Japan is moving forward to large-scale CCS demonstrations

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9 December 2010

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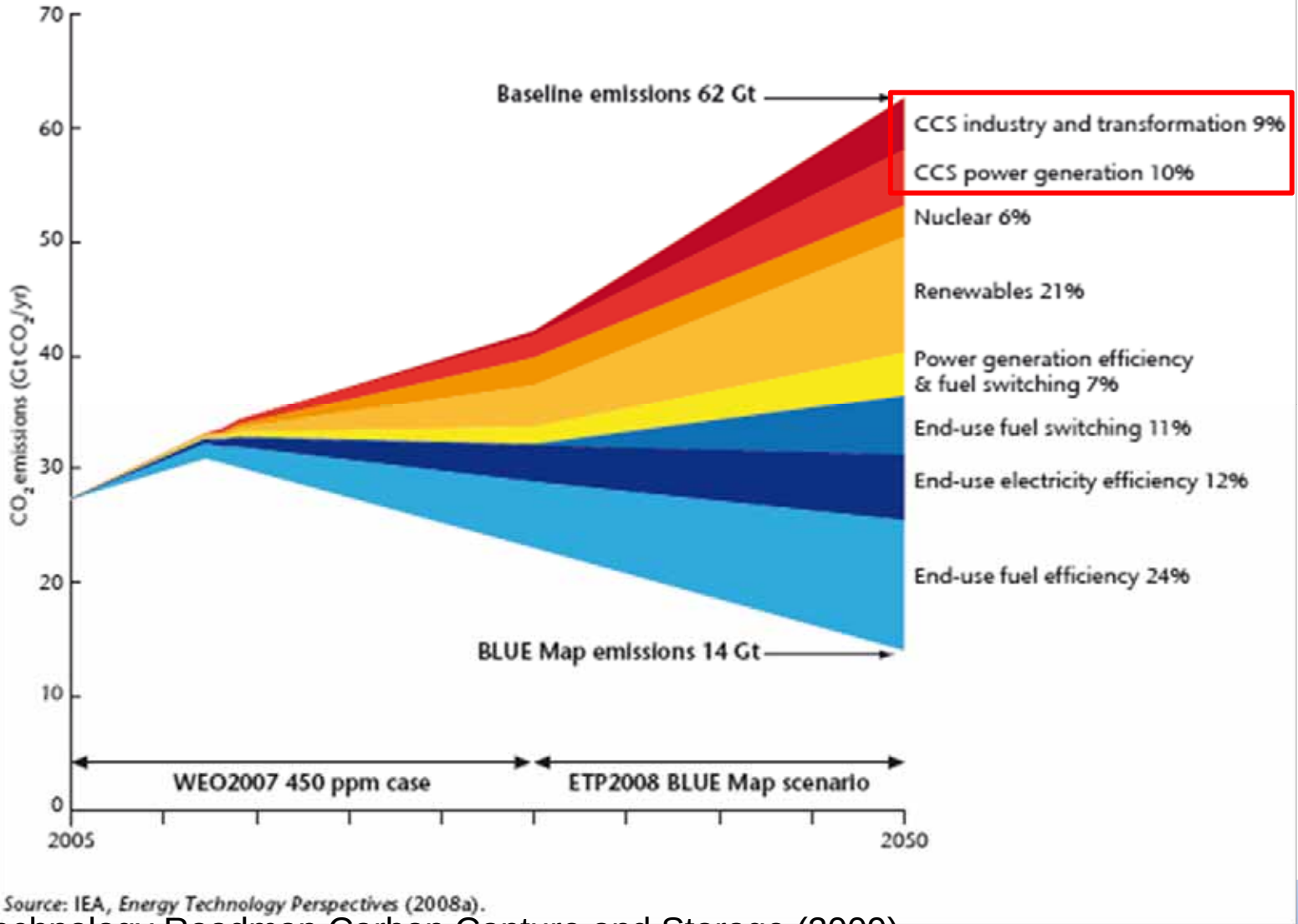
Contents

CCS is a key technology (1)

Figure 1: CCS delivers one-fifth of the lowest-cost GHG reduction solution in 2050

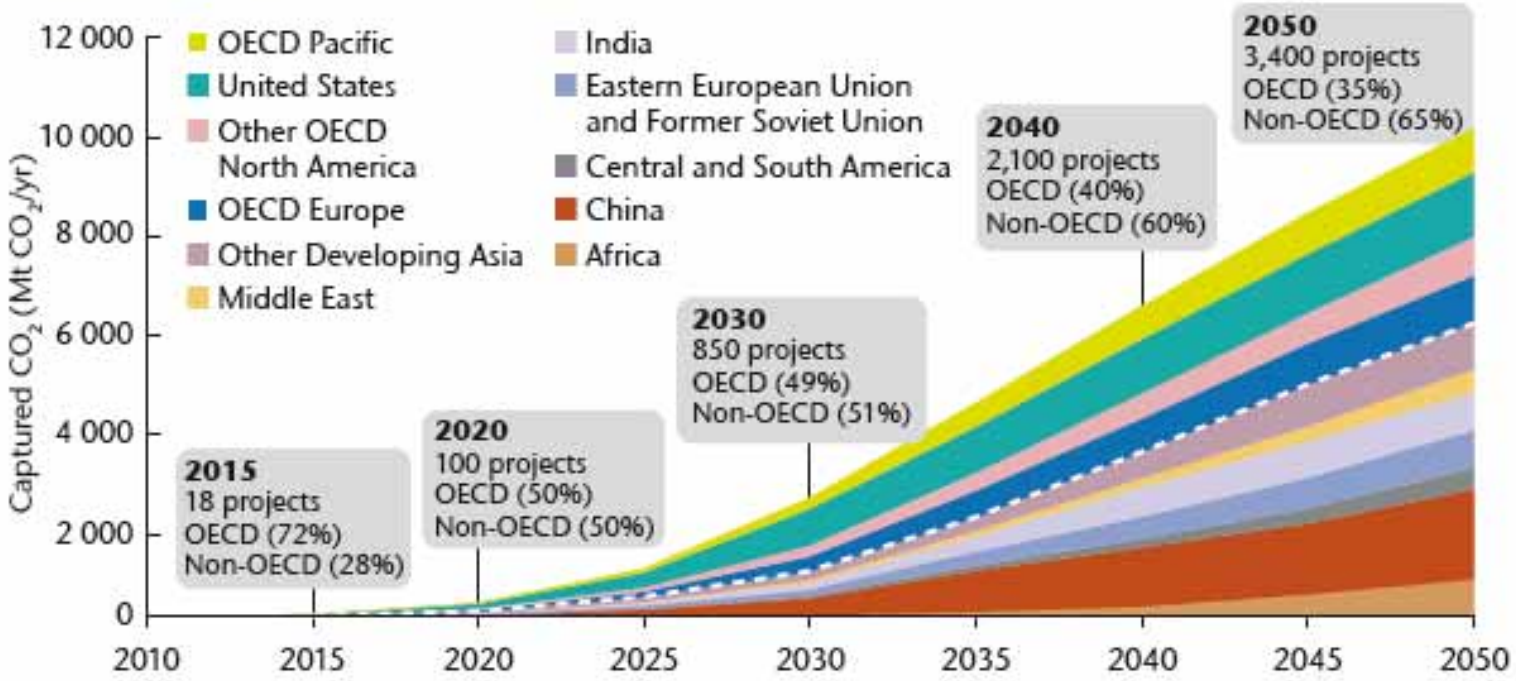


Source: IEA, *Energy Technology Perspectives* (2008a).

IEA, Technology Roadmap Carbon Capture and Storage (2009)

CCS is a key technology (2)

Figure 6: Global deployment of CCS 2010–50 by region ($MtCO_2$ captured/year)



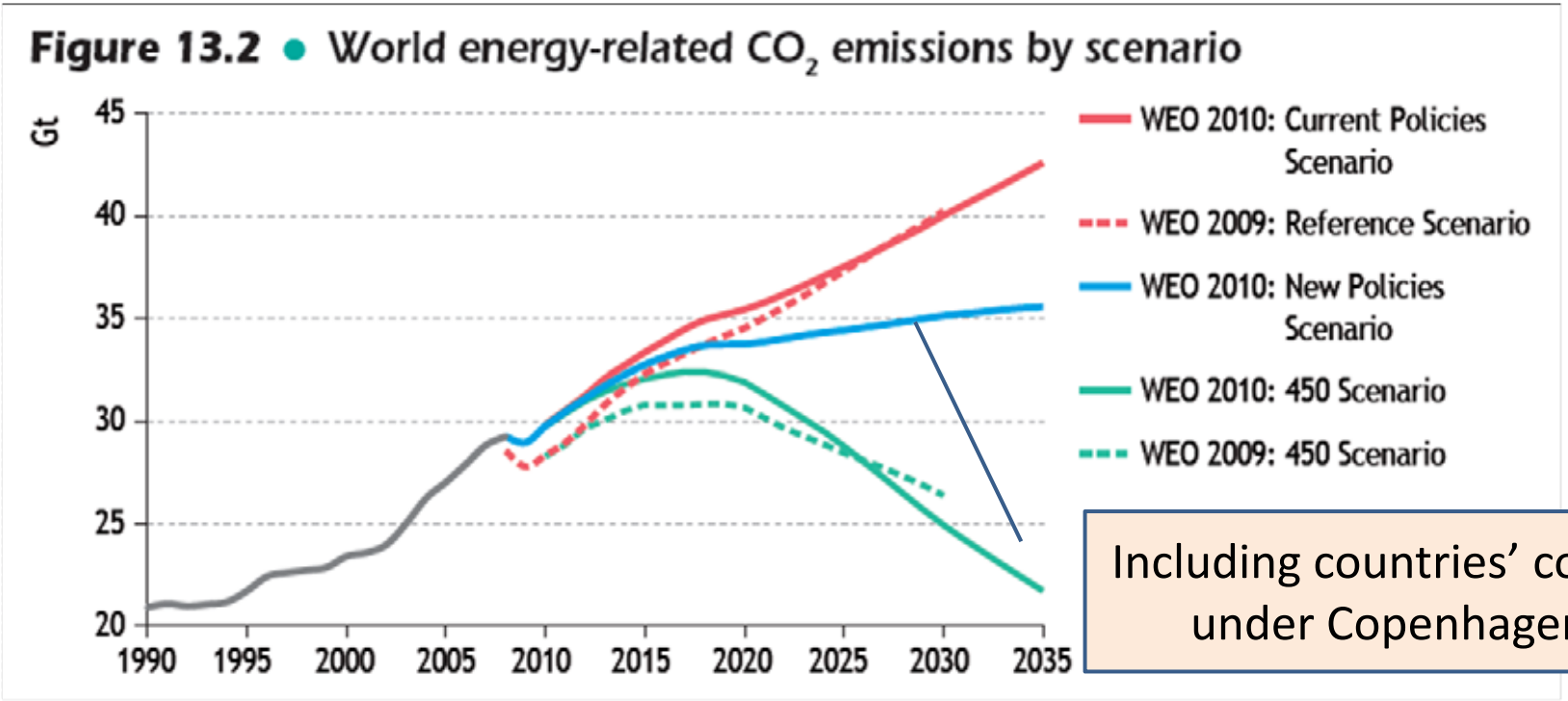
Note: The dashed line indicates separation of OECD/non-OECD groupings.

***KEY POINT**: To achieve the BLUE Map targets, OECD regions must lead in the demonstration phase but then CCS technology must spread rapidly to the rest of the world.*

IEA, Technology Roadmap Carbon Capture and Storage (2009)

Copenhagen Accord

- Taken by the Conference of Parties of UNFCCC of December 18, 2009
- Agree that deep cuts in global emissions are required so as to hold the increase in global temperature below 2 ^{O}C, and take action to meet this objective



Including countries' commitments under Copenhagen Accord

Source: World Energy Outlook 2010, IEA

World Energy Outlook 2010 by IEA

- New Policies Scenario
  -Implementation of the policy commitments and plans announced by countries including Copenhagen Accord
  -Increase of the world energy demand 1.2% per year between 2008 and 2035
  -Concentration of GHG: 650 ppm
  -Long term pletemperature rise: 3.5 ^{O}C

- 450ppm Scenario
  -Long term temperature rise: 2.0^{O}C
  -Increase of the world energy demand 0.7% per year between 2008 and 2035
  -Require far –reaching transformation of the global energy system and $13.5 trillion more than in the New Policies Scenario

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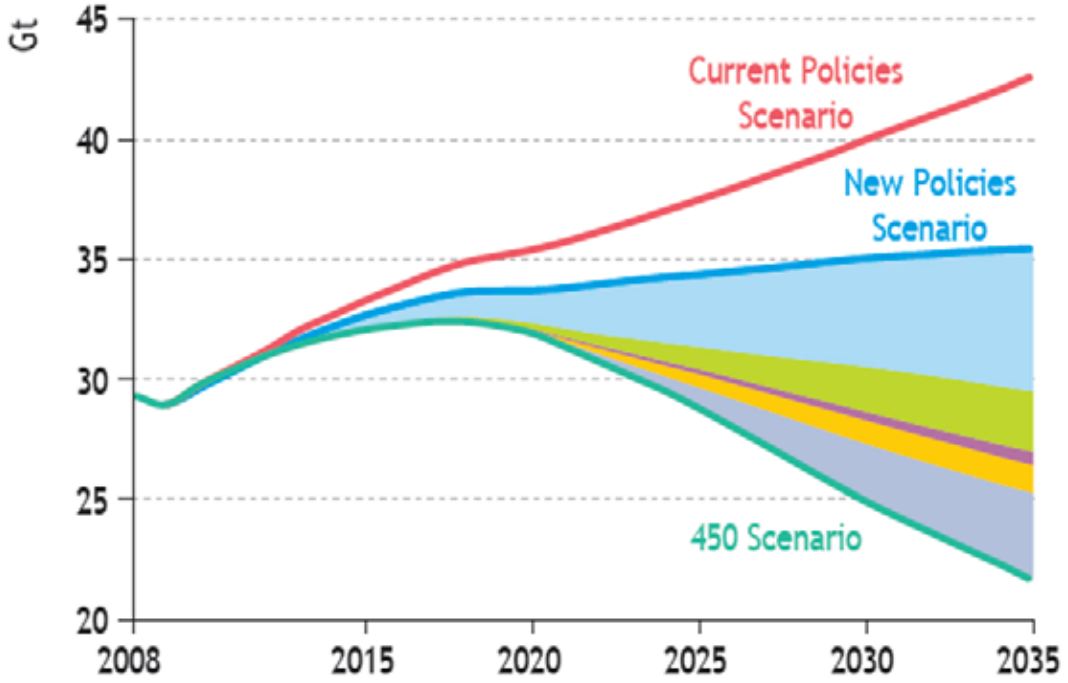
World Energy Outlook 2010 by IEA

Figure 13.18 ● *World energy-related CO_2 emission savings by policy measure in the 450 Scenario compared with the New Policies Scenario*



	Abatement	
	2020	2035
Efficiency	76%	43%
Renewables	14%	18%
Biofuels	2%	4%
Nuclear	4%	8%
CCS	3%	26%
Total (Gt CO_2)	1.8	13.7

Source: World Energy Outlook 2010, IEA

- "In Japan, CCS becomes much more important, accounting for some 75 Mt CO2, or nearly a quarter, of abatement in 2035."

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G8 Hokkaido Toyako Summit Leaders Declaration

8 July 2008

- We will establish an international initiative with the support of the IEA to develop roadmaps for innovative technologies and cooperate upon existing and new partnerships, including carbon capture and storage (CCS) and advanced energy technologies.

- We strongly support the launching of 20 large-scale CCS demonstration projects globally by 2010, taking into account various national circumstances, with a view to beginning broad deployment of CCS by 2020.

CCS Projects Status

by IEA/CSLF/GCCSI to the Muskoka 2010 G8 Summit

1. By April 2010, active collaboration between government and industry has led to:
   -80 large-scale integrated projects at various stages
   -9 operating large-scale projects and 2 projects under construction
   -Over US$26 billion world-wide in proposed government support for large-scale CCS projects.
2. All nine operating projects and the two under construction have linkages to the oil and gas sector.
3. The Gorgon Project in Australia has received a green classification for all seven G8 criteria.

Outline of the Criteria for the large-scale CCS demonstration projects

1. Large enough to demonstrate the technical and operational viability
   -1 Mtpa for coal-fired power station
   -0.5Mtpa for gas-fired power station, an industrial or natural gas processing
2. Full integration of CO_2 capture, transport and storage
3. Begin full-scale operation before 2020
4. Identification of storage site
   -Identification of primary site with site characterization underway
   -Identification of preferred CO_2 transport route
5. Providing a monitoring, measurement and verification plan
6. Appropriate strategies to engage the public
7. Adequate funding to advance the project operation

New Strategic Energy Plan

- Enacted in 2003, revised in 2007 and 2010 by Japanese Government
- Show the direction of the country's energy policy by the government based on the 3E principles, Energy security, Environment, and Economy

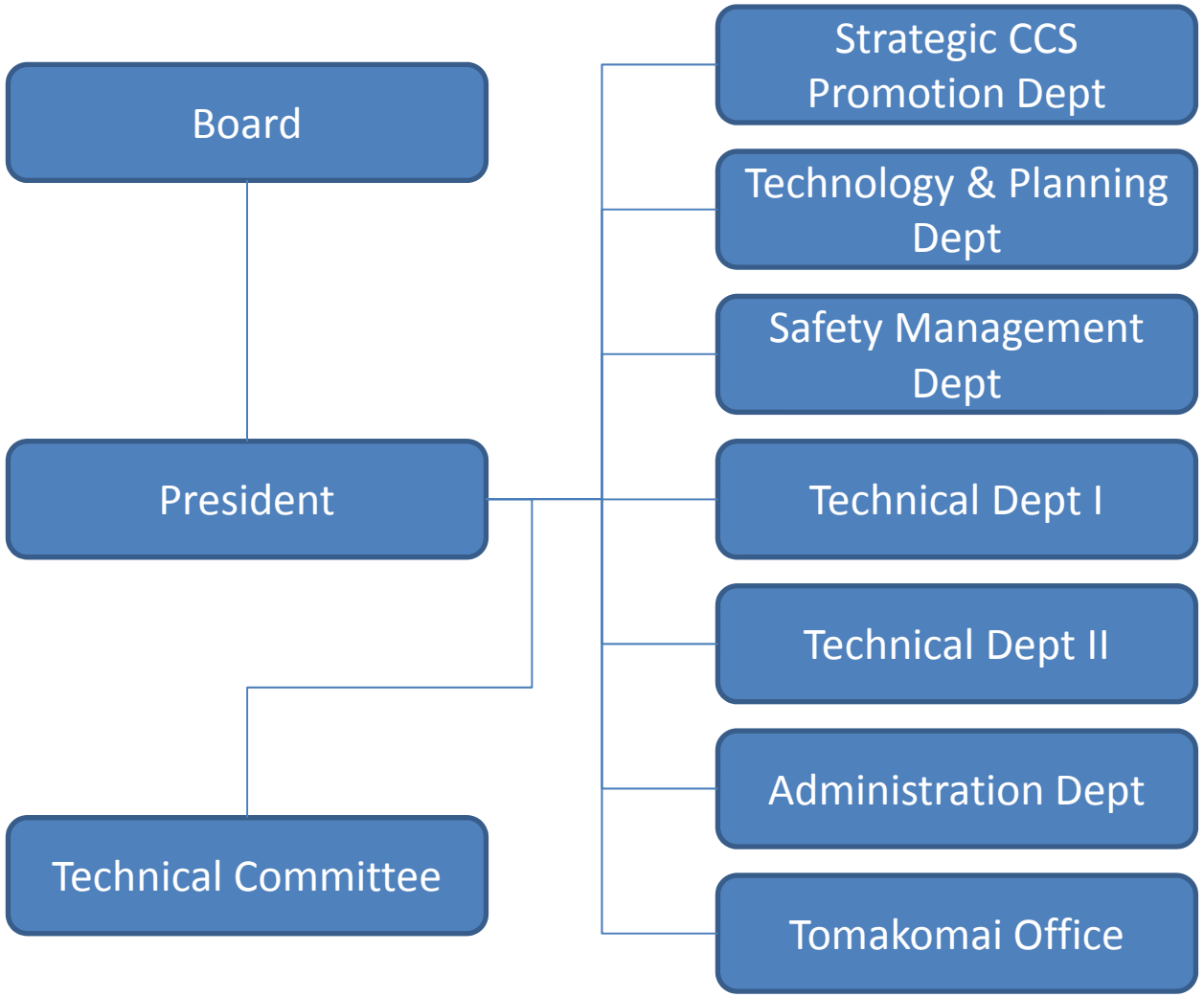
Placement of CCS

- It is important to efficient and stable energy supply consisting with the countermeasures of climate change, and the utilization of non-fossil fuel energies, such as nuclear power and renewable energy, should be promoted. From the viewpoint of supply capability, economy, and convenience, the utilization of fossil fuel will be still required. It is necessary to use fossil fuel efficiently and environmentally, therefore, the development of innovative technologies, such as CCS, is indispensable.

Who is Japan CCS?

Name:	JAPAN CCS Co., Ltd.
Date of Incorporation:	May 26, 2008
Business Description:	A comprehensive investigation for Carbon-dioxide Capture and Storage Projects in Japan
Capital:	243 mm yen (ca. US$2.3mm)
Shareholders:	36 companies 11 electric power, 4 petroleum, 5 engineering, 4 petroleum resource developing, 4 general trading, 2 iron and steel, 2 city gas, 1 chemical, 1 non-ferrous metal and cement, 1 steel pipe, 1 special trading
President:	Shoichi Ishii, Managing Director for Japan Petroleum Exploration Co., Ltd. (JAPEX)
Directors:	8 representing the shareholders' industries
Auditor:	Takashi Honjo, RITE
No of Staff:	ca. 70

Organization of JCCS



Planning, public relations, public outreach

Technical coordination, technical committee, environmental surveys, site characterization

HSE, regulations, permissions

Nakoso-Iwaki oki demonstration

Tomakomai and Kitakyushu demonstrations

Personnel, accounting, contract, procurement

Local relations

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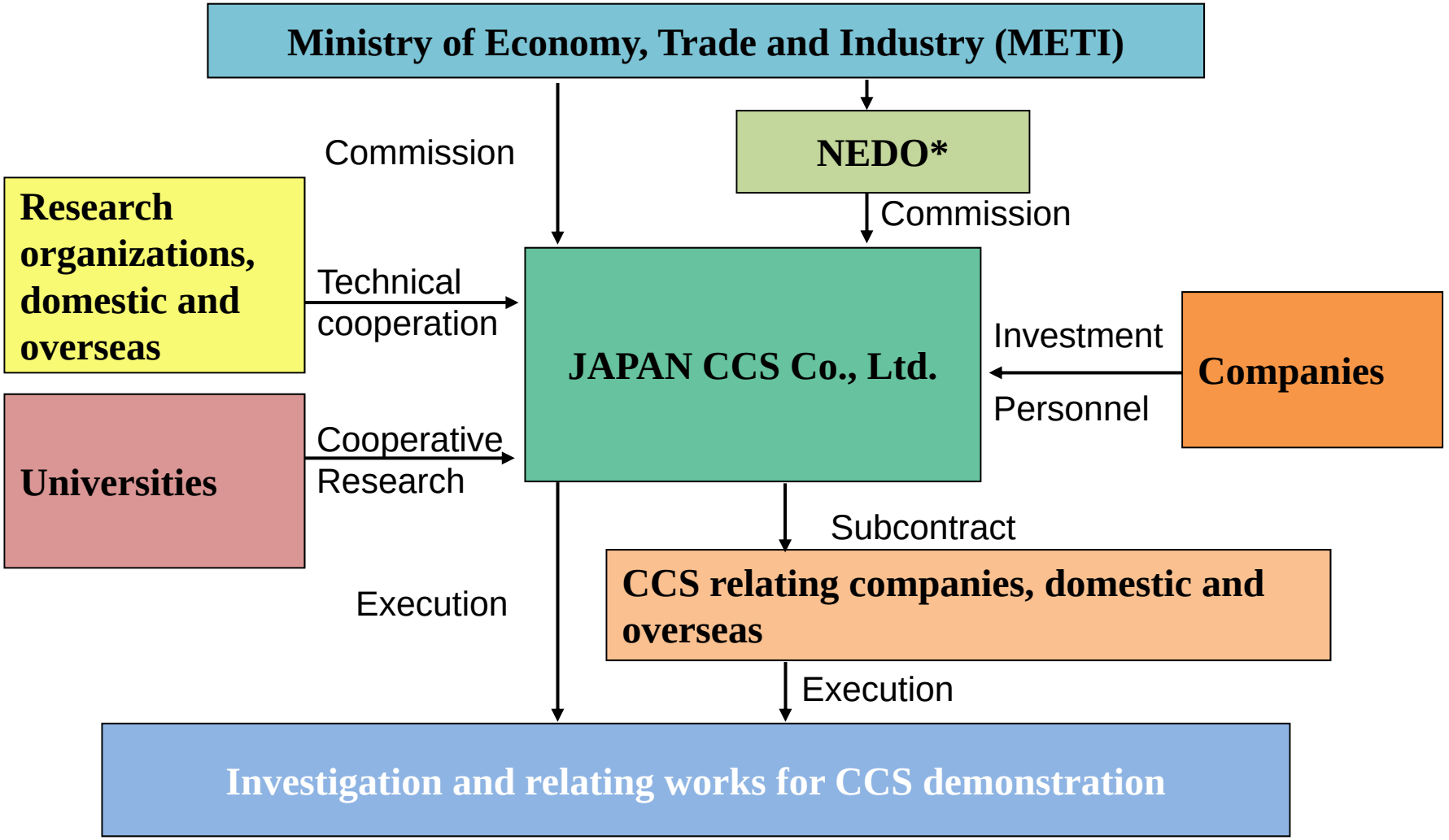
List of Shareholders

Hokkaido Electric Power Co., Inc.
Tohoku Electric Power Co., Inc.
The Tokyo Electric Power Co., Inc.
Chubu Electric Power Co., Inc.
Hokuriku Electric Power Co., Inc.
The Kansai Electric Power Co., Inc.
The Chugoku Electric Power Co., Inc.
Shikoku Electric Power Co., Inc.
Kyushu Electric Power Co., Inc.
The Okinawa Electric Power Co., Ltd.
Electric Power Development Co., Ltd.
COSMO OIL CO., LTD.
Idemitsu Kosan Co., Ltd.
Japan Energy Corporation
JX Nippon Oil and Energy Corporation
Showa Shell Sekiyu K. K.
Chiyoda Corporation
JGC Corporation
JFE Engineering Corporation
Nippon Steel Engineering Co., Ltd.
Toyo Engineering Corporation
Arabian Oil Company Ltd.
INPEX CORPORATION
Japan Petroleum Exploration Co., Ltd.
Mitsui Oil Exploration Co., LTD.
JFE Steel Corporation
Sumitomo Metal Industries, Ltd.
Tenaris NKK Tubes
ITOCHU Corporation
Marubeni Corporation
Mitsubishi Corporation
Sumitomo Corporation
Marubeni-Itochu Steel Inc.
Tokyo Gas Co., Ltd.
Osaka Gas Co., Ltd.
MITSUBISHI GAS CHEMICAL CO., INC.
Mitsubishi Materials Corporation

PROJECT FRAMEWORK
- FUNCTIONS OF JCCS -



*New Energy and Industrial Technology Development Organization

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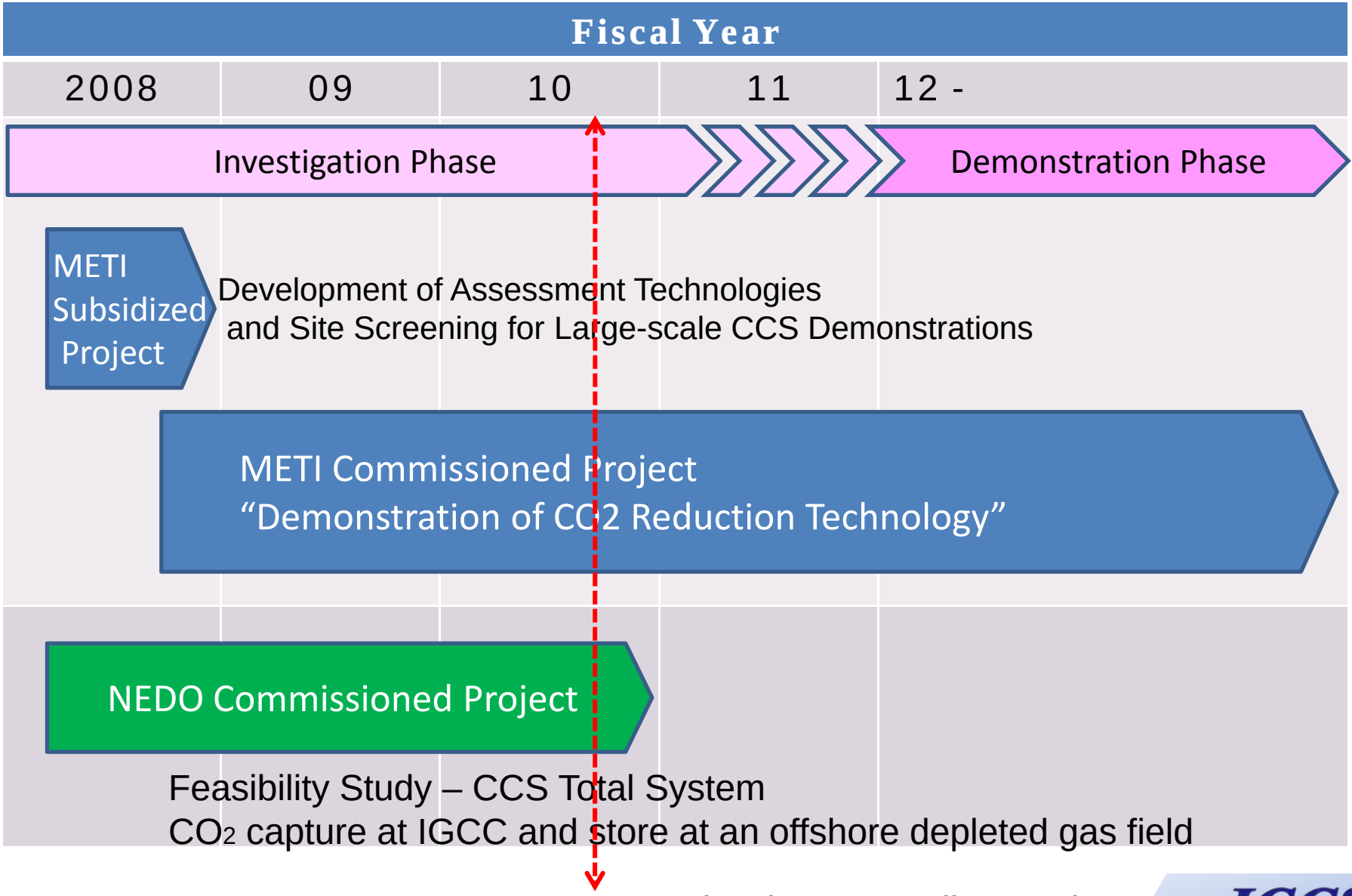
CCS Demonstration Project Phase



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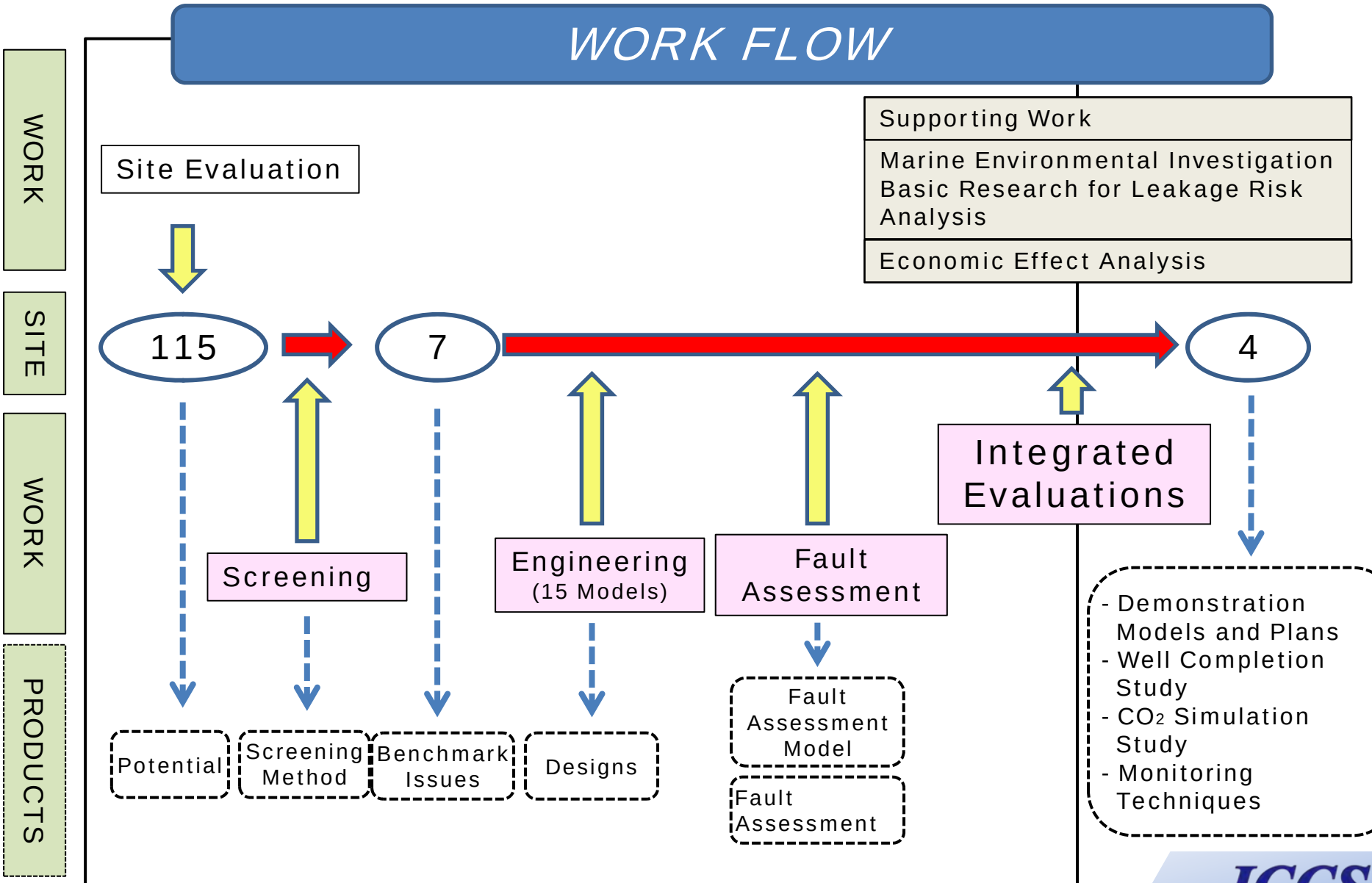
METI Subsidized Project in FY 2008



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CCS Demonstration Models

METI Subsidized Project in FY 2008

15 models of CCS total systems
for engineering and reservoir study

Source
IGCC
Coal Pulverized Power Plants
Oil refineries
Chemical Plants
Gas Field
Paper Mill Plant
Cement Plant
Ironworks

Capture
Physical Absorption
Chemical Absorption

Transport
Land Pipeline (gas)
Offshore Pipeline (gas)
Lorry (liquid)
Ship (liquid)

Injection
ERD (Extended Reach Drilling) Well
Directional Drilling Well
Subsea Completion
Platform

Store
Depleted Gas Field
Aquifer with closure
Neogene aquifer without closure
Palaeogene aquifer without closure

Candidate sites for CCS demonstrations

JCCS is conducting surveys and studies on three candidate sites for CCS demonstrations

Candidate Sites	Reservoir Types	CO_2 Source	Trans-portation	Current status
Iwaki-oki	**Depleted gas reservoir**	**IGCC**	**Offshore pipeline**	**1) Geological modeling and simulation**
Tomakomai	**Saline aquifer with closure**	**Plants**	**Onshore pipeline and tank trucks**	**1) Seismic survey 2) Survey well 3) Geological modeling and simulation**
	Saline aquifer without closure (Neogene)			
Kitakyushu	**Saline aquifer without closure (Palaeogene)**	**Preliminary survey well**		

Rules and Regulations for CCS Demonstrations

- in terms for site characterization -

Law relating to the Prevention of Marine Pollution and Maritime Disaster (amended May, 2007) and its guidelines

Geological assessment should be made in the following items; available data volume, seal efficiency of caprock, active fault, future behavior of stored CO2 , storage security in terms of reservoir depth and multi-layered caprock, etc.

For safe operation of a CCS demonstration project (operational guidelines set forth by METI in August, 2009 and to be modified)

1. Things to be assessed for CO2 storage from geological aspects

1-1 Formulation of hydrogeological and geological structure model
(1) Formulation of regional (conceptual) model
(2) Formulation of detailed (numerical simulation) model

1-2 Things to be assessed to perform large-scale demonstration project
(1) Confirmation of the existence of reservoir and cap rock
(2) Setting of adequate CO2 injection plan (injection rate and amount)
(3) Sealing property of cap rock
(4) Seismic activities occurred in the past in the vicinity of CO2 injection site

1-3 Data to be acquired, acquisition methods, and time-frame for acquisition
(1) Data to be acquired before drilling the exploration well
(2) Data to be acquired before CO2 injection

Offshore pipeline route survey at Iwaki-oki candidate site

Purpose

Acquire basic marine data to select the route of and to design an offshore pipeline from Nakoso to Iwaki-oki depleted gas field

Area

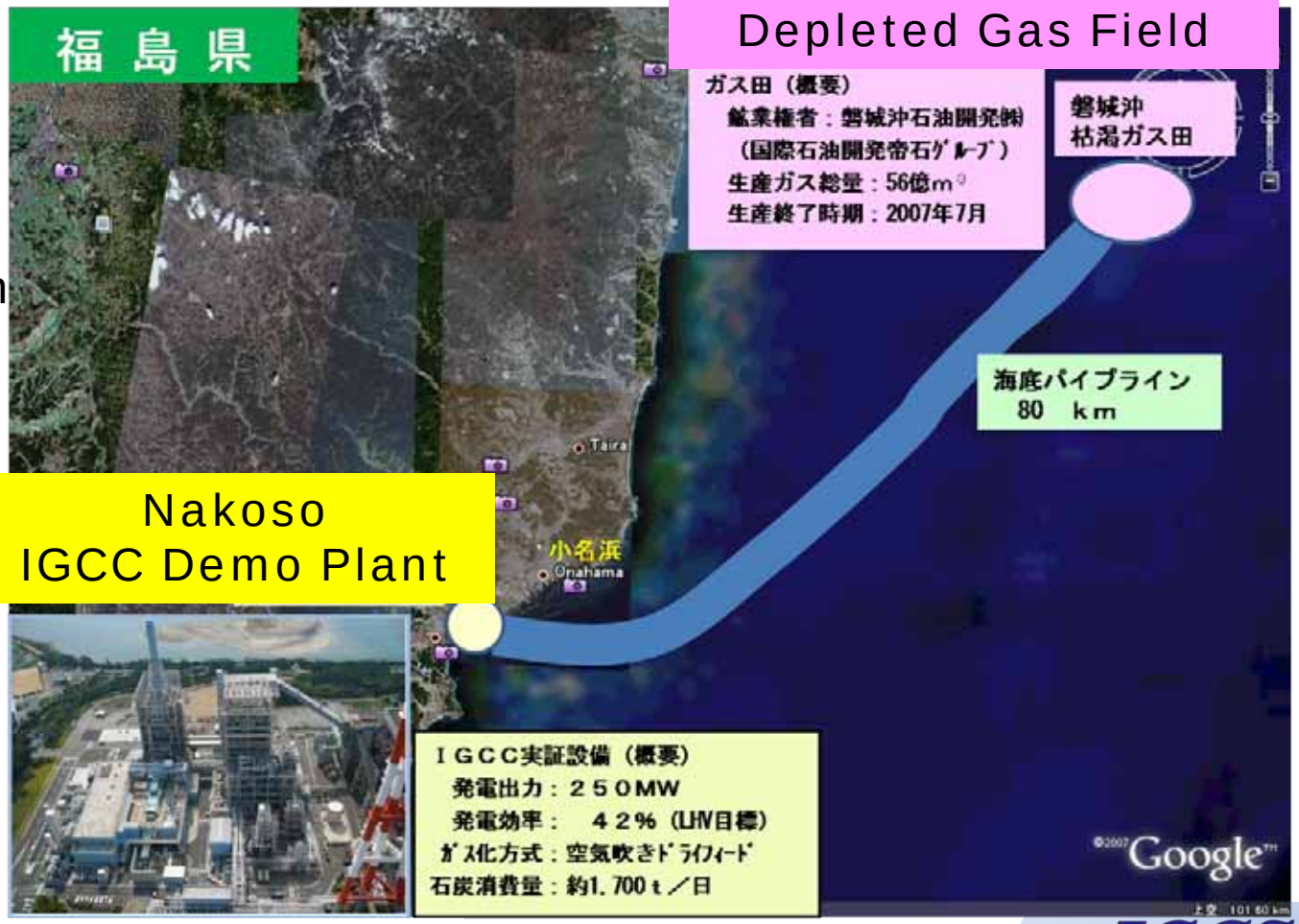
- 80 km x 400 m

Items

- sea bottom condition
- depth
- sea bed geology

Term

July – August 2009



From HP of Clean Coal Power R & D Co., Ltd.
http://www.ccpower.co.jp/topics/sekitan_02.pdf

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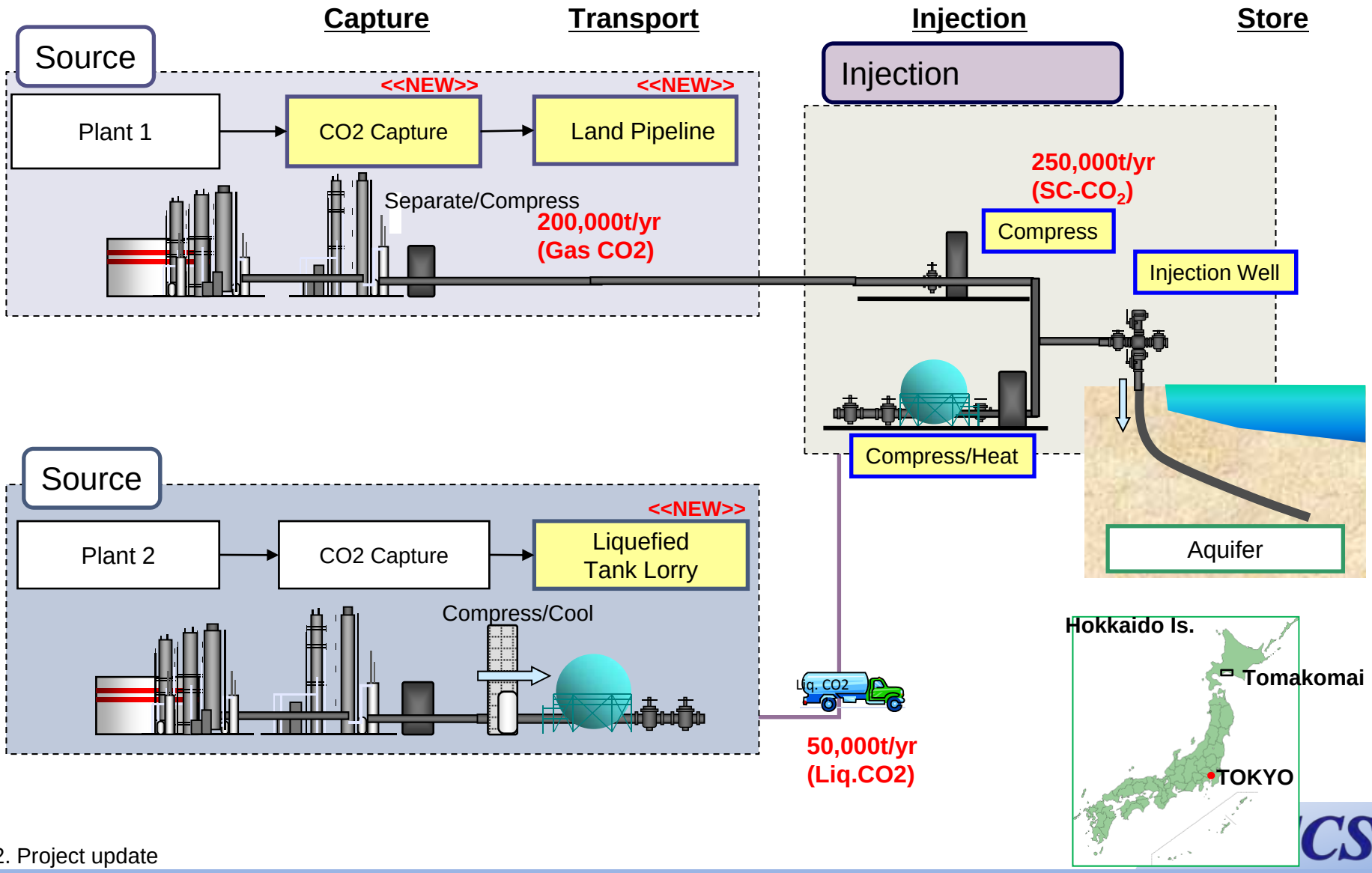
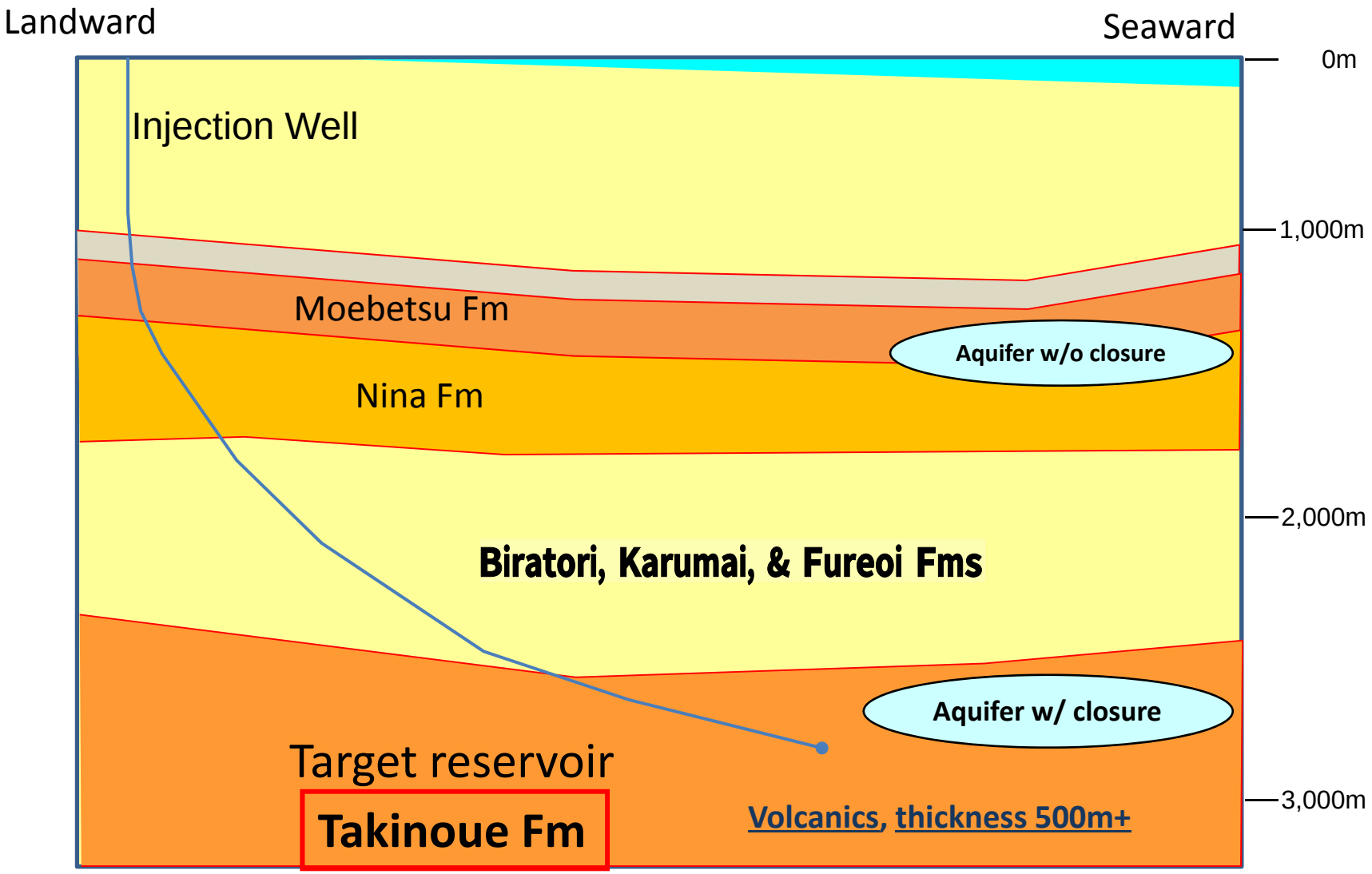
Assumed Flow at Tomakomai Site

One Example



Schematic cross section at Tomakomai candidate site



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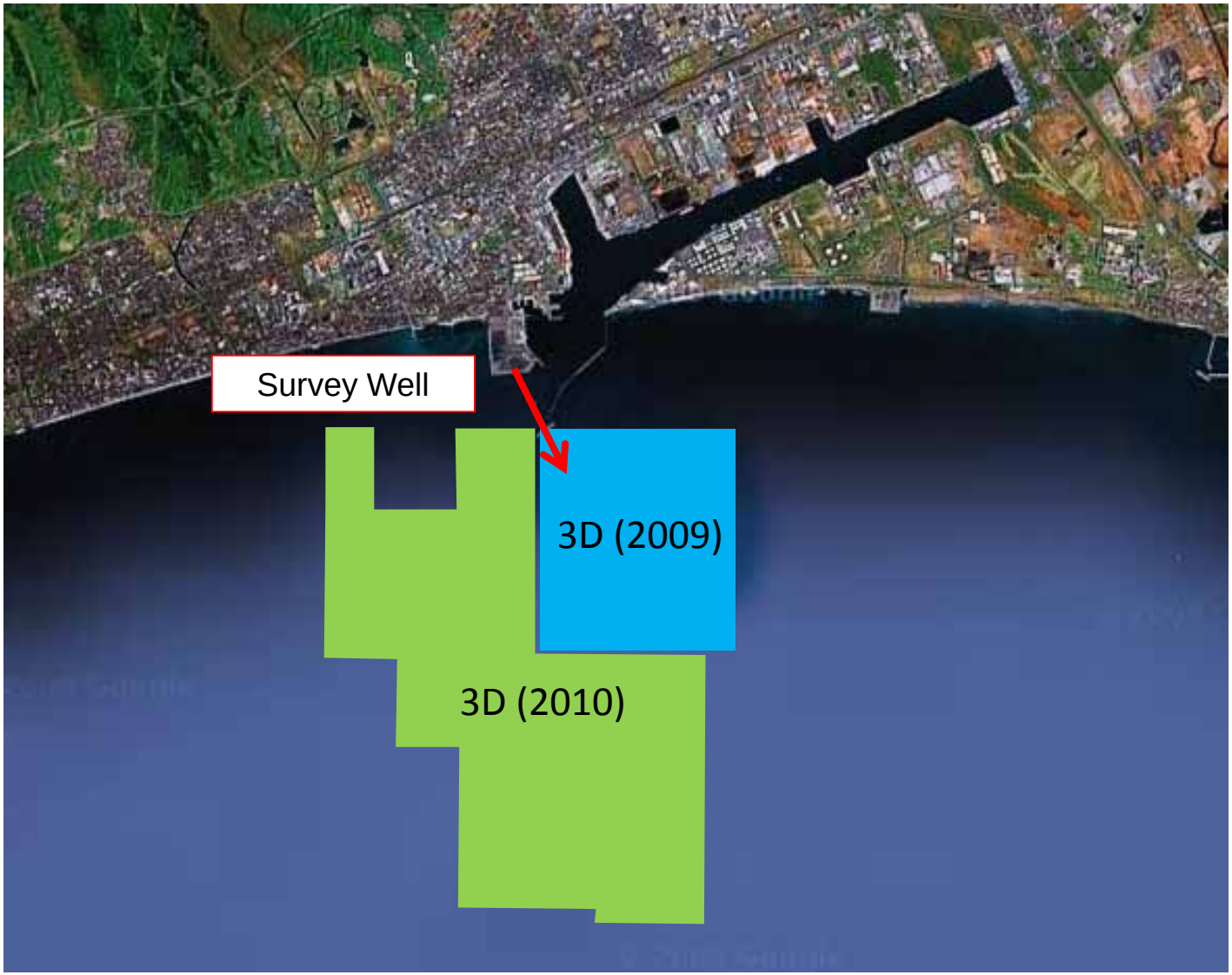
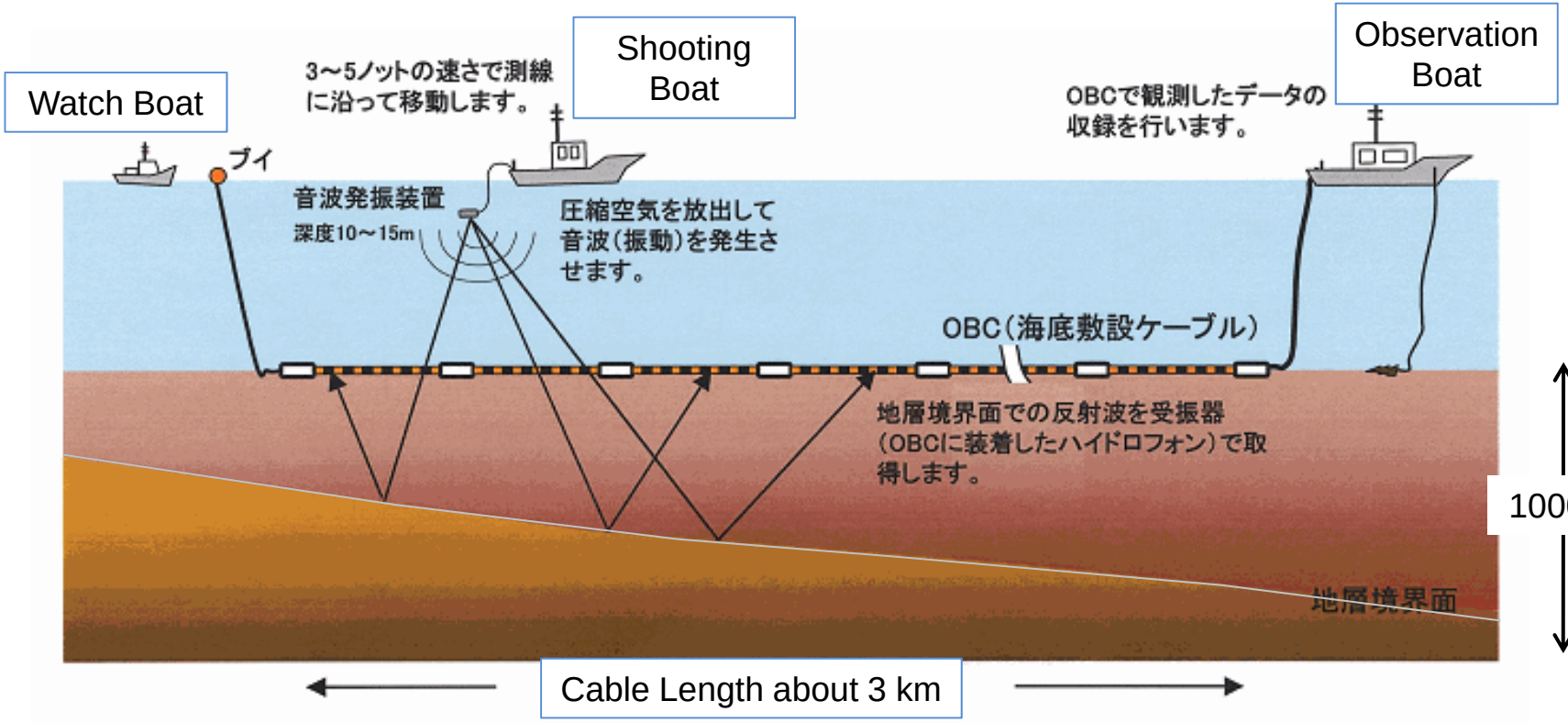
Field Location Map
Tomakomai candidate site



Shallow Marine 3D Seismic Survey
Ocean Bottom Cable System



3D Seismic Survey in 2009

Shooting on 22 Oct. 2009

Drilling Rig for Tomakomai Survy Well

Name: 1320-M
(owned by SKE)
Height: 48.8m
Max. Drilling Depth:
6100m (vertical well)

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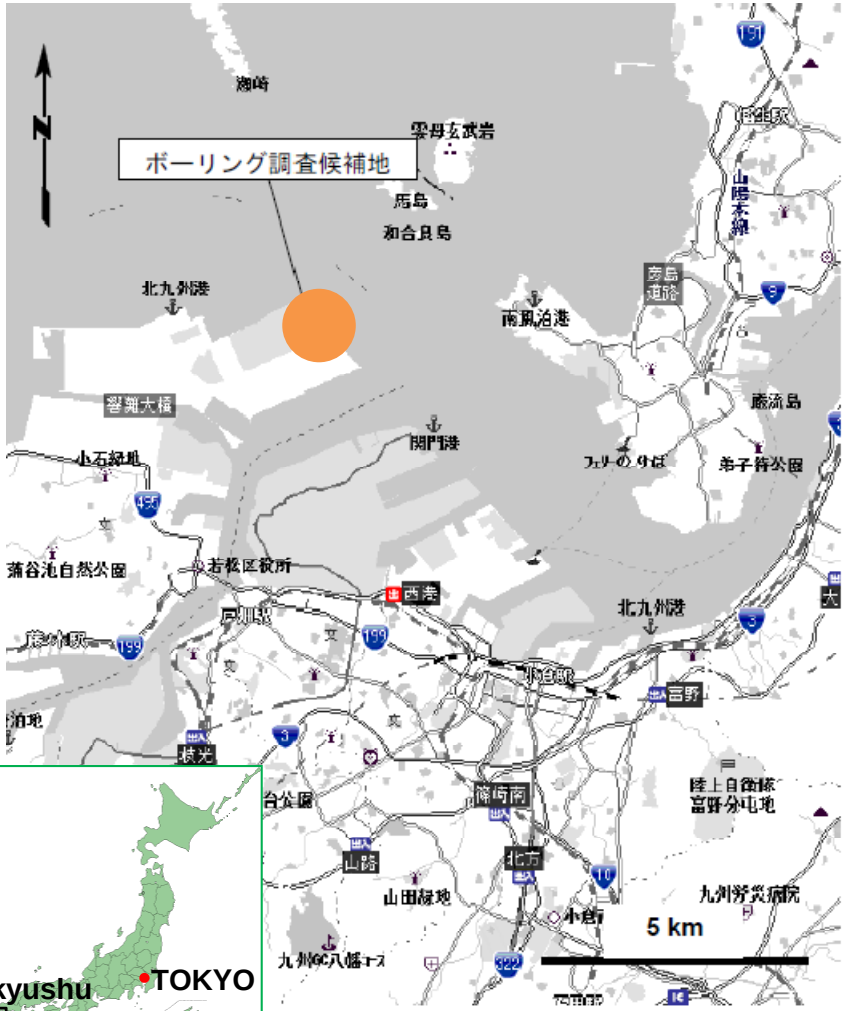
Boring Survey at Kitakyushu Candidate Site

Objective is to evaluate geological potential of Palaeogene formations at Kitakyushu candidate site



Drilling Rig

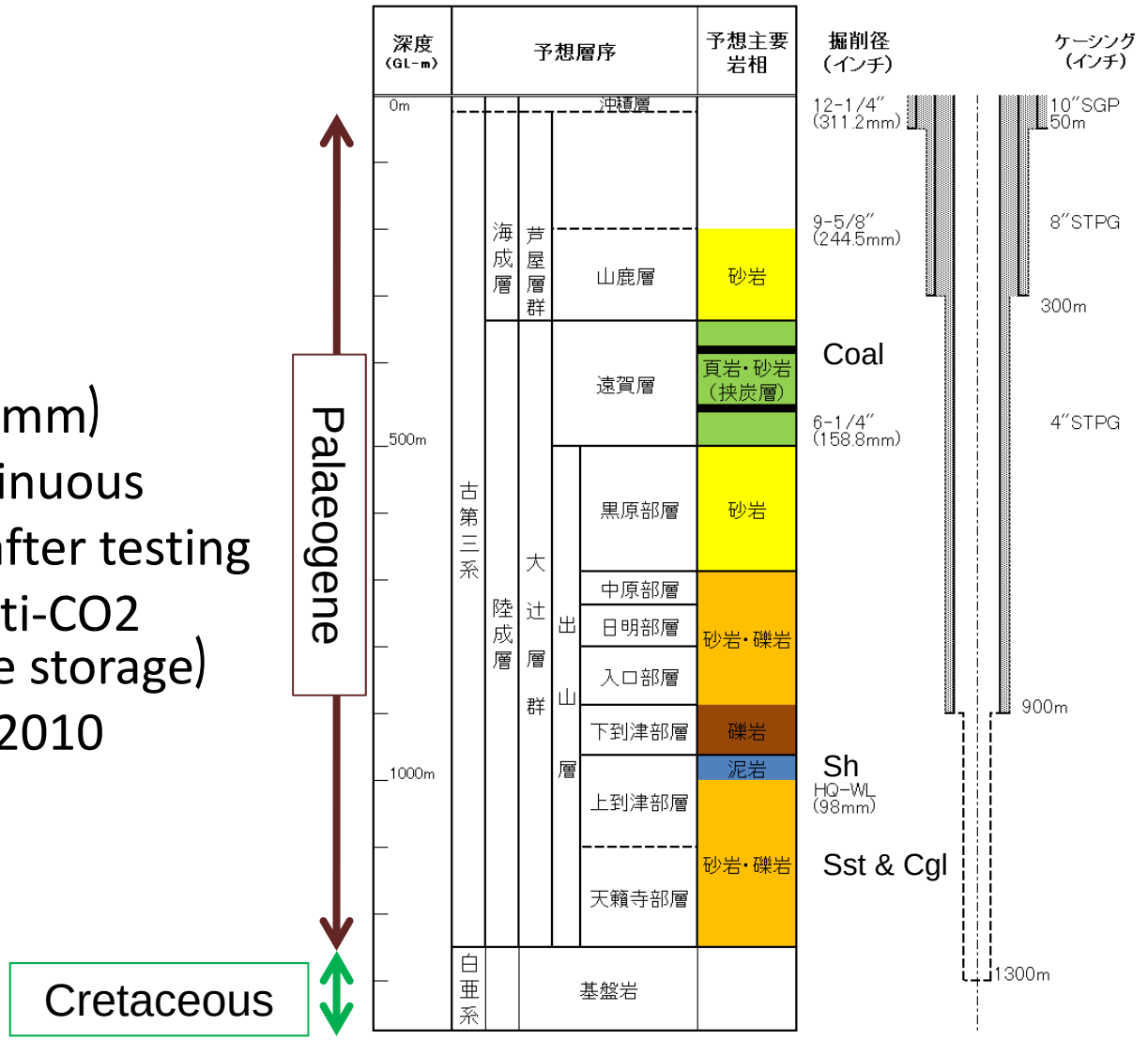
Spindle

BOP

Core and Coring Bit

Well Specs at Kitakyushu Site

- PTD：1,300m
  (to see Cretaceous)
- Well Type: Vertical Well
- Drilling System: Spindle
- Final Diameter：HQ (Φ98mm)
- Coring: 300-1300m Continuous
- Completion: To be P&A after testing
  (Bore hole will be anti-CO2 cemented for future storage)
- Term：June – November 2010



Monitoring 1/2

Purpose :

Guideline “for safe operation of a CCS demonstration project” (METI, 2009)

The monitoring items aim to;

1. monitor the behavior of the injected CO2 (to confirm that the CO2 is injected and stored securely and stably as it was originally planned),
2. improve the accuracy of the simulation model through comparison of the acquired data with the detail model simulations, and
3. detect abnormalities, such as CO2 leakage if any such should occur.

CO2QUALSTORE Guideline

(Guideline for Selection and Qualification of Sites and Projects for Geological Storage of CO2, DNV, 2010)

The objective of monitoring is to;

1. ensure safe and reliable operation of CGS* projects in accordance with regulations and industry practice,
2. measure emission reductions, and
3. provide assurance to regulators and stakeholders that the storage site is properly managed and that risks are controlled or mitigated.

*CGS: CO2 geological Storage

Monitoring 2/2

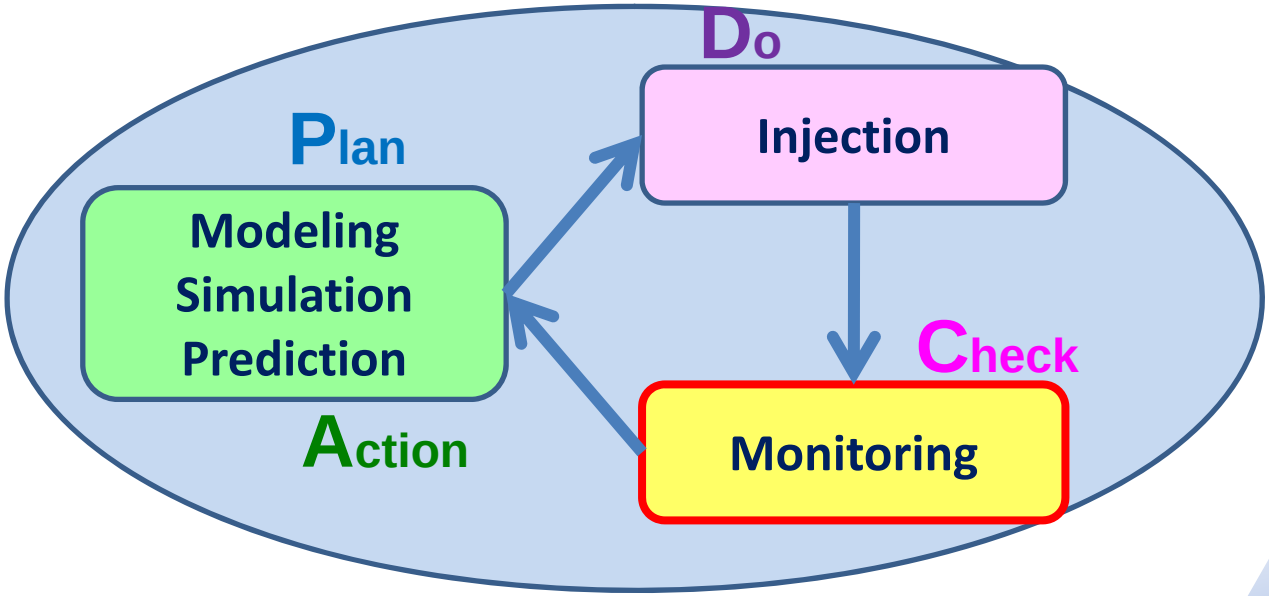
Objects: air, sea water, and subsurface (geological formations)

Phase: pre-injection, during injection, and post-injection/closure

Regulations: Law relating to the Prevention of Marine Pollution and Maritime Disaster (amended in 2007)

Guideline “For safe operation of a CCS demonstration project” (METI, 2009)

To achieve the objectives:



Description in this slide is a personal opinion of the author.

Monitoring during Demonstration 1/3

Guideline “For safe operation of a CCS demonstration project”

Things to be monitored constantly

1. Pressure and temperature at the bottom-hole of the injection well
2. Injection rate, pressure, and temperature of CO2 at the well-head of the injection well
3. Annulus pressure at the well-head of the injection well
4. Pressure and temperature in the same formation (continuously linked) where the CO2 is injected and pressure at this well-head, if observation well(s) exist
5. Annulus pressure at the observation well(s), if observation well(s) exist
6. Microseismicity at the injection site and in its vicinity

Things to be monitored periodically

Seismic survey (twice within a permit period, i.e. **once in every two years**)
Properties of CO2 to be injected (concentration of CO2 and impurities)

Things to be monitored as much as possible

1. Pressure and temperature in the formation located shallower than the cap rock,
2. Properties effective for detecting CO2 such as electrical resistivity, acoustic wave velocity, and saturation,
3. Chemical properties of groundwater sampled in the observation well(s)
4. Volume and geochemical properties of the fluids, if there are discharge points of subsurface fluids on the ground

Monitoring during Demonstration 2/3

CCS Demonstration Periods are assumed as;
- Construction for 3 – 4 years
- Injection for 3 - 4 years
- Monitoring (post injection) for 3 years

Planned methods to be tested during the demonstration;

1. Effectiveness of 2D seismic method to substitute for 3D
   ✓*3D seismic is thought to be the most effective method to delineate the shape of CO2 plume, but expensive!*
   e.g. approx. ¥1billion for 10km x 10km in Japan

2. Effectiveness of electromagnetic method, especially for depleted gas reservoir

3. Effectiveness of gravity method

4. Effectiveness of Instrumented OBC System, especially for shallow sea
   To avoid placement error of receivers in each surveys

Description in this slide is a personal opinion of the author.

Monitoring during Demonstration 3/3

- The Law relating to the Prevention of Marine Pollution and Maritime Disaster;

  - Permits an operator to store CO2 sub-seabed for 5 years and requires seismic surveys twice within a permit period, *i.e.* once in every two years.
  - Requires the operator to seek a permission every 5 year as long as CO2 stays subsurface.

This means the operator has to carry out monitoring forever!

- Issues to be discussed with the authorities;
  - The operator has to hand over liability to the government at the end of the demonstration.
  - Which monitoring methods has to be implemented?

Description in this slide is a personal opinion of the author.

Summary

- CCS is expected to play an important role to reduce CO2 emissions and the government and industry have to work in concert to launch a large-scale CCS demonstration project.
- In order to deploy CCS widely in Japan, several demonstration projects are required.
- Site screening and engineering studies was carried out for CCS demonstrations in 2008, and field surveys have been done in 2009 and 2010.
- This year, 3D seismic survey was carried out and a survey well is being drilled at one of the potential sites, and a preliminary survey well was drilled at another potential site.
- After necessary field surveys, JCCS will submit site evaluation reports to the government, and demonstration site(s) will be selected by the government.
- JCCS is making an elaborate monitoring plan for a demonstration project, and is discussing which items and how much detail the monitoring should be carried out during the limited time of the demonstration project.

Thank you for your attention.

Let's save the Earth!

Any comment and inquiry to
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