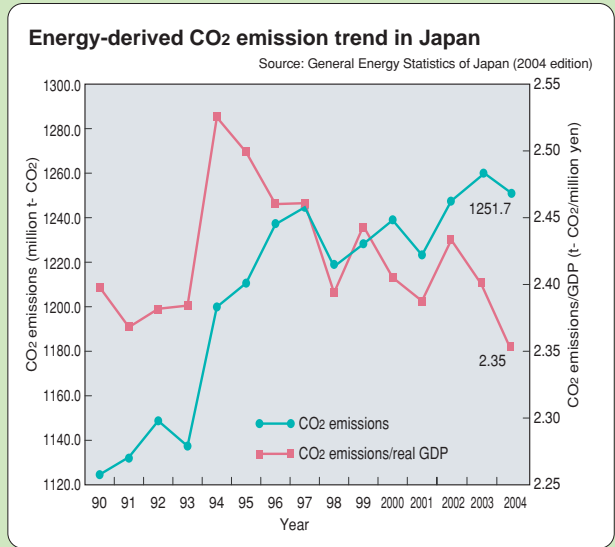
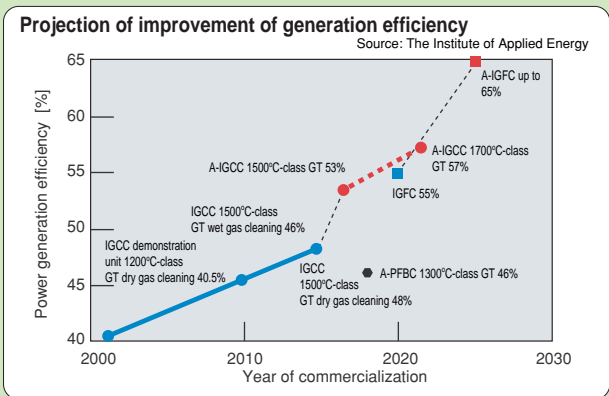


Efforts to reduce CO2 emissions

The Kyoto Protocol, which requires Japan to reduce greenhouse gas emissions, including carbon dioxide, methane, nitrous oxide and alternative CFCs, by 6 percent from the 1990 level between 2008 and 2012, came into effect on February 16, 2005.

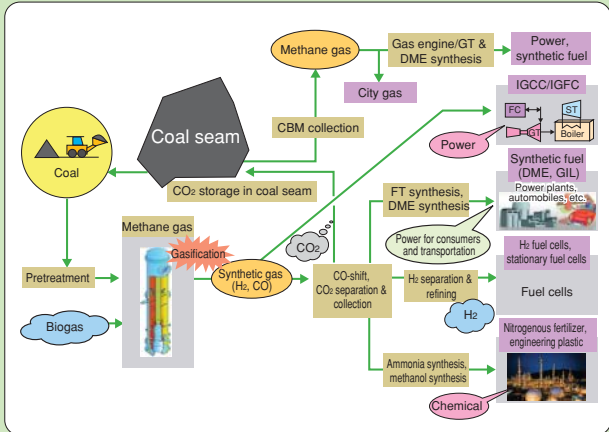
Among these global warming gases, carbon dioxide (CO2) has the greatest impact on the environment. To reduce emissions of CO2, Japan, with the most highly advanced clean coal technologies in the world, is promoting further technological developments, including:

- [1] Reduction of CO2 generation by enhancing coal utilization efficiency,
  - [2] Control of CO2 emissions generated through direct coal burning by utilizing the carbon component in coal for material production, and
  - [3] Underground CO2 sequestration and storage by decomposing and capturing CO2 contained in flue gas.
- Japan also promotes the reduction of CO2 emissions through international cooperation using the Kyoto Mechanisms.

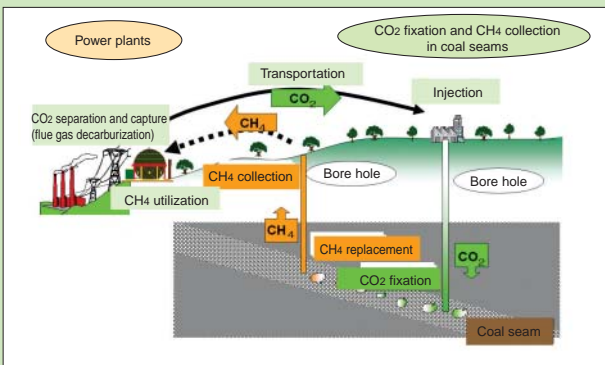
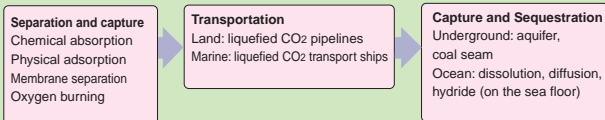


Co-production

Source: JCOAL Journal, First issue



CO2 capture and sequestration



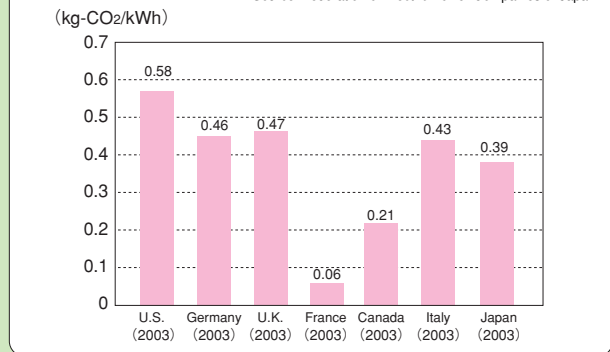
CO2 emissions in major countries (million tons)

Source: IEO 2005

	1990	2001	2002	2010	2015	2020	2025
U.S.	4,989	5,692	5,751	6,561	6,988	7,461	7,981
Canada	473	573	588	681	726	757	807
Western Europe	3,413	3,585	3,549	3,674	3,761	3,812	3,952
Russia	2,347	1,553	1,522	1,732	1,857	1,971	2,063
China	2,262	3,176	3,322	5,536	6,506	7,373	8,133
India	583	1,009	1,025	1,369	1,581	1,786	1,994
Japan	990	1,182	1,179	1,211	1,232	1,240	1,242
World total	21,460	24,072	24,409	30,201	33,284	36,023	38,790

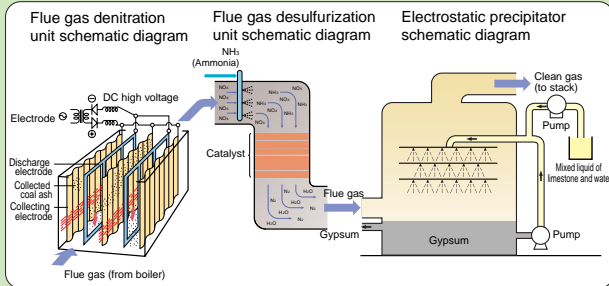
CO2 emissions per generated power unit in major countries

Source: Federation of Electric Power Companies of Japan



### Flue gas treatment technologies

Emission reduction technology to remove dust, sulfur oxides, and nitrogen oxides has been developed by treating and combusting flue gas from coal combustion through a superior process design.



#### Electrostatic precipitator

Flue gas containing ash and dust passes between two electrodes that are charged by a high voltage current. The negatively charged ash and dust are attracted toward and deposited on the cathode. The ash and dust deposited on the cathode are tapped periodically, and are collected in the lower section of the electrostatic precipitator and then subsequently removed. The principle is the same as the phenomenon where paper and dust adhere to a celluloid board electrostatically charged by friction.

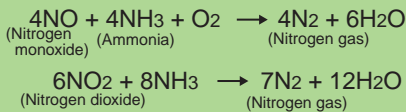
#### Flue gas desulfurizer

Limestone is powdered to prepare a water-based mixture (limestone slurry). The mixture is injected into the flue gas to induce a reaction between the limestone and the sulfur oxides in the flue gas to form calcium sulfite, which is further reacted with oxygen to form gypsum. The gypsum is then separated as a product.

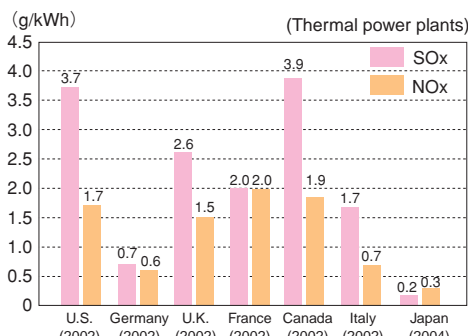
#### Flue gas denitrizer

Ammonia is injected into the flue gas containing nitrogen oxides. The gas mixture is introduced to a metallic catalyst (a substance which induces chemical reactions). The nitrogen oxides in the flue gas undergo catalyst-induced chemical reactions, causing them to decompose into nitrogen and water.

#### Reaction formulae



**Emissions of SO<sub>x</sub> and NO<sub>x</sub> per generated power in major countries**  
Source: The Federation of Electric Power Companies of Japan



### Coal preparation technologies

Reducing sulfur oxide emissions during coal utilization is an important environmental conservation challenge. Coal preparation is an environmental control technology that removes iron pyrite particles that may be a source of ash content or sulfur oxides before coal is used.



Flotation machine



Heavy media cyclone

### Sludge coal collection and dehydration technologies

Coal preparation leaves an effluent containing pulverized coal. Releasing the effluent into rivers and streams without treatment may cause environmental problems. To resolve the issue, and to also make effective use of this resource, a high-efficiency sludge coal collection and dehydration technique is now under development.



Effluent thickener



Dehydrator

### Effective coal ash utilization technologies

Ash generated during coal combustion can be effectively used as a raw material for cement and other products. The use of ash for multiple purposes is under study.

Effective use of coal ash from power generation or general industries in Japan (FY2003)  
Source: Survey report on actual usage of coal ash in Japan (JCOAL)

