

Status of CCS and its Barriers in Korea

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Global Energy Consumption

- Global energy consumption will increase by 49% from 2007 to 2035
- 80% of the energy demand will be covered by fossil fuels
- GHG emission reductions is required for sustainable development

Figure 1. World marketed energy consumption

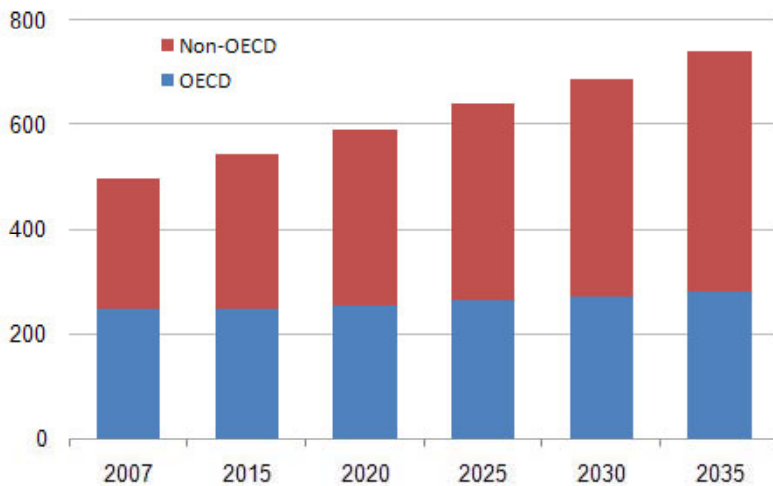
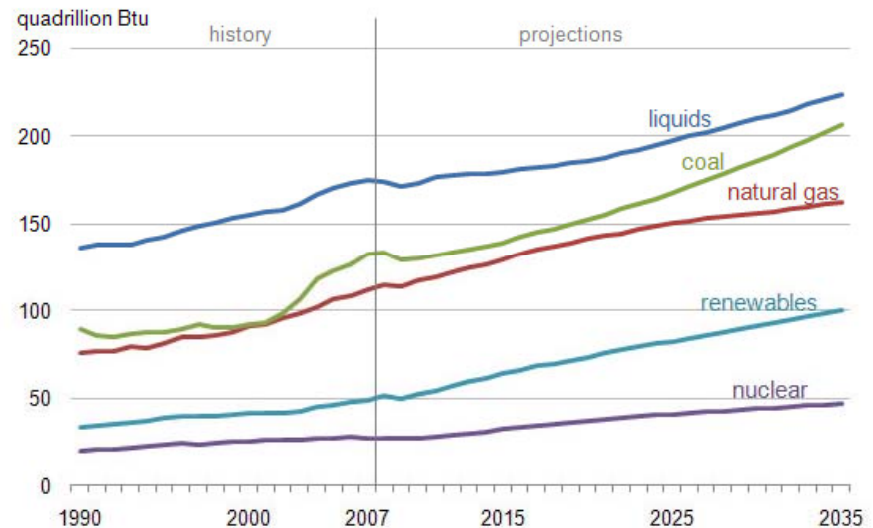
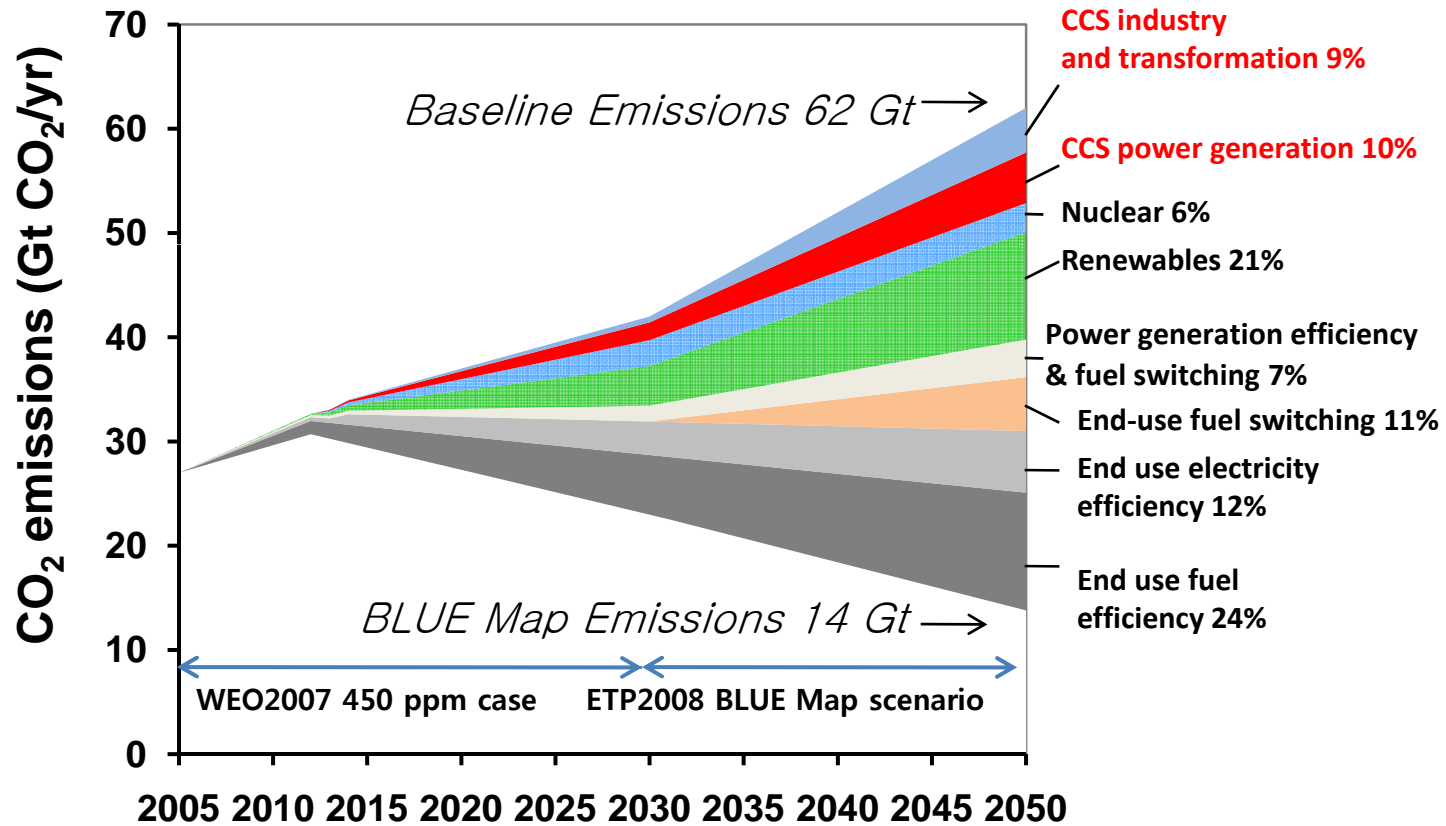


Figure 2. World marketed energy use by fuel type



(US EIA, 2010)

Energy Revolution Needed

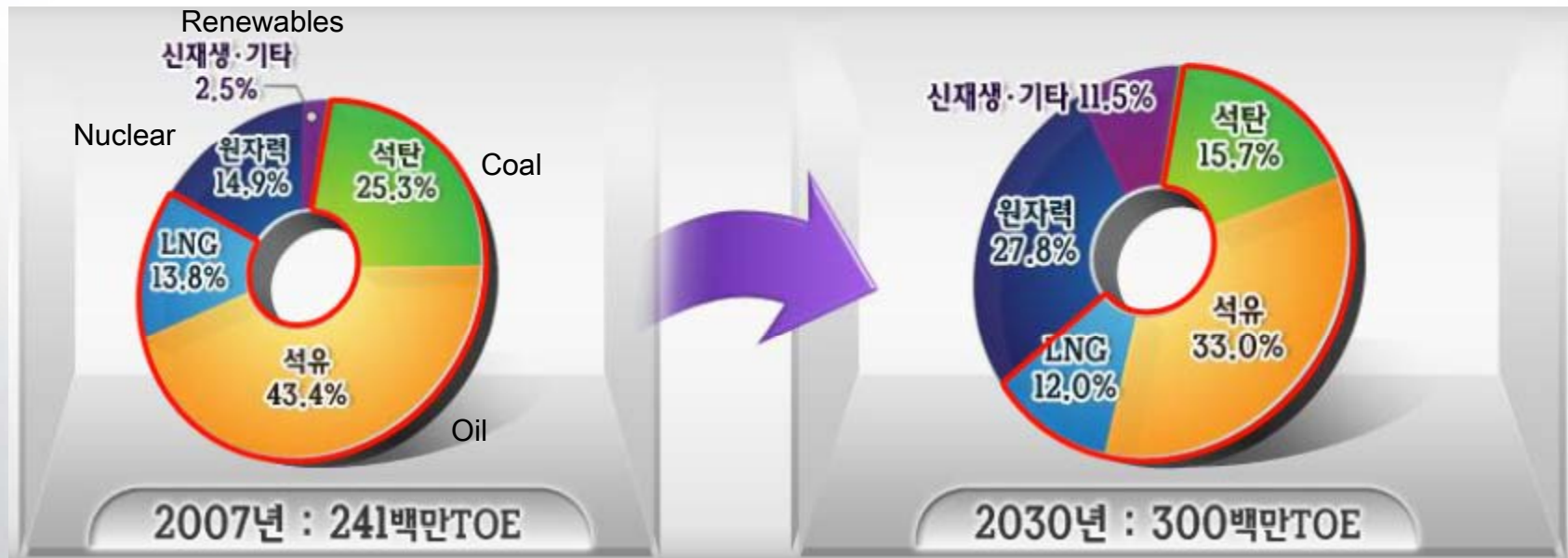


IEA ETP2008



Korea Energy Mix

- Energy demand will increase by 24.5% by 2030
 - Still 60% of the energy demand will be covered by fossil fuels in 2030
- (Energy imports: US\$85.6bn, Dependency on imports of Energy: 97%)

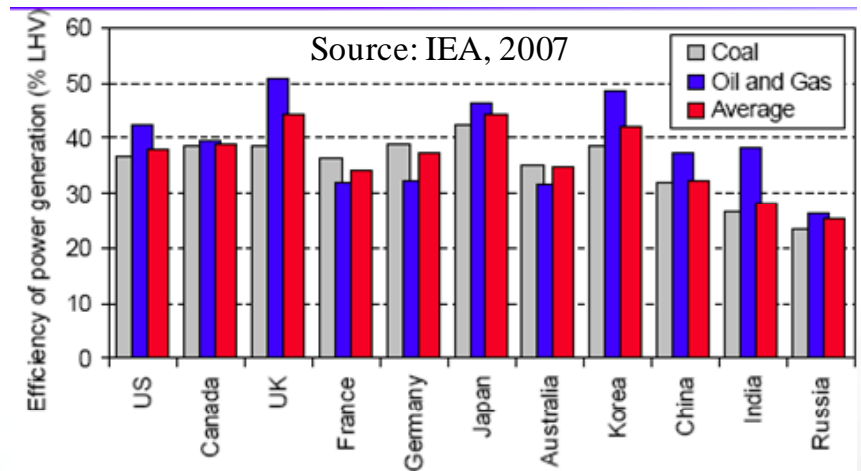
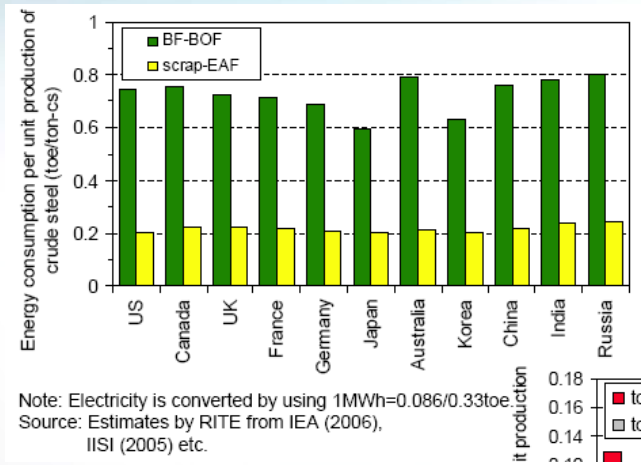


(Korea National Energy Committee, 2008)



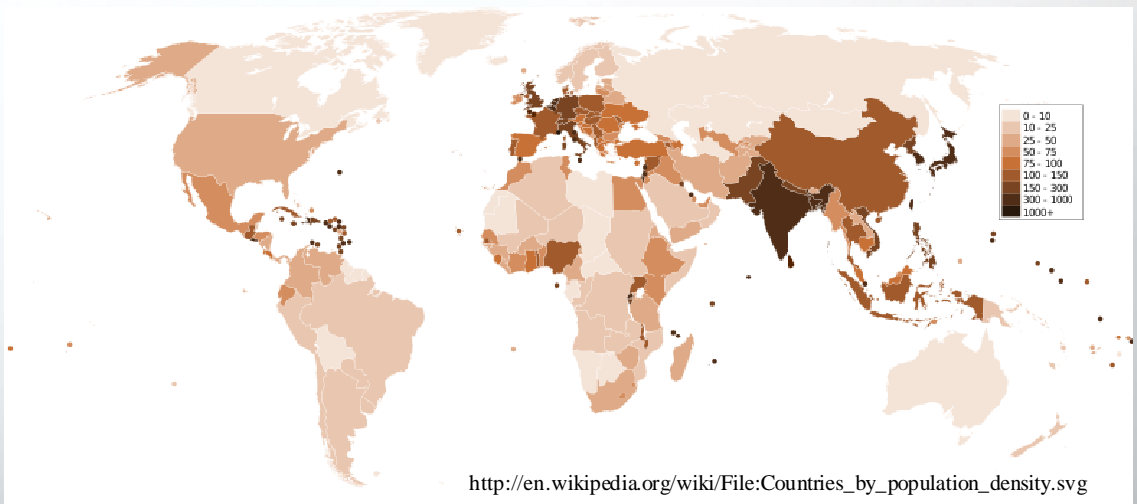
Why we need CCS

- World's Top Level Efficiency



- High Population Density

- Korea: 487/km² (21)
- Australia: 2.84 (232)
- U.S.: 31(177)

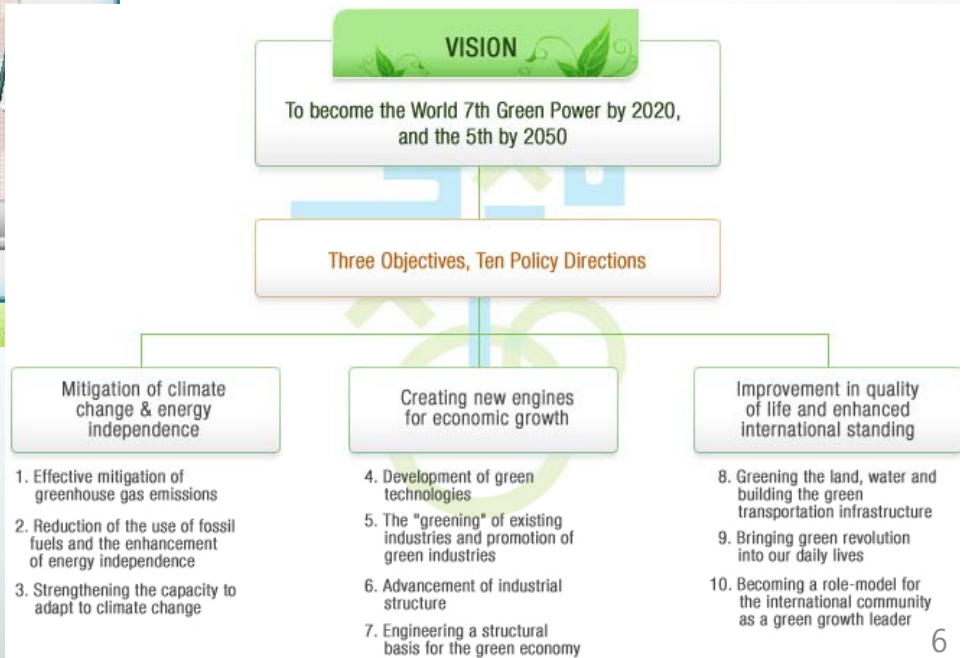


Green Growth Policy of Korean Government



2020 Reduction Target
 - 4% cut in GHG emission by 2020
 - 1~2 CCS project needed

(Korea Presidential Committee on Green Growth, 2010)



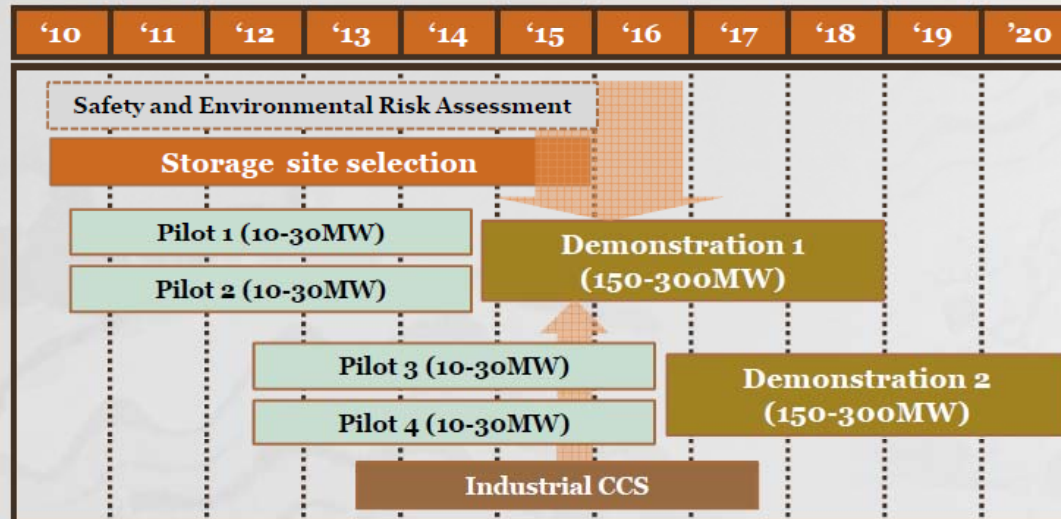
CCS in Korea

- **CCS-related Policy**
 - Included in the technologies for achieving the 30% GHG reduction target('09.11)
 - Included in the 17 new national growth engines ('09.01)
 - National CCS Plan under development
- **CCS R&D Status**
 - US\$ 22m investment in CCS related R&D in 2009
 - Capture (\$17m)
 - . Post-combustion: dry sorbent, advanced amine, etc
 - . Pre-combustion: solid sorbent, membrane separation, etc
 - . Oxy-fuel, chemical looping, etc
 - Storage (\$5m)
 - . Storage Atlas, etc



CCS Demonstration Plan in Korea(I)

CCS Demonstration Plan



- **Pilot:** two sets of two 10-30MW projects for competitive selection
- **Demonstration:** two 150-300MW projects selected through pilot projects feedback
- **Storage:** Ulleung Basin [sandstone reservoir (1.8-2.6 km depth, shale caprock)]
 - Gorae V: 0.15Gt CO₂ potential storage capacity

► Budget (estimated)

	Pilot	Demonstration	Storage	Total
Government	\$80 million	\$192 million	\$570 million	\$842 million
Private Sector	\$80 million	\$767 million	\$380 million	\$1,227 million

* Private sector: KEPCO, KNOC, KOGAS, etc.



CCS Demonstration Plan in Korea (II)

Proposal

- The 9th largest emitter of GHG, Korea announced an ambitious GHG mitigation commitment and is striving to achieve the goal with a set of technology options including CCS among others.
- Inclusion of a Korean CCS project in the “20 by 20” or “20+ by 20” will greatly encourage us to further our efforts to accelerate the deployment of one of the most important technology options for a greener world.
- Therefore, we request the international community to consider our proposal in a positive light. Your cooperation will be greatly appreciated.

Project Name	District, Country	Estimated Operation Date	Capture Facility	Capture Type	Transport Type	Storage Type	Storage Rates
KOR-CCS1	Samcheok/ Boryeong, Korea	2016	300-500MW coal-fired power plant	Post- combustion	Pipeline /Ship	Sandstone /saline aquifer/ depleted gas field	1Mtpa
KOR-CCS2	Youngdong/ Taeon, Korea	2018	300MW coal-fired power plant or 300MW IGCC plant	Pre- or Oxy- fuel combustion	Pipeline /Ship	Sandstone /saline aquifer/ depleted gas field	1Mtpa

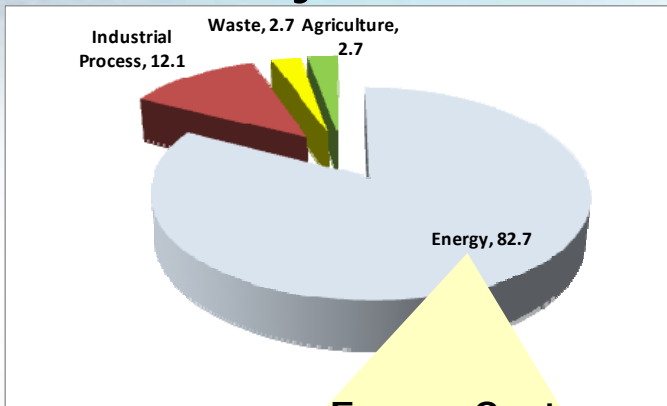
* With due respect to early movers, we propose the number of the selected projects be increased to include as many projects as we agree to be sufficiently qualifying. This, we believe, will better promote the goal of "20 by 20" initiative, that is, to accelerate the deployment of CCS worldwide.



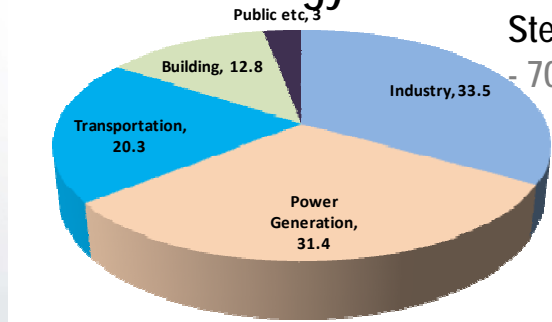
(The ministry of Knowledge Economy, 2010)

Major Emission Sources

■ Emission by Sector

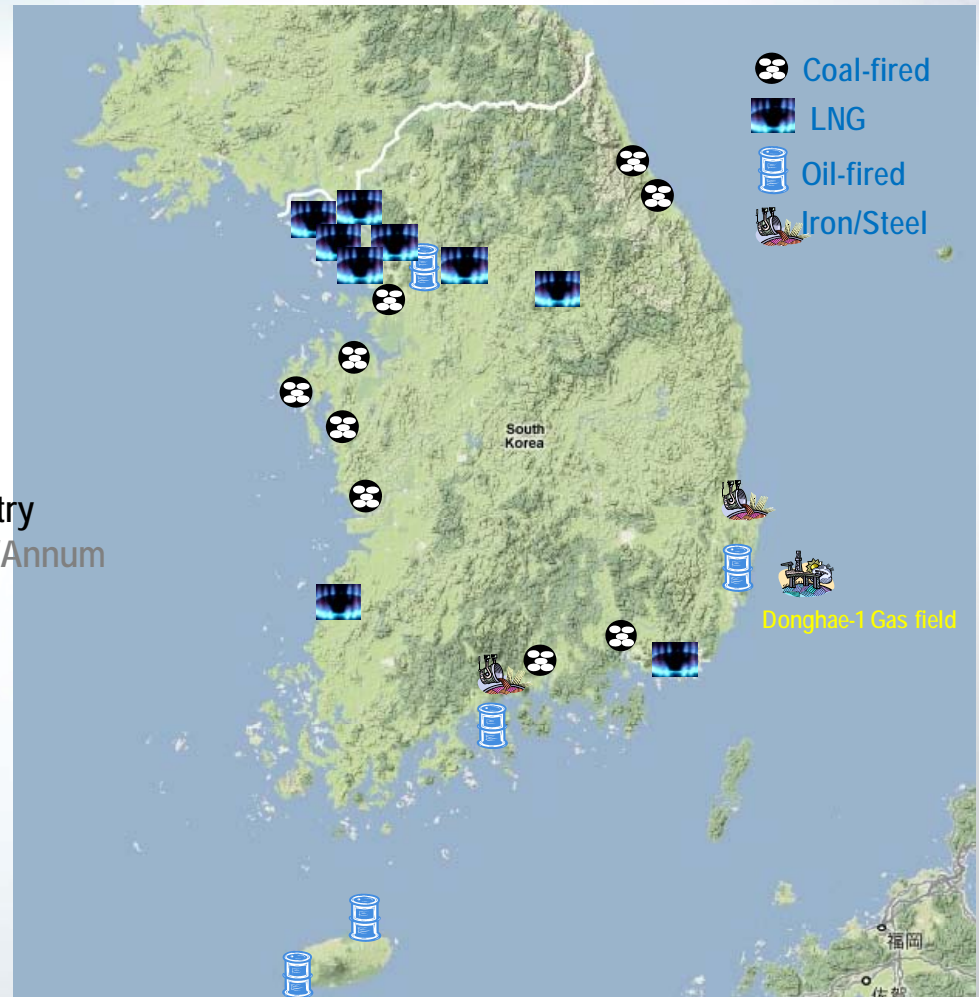


Energy Sector



Electric Power Sector
 - 150 MtCO₂/Annum
 - 25% of GHG Emission
 Coal-firing Power
 - 115 MtCO₂/Annum

Steel industry
 - 70 MtCO₂/Annum



Carbon Capture Technology

- Solid sorbent technology for pre-combustion (100 Nm³/h)
- Membrane for pre-combustion (?)
- **IGCC demonstration ('2012, 300 MW)**
- Chemical looping combustion (50 kW)
- **Oxy-fuel demonstration ('2015, 100 MW)**
- Dry solid sorbents for post-combustion (0.5 MW)
- Advanced amine process for post-combustion (2 TPD CO₂ capture)
- Ammonia based CO₂ capture process for Iron & Steel works



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Carbon Storage – R&D Programs

- **Basic Research**
 - CO₂-Water Relative Permeability Tests
 - Seismic Wave and Specific Resistance Tests
 - Simulation using Own or Commercial Models
- **Site Screening for Geological Sequestration**
 - Assessment of CO₂ geological storage potential
 - Review feasibility of CCS project in Korea
- **Pilot Test of Geological Storage in Korea**
 - Site screening and exploration; MT/AMT, 2D/3D Seismic etc.
 - Injection of small amount of CO₂ into onshore test site
- **International Collaborative Study**
 - Participation in the Otway Pilot Project of CO₂CRC
 - Joint Workshop with AIST/GSJ



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Barriers to Implementing CCS

- **Uncertainty on Storage site**
- **Financial barriers**
- **Legal and regulatory barriers**



Carbon Storage – E&P Activities



- No possible onshore basin
- Three offshore sedimentary basins
 - West Sea Basin
 - Cheju Basin
 - Ulleung Basin
- Exploration
 - Partnered with international oil companies (91,079 L-km, 20 exploratory wells since 1969)
 - KNOC (Korea National Oil Corporation) (186,278 L-km, 24 exploratory wells since 1983)
- Production
 - Discovered gas in Gorae-V (250 BCF & 1.7 mmbbls condensate)



Carbon Storage – Ulleung basin

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박용찬 · 허대기 · 유동근 · 황세호 · 이흥연 · 노을

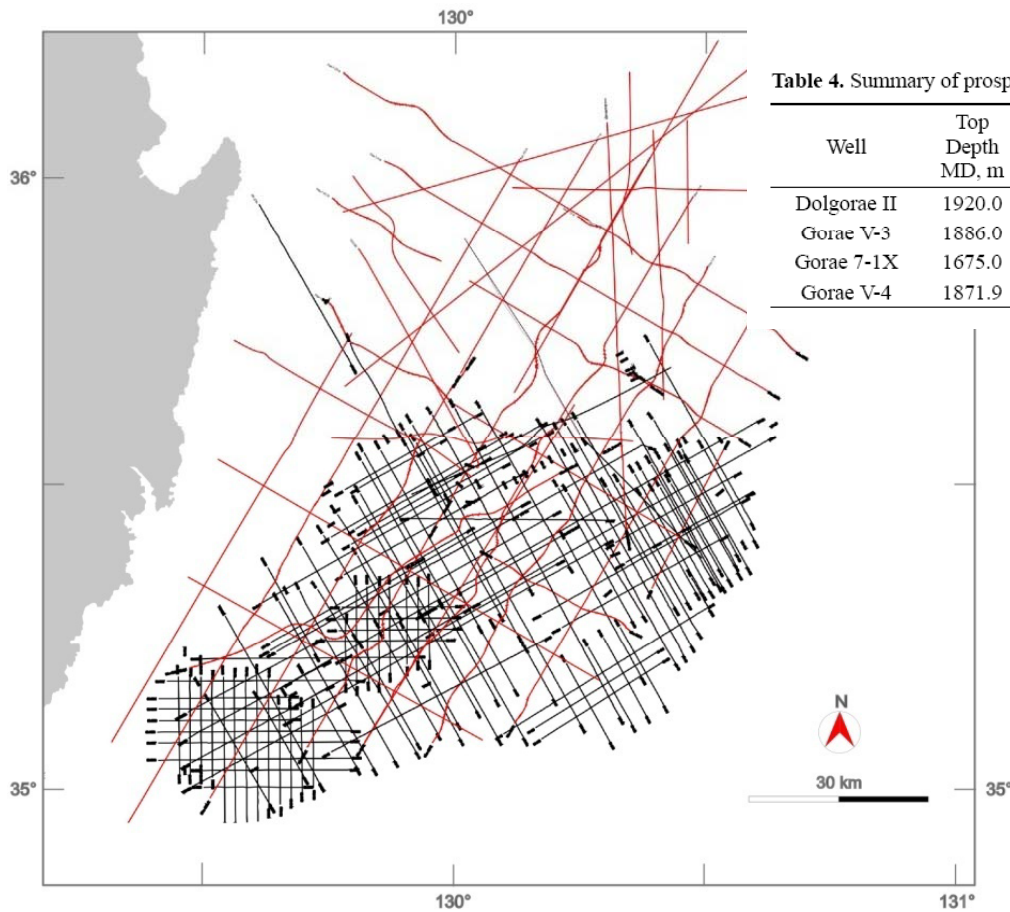
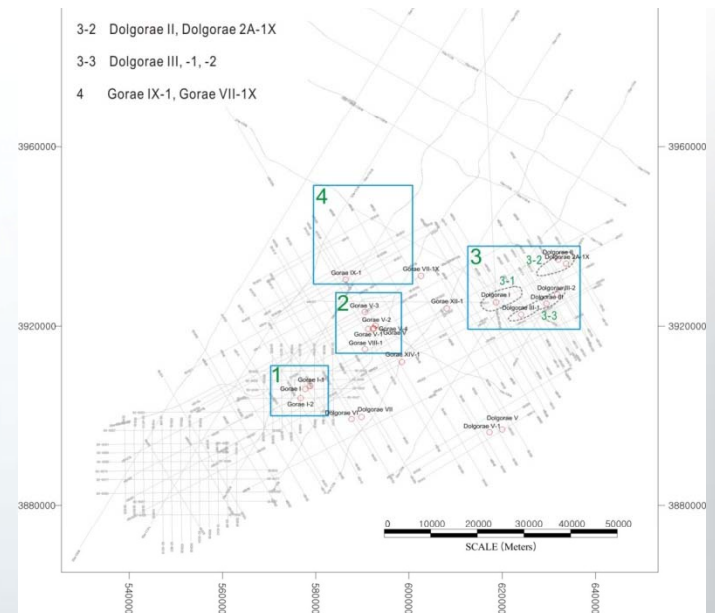


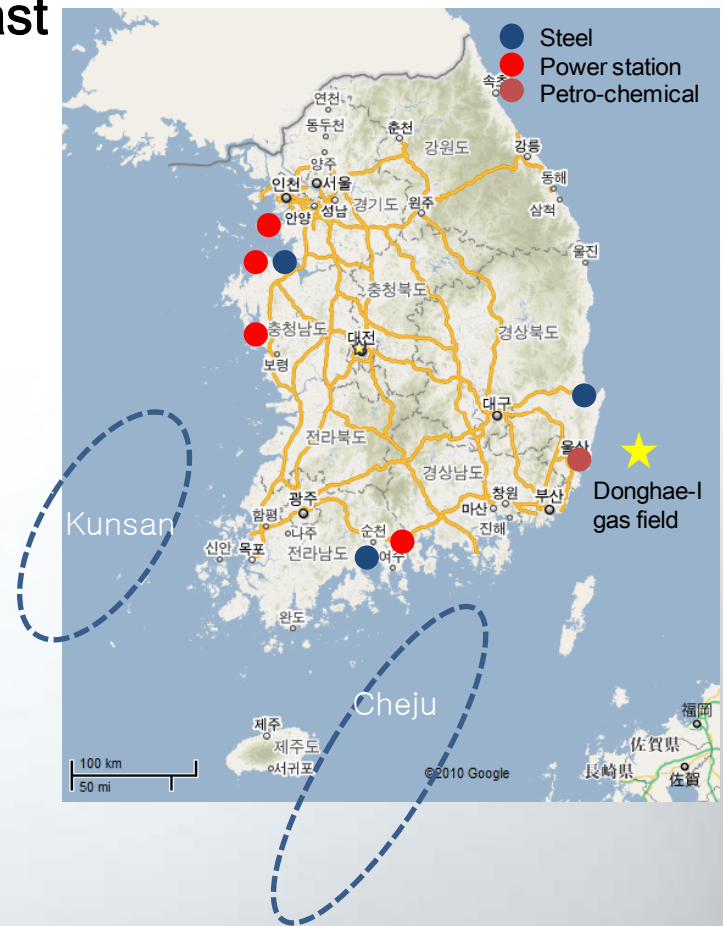
Table 4. Summary of prospects for CO₂ geological storage on the block VI-1 (석유공사, 2003)

Well	Top Depth MD, m	Bottom Depth MD, m	Gross Interval	Gross sand	Net sand	Net sand/Gross	Porosity	Water saturation
Dolgorae II	1920.0	2437.0	517.1	216.8	214.3	0.41	0.236	0.942
Gorae V-3	1886.0	2560.0	674.1	466.9	417.9	0.62	0.192	0.948
Gorae 7-1X	1675.0	2100.0	425.1	319.8	303.2	0.71	0.253	1.0
Gorae V-4	1871.9	3001.1	1129.3	482.6	339.7	0.30	0.154	0.585



Mismatch between Capture & Storage

- Most of emitters located on the W or S coast
- No power plant near Ulleung basin
- More data needed for
Cheju and Kunsan basins



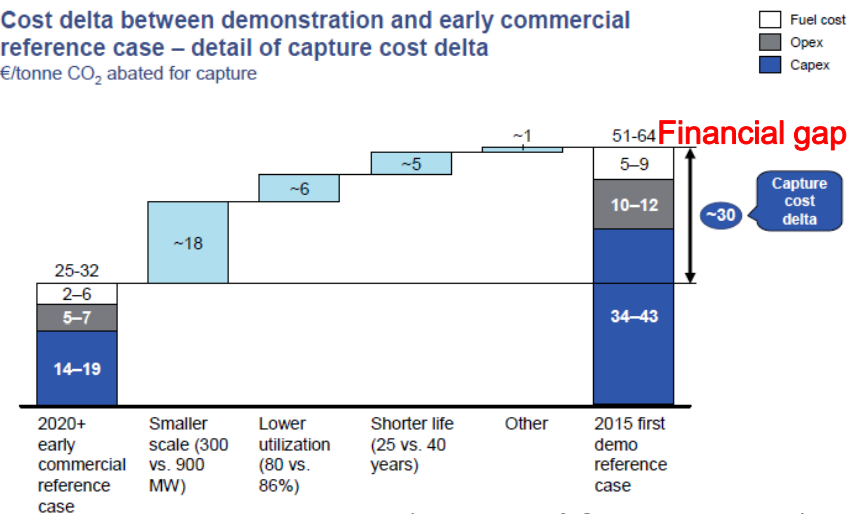
Financial barriers

- **CCS under UN climate change negotiation**

- CCS is not CDM yet
- Including in GHG inventory is not agreed yet

☞ No economic mechanism for CCS

Cost delta between demonstration and early commercial reference case – detail of capture cost delta
€/tonne CO₂ abated for capture



- **No stimulus or Incentives yet in Korea**

- Global emission target will decide the value of CCS
- Mid-term to 2015 or 2020 financial support needed

☞ Some want CCS to be included in RPS or to be used for offsetting RPS partially

(Renewable Portfolio Standard)

(McKinsey&Company, 2008)



Legal and regulatory framework (I)

- **No applicable legislation for CCS**
 - Even EOR/EGR don't have any legal basis in Korea
 - No legislation for CCS

- **Related legal regimes**

- Groundwater Act

Onshore E&P

- Mining Industry Act

- Submarine Mineral Resources Development Act

- Marine Environmental Management Act

- (law to reflect London convention)

Offshore E&P



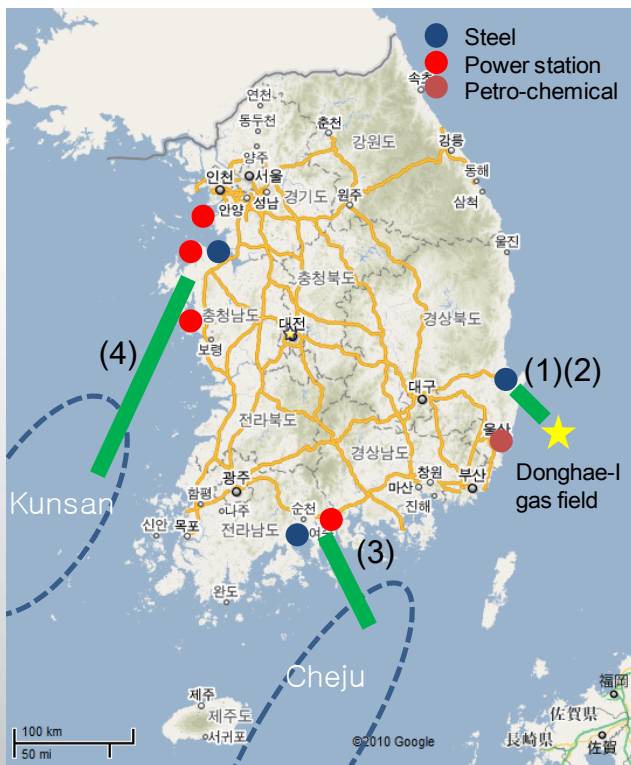
Legal and regulatory framework (II)

- **Amendment needed for permission and short- and long-term liability**
 - Submarine Mineral Resource Development Act
 - Marine Environmental Management Act
(to implement London protocol of 1996)
- **Nothing has done for the regulation but it could be settled easily because of the simple situation (only offshore project is possible)**



Future of CCS in Korea

- Site specific assessment of geo-sequestration should be done
- Source-Sink linkage
- Possible Capture & Storage Link



- (1) Steel/Iron works – Ulleung basin
- (2) New power station – Ulleung basin
- (3) Power station – Cheju basin
- (4) Power station – Kunsan basin



100 km
50 mi

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Summary

- **Technical and financial barriers in Korea are the most significant**
- **Legal and regulatory barriers exist, but the government is very active so it could be solved**





Thank you for your attention

This photo was taken at Otway, Australia²²