Research Acitivities on CCS in Korea

Nov. 17, 2009

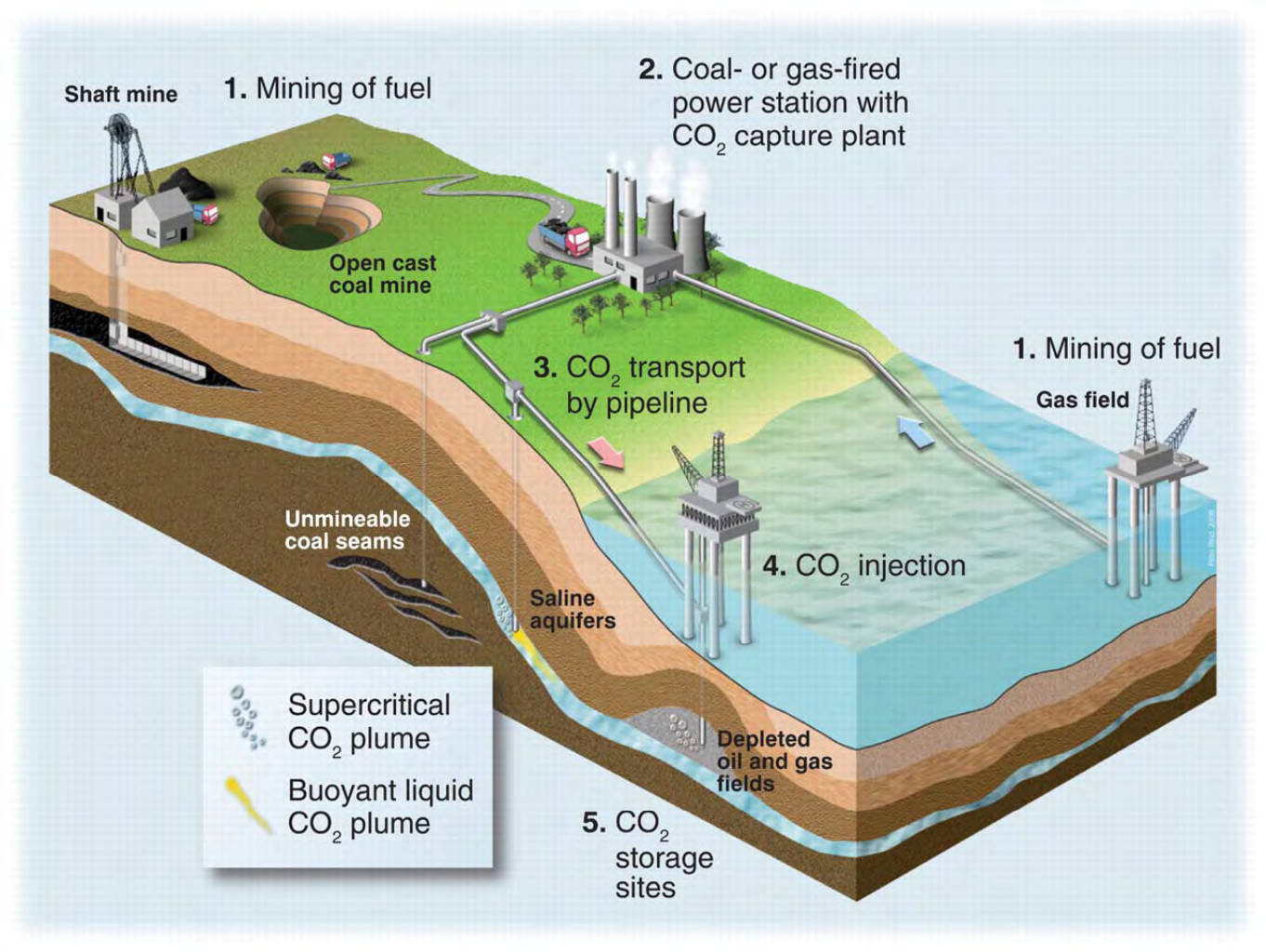
Kue-Young Kim

KIGAM 한국지질자원연구원

Contents

1. Overview of CCS
2. Energy statistics
3. National strategy
4. KIGAM's projects
5. Regulations
6. Summary

Overview of CCS



R. S. Haszeldine Science 325, 1647-1652 (2009)

Overview of CCS

Carbon Capture and Sequestration

Clearing the Air
H. Jesse Smith, Julia Fahrenkamp-Uppenbrink, and Robert Coontz
Science 25 September 2009: 1641.
Full Text » PDF »

News

☐ **Round and Round: A Guide to the Carbon Cycle**
Dennis Normile
Science 25 September 2009: 1642-1643.
The atmosphere is only one component in an enormous complex of nested physical and chemical processes, some of which remain poorly understood. *Science* offers this user's guide to the carbon cycle.
Summary » Full Text » PDF »

☐ **Carbon Sequestration**
Science 25 September 2009: 1644-1645.
Science has created a map showing some of the major carbon capture and storage projects around the world, either completed, in operation, or scheduled for the near future.
Summary » Full Text » PDF »

☐ **China Grapples With A Burning Question**
Josh Fenn
Science 25 September 2009: 1646.
Two new projects, one in Inner Mongolia and the other in Tianjin, mark the coal-hungry country's first major steps toward trapping carbon emissions.
Summary » Full Text » PDF »

Perspectives

☐ **Amine Scrubbing for CO_2 Capture**
Gary T. Rochelle
Science 25 September 2009: 1652-1654.
Abstract » Full Text » PDF »

☐ **Why Capture CO_2 from the Atmosphere?**
David W. Keith
Science 25 September 2009: 1654-1655.
Abstract » Full Text » PDF »

KIGAM 한국지질자원연구원

Overview of CCS

Steven Chu is the U.S. Secretary of Energy and a Nobel Laureate in physics.

EDITORIAL

Carbon Capture and Sequestration

OVERWHELMING SCIENTIFIC EVIDENCE SHOWS THAT CO_2 EMISSIONS FROM FOSSIL FUELS HAVE caused the climate to change, and a dramatic reduction of these emissions is essential to reduce the risk of future devastating effects. On the other hand, access to energy is the basis of much of the current and future prosperity of the world. Eighty percent of this energy is derived from fossil fuel. The world has abundant fossil fuel reserves, particularly coal. The United States possesses one-quarter of the known coal supply, and the United States, Russia, China, and India account for two-thirds of the reserves. Coal accounts for roughly 25% of the world energy supply and 40% of the carbon emissions.* It is highly unlikely that any of these countries will turn their back on coal any time soon, and for this reason, the capture and storage of CO_2 emissions from fossil fuel power plants must be aggressively pursued.

US DOE invests $3.4 billion in CCS R&D !!

Overview of CCS

CCS component	CCS technology	Research phase [a]	Demonstration phase [b]	Economically feasible under specific conditions [c]	Mature market [d]
Capture	Post-combustion			X	
	Pre-combustion			X	
	Oxyfuel combustion		X		
	Industrial separation (natural gas processing, ammonia production)				X
Transportation	Pipeline				X
	Shipping			X	
Geological storage	Enhanced Oil Recovery (EOR)				X[e]
	Gas or oil fields			X	
	Saline formations			X	
	Enhanced Coal Bed Methane recovery (ECBM)[f]		X		
Ocean storage	Direct injection (dissolution type)	X			
	Direct injection (lake type)	X			
Mineral carbonation	Natural silicate minerals	X			
	Waste materials		X		
Industrial uses of CO_2					X

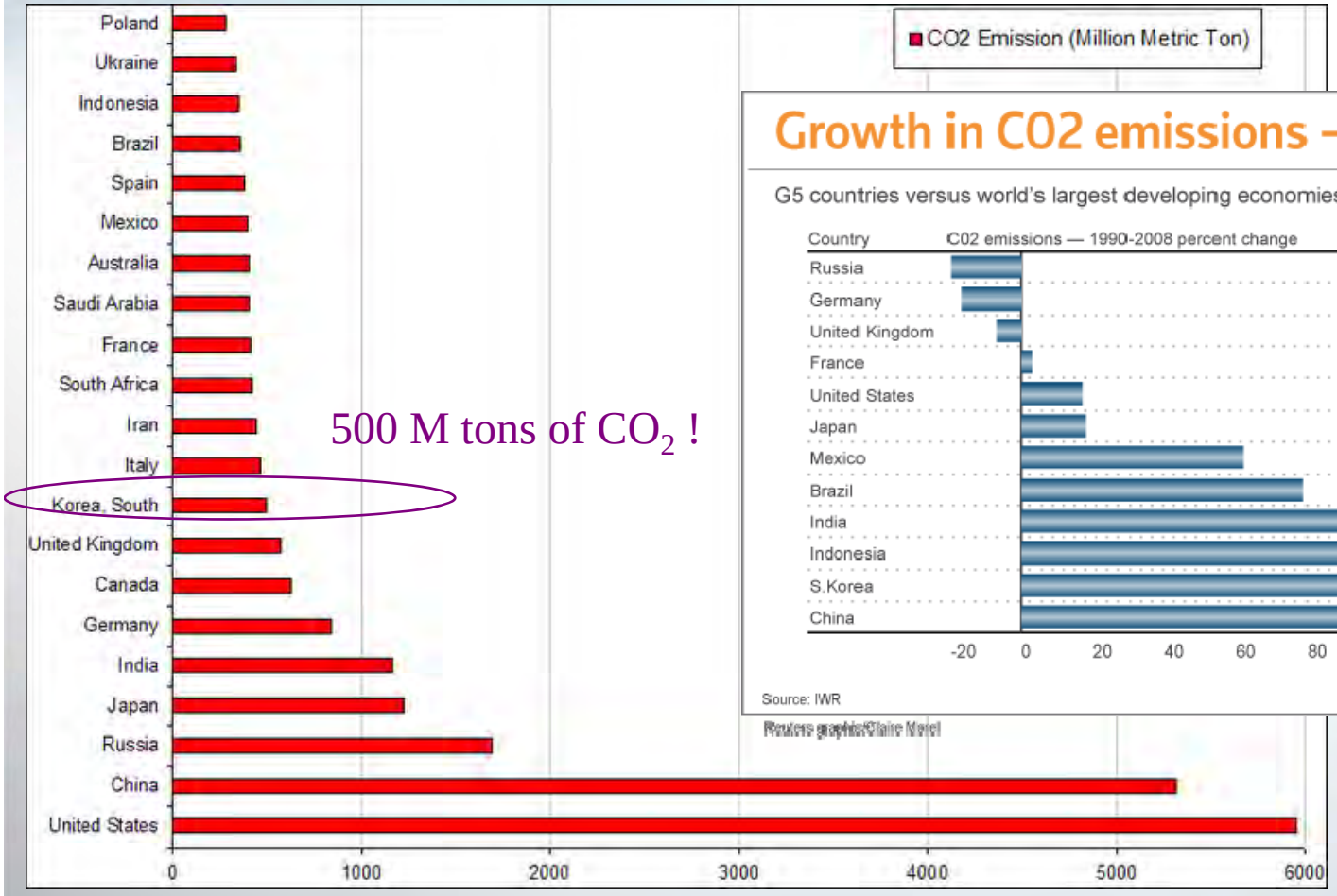
Energy Statistics

	1	2	3	4	5	6	Korea
Energy Consumption (million TOE)	US 2,361.4	China 1863.4	Russia 692.0	Japan 517.5	India 404.4	Germany 311.0	Korea (10) 234.0
Oil Consumption (million tons)	US 943.1	China 368.0	Japan 228.9	India 128.5	Russia 125.9	Germany 112.5	Korea(7) 107.6
Coal Consumption (million TOE)	China 1,311.4	US 573.3	India 208.0	Japan 125.3	S. Africa 97.7	Russia 94.5	Korea(8) 59.7
Nuclear (million TOE)	US 192.1	France 99.7	Japan 63.1	Russia 36.2	Korea 32.3	Germany 31.8	
Oil Import* (million bpd)	US 13.2	Japan 5.4	China 3.2	Germany 3.0	Netherlands 2.5	Korea 2.4	

Source: BP Statistical Review of World Energy 2008, *CIA's The 2008 World Factbook

TOE: Tonnes of Oil Equivalent

National Strategy



500 M tons of CO_2 !

KIGAM 한국지질자원연구원

National Strategy

Greenhouse gas target

	BAU	2005
Scenario 1	-21%	+8%
Scenario 2	-27%	0
Scenario 3	-30%	-4%

National Strategy

South Korea to invest $1.1bn in CCS

13 October 09 - The South Korean government has said that the state owned utility, Korea Electric Power Corp. will invest $1.1 billion (1.3 trillion won) by 2020 in CCS. The Ministry of Knowledge Economy announced that the Government will also spend a further 100 billion won on CCS R&D. View the **full story**.

Korea Institute of Geoscience & Mineral Resources

✓Established in 1918 and only one geological research institute in Korea
✓Covering geological research in nationwide and overseas
- Geological survey
- Mineral resources research
- Petroleum, gas and gas-hydrate exploration
- Groundwater resources research
- Geological disasters such as earthquakes and landslides
- CO_2 Geological storage

KIGAM 한국지질자원연구원

KIGAM's Projects

1. CO2 Offshore Storage Project

MLTM
Ministry of Land, Transport and Maritime Affairs

- ✓ **Goal:**
  - ✓ **Selection of suitable site for CO2 storage**
  - ✓ **Development of elemental technologies for CO2 storage**
  - ✓ **Risk assessment**

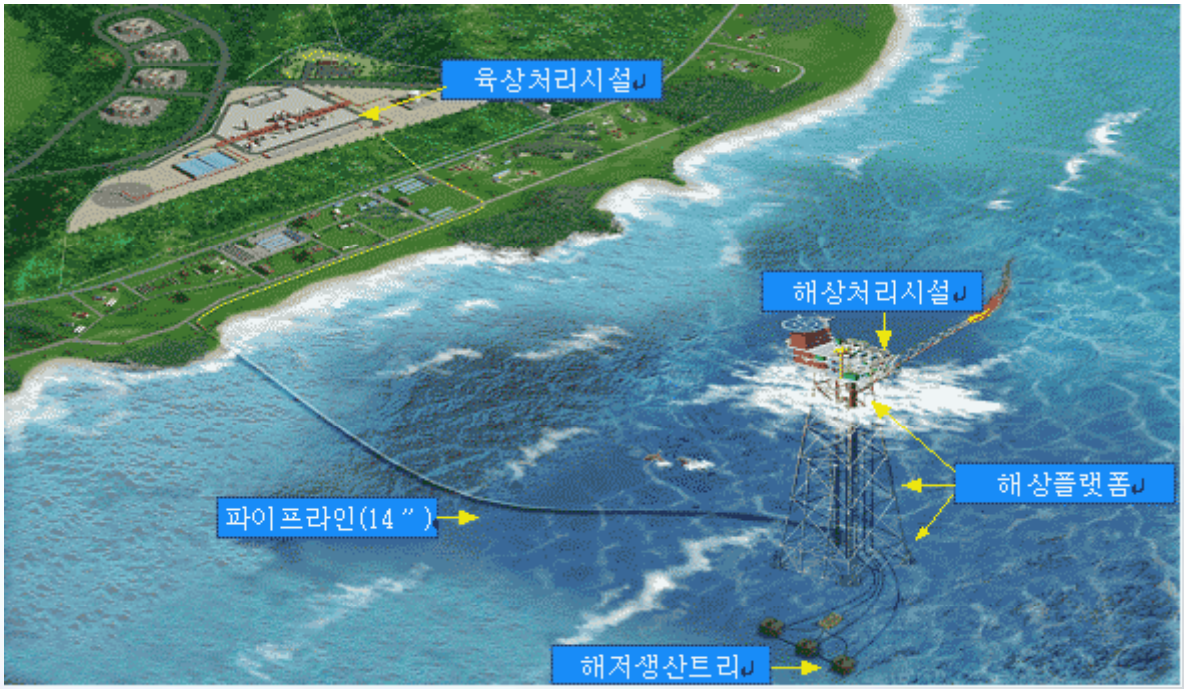
- ✓ **Project Schedule**
  - ✓ **Phase 1 : 2005 - 2009 (5 years)**
  - ✓ **Phase II : 2010 – 2014 (5 years)**

KIGAM Korea Institute of Geoscience and Mineral Resources

KORDI Korea Ocean Research & Development Institute

KIGAM's Projects

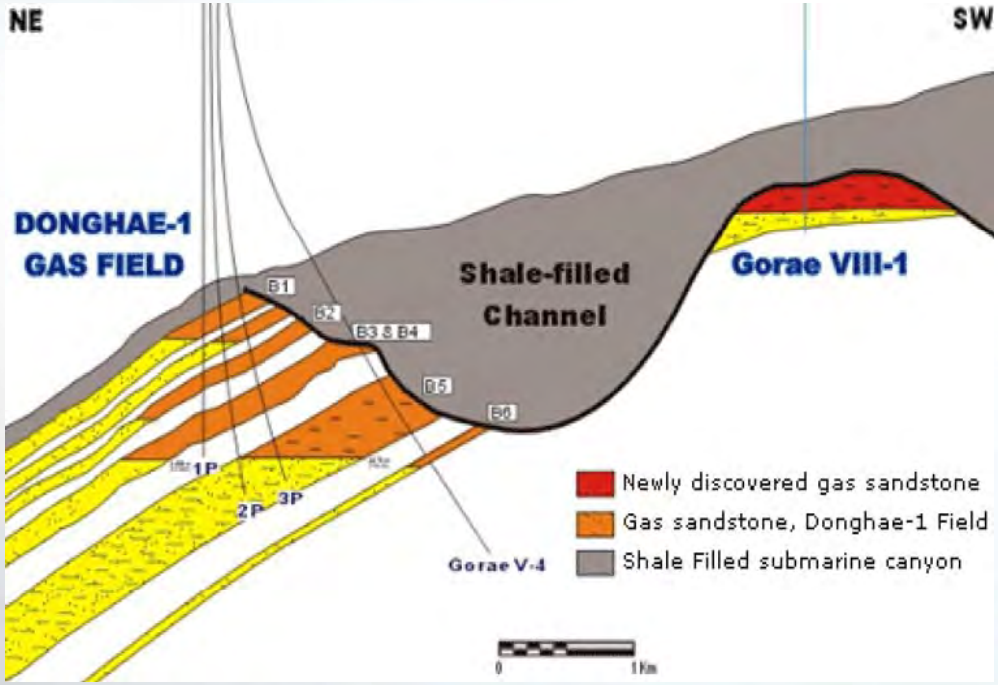
Donghae-1 gas field



Gas initial: 250-300 billion ft^3
Recoverable reserve: 170-200 billion ft^3

KIGAM's Projects

Donghae-1 gas field



Depth: 2,600-2,700 m

Porosity: 0.25

Water saturation:0.3

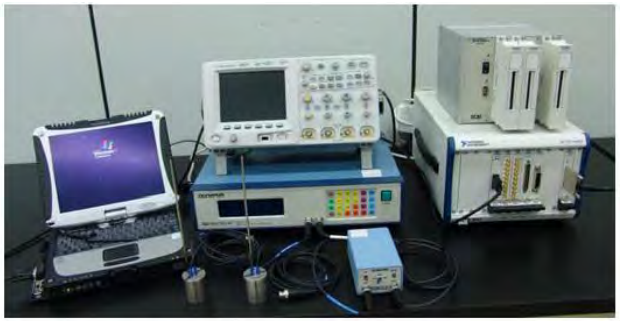
Pressure: 3,600 psi

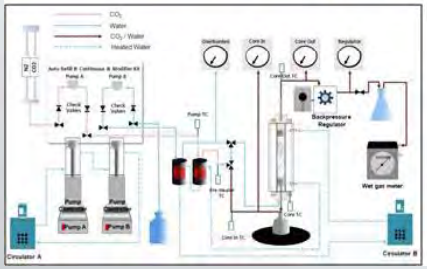
Production period: 2004-2018

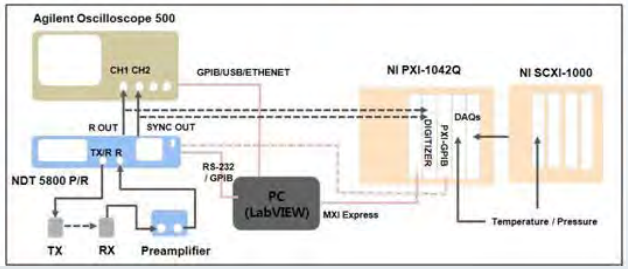
KIGAM's Projects

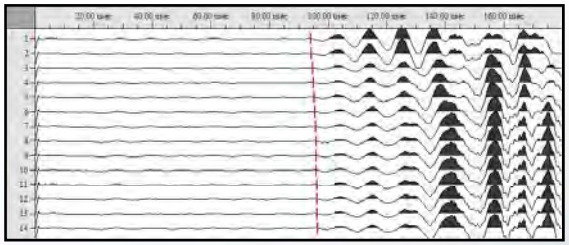
Basic laboratory experiments

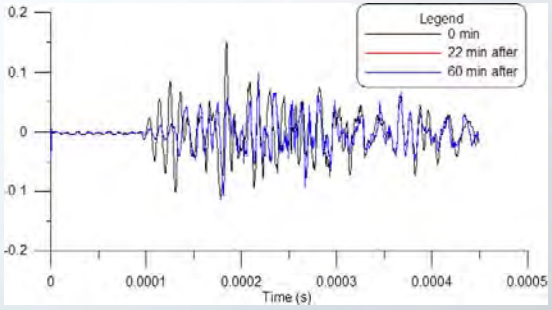
- ✓ Seismic P-wave Measurement of core containing CO_2-Water
- ✓ Effects of P, T and CO_2 Saturation on Seismic P&S wave
- ✓ Seismic Tomography Simulation







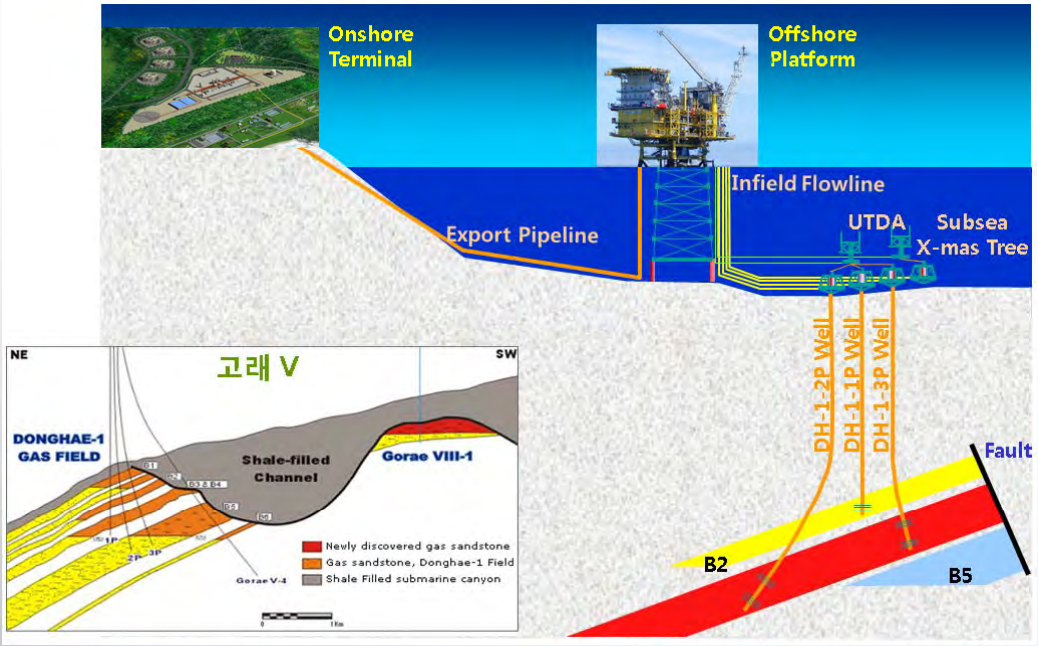


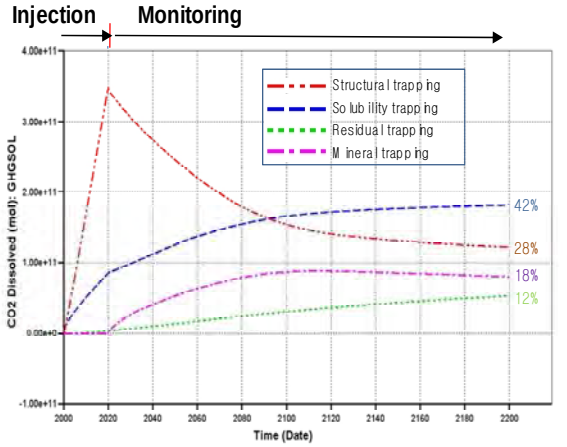


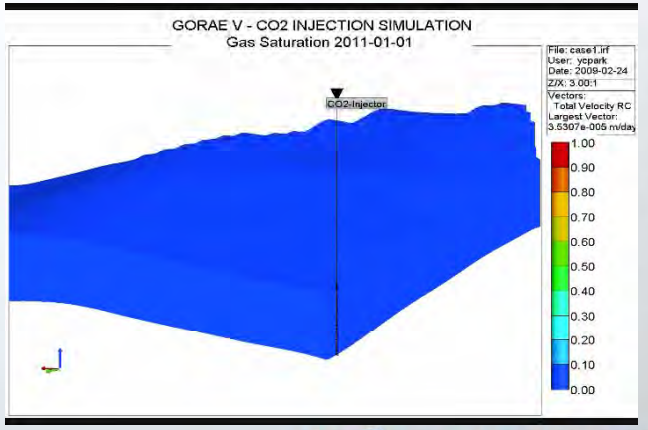
KIGAM 한국지질자원연구원

KIGAM's Projects

Numerical study





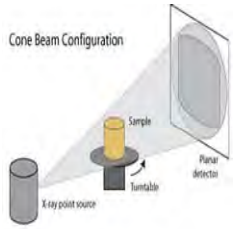


KIGAM 한국지질자원연구원

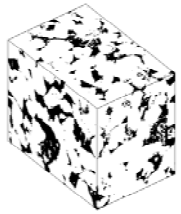
KIGAM's Projects

Petrophysical modeling

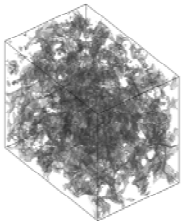
- ✓ Unsteady Petrophysical Modeling using Lattice-Boltzman
- ✓ Physical property changes with gas saturation



(Xradia Inc. USA)

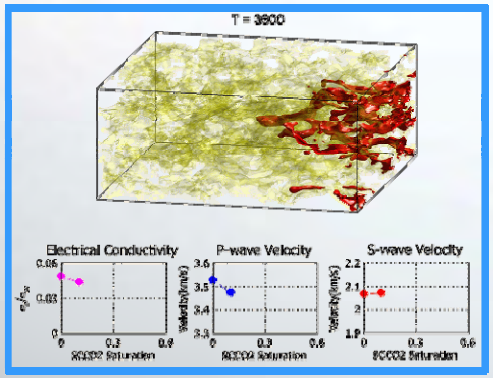


Slice of pore structures

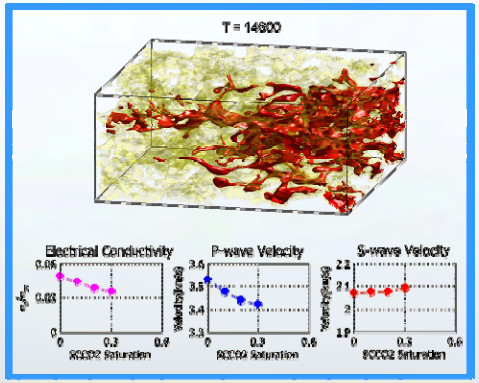


Isosurface of pore structures

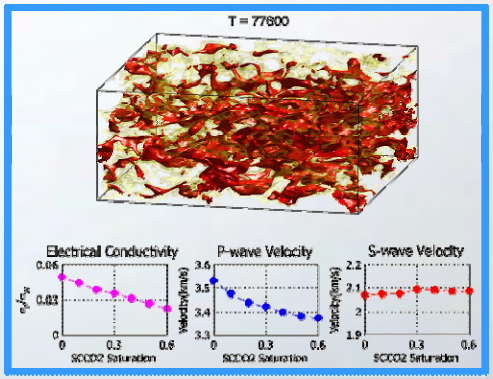
(Gas saturation 10%)



(Gas saturation 30%)



(Gas saturation 60%)



KIGAM 한국지질자원연구원

KIGAM's Projects

Ministry of Knowledge Economy

2. Development of CO2 injection system for geologic sequestration

- ✓ **Goal:**
  - ✓ **Design & implementation of CO2 injection well**
  - ✓ **Design & implemenation of injection facilities**
  - ✓ **Develop effective operating system**

- ✓ **Project Schedule**
  - ✓ **Phase 1 : 2009. 7 - 2012. 6 (3 years)**
  - ✓ **Phase II : 2012. 7 - 2014 .6 (2 years)**

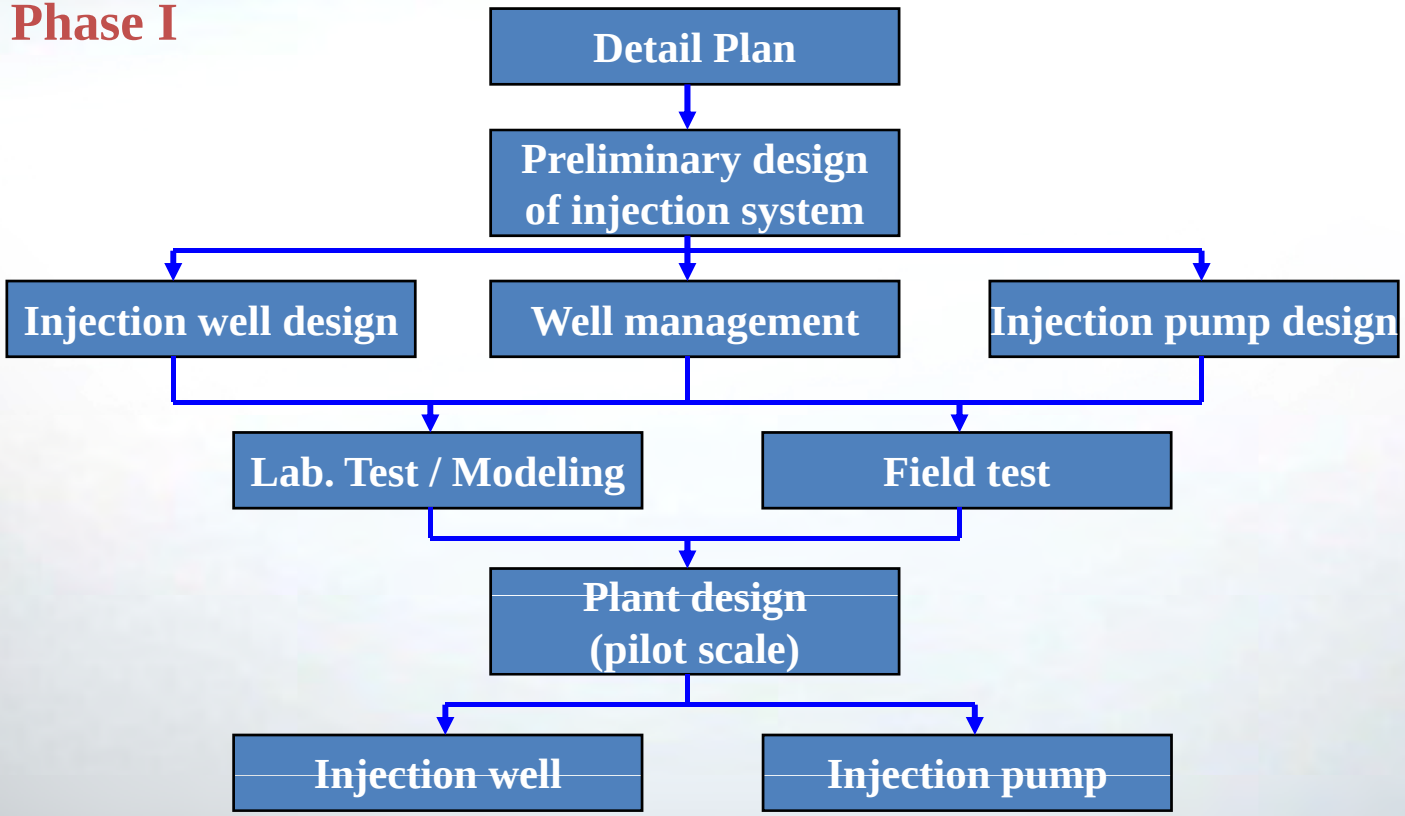
KIGAM Korea Institute of Geoscience and Mineral Resources

KIMM 한국기계연구원 KOREA INSTITUTE OF MACHINERY & MATERIALS

KIGAM's Projects

2. Development of CO2 injection system for geologic sequestration

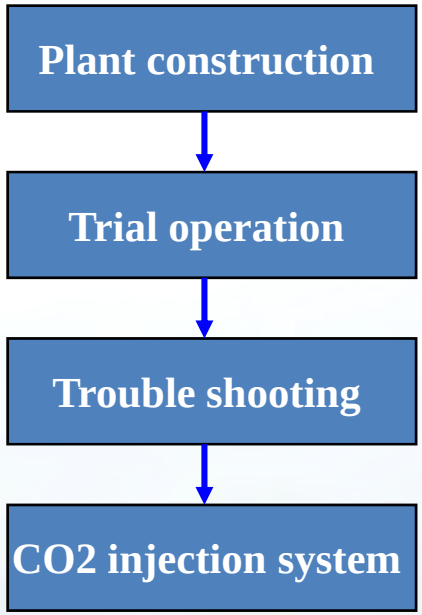
Phase I



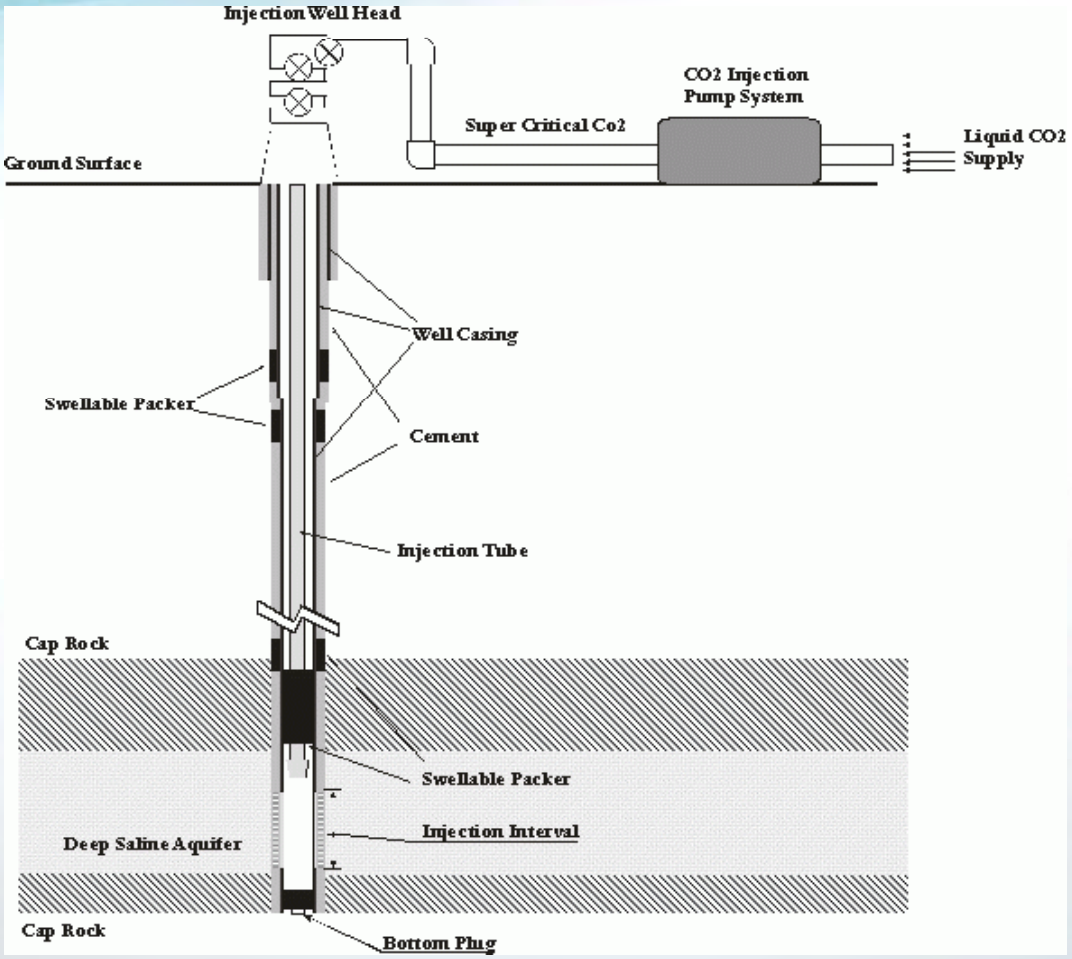
KIGAM's Projects

2. Development of CO2 injection system for geologic sequestration

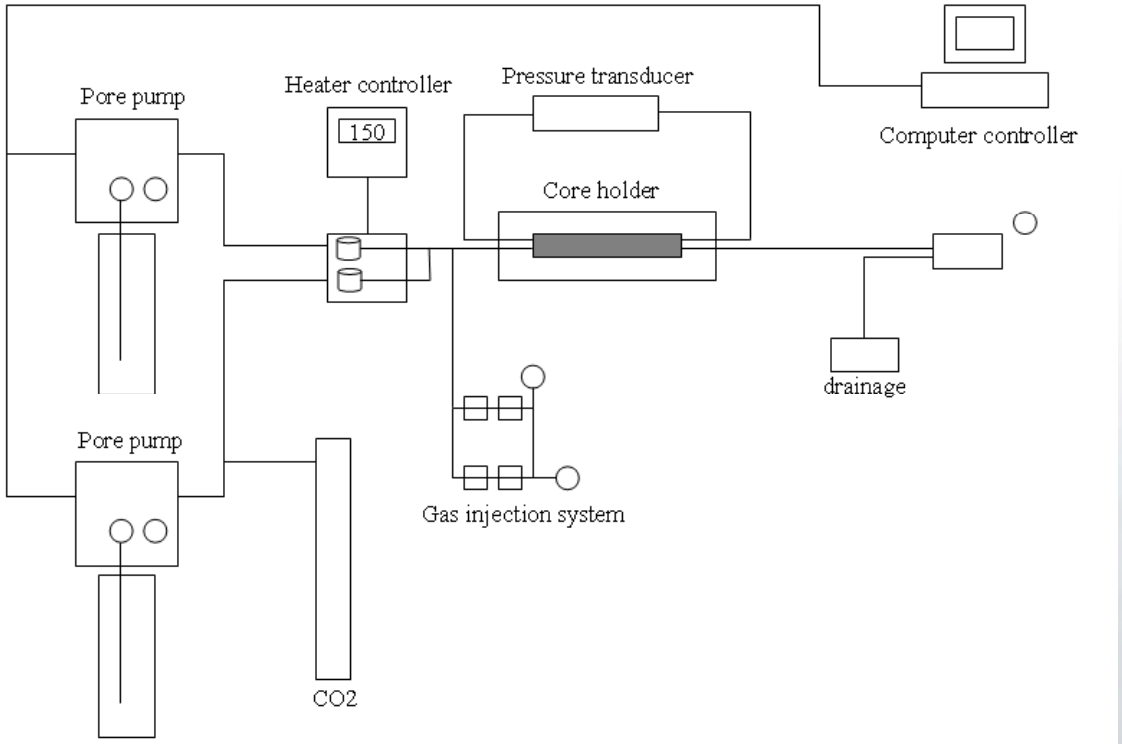
Phase II



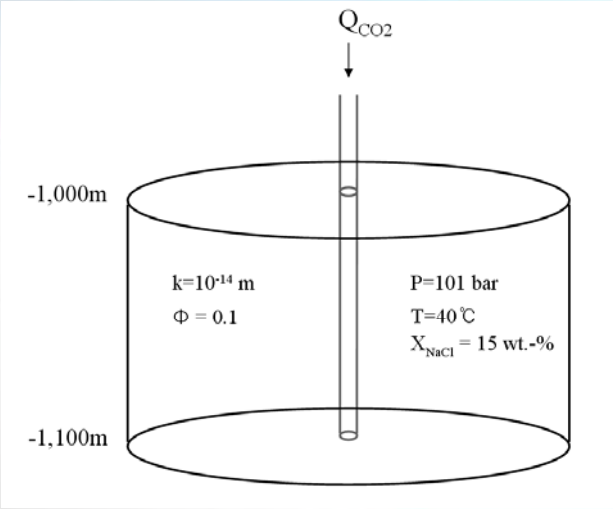
Design Injection Well

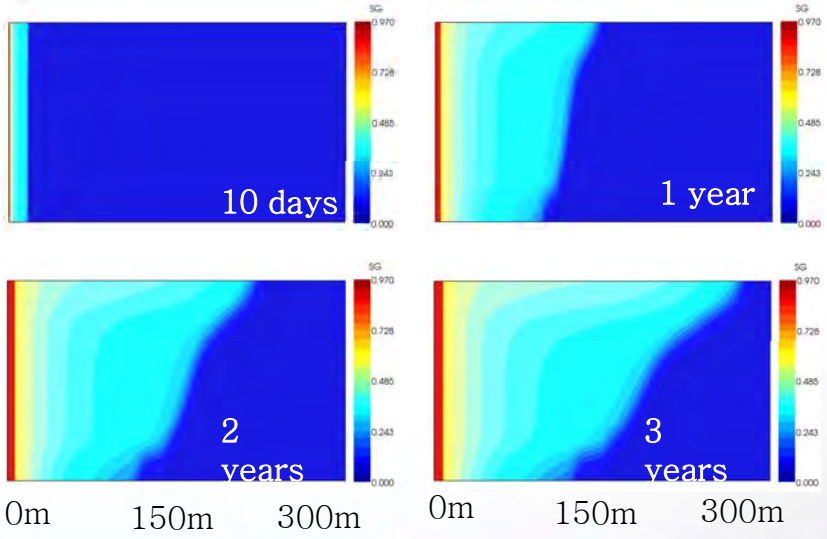


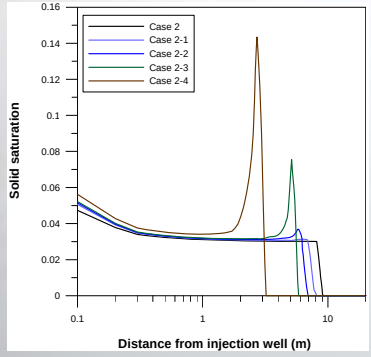
Lab Experiments

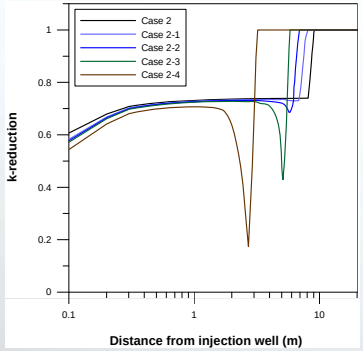


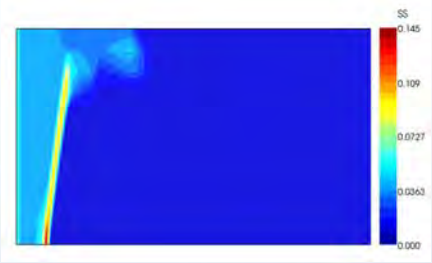
Numerical Modeling

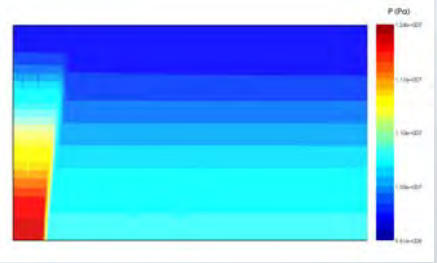












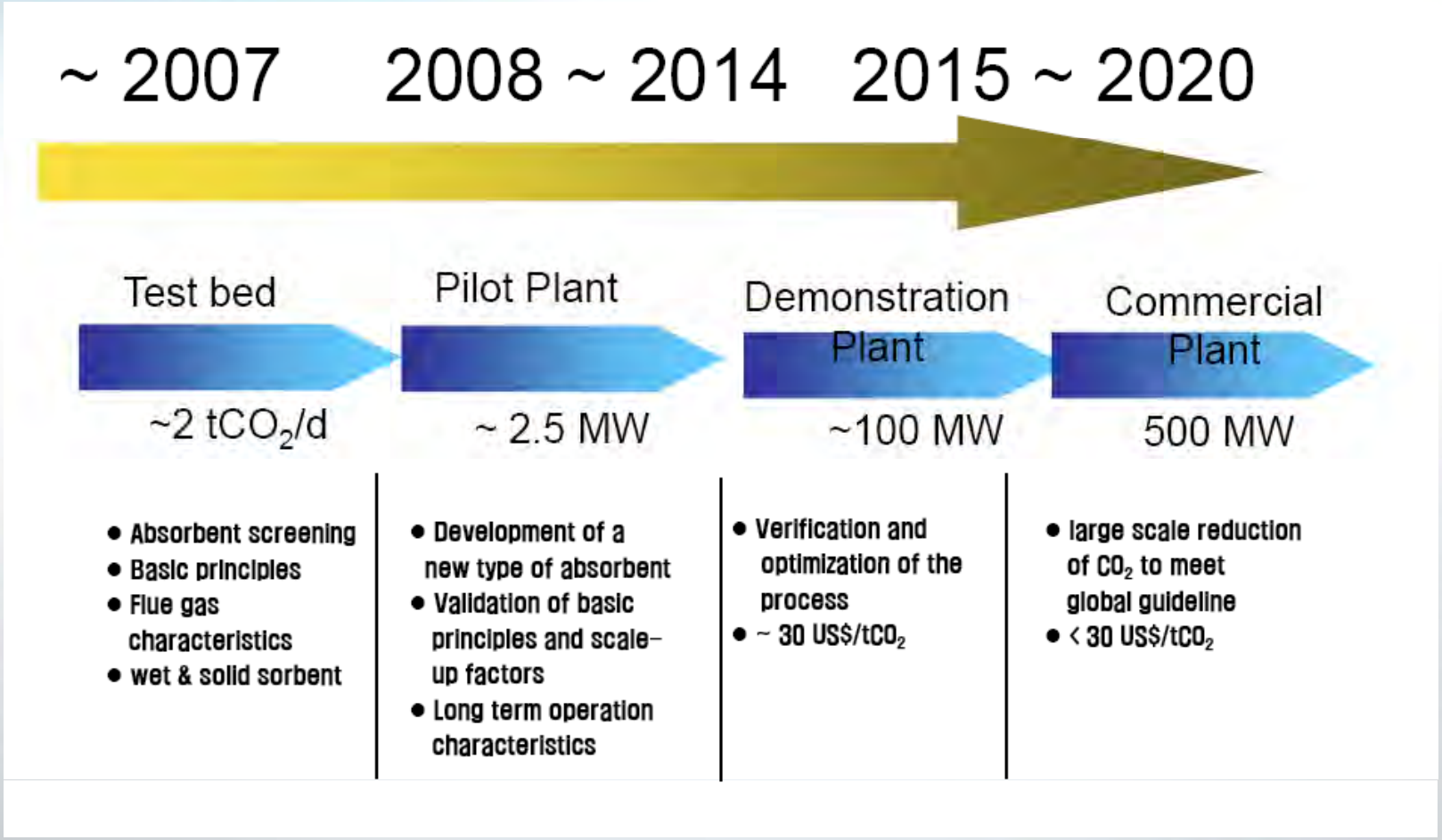
KIGAM 한국지질자원연구원

Technologies for CO2 Capture

Oxyfuel combustion	Fuel is combusted in pure Oxygen instead of air
Postcombustion	CO_2 is removed from the flue gas after combustion
Precombustion	Carbon is removed from the fuel before combustion

Source: VATTENFALL

Roadmap to realization



Regulation

Mining Act

Article 1. (Purpose) This Act aims to provide for the basic system of mining in order to promote the development of the national industry through the rational exploitation of mineral resources.

Article 2. (Authority of State) The State has the authority to grant rights to mine and acquire unexploited minerals.

Article 4 (Mining) The term, "mining" as used in this Act means exploration and extraction of minerals and ore dressing, refining and other activities incidental thereto.

Article 17. (Application, etc. for Establishment of Mining Rights) Persons wishing to secure establishment of mining rights shall apply to and obtain approval of the Minister of Trade, Industry and Resources under the conditions as prescribed by the Presidential Decree.

Regulation

Groundwater-related law

Groundwater Laws.
Drinking Water Management Laws
Spring Water Laws

- The laws that prescribe the provisions for the development, utilization, preservation and management of groundwater

- To provide the detail regulations regarding establishment of the master plan, permission and report on development and utilization, designation of groundwater preservation area, prevention and measurement of water contamination, registration of construction business for development and utilization of grounder, grounder impact investigation agency and groundwater purification business

Environment Impact Assessment Law

Purpose of Law (Article 1)

- To assure that projects are carried out in full consideration for the environmental preservation by specifying the procedure of the Environmental Impact Assessment

- To reflect the results of Environmental Impact Assessment on decision making process

Collaborative works

Participation in Otway Pilot Project

- ✓ Join CO2CRC in FY2007/2008
- ✓ Planning of Collaborative studies in many ways
- ✓ Experience for our own pilot project

Supporting participants: Department of Resources, Energy and Tourism-AusIndustry |The Department of Environment, Water, Heritage and the Arts | CANSYD | Meiji University | The Process Group | University of Queensland | Newcastle University |

Established & supported under the Australian Government's Cooperative Research Centres Programme

KIGAM 한국지질자원연구원

Collaborative works

Joint workshop between KIGAM-AIST

- ✓ 1st joint workshop on geologic storage in 2008 (Tokyo, Japan)
- ✓ 2nd joint workshop in 2009 (Gyeongju, Korea)

KIGAM 한국지질자원연구원

Challenges

1. **Integration of capture and storage program is needed.**
2. **More demonstrations are needed to provide more information.**
3. **Urgent need of legal and regulatory framework for CO2 storage.**
4. **Public acceptance of CCS.**

Summary

1. CCS technology has the potential to reduce CO2 emission from coal-fueled power plant, and CCS is forecast to provide significant CO2 emission reductions.

2. Korea ranked ninth in the world in CO2 emission in 2007. The government recently announced the greenhouse gas reduction target.

3. KIGAM is actively working to provide solutions for CO2 geologic storage.

4. International collaboration is needed to overcome and for successful deployment of CCS technologies.

Thank You

KIGAM 한국지질자원연구원