Energy Strategies of Japan
- The Role of Clean Coal Technologies-

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Presentation Overview

- Coal resources situation in Asia and in the world
- Energy resources and power generation in Japan
- Japan's new coal policy toward 2030
- Development of Clean Coal Technology
- Development of IGCC demonstration plant in Japan
- CRIEPI's activity to develop IGCC Technology
- CCS (CO_2 Capture and Storage) as option in the future

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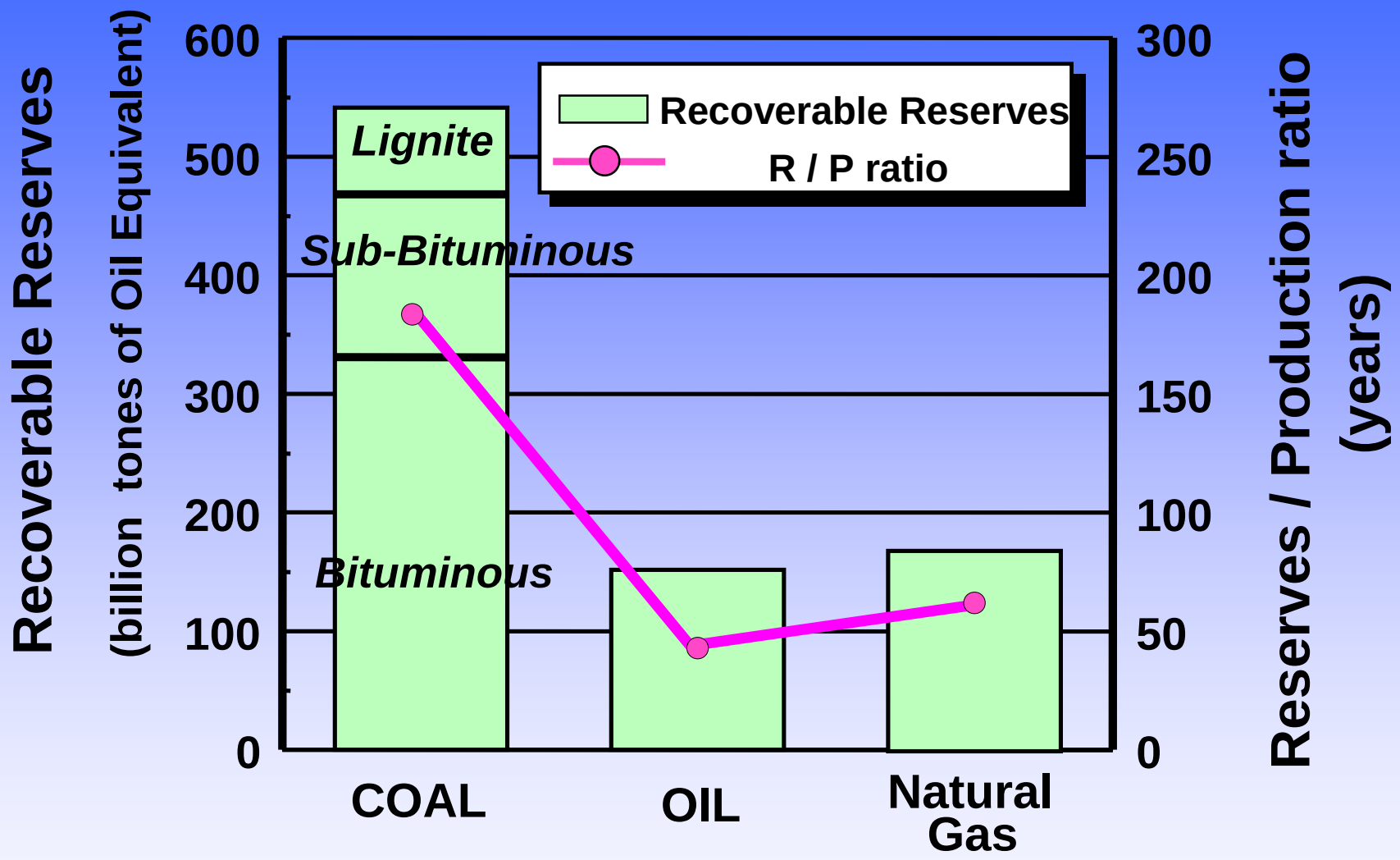

Recoverable Reserves of Energy Resources

(Sources:World Energy Council 2004)

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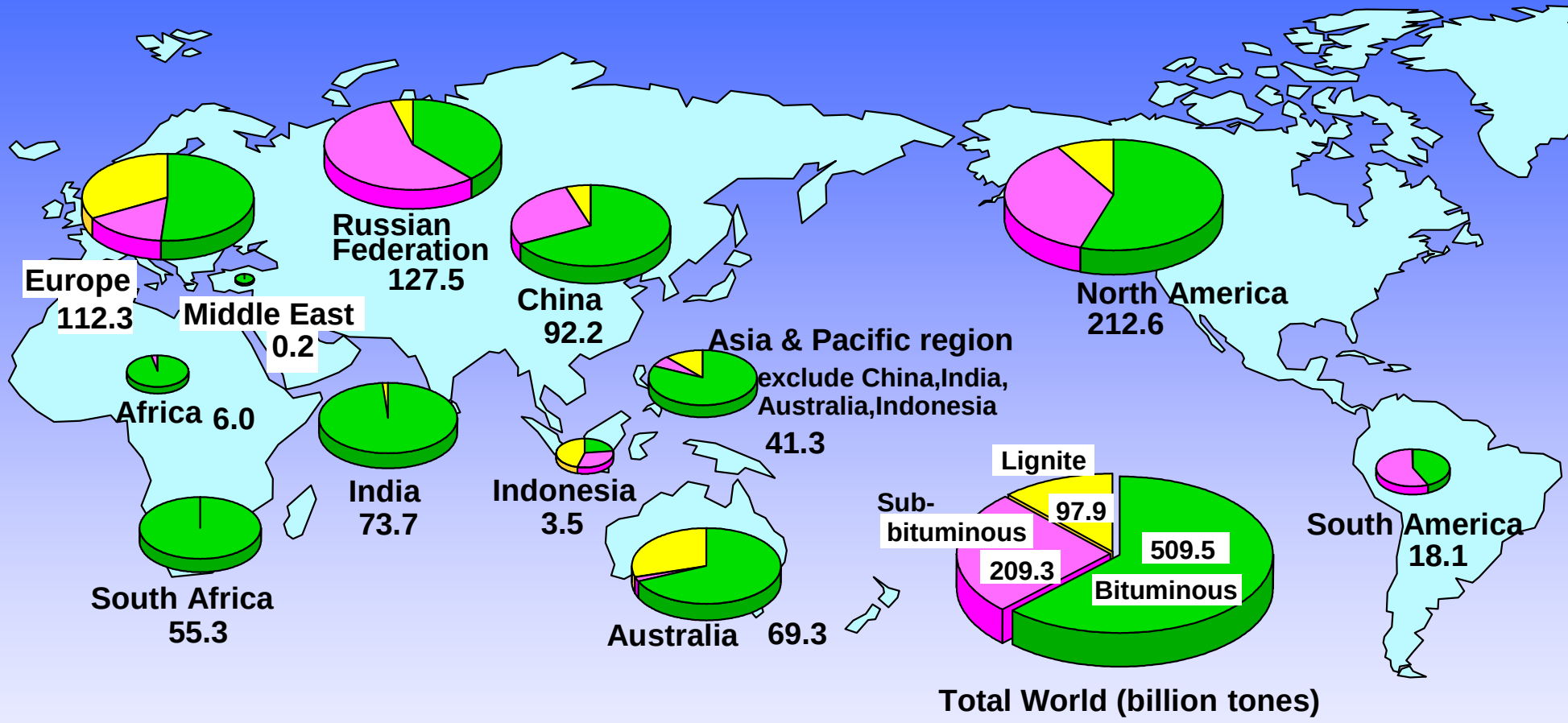

Proved Recoverable Researves of Coal in the World at End-1996

(unit : billion tones of bituminous coal equivalent)

Sources: Survey of Energy Resources / World Energy Council 1998

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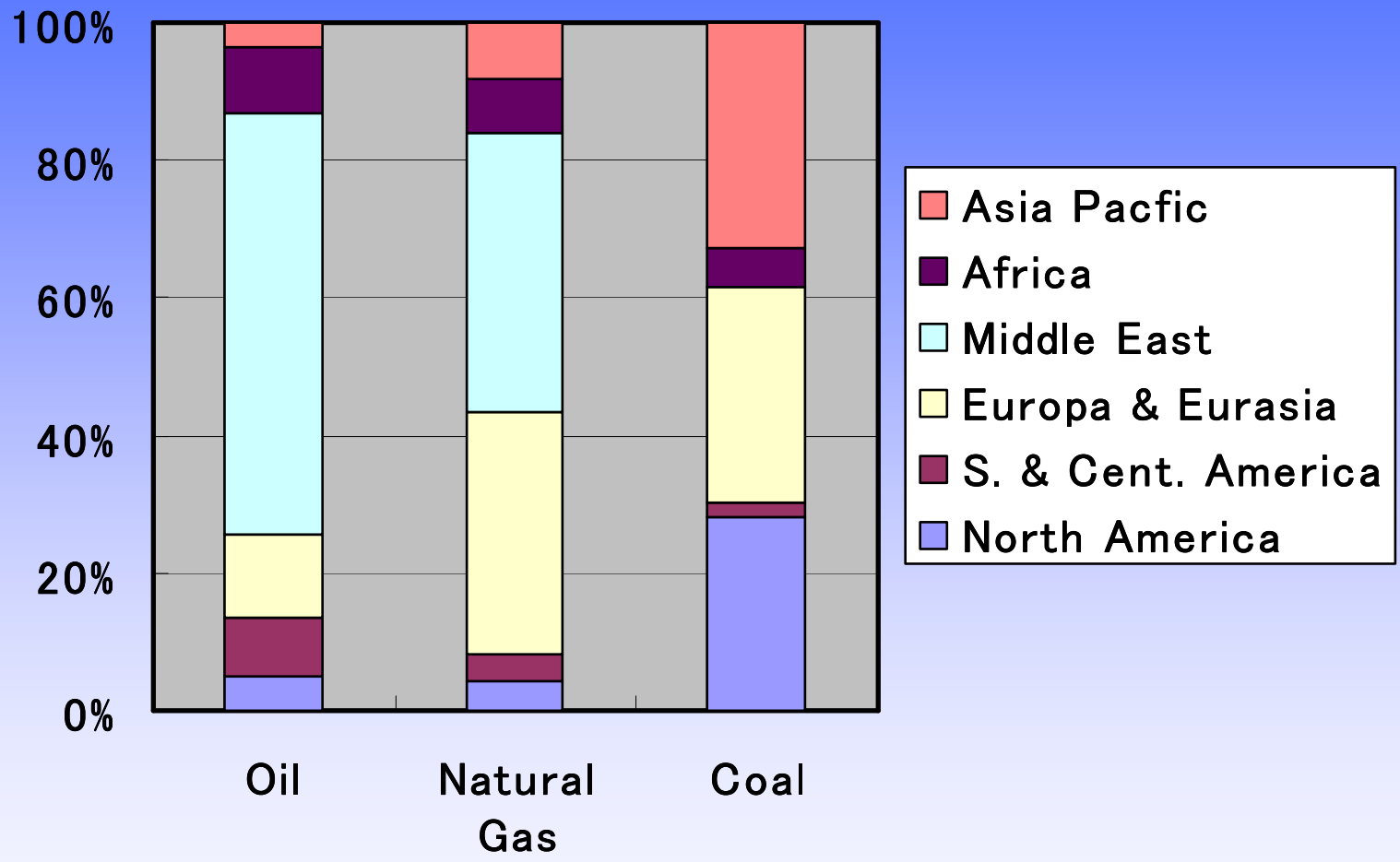

Distribution of Proved Reserves

(Sources: BP Statistical Review of Word Energy 2006)

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Consumption of Coal in the world :

4.0 billion ton in 2004		6.1 billion ton in 2030	
Asia:	53%	Asia:	61%
North America:	20%	North America:	20%
Europe:	20%	Europe:	14%
Others:	7%	Others:	5%

Consumption of Coal in Asia :

2.1 billion ton in 2004		3.7 billion ton in 2030	
China:	67%	China:	62%
India:	13%	India:	17%
Japan:	8%	Japan:	4%
Korea:	3%	Korea:	3%
Others:	9%	Others:	14%

(Sources: IEEJ, Asia/World Energy Outlook 2006)

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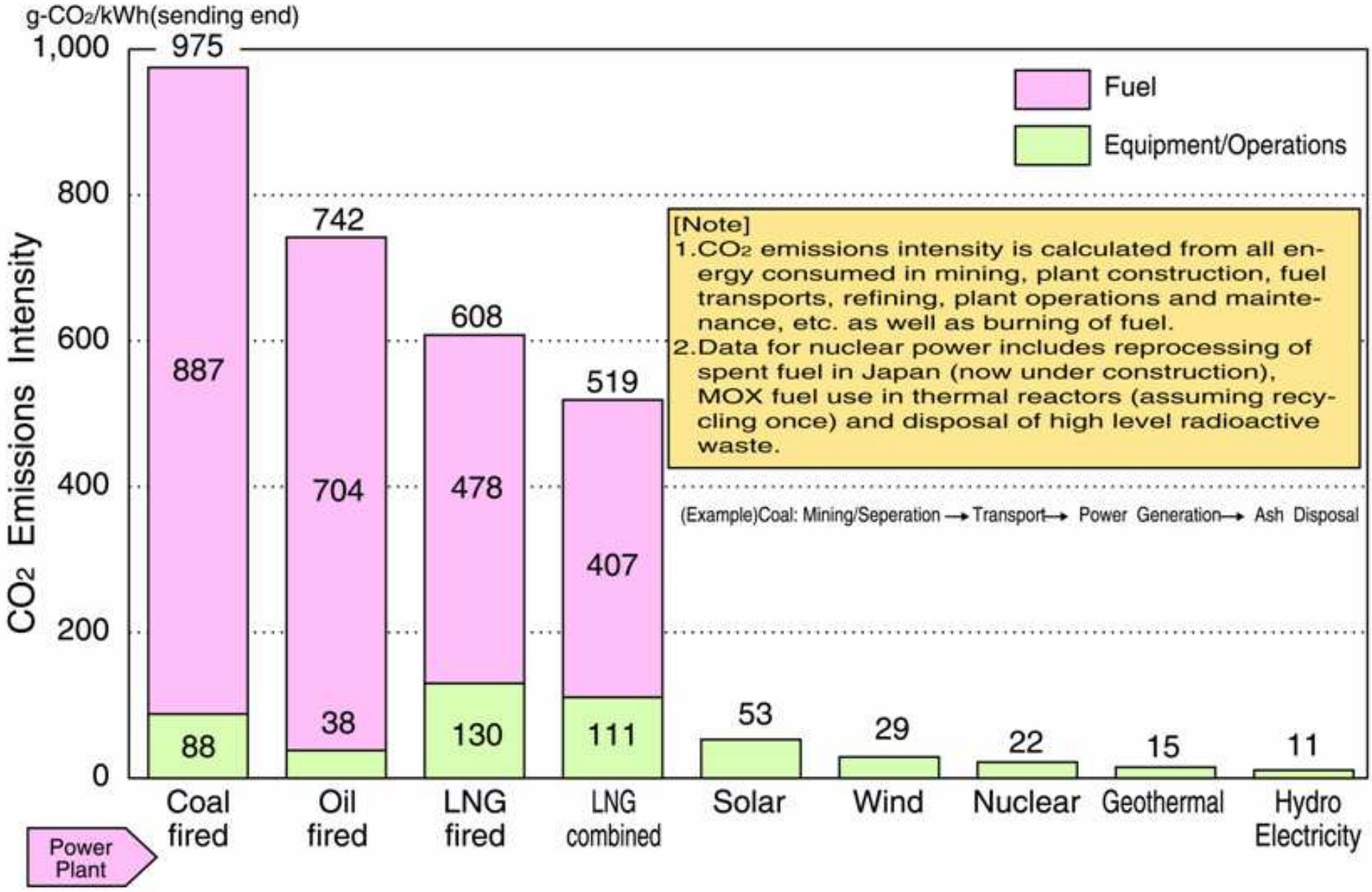
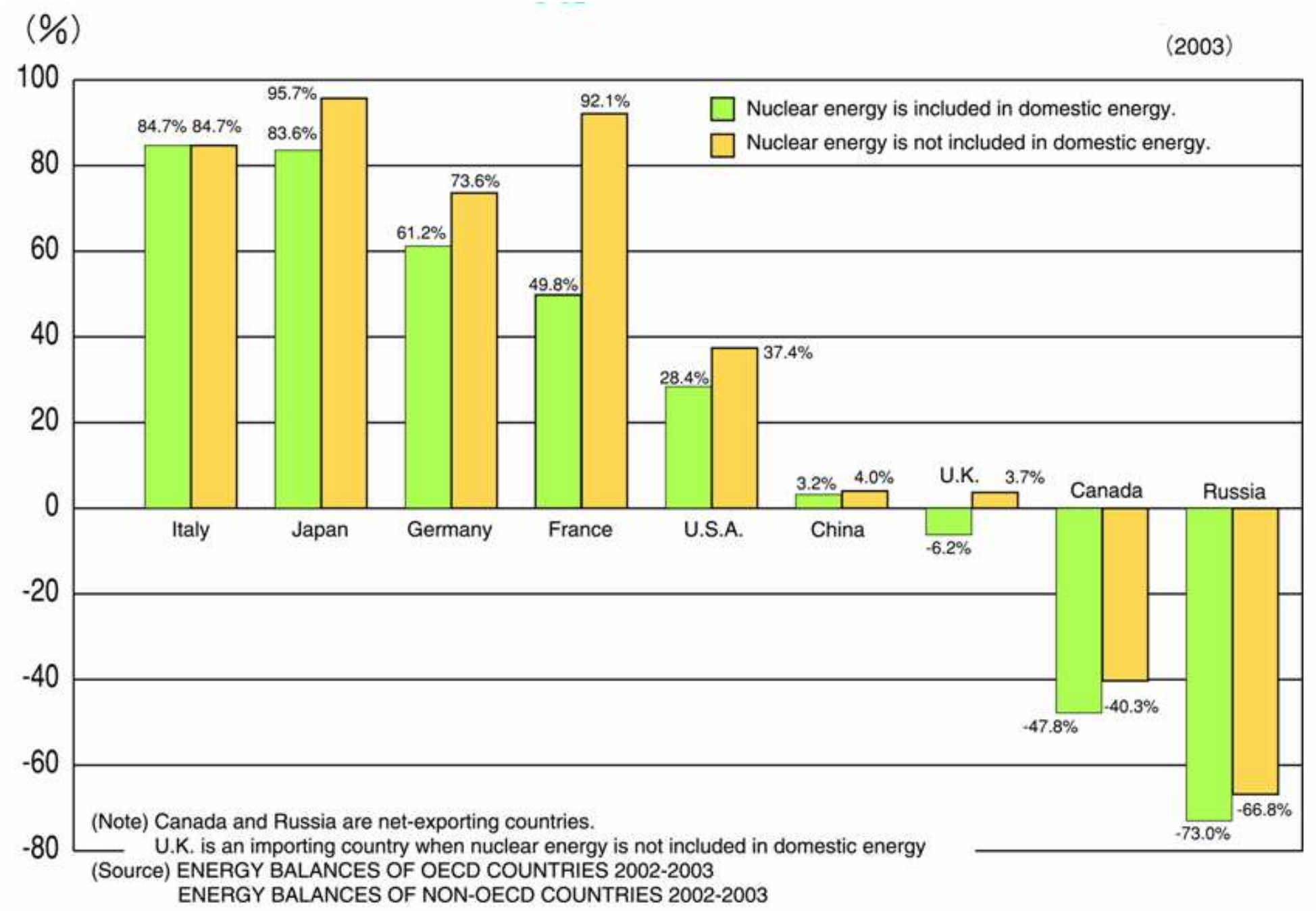
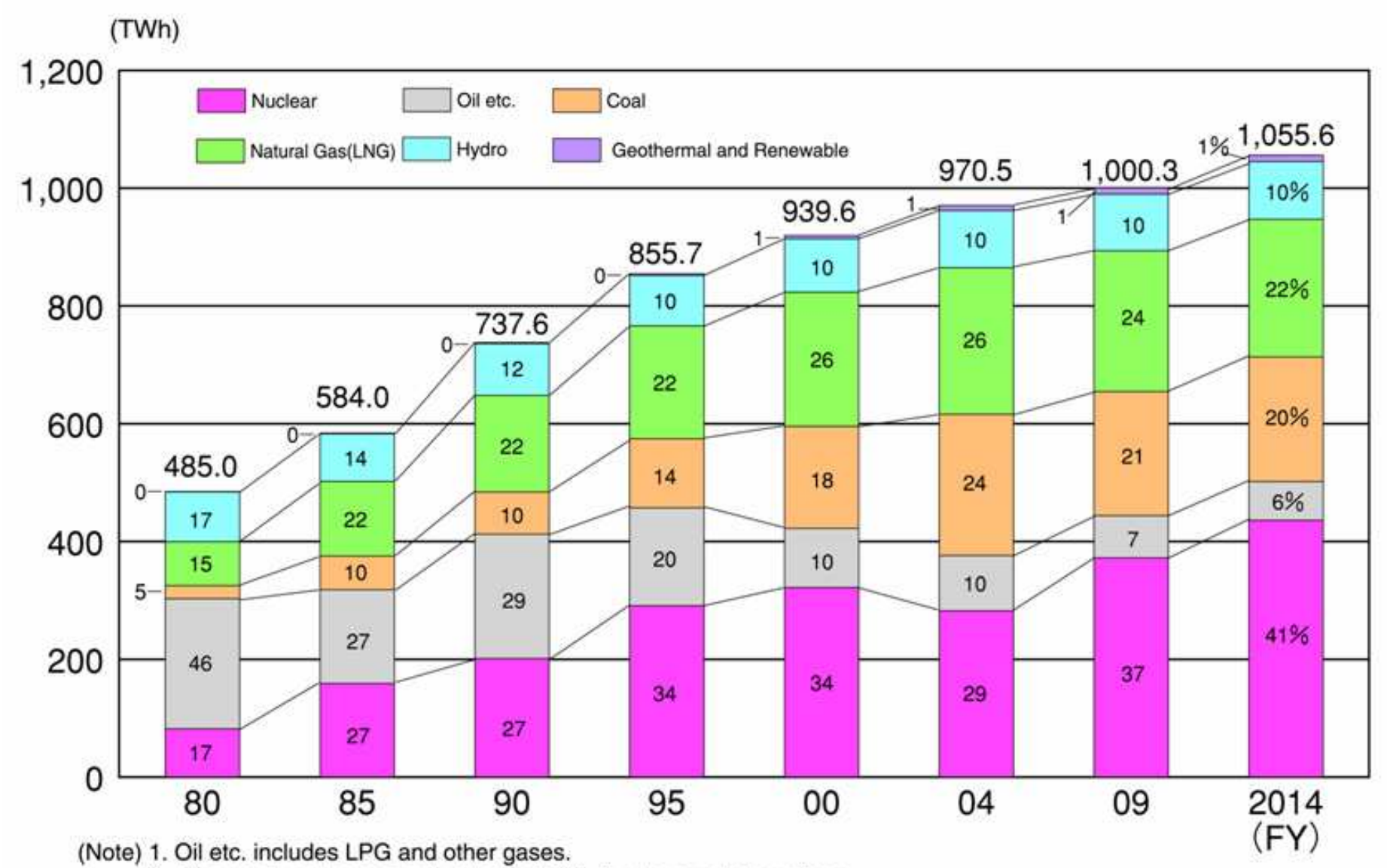


(Note) An aggregate may not match a total of each entry due to rounding.
(Source) Central Research Institute of Electric Power Industry Report etc.

Lifecycle Assessment CO_2 Emissions Intensity by Sources in Japan



Dependence on Imported Energy Sources by country



(Note) 1. Oil etc. includes LPG and other gases.
2. Figures do not necessarily total to 100% due to rounded numbers.
3. Total of 10 electric power companies and power purchased.
4. Figures within the graph represent the composition ratio.

(Source) The Central Electric Power Council "Long Term Electric Power Facilities Development Plan, March 2005" and others.

Trend of Annual Power Generation by Energy Sources in Japan

New Coal Policy toward 2030

Japanese government proposed New coal policy toward 2030 to promote Clean Coal Technology in 2004 .

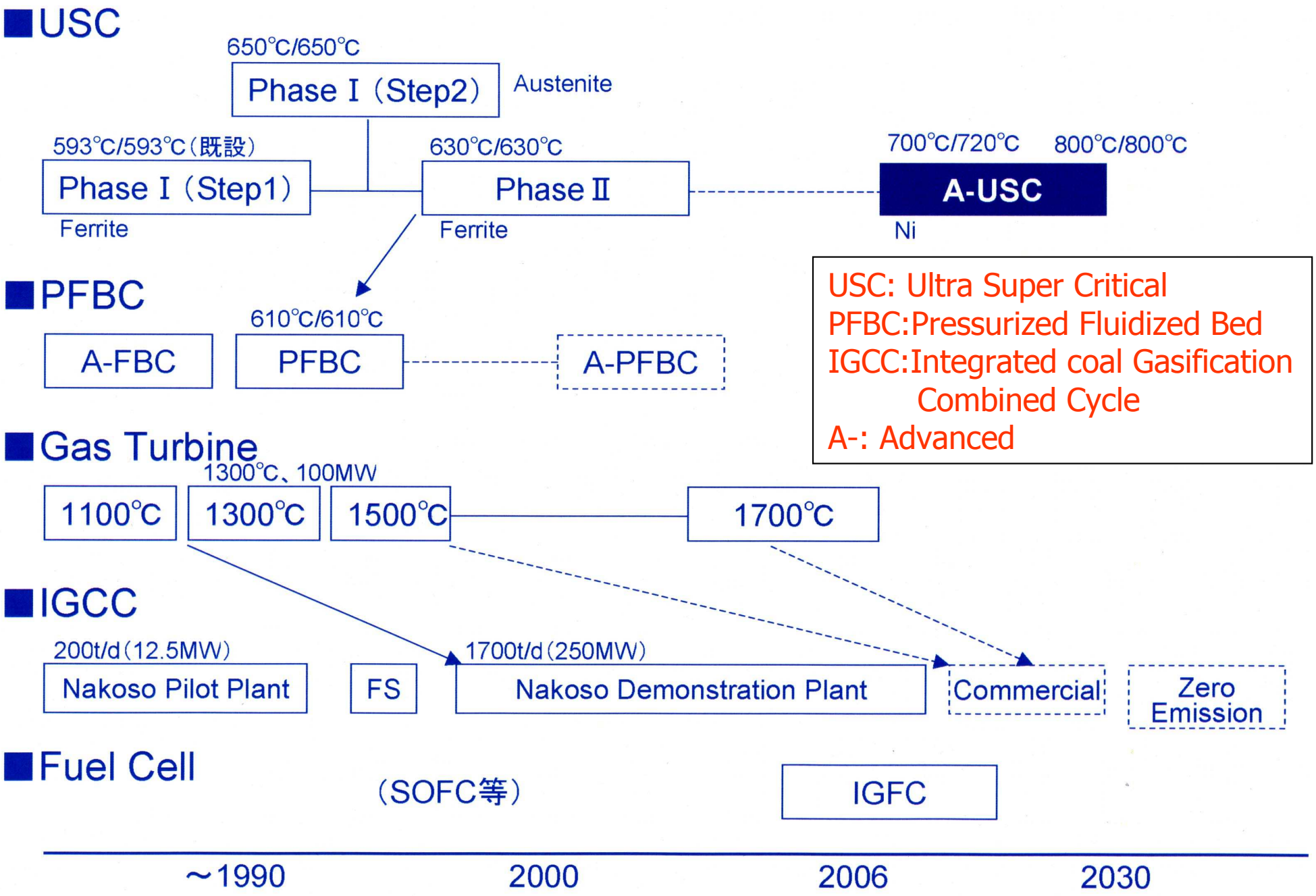
Five Basic Directions

-- Promote high-efficiency use
-- Reduce/utilize environmentally harmful byproducts
-- Cultivate new possibilities of coal utilization
-- Expand supply potential of coal
-- Improve efficient procurement of coal

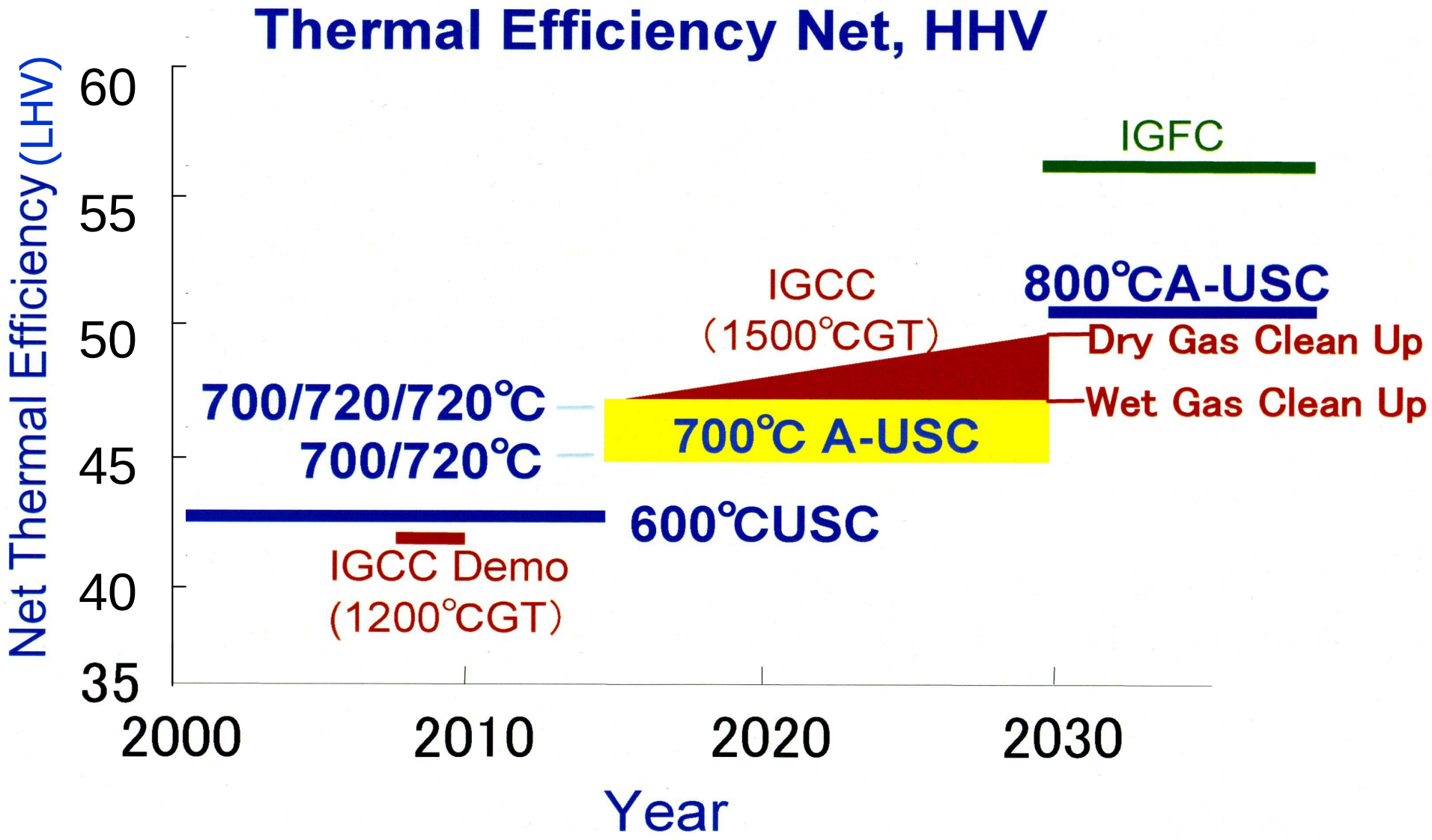
Activity of Electric Power Company

-- Develop high-efficiency power generation systems, such as USC, IGCC and IGFC

-- Promote utilization of biomass by co-fireing in pulverized coal power plant

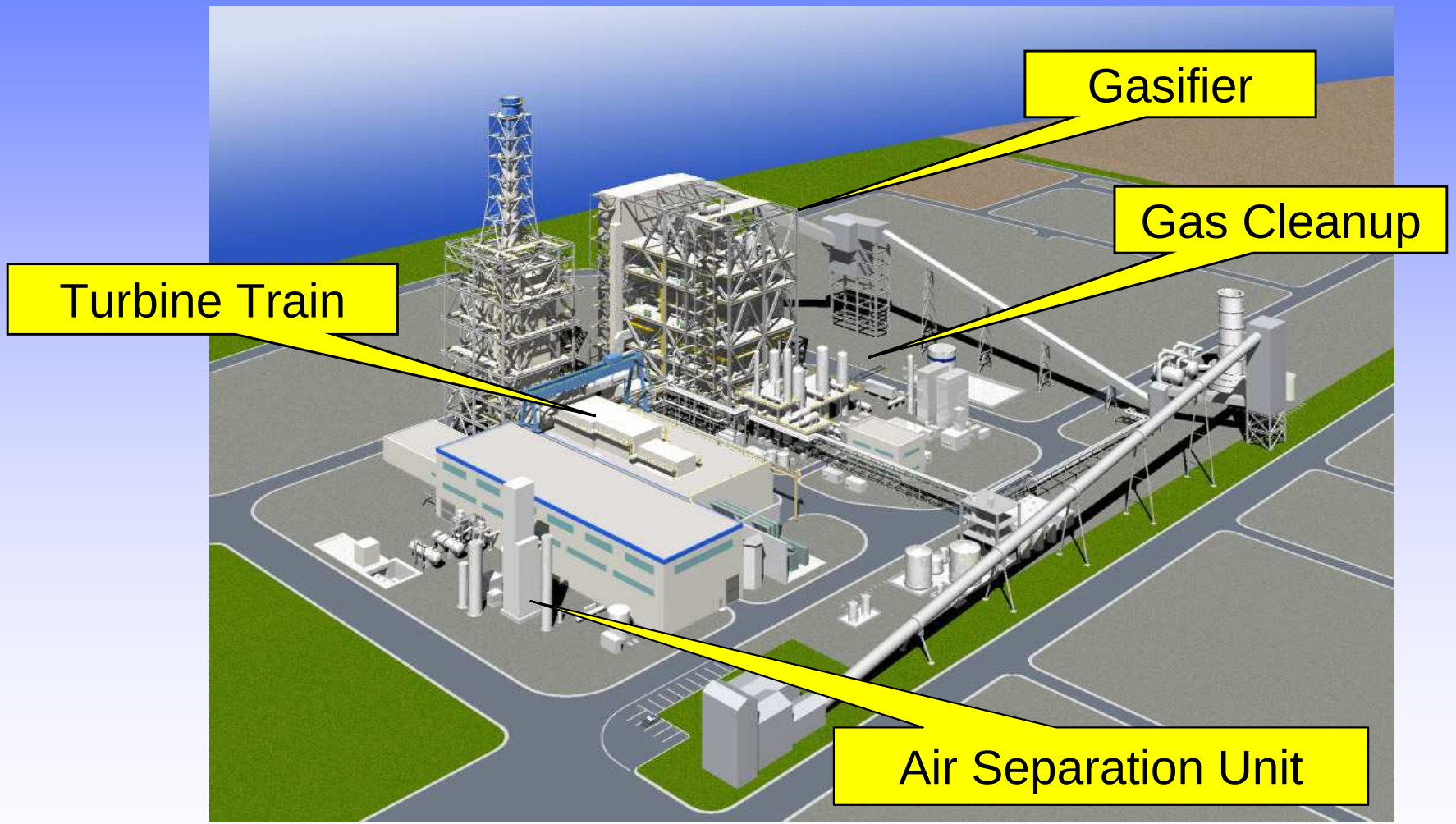


Development of Coal Coal Technology in Japan



Future aspect of thermal efficiency in coal utilization power generation system

Conceptual Drawing of 250MW IGCC Demonstration Plant



(Sources: Clean Coal Power R&D Co.)

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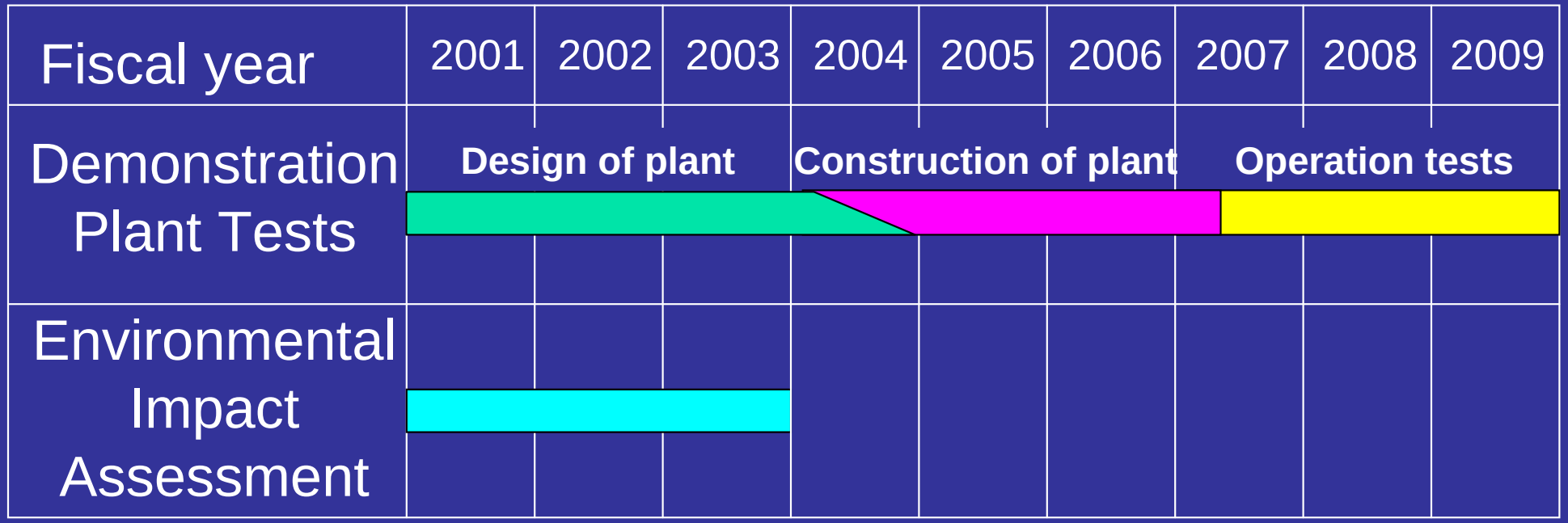
Schedule of IGCC Demonstration Plant Project



Specification

Coal Capacity: 1700 tons/day

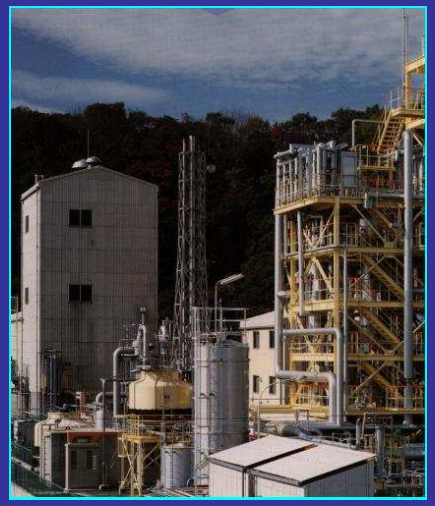
Cross Output: 250 MW

Net thermal Efficiency: 42%(LHV)

Emission Level:SOx / NOx / PMs:

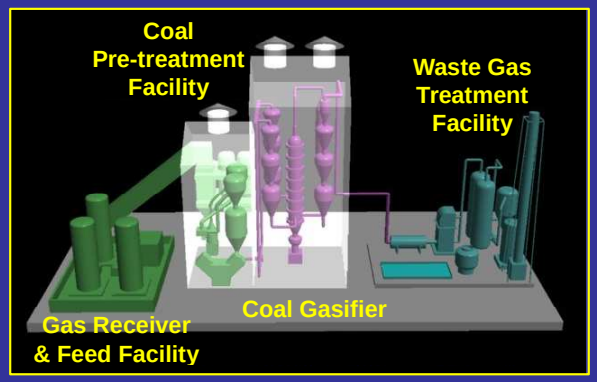
8ppm / 5ppm / 4mg/m^3_N

CRIEPI's Activity to develop IGCC technology using a bench scale gasifier



- Capacity：2.4 T/D
- Pressure：2 MPa
- Operation：1983-1995
- Tested Coal：Over 20 types
- Development of Air-blown Entrained Flow Gasifier

CRIEPI has been carrying out a series of R&D including the experiments using 2.4 T/D coal gasifier 1983-1995 in order to support the design and operation of IGCC Pilot Plant (200 T/D).

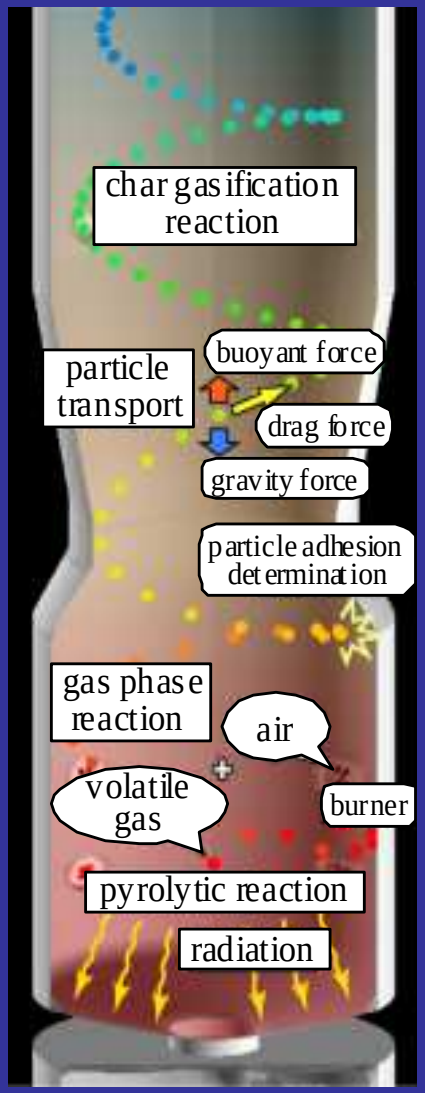


Specifications of 3T/D New Coal Gasifier

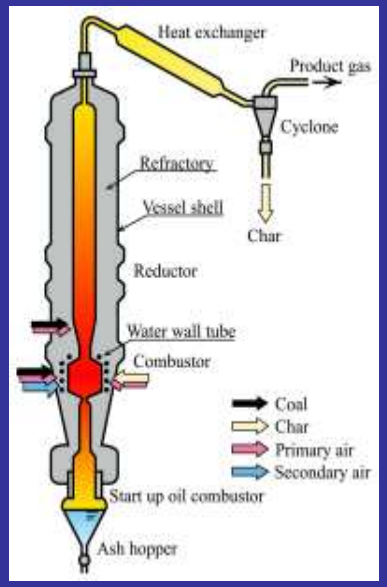
Gasifier Type：Pressurized Entrained Flow
Fuel Feed：Dry Feed System
Fuel Capacity：3 T/D
Operating Pressure：2 MPa
Fuel Types：Coal(Including Low Rank Coal)
Gasifying Agent：Air, Oxygen, Steam

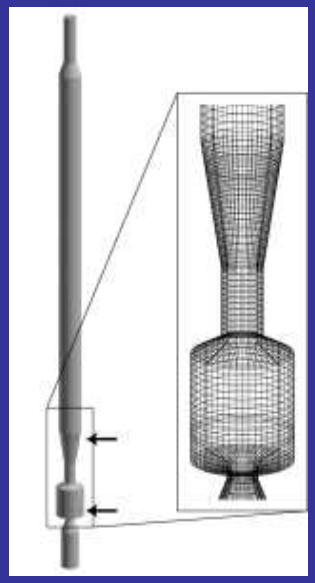
CRIEPI constructed the new gasifier to develop advanced IGCC technologies required to commercialize IGCC.

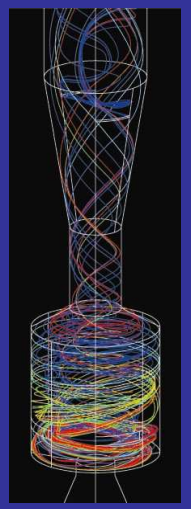
CRIEPI's Numerical Simulation Technology for Coal Gasifier to support IGCC demonstration project



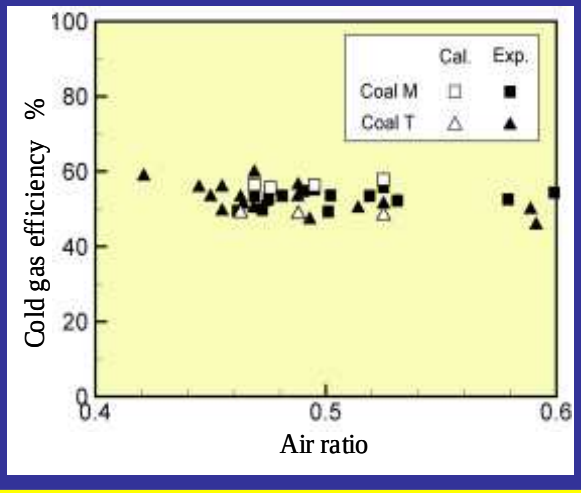
Numerical Simulation of 2.4T/D Gasifier





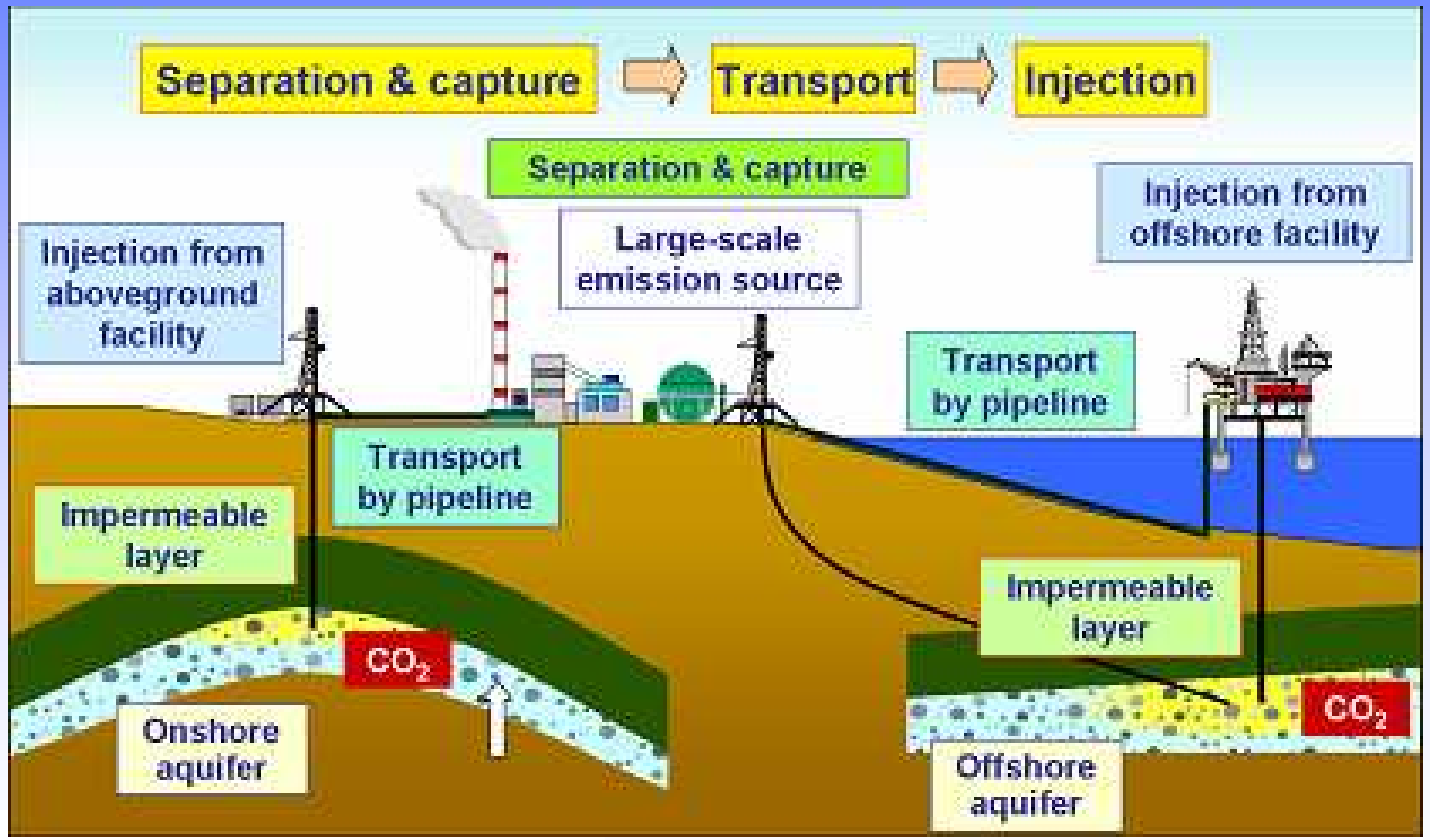


Temp. CO H2 Concentration Particle path



- **Numerical simulation makes it possible to predict the physical values which are hard-to-measured.**
- **Numerical simulation results show good agreement with experimental results.**

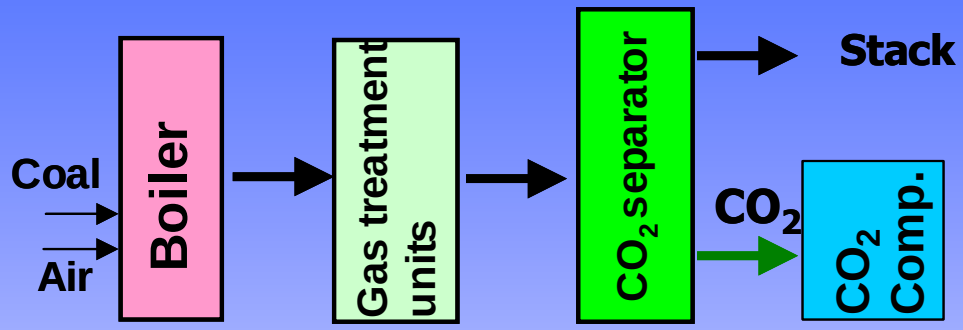
CCS (CO_2 Capture and Storage) as option in the future



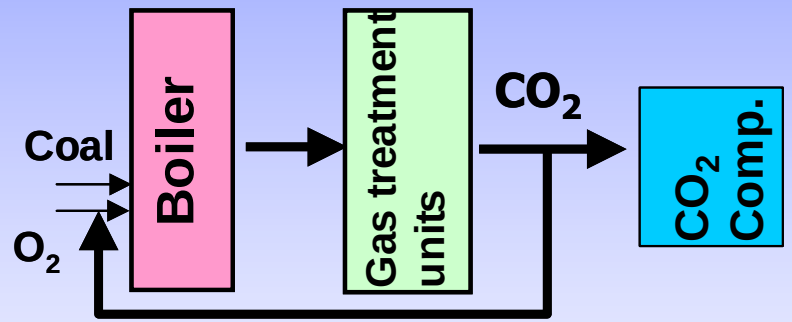
(Sources: HP of RITE)

CO_2 capture technologies

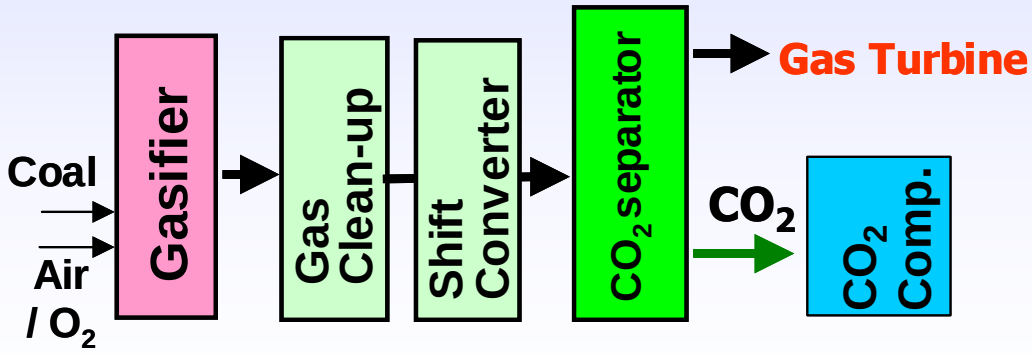
1. Post Combustion



2. Oxy-fuel Combustion



3. Pre Combustion



Shift Reaction: $CO+H_2O \rightarrow H_2+CO_2$

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Thermal efficiency and power generation cost of CO_2 Capture System

Generation	Coal-fired		IGCC		Oxy-fuel	IGCC +SOFC
	min	max	min	max		
Non-CO_2Capture						
Efficiency[%]※	41	45	38	47		
Generation cost [US$/MWh]	43	52	41	61		
CO_2Capture						
Capture	MEA, KS-1		Selexol		Oxy-fuel	Oxy-fuel
CO_2recovery[%]	85	90	85	91	91	95
Efficiency[%]※	30	35	31	40	35	61
Generation cost [US$/MWh]	62	86	54	79	61	54
CO_2recovery cost [US$/t$CO_2$]	23	35	11	32	-	-

※ Efficiency :LHV Excluding CO_2 transport and storage cost

IPCC Special Report on Carbon dioxide Capture and Storage 2005/12 Cambridge Univ. Pr.