

**● Coal Gas Production Technology for Fuel Cell
“EAGLE Project ”
(Coal Energy Application for Gas, Liquid and Electricity)**

1. Background of the Technology Development

In the Energy Policy framework of Japan, coal is ranked as a core forming energy source to alternate petroleum. Consequently, **coal occupies as high as 17.4 % in 1999 fiscal year**, and 19 % or so in FY2010 in view of its targeted energy saving case prospect, according to the Primary Energy supply prospect reported by the General and Supply / Demand committees under the Investigating Committee on Comprehensive Natural Resources and Energy. Thus, coal will be continuously bearing important role in Japan. However, in these years, the increased concern on the global environment (namely, CO₂ issues) has been driving us to use coal more efficiently as a whole in order to reduce its environmental burden, year after year, because of the fact that **coal produces 25% more CO₂ emission than petroleum**. Furthermore, currently, **coal thermal power generation in Japan consumes about one third (1/3) of her total coal utilization demand**. And it pushes us more strongly to promote higher efficiency technology development on her power generation, as well as, to reduce her environmental burdens. The abovementioned technology development is also required to lead to commercial use of such new technologies.

2. Positioning and Purpose of Technology Development

In comparison with conventional pulverized coal thermal power generation, **the EAGLE project** is a very much advanced, innovative technology development project, which could meet the requirement of the quickly changing global needs. The reason is that it ultimately aims at commercialization as the most advance innovative power generation system called **IGFC**, which uses coal in a combined cycle coal gasification fuel cell power generation, “Integrated Coal Gasification Fuel Cell Combined Cycle” system, which is composed of a coal gasification furnace, gas turbine(s), a steam turbine and a fuel cell.

The practical purposes of the project are as follows, through construction (*) of a pilot plant of 150 ton/day in coal processing capacity and its related test operation;

- 1) Development of a most optimum coal gasification furnace**
- 2) Establishing a gas cleaning and refining system, which enable to supply suitable gas to the Fuel Cells (**)**

(*) Location of the pilot plant: Electric Power Development Co., Ltd. (EPDC)
Wakamatsu Power Station

(**) Development of Molten Carbonate Fuel Cell (MCFC) and Solid Oxide Fuel Cell (SOFC), etc. is promoted under the other development project and it is not included in the EAGLE project.

3. Development Target

- (1) Establishing a Coal gasification system for Fuel Cell (IGFC at commercially usable scale)
 - Energy saving ratio over 30 %
 - Environmental burden reducing ratio over 30 % (CO₂, SO_x and NO_x respectively)
- (2) Operation test of Oxygen blowing coal gasification furnace (EAGLE pilot plant test)
 - Producing of medium calorie coal gasification gas (8,000 to 10,000 kJ/m³N)
- (3) Collecting designing data for a Large-scale practical plant by operating a 150 t/d pilot plant

4. Content of Project

It is planned to undertake the project in a steady way, step by step, in picking up the following development items,

(1) Gasification furnace technology

- a) Upgrading of the Gasification furnace efficiency (Reduction of the respective amount of seal gas, oxygen and loss of carbon)
- b) Improvement of Reliability (Prevention of slagging, fouling and slag down-flowing technology)
- c) Light weight fabrication of equipments
- d) Enlargement of adoptable coal types

(2) Gas cleaning and refining technology

- a) Establishment of Gas cleaning technology
- b) Establishment of Gas refining technology (DeH₂S (hydro-sulfur), removal of harmful gases and liquid degradation characteristics)
- c) Establishment of a gas refining process for Fuel Cell uses
- d) Establishment of a Highly dense sulfur treating technology
- e) Establishment of Material selecting guidelines and selection of suitable measuring technology
- f) Establishment of Scale-up technology

(3) Total System

- a) Verification of Fuel gas manufacturing technology for Fuel Cell uses
- b) Grasping of operation characteristics, including both under partial load and minimum load situations
- c) Establishment of Operation procedures for starting, stopping and load variation following of the system
- d) Establishment of Operation controlling technology
- e) Grasping of Environment related suitability
- f) Acquisition of Drainage water treatment data

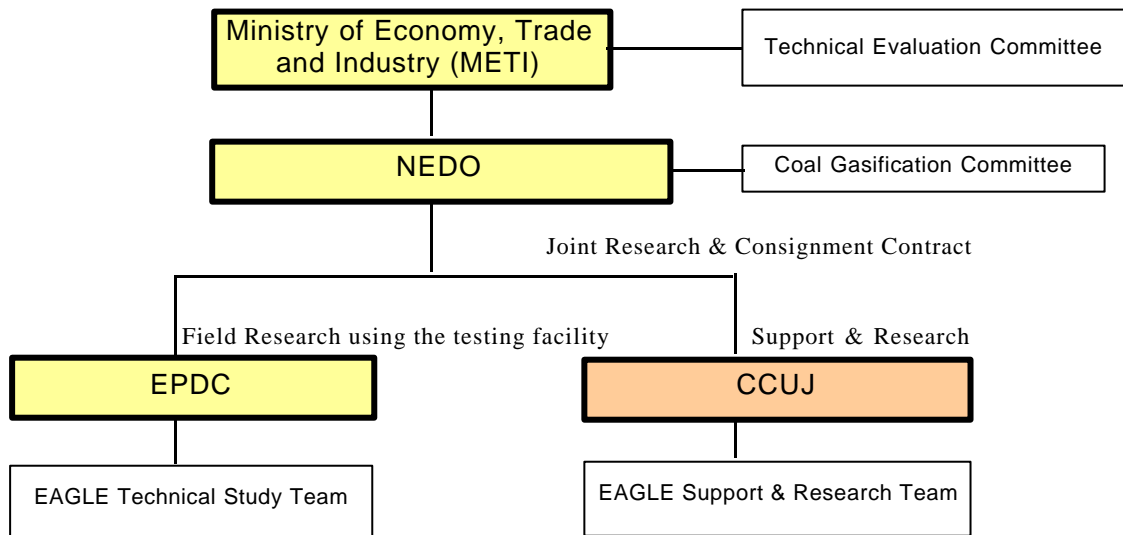
- g) Verification of Reliability on Continuous system operation
- h) Establishment of a Total system towards Commercialization

5. Development Schedule

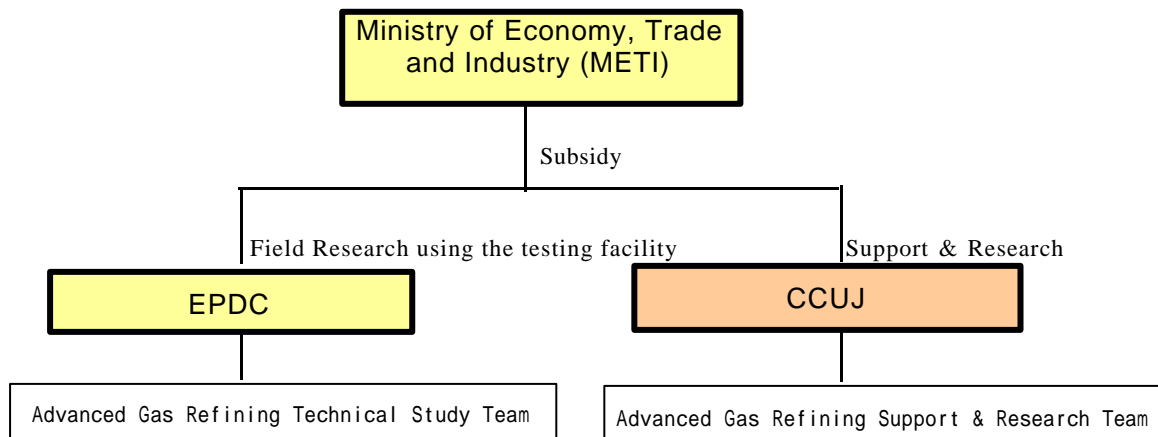
The development period is scheduled for 12 years starting in FY1995 until FY2006. In the initial 3 years, necessary component technologies to be developed were picked-up and then technical studies and experiments of their component technologies were implemented to choose the optimum ones. In the next 4 years, based on the test results, the pilot plant as a testing facility has been constructed. In the remaining 5 years afterwards, implementation of various tests including trial run test and their evaluation works are scheduled.

6. Development Framework

(1) Implementation Framework for Fuel Cell supplying Coal Gas Production Technology Development



(2) Implementation Framework for Fuel Cell supplying Advanced Coal Gas Refining Technology Development

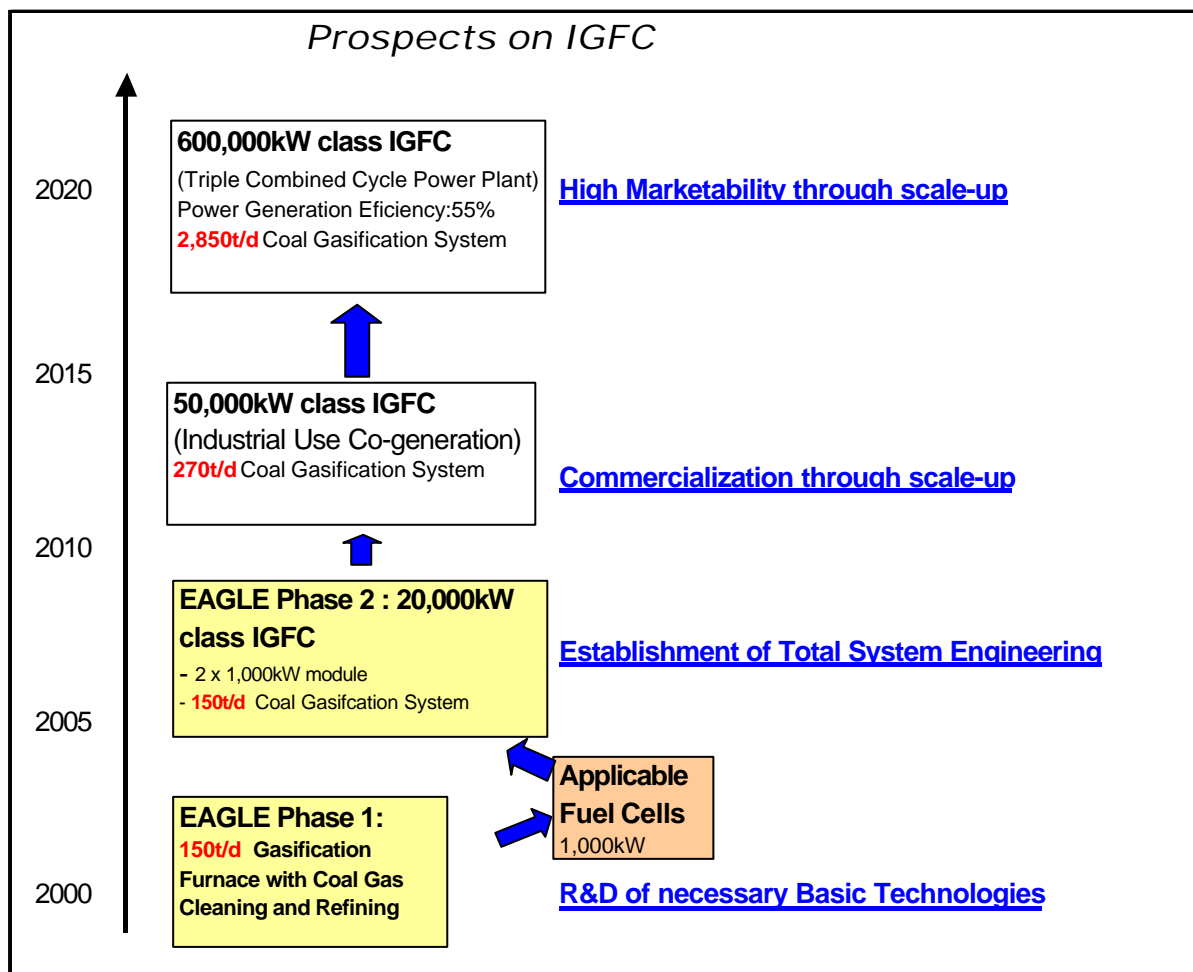


7. Prospect of Commercialization

Based on results of the Technology Development, after FY2006, as for its Phase 2, a test combined with a fuel cell is scheduled [combined with a 1,000 kW module of either MCFC or SOFC], by which commercialization of IGFC would become realistic through ascertaining reliability of the fuel cell fueled by the coal gasification gas. A large-scale fuel cell would be available by multiplying the above-mentioned basic Fuel Cell module of 1,000 kW. It means that if we could combine a 150t/d coal gasifying pilot plant with several sets of the fuel cell module and a gas turbine, we would be able to construct a 20,000 kW class IGFC plant.

On the other hand, in cases of either industrial co-generation or dispersed and small-sized type IGFC plants, more or less 50,000kW scale power plant for general use will be quite introducible to the markets both domestically and internationally. There would occur no technical problems on these commercial uses, because the scale-up ratio for the required coal gasification furnace would be a little over two times.

The following figure illustrates a future prospect of the technology development and marketability.



8. Testing facility installations of the Pilot plant

