3. Environmental and Innovative Technology: Sustainable Use of Fossil Fuels and New Energy

(1) Scientific assessment of global warming impacts and adaptation (promoted project subject): FY 2006 - FY 2010

[Objectives]

To predict and evaluate global warming while considering the interaction between the ecosystem and climate for long-term CO_2 reduction scenarios and to clarify a method of adapting to unavoidable climate change for the purpose of contributing to the formulation of energy policies on global warming and IPCC activities; to develop CO_2 reduction technologies, such as mangrove reforestation, which utilise the capacity of nature.

[Principal Results]

- Global warming projections for three types of IPCC emission scenarios were completed and the scientific basis for the CO_2 concentration stabilisation target was put forward. This achievement was reflected in the IPCC's Fourth Assessment Report.
- While the development of an earth system model was in progress through collaborative research with the US National Center for Atmospheric Research (NCAR), computing to reproduce the vegetation distribution in the glacial age was successfully conducted for the purpose of establishing an evaluation model for the impacts of climate change on vegetation. Moreover, the development of a high resolution model made progress to predict changes of the ocean environment around Japan in a highly accurate manner.
- A simplified prediction model of the mean global temperature on the ground and ocean surface (impulse response model) was developed as a method to examine diverse energy policy scenarios.
- A CO_2 evaluation method was verified at mangrove plantations in Vietnam and the achievements of an international symposium sponsored by the CRIEPI in FY 2005 were compiled and published.

(2) Development of underground storage technology for carbon dioxide: FY 2006 - FY 2008

[Objectives]

To clarify the characteristics of CO_2 behaviour in the ground to advance the method to monitor CO_2 behaviour in the ground, etc. for the purpose of assisting the formulation of national standards for underground storage technologies for CO_2.

[Principal Results]

- The geological characteristics around major emission sources of CO_2 were investigated using existing literature and the feasibility of the underground storage of CO_2 at each site was roughly evaluated.
- Based on the results of on-site testing and laboratory testing, an underground migration behaviour model was established, taking the interaction of groundwater, CO_2 and bedrock into consideration.
- Field tests, such as a borehole survey and test and a gushing gas flax survey, etc., and the analysis of the chemical constituents of the sub-surface gas and rocks collected at each site were conducted to obtain basic data on the characteristics of the rising and gushing behaviour of CO_2 in the shallow layer.

(3) Innovative environmental monitoring technologies: FY 2006 - FY 2008

[Objectives]

To develop innovative chemical and biological technologies capable of measuring chemical substances and microbes in a convenient manner as such technologies are strongly demanded by society in general and by the electric industry in particular.

[Principal Results]

- A simplified cleaning technology (circulation cleaning by new oil) was developed to clean pole-mounted transformers containing trace PCBs. In addition, a PCB biosensor was developed and its commercialisation was assisted by external organizations to

commence the supply of analysis kits and the provision of an analysis service.

・Another simplified analysis method was developed for the on-line monitoring of selenium in effluent. The necessary development themes were identified for the development of a simplified practice analysis method for asbestos.

(4) Environmental impact assessment of and countermeasure for the coal-ash recycling process

[Objectives]

To establish an environmental impact assessment method in response to the strengthening of various environmental regulations and to develop technologies to reduce the environmental load in order to facilitate the recycling of coal-ash and other waste materials.

[Principal Results]

・A new method was developed to contain boron, one of the trace substances in coal-ash, as part of the process of containing the elution of such substances. In addition, the elution characteristics of the existing coal-ash at landfill sites was analysed and the characteristics of the secular chemical alteration were clarified as they have important implications for the effective use of the existing ash as a resource.

・A basic technology was developed to manufacture low cost coal ash zeolite which has a practical decontamination capacity for the sea area environment.

・A long-term performance assessment test was conducted for a trace substance absorbent made from desulphurised gypsum and developed by the CRIEPI and it was verified that a high performance level will continue for a long time in a stable manner.

(5) Development of integrated operation and evaluation system for pulverized coal-fired power generation: FY 2006 - FY 2009

[Objectives]

To develop an integrated operation and evaluation system for pulverized coal-fired power generation which is capable of controlling the properties of the generated ash to match the coal properties and boiler characteristics and of optimising the management of the heat absorption characteristics of the heat transfer surface of the boiler for the purpose of reducing the cost and improving the environmental performance of pulverized coal-fired power generation.

[Principal Results]

・The impacts of changes of the pulverised coal properties on the properties of the generated ash in the case of the mixed burning of bituminous coal and sub-bituminous coal were clarified. It was also clarified that the method of mixing sub-bituminous coal in the upper section of the burner inside the furnace is effective to reduce the unburned combustible content of the NOx and unburned content in ash (Fig.5).

・In regard to the sulphidation corrosion of the heat transfer surface of the boiler, the impacts of the gas atmosphere, including the sulphur content (H_2S and SO_2), were clarified and the findings were used for the diagnosis of actual boilers.

Combustion Method	Burner Operation Conditions; Two-Staged Combustion Conditions	Primary Air Tube	Pulverised Coal Condensing Function
A	For bituminous coal	For bituminous coal	No
B	Optimised for the admixture of sub-bituminous coal	For bituminous coal	No
C	Optimised for the admixture of sub-bituminous coal	Enlarged for the admixture of sub-bituminous coal	No
D	Optimised for the admixture of sub-bituminous coal	Enlarged for the admixture of sub-bituminous coal	Yes

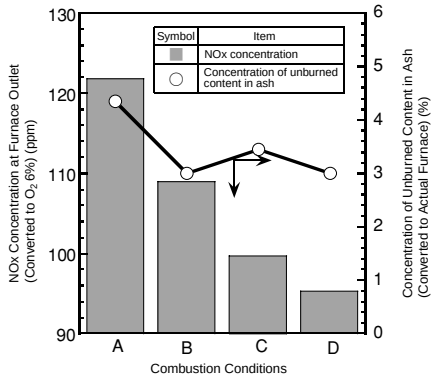

Fig.5 Effects of the Optimisation of the Mixed Combustion of Bituminous and Sub-Bituminous Coal on the Reduction of NOx and Unburned Content in Ash

(6) Development of a coal gasification technology for demonstration and commercial reactors: FY 2006 - FY 2009

[Objectives]

To assist the achievement of the stable and high efficiency operation of integrated coal gasification combined cycle power generation (IGCC) demonstration plants and to develop a system to assist the design and optimal operation of coal gasifier which can be applied to such plants of a commercial scale.

[Principal Results]

- The basic gasification characteristics of Indonesian coal were clarified using a coal gasifier for basic research, etc. to enable the expansion of coal types suitable for IGCC.
- For the effective utilisation of the slag produced by coal gasification as a light weight aggregate, etc. through the hot foaming process, a technology was developed to improve the foaming potential of slag by means of adjusting the composition of slag with the addition of fly ash, etc. to coal with a poor foaming potential before gasification.

(7) Clarification and control of trace substance behaviour in combustion process

[Objectives]

To establish behaviour prediction and control technologies applicable to actual equipment in order to contain the emission of trace substances at coal-fired power plants; to develop a technology to control the elution of trace substances in coal ash to facilitate the extended use of coal ash.

[Principal Results]

- The accuracy of the technology to measure gaseous B and Se in flue gas was verified and the impacts of the combustion and flue gas treatment conditions on changes of the chemical forms and behaviour of these trace substances in the flue were clarified. In addition, the performance of the Hg removal technology using the existing flue gas treatment facility was evaluated to clarify the long-term performance of the V_2O_5 catalyst.
- Based on analysis of the coal and coal ash from 12 actual units, the impacts of the flue gas treatment conditions on the elution characteristics of trace substances in coal ash were clarified.

(8) Development of highly-effective application system for biomass energy (promoted project subject): FY 2006 - FY 2008

[Objectives]

To develop biomass potential evaluation and highly efficient utilisation technologies for CO_2 emission reduction and the establishment of a recycling-oriented society.

[Principal Results]

- A biomass rating map for 21 Asian countries was developed using satellite data and others to assist CDM/JI business.
- A mixed combustion test of various types of biomass and coal was conducted and the combustion characteristics and properties of the exhaust gas were clarified.
- A power generation test involving a gas engine generator for which woody biomass was used as the fuel for gasification was conducted using “Carbonizing Gasification Gas Engine Power Generation Test Facility for Biomass/Waste”, a large-scale base research facility, and a rated output of 320 kW was produced in a stable manner, suggesting the prospect of the commercialisation of a highly efficient power generation system.
- A high performance absorbent for hot dry gas refining featuring halogenides and others was developed for further efficiency improvement of power generation systems.

(9) Development of high performance all ceramic SOFC stack: FY 2006

[Objectives]

To perfect the manufacturing technologies for high performance and highly reliable unit cell electrodes and stacks to materialise all ceramic SOFCs (solid oxide fuel cells) capable of operating at a high temperature (1,000℃ class).

[Principal Results]

- The power generation efficiency and stability of unit cells were improved through improvement of the electrode material, improvement of the gas supply method and the development of a new sealing material. In addition, a gas leak check method to be used prior to the power generation test to ensure the reliability of the test was established and an expression indicating the power generation performance was formulated. (The theme was completed in FY 2006.)