Clean Coal Technology and CCS in Japan

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Japan Coal Energy Center

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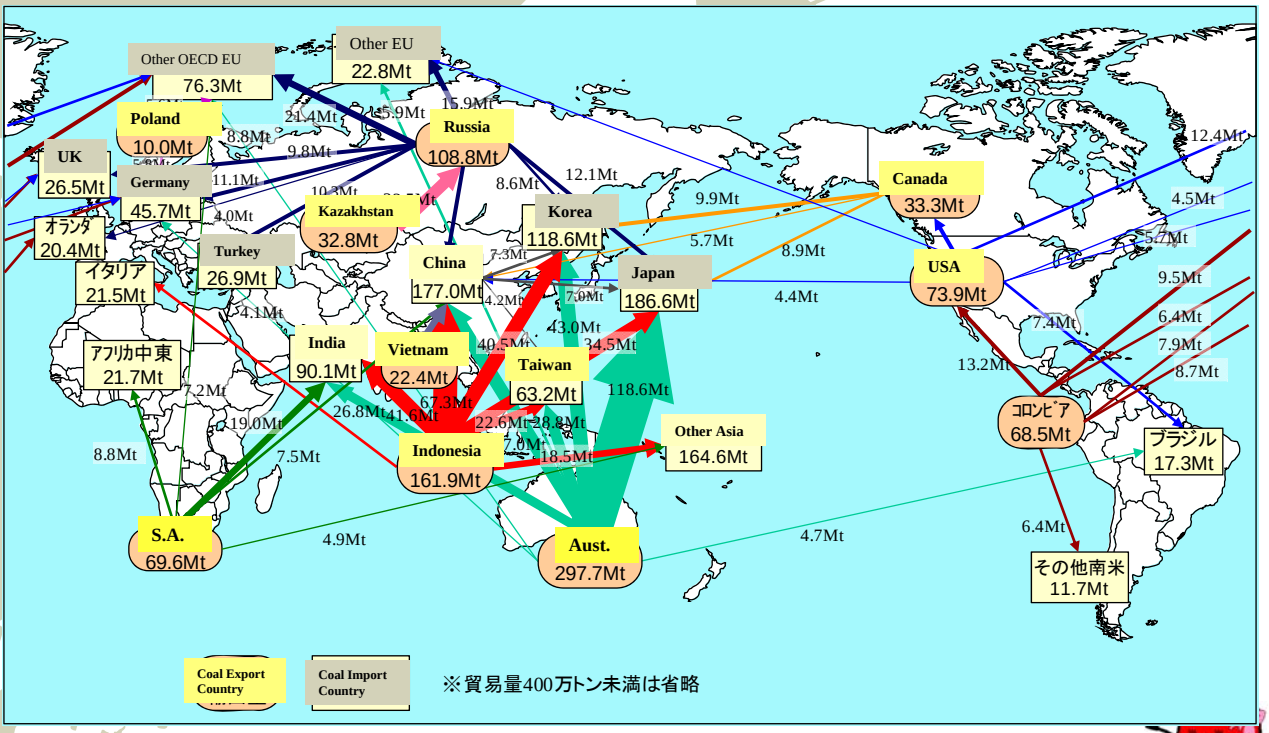
World Coal Trading (2011)



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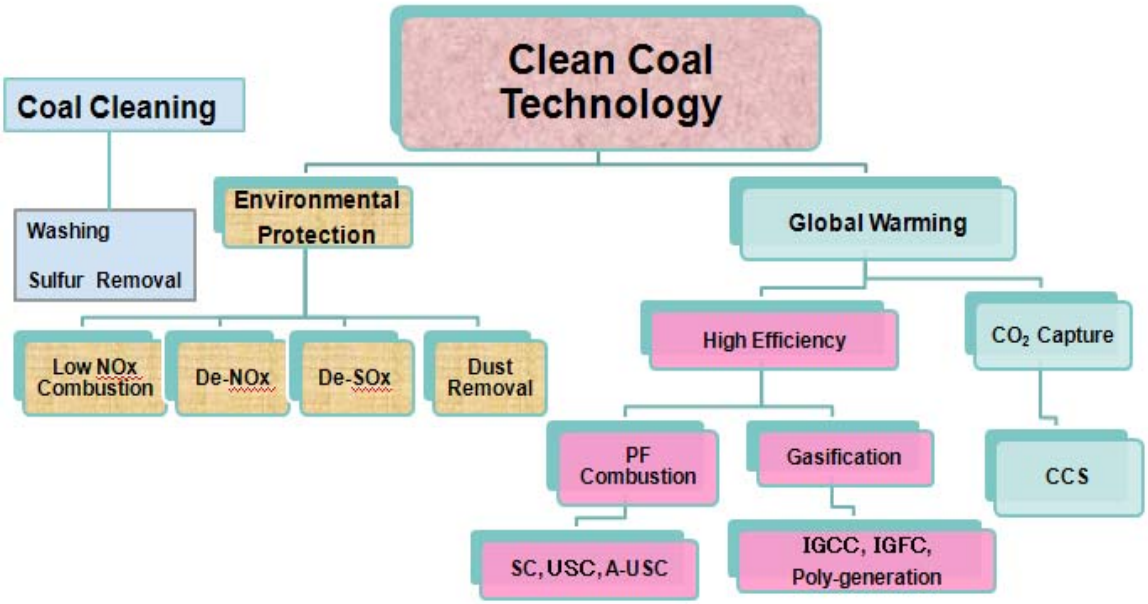
Clean Coal Technologies for Power Generation



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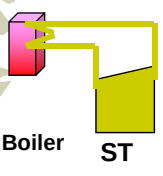
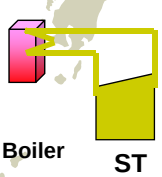
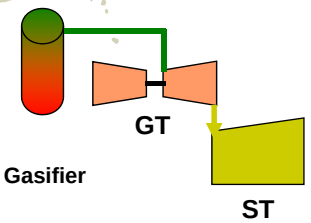
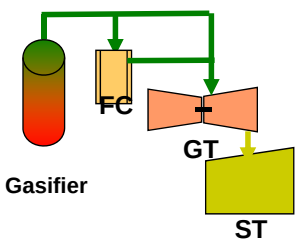
1. High Efficient Technology in Japan

Towards Higher Thermal Efficiency Development of Coal-fired Power Generation

- **Pulverized Coal-Fired System (PCF)**: Efficiency upgrade by increasing steam temperature and pressure; A-USC（Advanced USC, 700℃ class）is under development
- **Integrated Coal Gasification Combined Cycle System (IGCC)**: Combined Gas turbine (GT) and steam turbine (ST) cycle; Higher thermal efficiency than PCF; Increasing the GT inlet gas temperature is necessary for efficiency upgrade
- **Integrated Coal Gasification Fuel Cell Combined Cycle System（IGFC）**: Triple combined cycle (GT+ST+FC); Higher thermal efficiency than IGCC

① PCF		② IGCC（1500℃ class）	③ IGFC
Latest PCF（USC） 	700℃ class（A-USC） 		
Gross：42～43%（HHV） Net ：41%(HHV)（Basis）	Gross：48% Net ：46% CO_2 reduction: approx. 11%	Gross：51～53% Net ：46～48% CO_2 reduction: approx. 13%	Gross：60%～ Net ：55%～ CO_2 reduction: approx. 25%～

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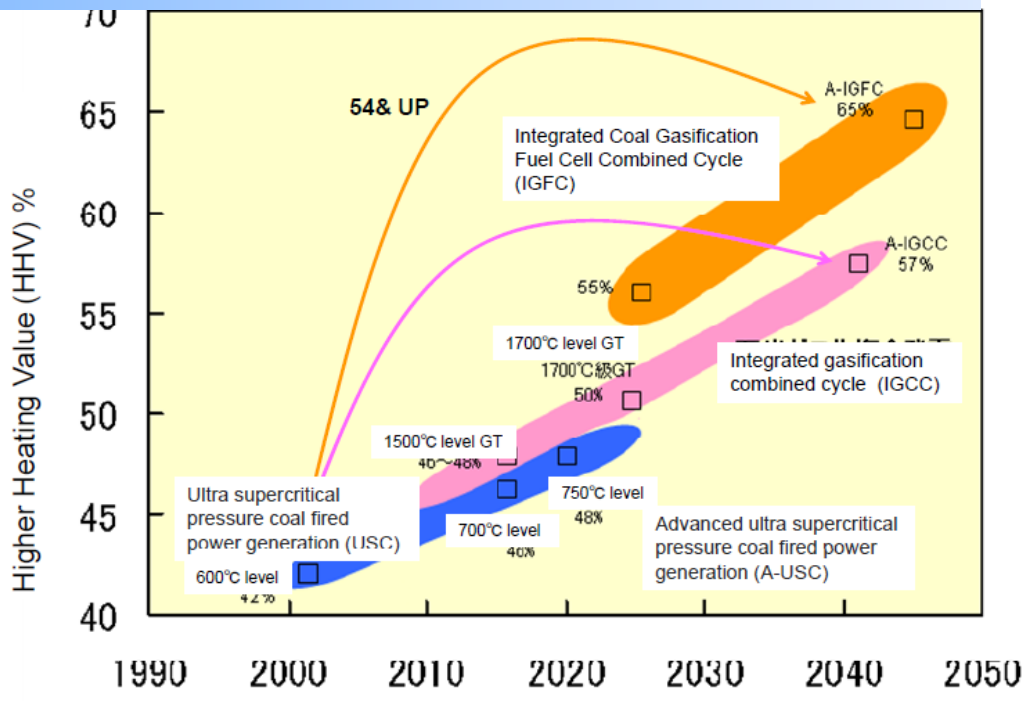
Roadmap on improving the efficiency of coal fired power plants



Source of reference: [Action Plans on Forming a Low Carbon Society] and from [Cool Earth: Energy Technology Innovation Project]

Efficiency Upgrade by Plant Replacement (Isogo Thermal Power Station)

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Old Isogo, Startup:1967

New Isogo No.1, Startup: 2002
New Isogo No.2, Startup: 2009

Three Purposes

- ◇ **Output Upgrade**
- ◇ **Environmental Upgrade**
- ◇ **Efficiency Upgrade**

◆ Output	530MW (265MW×2)	⇒	1,200MW (600MW×2)
◆ SOx	60 ppm	⇒	20 ppm (10)
NOx	159 ppm	⇒	20 ppm (13)
Dust	50 mg/m³N	⇒	10 mg/m³N (5)
			( ):No. 2
◆ Steam condition	Sub-critical	⇒	Ultra Super Critical (USC)
Efficiency	38% (Gross%; HHV)	⇒	42～43% (Gross%; HHV)
CO_2 Emissions	**100**	⇒	**83** ※

※ A comparison of the CO_2 emission per gross output (kWh) with an old plant (100 basis).

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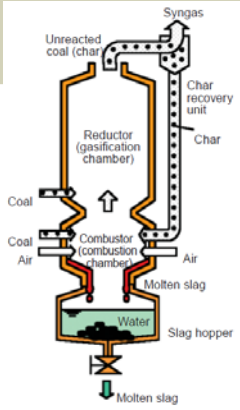
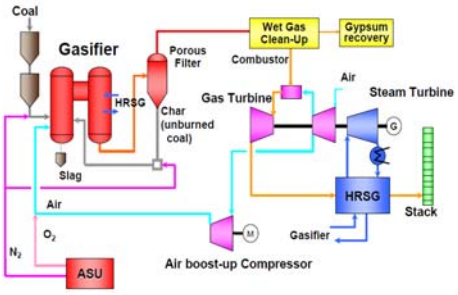
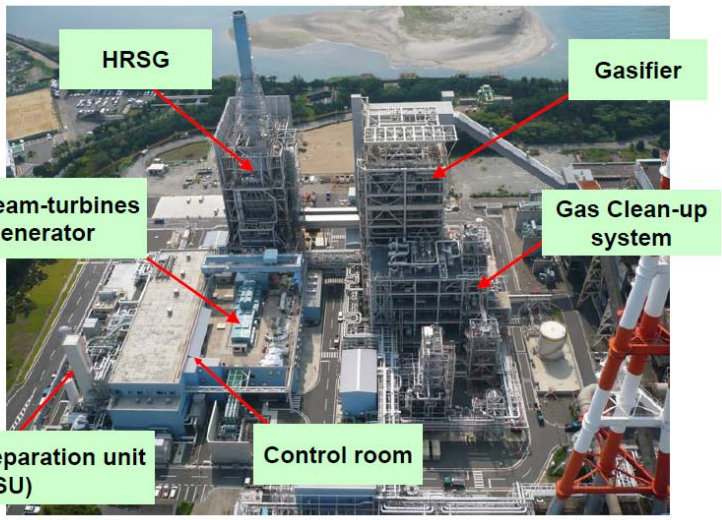
New Energy Efficient Technologies
IGCC in Japan Nakoso 250MWe







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IGCC, IGFC& CCS: Osaki CoolGen Project

IGFC, the Ultimate High Efficiency Coal Fired Power Technology

Demo. Project by Osaki CoolGen Corp.

Output: 170 MW Class
Coal Feed: 1,100 t/ d
Net Efficiency: Comparable to 1000 MW Class USC

Osaki-kamishima, Hiroshima

Fiscal Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
EIA													
Demo. Schedule IGCC	Optimization Research & Study		Design, Manufacturing & Construction				Test Ope.						
+CO_2 Capture			Start of Construction				D, M & C			T.O.			
+Fuel Cell=IGFC									D, M & C			T.O.	

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2. CCS Projects in Japan

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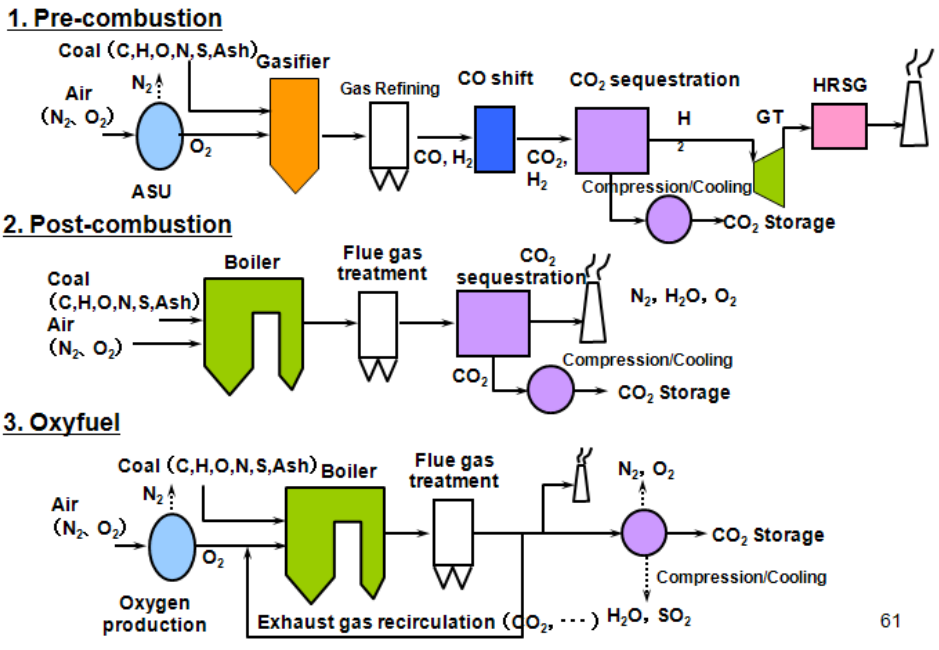
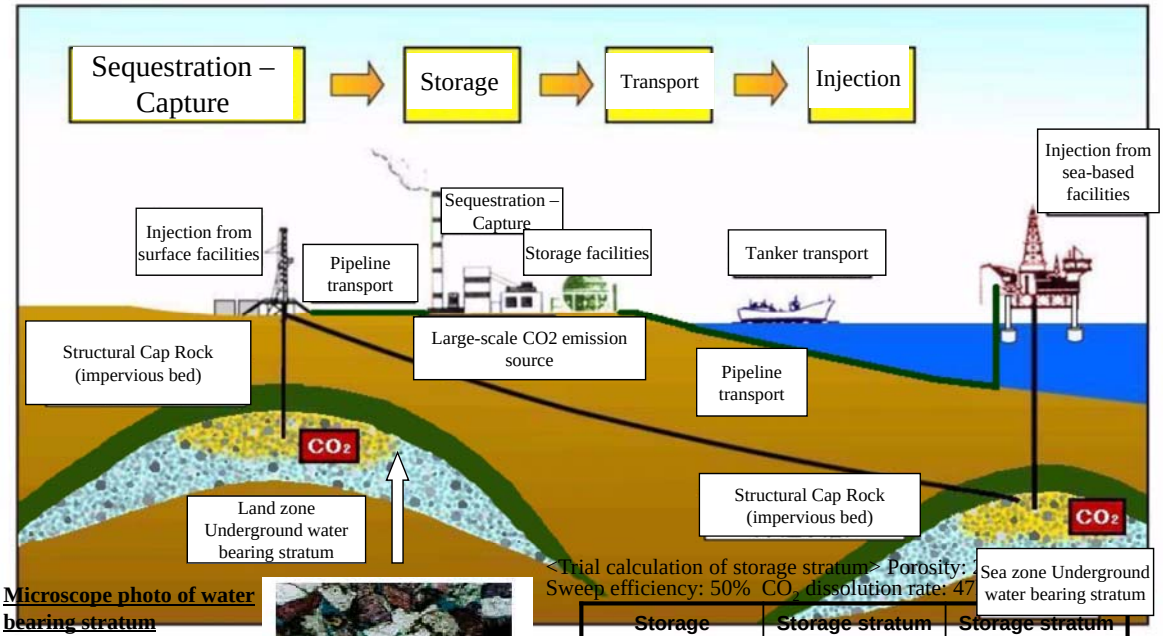
Carbon Capture & Storage(CCS)

Pre, Post, Oxyfuel-combustion

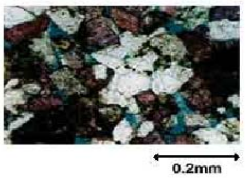


Carbon Capture & Storage(CCS)



Microscope photo of water bearing stratum

The layer is a stratum including brine formed by porous sandrock with a high porosity.



<Trial calculation of storage stratum> Porosity: 1
Sweep efficiency: 50% CO_2 dissolution rate: 47

Storage capacity	Storage stratum thickness	Storage stratum diameter
10,000 t-CO_2	10m	260m
1 million t-CO_2	50m	1.2km

Japan-Australia Callide-A Oxy-fuel Project outline

Demonstration of 30MWe coal fired power plant with CCS by Oxy-fuel technology

Callide-A: 4 x 30 MWe (Use one unit)
Evaporation: 123 t/h steam
4.1 MPa/460°C
Operation terminated 2002
Flue gas treatment / Fabric filter (without DeNOx / DeSOx)

Partners
CS Energy, Xstrata, Schlumberger
JPOWER,I HI, Mitsui & Co, JCOAL

CO2 storage site area (app.300km far east from Callide-A)

Callide-A Power Plant

Callide Oxyfuel Project

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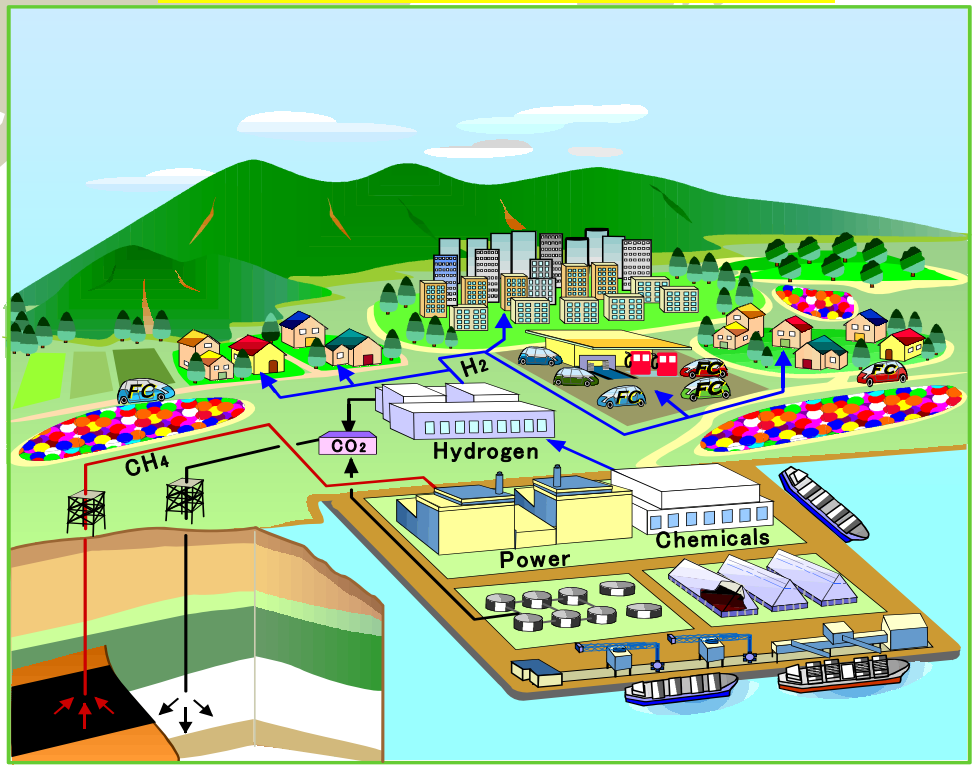
3. The Future of Coal

The Future of Coal



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Thank you for your attention!