-1.6%	Utilization of Kyoto mechanisms

## The Guidelines - Summary - *Revised GHG reduction target*

<b>-0.5%</b>	<b>Domestic GHG Emission</b>
	+0.6% Energy related CO <sub>2</sub>
	±0% Energy supply and demand measures
	-1.4% Effort of each citizen
	-0.6% R&D and introduction of innovative technologies
	+0.1% CFC alternatives, etc. (HFC, PFC and SF <sub>6</sub> )
	-1.2% Non-energy related CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O
<b>-3.9%</b>	<b>Sinks such as Japan's forests and land use change</b>
<b>-1.6%</b>	<b>Utilization of Kyoto mechanisms</b>

57

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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

58

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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**"



*Global Warming Research Initiative*

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

59

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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

60

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