CCS Activities in Japan

Expert Group Meeting on
Sustainable Development and
Carbon Capture and Storage

10 -11 September 2007

UN, New York

Makoto Akai, AIST

Contents

- Technical R&D
- Research on non-technological aspects
  - Public perception,
  - Accounting,
  - Applicability to CDM,
  - Confidence building on CCS, etc.
- Development of regulatory framework by the Ministry of Environment
- Prime Minister's "Cool Earth 50" initiative

Technical R&D in Japan

- **Late 80's:**
  - **Proposal of the concept of CCS**
- **Early 90's:**
  - **Independent research activities in National Labs., Electric Utilities, Universities, etc.**
  - **Comprehensive feasibility study on performance and cost analysis**
- **Mid 90's -:**
  - **Establishment of R&D projects under METI (former MITI)**

METI's Technical R&D Program on CCS (1997 -)

Diversified portfolio approach considering the storage potential, risk, etc.

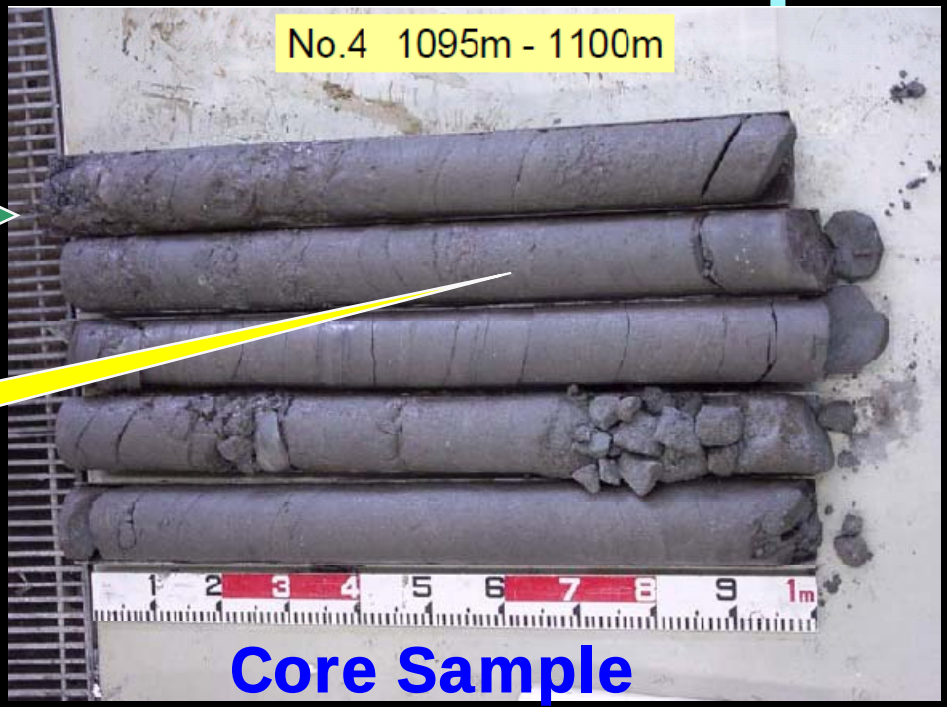
- **Ocean sequestration (1997 -)**
  - **Focused on environmental assessment and development on near-zero impact technology**
- **Geological storage (2000 -)**
  - **Nagaoka project**
- **ECBM (2000 -)**
  - **Yubari project**

RITE/ENAA - NAGAOKA project

- Injected CO_2: 10,405 t (2003 - 2005)

Experimental Site and Core Sample

CO_2 was injected into this structure



Porosity (ϕ) = 24 ~ 25%

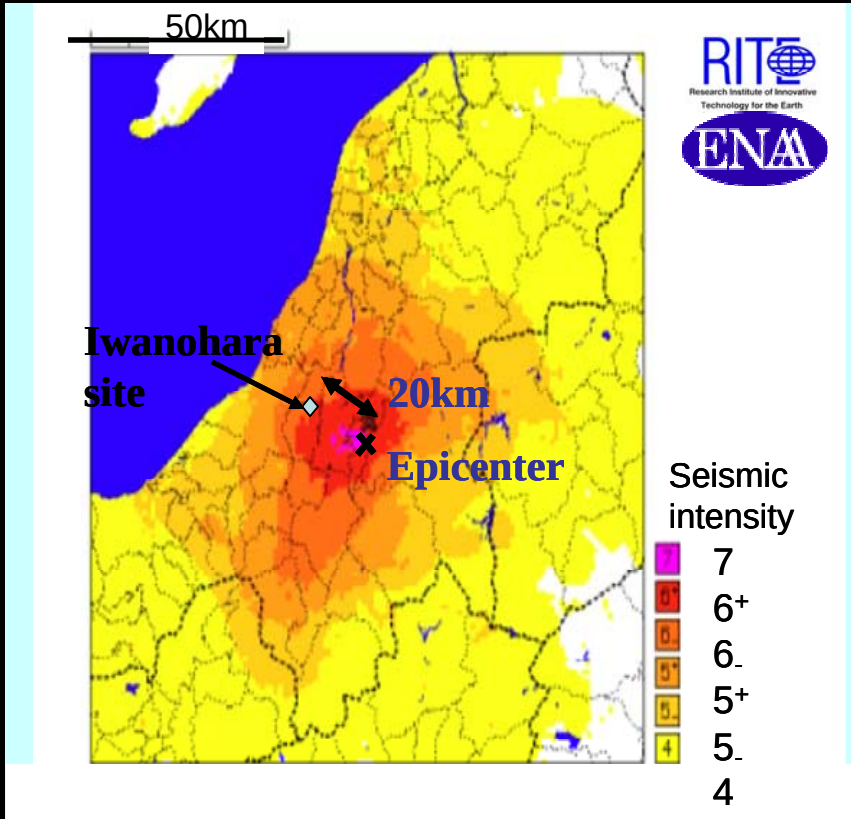
- Porosity describes how densely the material is packed, and defined by the proportion of the non-solid volume to the total volume
- Examples:
  - ϕ < 1% for solid granite;
  - ϕ > 50% for peat and clay

Big Earthquake and Nagaoka Project

Niigata Chuetsu Earthquake

- Main shock: 23 Oct 2004
- M6.8 at 10km depth
- Distance between the epicenter and the injection site is about 20km.
- The ground motions at the CO_2 injection site was 705 gal (maximum).

Injection was automatically stopped at the main shock.



(GSJ, 2004 http://www.gsj.jp/jishin/chuetsu_1023/)

Response to Big Earthquake in Nagaoka Injection Project

- Injection was automatically stopped at the main shock.
- Safety inspection made:
  - Surface Inspection
  - Press & Temp
  - Geophysical Logging
  - Acoustic Borehole Televiewer
  - Cross Well Seismic Tomography
- Injection was carefully resumed after confirming safety (6 Dec 2004)
  - Injection rate: 40t-CO_2/day

Access road to the injection site

No damage to the project

Non-technical R&D

- **Public perception,**
- **Accounting,**
- **Applicability to CDM,**
- **Confidence building on CCS, etc.**

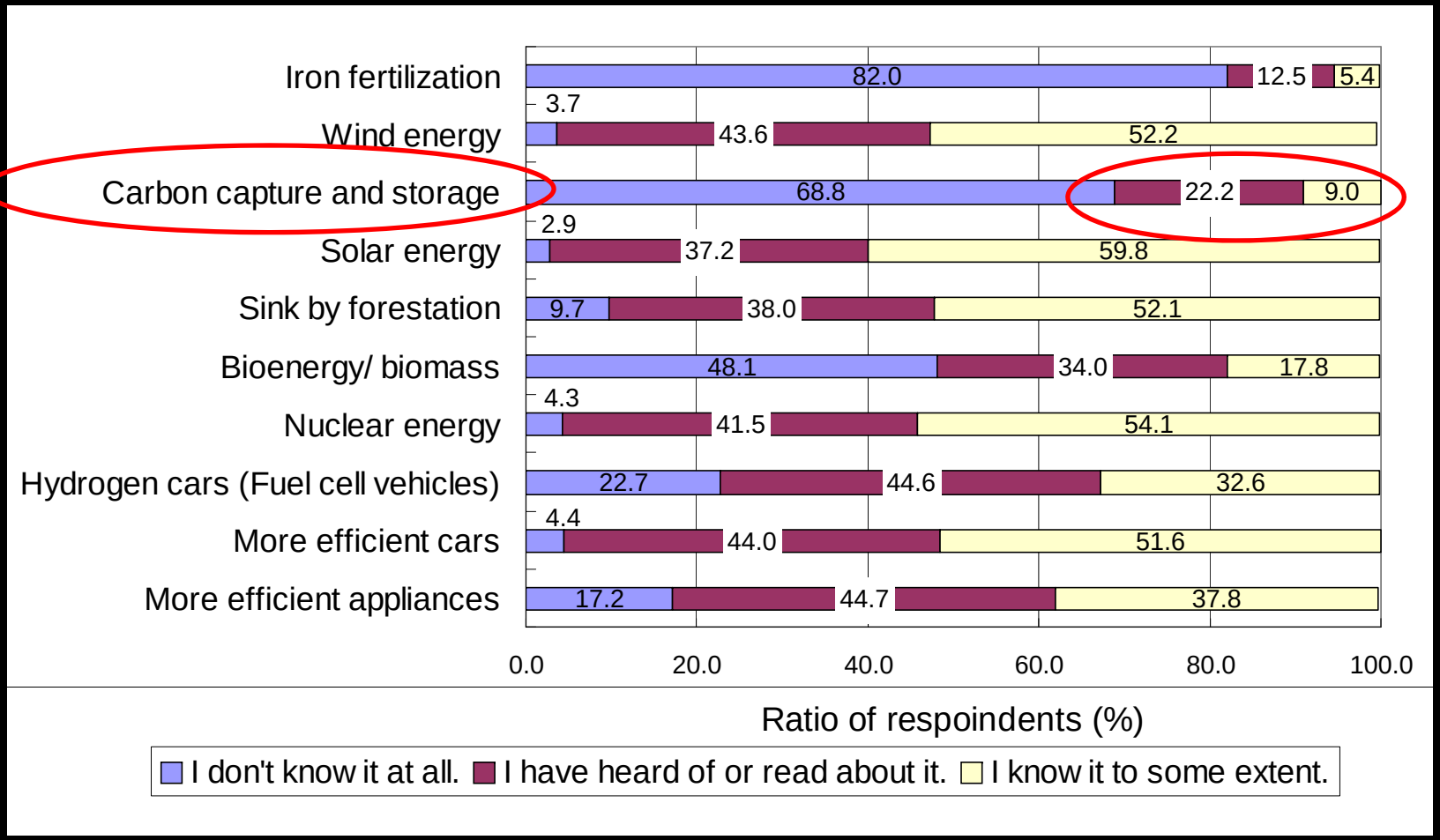
Public Perception Study

- Conducted in December 2003
- N=1006 (acceptance ratio 64%)
- Sampling
  - Method: multistage stratified sampling

Tokyo n=504	Sapporo n=502
Summer :hot and humid Winter: mild climate	Summer : pleasant climate Winter: severe climate

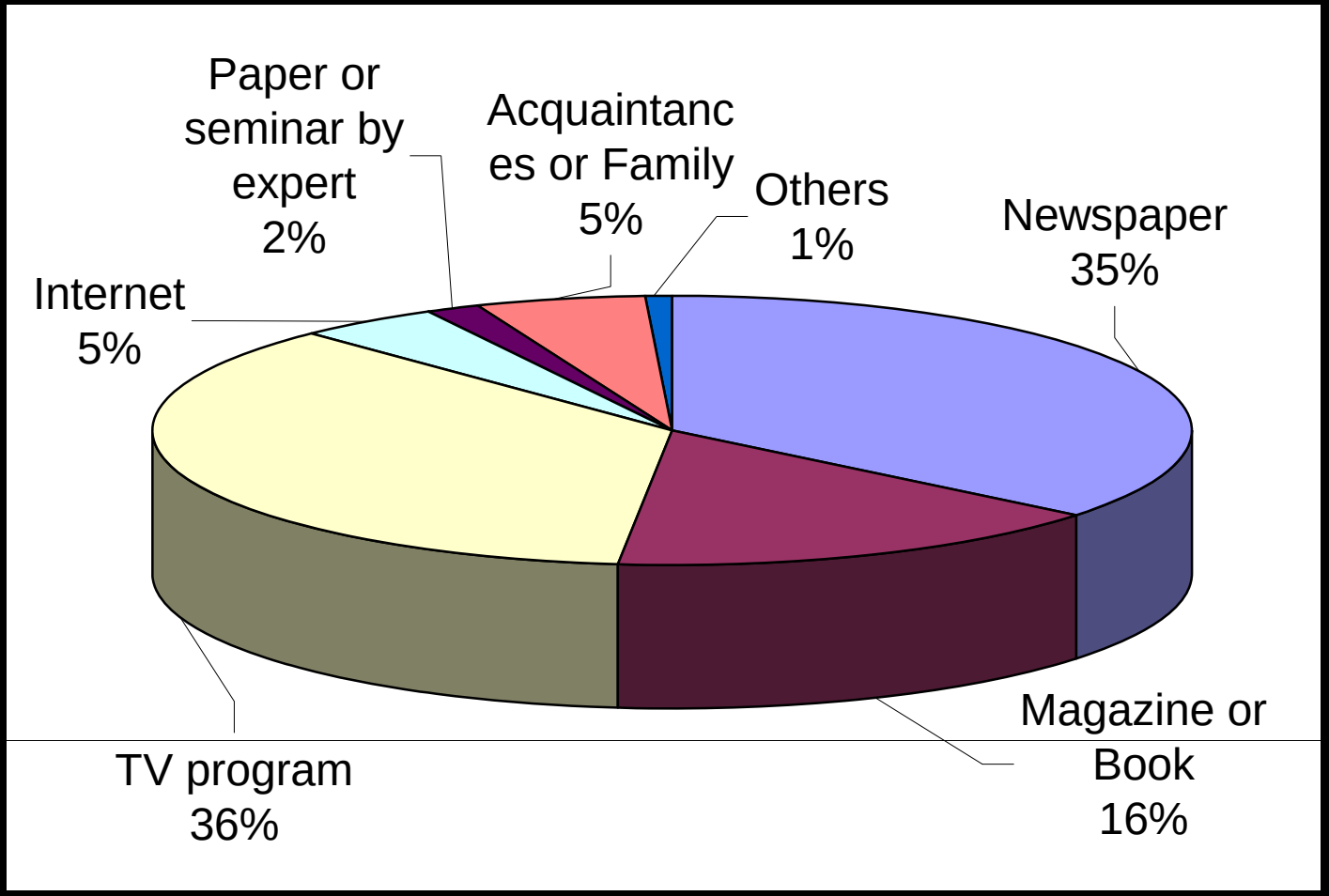
  - Age :mean=47.3 yeas old
    Sex :female=50.6%

To What Extent Public Know CCS



- **About 30％ have heard of CCS.**

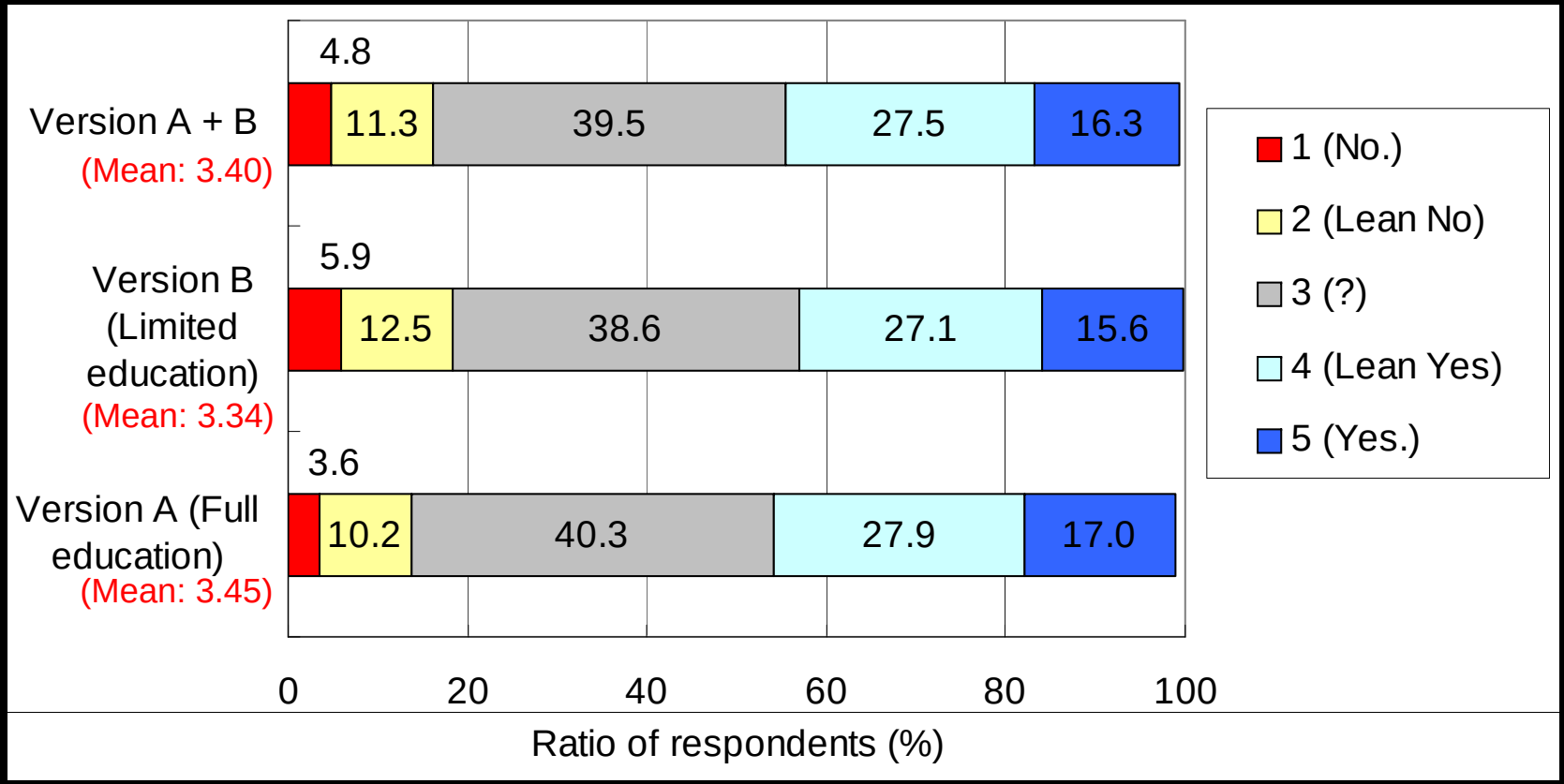
Sources of Information on CCS



- **TV and newspaper account for 1/3 respectively.**

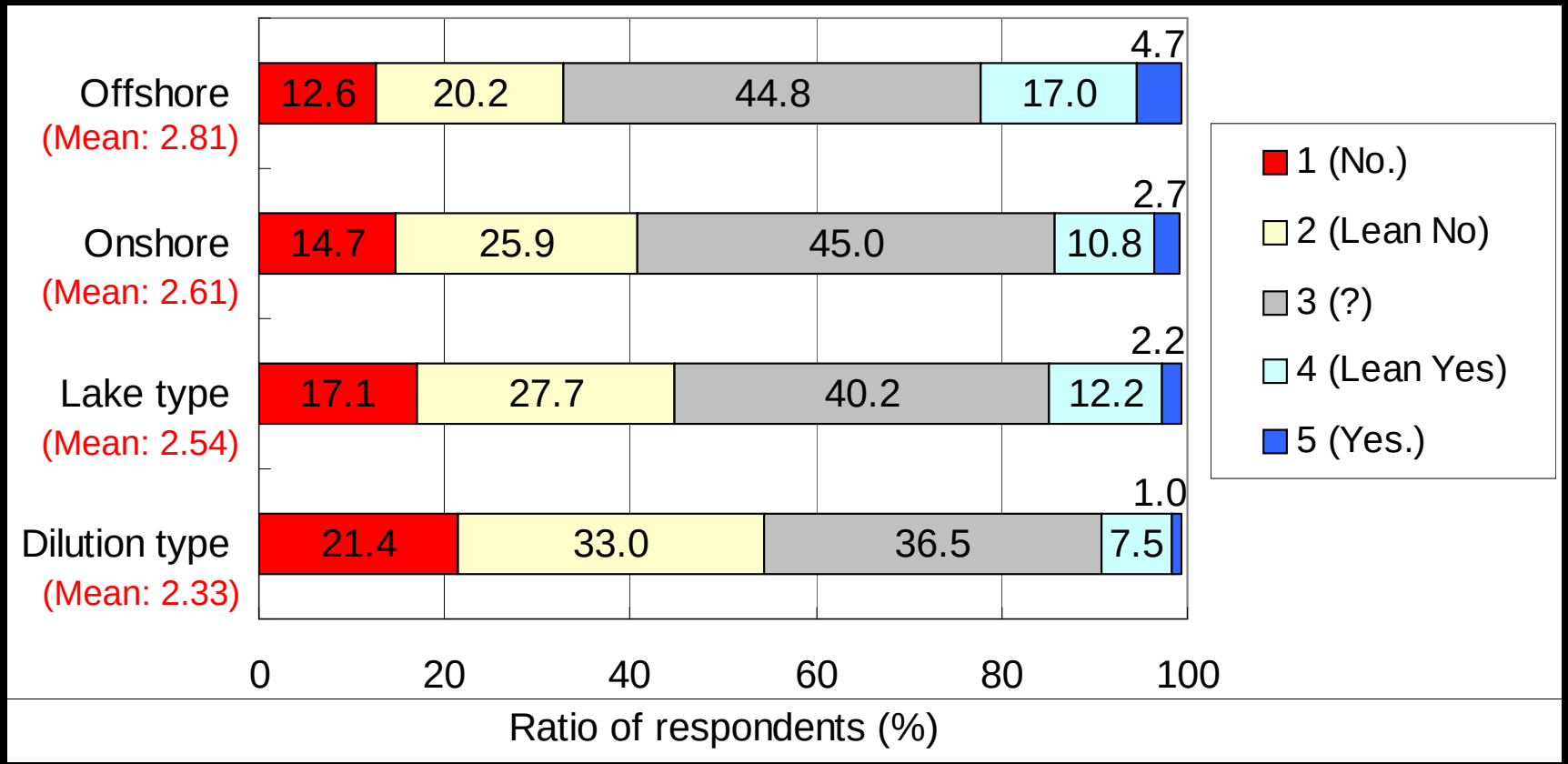
Yes / No about CCS

- **About promoting CCS toward implementation as a part of climate policy portfolio (5 level rating scale)**



Yes / No about CCS

- **About implementation by type of CCS? (5 level rating scale)**



Findings (1)

- **CCS is still not a well-known technology in Japan.**
- **Factor analysis identified four underlying factors for public's views about CCS.**
  - **concern about risk and leakage,**
  - **understanding of effectiveness of CCS,**
  - **responsibility for mitigation of CO_2,**
  - **concern about use of fossil fuel**

Findings (2)

- **Public is possessing positive opinions in general for R&D promotion of CCS but rather negative opinions for implementation of each of the four specifics type of CCS technologies covered in the survey.**
- **Japanese public are expected not to voice extreme opinions about CCS.**

Findings (3)

- **Providing more education would increase public acceptability and thereby reduce fundamental opposition.**
- **Onshore geological storage needs a careful communication strategy because it is the only of the four CCS options where the amount of education did not influence public perceptions.**

On-Going Public Perception Study

- **Conducted in February – March 2007**
  - **To make comparative analysis**
  - **To study the impact of information provided**
- **Analysis is underway but …**
  - **Initial assessment reveals that general public would be influenced by the opinion of so called "intellectuals" regardless of their expertise**

A Research Project on Accounting Rules on CO_2 Sequestration for National GHG Inventories (ARCS)

Project Duration: FY02-06

Contact:
Makoto Akai (m.akai@aist.go.jp)
National Institute of Advanced Industrial Science and Technology (AIST)

Scope of ARCS project

- **To develop models** to assess effectiveness of storage and conduct case studies for various CO_2 injection scenarios
- **To propose guideline and/or protocol** for accounting sequestered CO_2 into GHG emission inventories through "thought experiment" using developed models
- **To assess socio-economic and policy implications** of the technology through energy modeling and evaluation of business opportunities

APPROACH

Emission Estimation Methodology

IPCC Framework
✓ Scientific assessment

UNFCCC Framework
✓ Workable rules

Accounting Rules for National Inventories

Accounting Rules for Project-based Activities

Progress

- **Proposal of leakage estimation and accounting rules for CCS ⇒ *Discussion Papers, which cover:***
  - **Accounting rules for National Inventories**
  - **Accounting rules for project-based activities**
  - **– Discussion paper was used as a text in the LA meeting to develop 2006 IPCC Guideline**
- **Case study for CCS-CDM to develop PDD.**
- **Additional support from METI for in-depth CCS-CDM Studies (FY04-05)**

The Challenge

Submission of Methodologies to CDM Executive Board

- **Recovery of anthropogenic CO_2 from large industrial GHG emission sources and its storage in an oil reservoir**
  - **EOR**
  - **Mitsubishi UFJ Securities (MUS)**
- **The capture of CO_2 from natural gas processing plants and liquefied natural gas (LNG) plants and its storage in underground aquifers or abandoned oil/gas reservoirs**
  - **Aquifer storage**
  - **Mitsubishi Research Institute, Inc. (MRI) and JGC Corporation.**

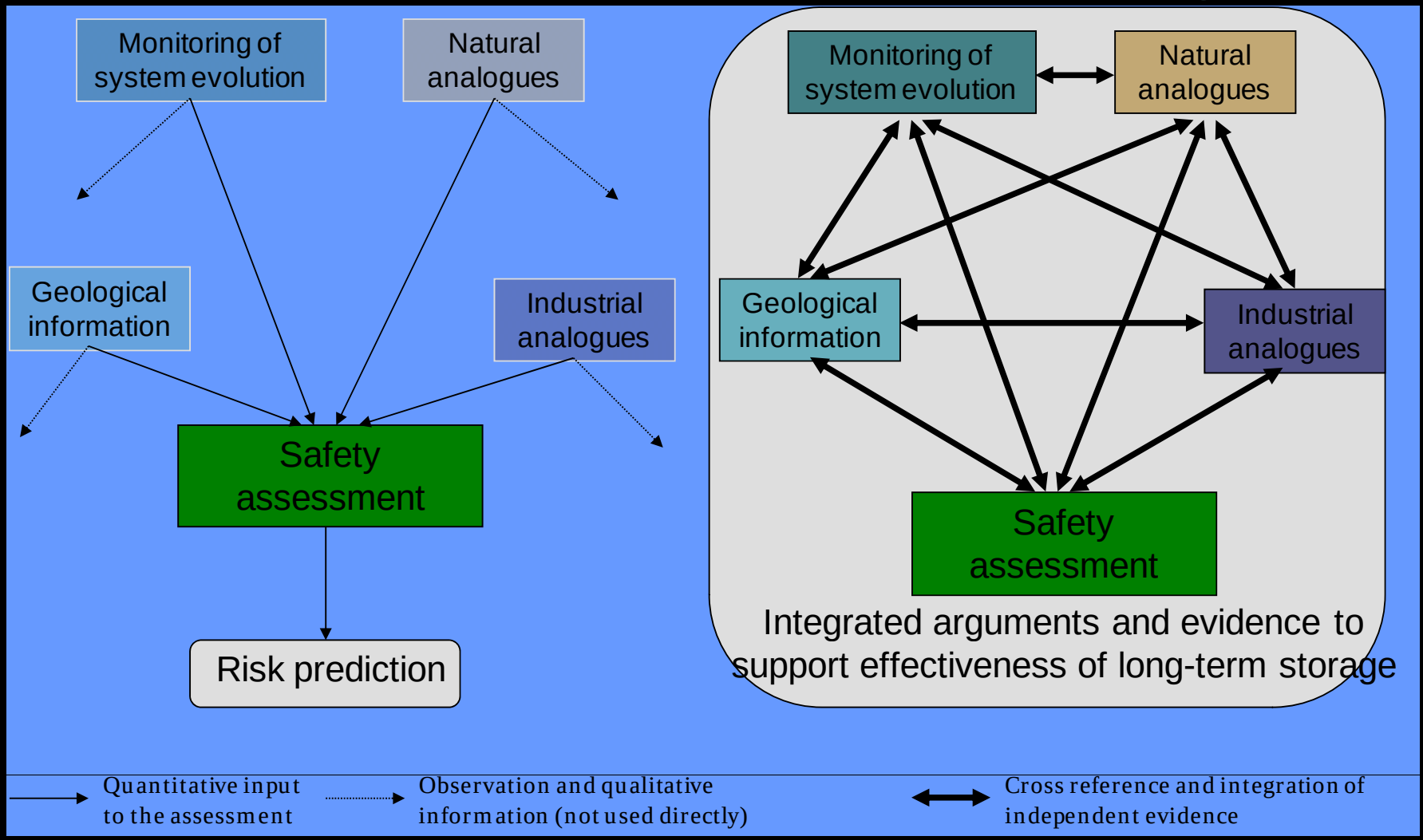
経済産業省
Ministry of Economy, Trade and Industry
METI

Workshop on Confidence Building in the long-term effectiveness of Carbon Dioxide Capture and Geological Storage

24-25 January 2007

Tokyo, Japan

Advantage of using multiple lines of reasoning



Toward a Policy Agenda

Recent Progress on Regulatory Framework for Sub-seabed Storage of Captured Carbon Dioxide

Background

- **In conjunction with the amendment of Annex I to the London Protocol 1996, Japan schedules to amend Law Relating to the Prevention of Marine Pollution and Maritime Disaster in order to manage and implement Carbon Dioxide (CO_2) sequestration in sub-seabed geological formations in an appropriate manner.**

Recent Development (1/2)

September 25, 2006

- **Environment Minister consulted Central Environment Council about the utilization of the sub-seabed CCS to help prevent climate change and on the framework for regulating SS-CCS to protect marine environment.**

February 20, 2007

- **The Council submitted the report to the Minister.**

Recent Development (2/2)

March 9, 2007

- **Based on the Council report, GOJ(MOEJ) drafted the bill on the revision of Marine Pollution Control Law, and submitted to the Diet.**

May 23, 2007

- **The bill was adopted by the Diet (promulgated on May 30).**

Permit from Minister of the Environment

- **Any party who plans to conduct CO_2 Storage to Sub Seabed Formation (CS-SSGF) shall submit application document including, but not limited to, the implementation plan, the environmental impact assessment and the monitoring plan, and shall obtain a fix-term permit from the Minister of the Environment.**
- **The Minister of the Environment issues the permit to the applicant only when:**
  1. **Proposed site and method of the CS-SSGF do not cause any adverse effects on the marine environment where the CS-SSGF takes place; and**
  2. **No other appropriate disposal methods are available.**

Application range of the framework

- In the event of a CO_2 leak, its impact on the marine environment will be the same regardless of the pathway or method of CO_2 injection into sub-seabed geological formations.
- Therefore, CS-SSGF with direct access from on-shore, which is excluded from definition of “dumping” in the London Protocol 1996, is also subject to this provision and shall obtain a permit from the Minister of the Environment.

Term of permit and its renewal

- **The permit is issued for a maximum period of five years.**
- **The Minister of the Environment will consider the renewal of the permit taking the state of operation and the possible impact on the environment into consideration.**

Site-selection criteria

- **Any party who plans to conduct CS-SSGF shall evaluate migration of CO_2 and leakage pathways, by reservoir simulations or other appropriate methods, based on the geological/hydrological features of the site.**
- **The party shall prove:**
  1. **that the stability/integrity of storage is guaranteed;**
  2. **that the capacity of reservoir is large enough compared to the total anticipated volume of the CO_2 steams; and**
  3. **that appropriate mitigation measures are available in the event of a leak.**

Consideration of reducing disposal amounts of CO_2 and other disposal options

- **Under the current regulatory framework on disposal into the sea of wastes and other matter from vessels, etc. , further attempts to reduce the necessity for disposal into the sea are required before disposal into the sea, based on WAF.**
- **In the case of CS-SSGF, the practical regulatory framework will be discussed, based on conditions to be included in CO2-WAG.**

Action list concerning the concentration of CO_2 and impurities in a CO_2 stream

The amended Annex I to the London Protocol 1996 stated that CO_2 streams to be considered for dumping consist overwhelmingly of CO_2. In addition, Annex II requires developing a national Action List to provide a mechanism for screening, which in principle bans dumping if it is not in compliance.

- In the case of CS-SSGF in Japan, the numerical limits are to be established in order to judge if CO_2 streams consist overwhelmingly of CO_2, and to confirm absence of high concentration of toxic substances such as sulfur dioxide.
- Those numerical limits and necessary criteria will be determined later in consideration with the international trends.

Assessment of potential effects on the marine environment in the event of a leak

- **Any party who plans to conduct CS-SSGF shall submit an impact assessment report to address potential impacts in the event of a leak, as stated in CO2-WAG. Main items of the assessment are described below.**
  1. **Characterization of CO_2 streams to be disposed into a sub-seabed geological formation**
  2. **Leakage case scenarios with its location and amount of leakage**
  3. **Description of the current marine environment including marine life**
  4. **Simulation results of possible changes in the marine environment and assessment of its impact, based on the leakage case scenarios**
- **The Minister of the Environment examines the impact assessment report, and issues a permit only when the minister confirms that the CCS has no potential risks to the marine environment.**

Monitoring (1/4)

- **Monitoring is one of the essential elements in a CS-SSGF project, to verify that no CO2 leaks from the reservoir, at the same time to know the possible changes in the marine environment.**
- **Therefore, any party who plans to conduct CS-SSGF shall submit the monitoring plan as a part of application documents for the review by the Minister of the Environment.**

Monitoring (2/4)

- **Once injection starts, monitoring is conducted in accordance with the monitoring plan. Main monitoring items are listed below.**
  1. **Injection pressure and formation pressure**
  2. **CO_2 migrations in the formation**
  3. **Parameters of sea water such as CO_2 concentration and pH**
  4. **Impact on marine life**

Monitoring (3/4)

- **Appropriate monitoring methods are selected in consideration of progress in science and technology, impact of monitoring itself on the environment, and other related issues.**
- **Since CS-SSGF aims long-term storage of CO_2 into sub-seabed geological formations, monitoring is required not only for the duration of injection, but also after the cease of injection (post closure).**

Monitoring (4/4)

- **The actual period of the post closure monitoring is left for future solution, and the post closure monitoring needs to be conducted in view of the international trends such as CDM verification methods. Possible conditions are that the formation pressure decreases to the pre-injection level, or that the accuracy of the numerical simulations reaches a satisfactory level.**
- **The party conducting CS-SSGF is required to report the monitoring results periodically to the Minister of the Environment.**

Response to the potential impact on the marine environment (1/2)

- In case monitoring results indicate that CO_2 migration or impact on the marine environment does not stay within the range of assessments, the party conducting CS-SSGF shall take corrective actions described below.
- If this is the case, the party shall immediately inform the Minister of the Environment of the monitoring results and the planned corrective actions.

Response to the potential impact on the marine environment (2/2)

- The party is also required to report on the implementation of the actions as well as subsequent periodical monitoring results.
  1. Corrective action – CO_2 leakage in the injection phase
     - The party is required to take mitigation actions such as cease of the injection activity and formation pressure release. The party is also required to continue monitoring with high frequency until the migration of CO_2 and the impact on the marine environment settle within the initial range of estimates.
  2. Corrective action – CO_2 leakage in the post-closure phase
     - The party is required to take mitigation actions such as formation pressure release. The party is also required to continue monitoring with high frequency until the migration of CO_2 and the impact on the marine environment settle within the initial range of estimates.

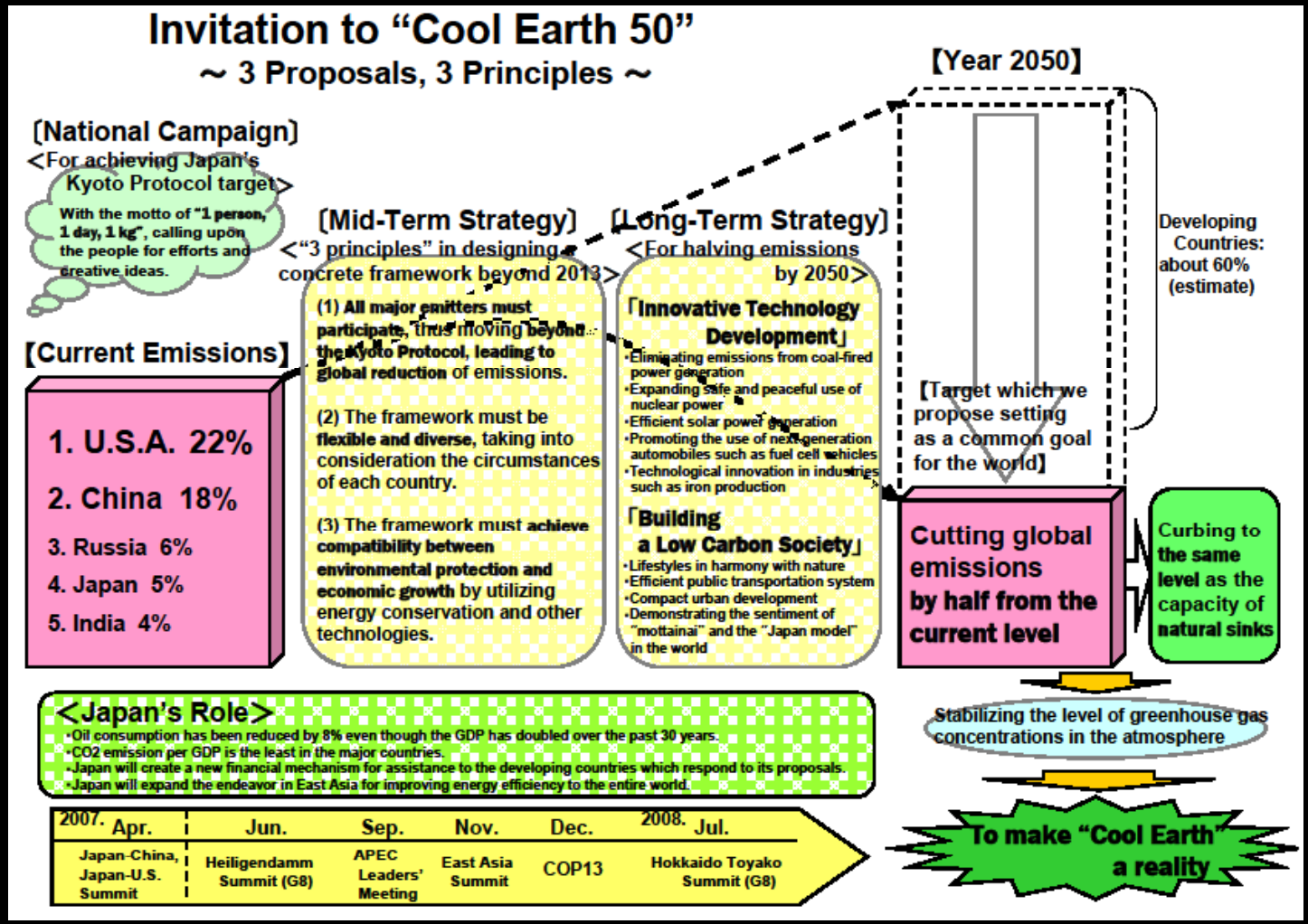
Development of Guidelines

- **With this amendment, the regulatory framework for CS-SSGF was established in accordance with Annex II (WAF) to the London Protocol 1996.**
- **Specific Guidelines for the Assessment of Carbon Dioxide Streams for Disposal into Sub-seabed Geological Formations (CO2-WAG) have been developed.**

From R&D towards a Policy Agenda

- Until recently, CCS has been discussed under the environmental R&D policy in METI
- **Agency for Natural Resources and Energy**, Ministry of Economy, Trade and Industry discussed CCS in the development of *Energy Technology Vision 2100* released in 2005.
- *New National Energy Strategy* (2006) and revised *Basic Plan on Energy* (2007) refers to CCS

Prime Minister's "Cool Earth 50" Initiative



Innovative Technologies for Significant Reductions of CO_2 Emissions

1. Innovative Zero-emissions Coal-fired Power Generation

The combination of the efficiency improvements of coal gasification power generation and CO2 capture and storage (CCS) technology to realize zero-emissions coal-fired power generation, which currently accounts for around 30% of the global emissions

2. Advanced Reactors for Nuclear Power Generation

The development and commercialization of next generation light water reactors, small and medium reactors, high temperature gas-cooled reactors, and fast breeder reactors (FBR) to significantly increase zero-emissions nuclear power generation

3. Innovative Technology for High-efficiency and Low-cost Solar Power Generation

A significant improvement in the efficiency of solar power generation to reduce its cost to the level of thermal power generation, together with the capacity increase and cost reduction of rechargeable batteries

4. Innovative Technology for the Use of Hydrogen

The cost reduction and efficiency improvements of fuel cells for the wide use of fuel cell vehicles to realize zero emissions in the automobile sector, which currently accounts for nearly 20% of the global emissions

5. Ultra High Energy Efficiency Technology

Ultra high energy efficiency technologies for production processes and equipment to realize significant energy saving and emission reductions, e.g. iron and steel making technology to partially substitute hydrogen for coke as a reducer

Concluding Remarks

CCS is now became an agenda for energy and environmental policy, however … there still exist needs for

- **Significant cost reduction**
- **Incentives including appropriate "mechanisms"**
- **Confidence by public, scientists and policy makers**

and … if CCS is inevitable for Japan's policy

- **Responsible body promoting ~~RD~~&DD**