Republic of Indonesia
Ministry of Energy and Mineral Resources
PT PLN（Persero）

Republic of Indonesia

The Project for Promotion of Clean Coal Technology (CCT) in Indonesia

FINAL REPORT

（Summary）

October 2012

Japan International Cooperation Agency (JICA)

Chubu Electric Power Co., Inc.
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Abbreviations

AMDAL	Analisis Mengenai Dampak Lingkungan (Environmental Impact Assessment)
BAKOREN	Badan Koordinasi Energi Nasional (National Energy Adjustment Committee)
BAPEDAL	Badan Pengendalian Dampak Lingkungan (Emvironmental Impact Management Agency)
BAU	Business as usual
CCT	Clean Coal Technology
COP	Conference of the Parties
EIA	Environmental Impact Assessment
FIRR	Financial Internal Rate of Return
GHG	Greenhouse Gas
IEA	International Energy Agency
IGCC	Integrated Coal Gasification Combined Cycle
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
LNG	Liquefied Natural Gas
MEMR	Ministry of Energy and Mineral Resources
MOE	Ministry of the Environment
NGO	Non-Governmental Organization
NPV	Net Present Value
PJB	PT Pembangkitan Jawa Bali (Jawa Bali Power Generation Company)
PLN	PT Perusahaan Listrik Negara (State Electricity Company')
PLTU	Pembangkit Listrik Tenaga Uap (Steam Power Plant)
PLTP	Pembangkit Listrik Tenaga Panas Bumi (Geothermal Power Plant)
PLTGU	Pembangkit Listrik Tenaga Gas Uap (Gas Combined cycle Power Plant)
PLTG	Pembangkit Listrik Tenaga Gas (Gas turbine Power Plant)
PLTA	Pembangkit Listrik Tenaga Air (Hydroelectric Power Plant)
RTRW	Rencana Tata Ruang Wilayah (Sapcial Plan)
RPJM	Rencana Pembangunan Jangka Menengah (Medium-term Development Plan)
RPJP	Rencana Pembangunan Jangka Panjang (Long-term Development Plan)
RUEN	Rencana Umum Energi Nasional (National Energy Plan)
RUKN	Rencana Umum Ketenagalistrikan Nasional (General National Power Plan)
RUPTL	Rencana Umum Penyediaan Tenaga Listrik (Electrical Power Supply Plan)
SC	Super Critical
USC	Ultra Super Critical

Chapter 1 Introduction

1.1 Backgrounds for the implementation of the study

Indonesia was rich in natural resources, including oil, coal, gas, geothermal and hydropower. In light of the abundance of energy resources, the country thought it was possible to acquire foreign currency by exporting fossil fuel resources while meeting domestic demand for the resources in the past. As for oil, however, due to increases in domestic demand and the stagnant growth of the output, Indonesia became a net-importer in 2004. In response, the country focused on the policy to reduce dependence on oil as a core of its energy policies, and announced to promote the diversification of energy sources in its policies on energy promulgated in the same year. Also in the presidential order on national energy policies issued in 2006, coal was deemed to become the greatest energy source in 2025, because the country had much reserve of coal, which is available at low cost.

The demand for electrical power is rapidly rising. In response, the government formulated a fast track coal-fired power development plan, i.e. the first Crash Program under the policy for alleviation of dependence on oil in 2006 and decided to develop a total of 10,000 MW worth of coal-fired power generation capacity by 2009. This was followed by formulation of the Second Crash Program under the policy for energy diversification in 2009, which targeted the development of an additional 10,000 MW in installed capacity by 2014. While the target capacity expansion includes renewable energies such as geothermal and hydropower, coal-fired power accounts for 36 percent of it. Coal-fired power remains to be actively promoted over the coming years in view of the aforementioned situation as well as the advantage of coal in terms of cost and availability. According to the Rencana Umum Ketenagalistrikan Nasional (RUKN; General National Power Plan), the share of coal in all primary energies for power generation is anticipated to increase from 45 percent in 2008 to 63 percent in 2018.

Meanwhile, the 13th Conference of Parties to the Framework Convention on Climate Change (COP 13) held on the island of Bali in 2007 adopted the Bali Action Plan, which encouraged efforts for reduction of emissions of carbon dioxide (CO_2) in developing countries. In September 2009, Indonesian President Susilio Bambang Yudohoyono announced that the country was targeting its greenhouse gas (GHG) emissions reduction by 26 percent in the business-as-usual (BAU) case, and 41 percent with assistance from the international community by 2020. To achieve this target, it was decided to have action plans for GHG emission reduction prepared in each industrial sector. In light of the high share of coal in the energy source mix in the power sector, efficiency increase in the country's coal-fired power generation could make a great contribution to GHG emissions reduction.

According to World Energy Outlook 2011 issued by the International Energy Agency (IEA), almost half of the world's energy demand has been met by coal for recent 10 years, and if the current policies continue to be implemented, the consumption of coal will increase by about 65% and account for the largest percentage in the energy source composition of the world, replacing oil. Coal is distributed evenly across regions and rich in the amount of reserve. It is therefore utilized around the world, and the coal producing countries attribute importance to make effective use of this valuable national

resource also from the aspect of energy security. As for the output by power source (as of 2009), coal-fired power generation accounts for the largest percentage at 40.9%, followed by natural gas (21.3%), hydropower (15.9%), and nuclear power (13.5%). IEA predicts that the percentage that coal-fired power generation accounts for in the composition will decrease by about 7% by 2035 but will continue to be the largest energy source toward the future.

In 2010, coal production in Indonesia reached 306 million tons and was ranked as No. 6 in the world's coal production[1] while the export totaled 298 million tons and was ranked as No. 2 in the world's coal export, following Australia. As for steam coal, Indonesia is the world's No. 1 exporter, while Japan is the world's largest importer of coal[2]. For Indonesia, Japan was the No.1 coal importer of Indonesian coal until 2008 and has been the No. 4 since 2009, next to China, India and South Korea. Japan has been building multi-layered relations of cooperation with Indonesia through a range of coal-related projects, with a view to ensuring the stable supply of coal from the country. Based on the recognition that coal is the largest energy source for Indonesia, Japan has been supporting the country in the multi-purpose use of low-rank coal for the more efficient use of coal and for low-carbon coal-fired power generation. In particular for coal-fired power generation, from which a large amount of CO_2 is emitted, the introduction of Japan's CCT（Clean Coal Technology）, which represents the highly efficient technology for coal-fired power plants, will help curb demand for coal and greenhouse gas emissions by making it possible to increase the output of power generation without increasing the use of the resource.

The Japan International Cooperation Agency (JICA) deems that it is significant to boost GHG emissions reduction efforts through the introduction of high thermal efficiency clean coal technology (CCT) for coal-fired power plants in close coordination with the on-going Climate Change Program Loan by Japan. There is a strong need to mount approaches for more efficient energy utilization along with the increasing development of coal-fired thermal power. This point to the necessity of pursuing the input of high efficiency coal-fired generation facilities applying CCT while preserving conformance with the Climate Change Program Loan provisions.

This situation constituted the background for a request by the Indonesian government for assistance with the input of CCT high efficiency coal-fired generation facilities for the purpose of reducing GHG emissions as well as upgrading energy utilization efficiency and mitigating environmental effect incurred by the power sector.

(1) Objective of the Study

Objective 1:	Formulate a roadmap of Clean Coal Technology(CCT) to achieve higher power generation efficiency and GHG emissions reduction
Objective 2:	Study a CCT coal-fired model power plant (implementation of a pre-FS)
Objective 3:	Transfer Japanese CCT and develop human resources

[1] BP statics 2011

[2] Statics Yearbook of Indonesia, Statics Indonesia

(2) Study Area

Java-Bali system

(3) Counterparts

- MEMR: Directorate General of Electricity (DGE), Ministry of Energy and Mineral Resources
- PT Perusahaan Listrik Negara (Persero) (PT PLN): State Owned Electric Power Company

1.2 Study schedule

The study was conducted for 16 months from April 2011 to July 2012, being divided into the following three phases. In the first phase, basic data were collected and study plan was formulated. In the second phase, the CCT introduction roadmap was created. In the third phase, candidates for the construction site of the CCT introduction model plant were selected and preparatory feasibility study was carried out.

During the study period, a total of three steering committee meetings were held for discussions on the study policies and for progress reporting, two seminars were held for briefing on the study details to those concerned, and three stakeholder meetings were also held. The counterpart training was provided in November 2011. The following shows the entire schedule for the study.

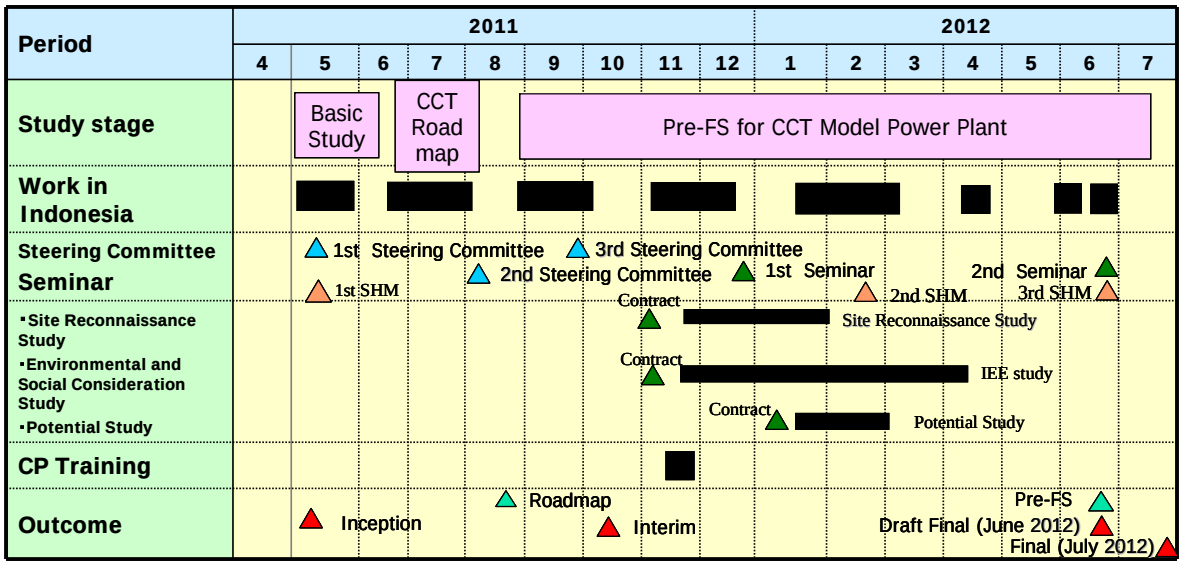


Figure 1.1 Schedule

Source: JICA Study Team

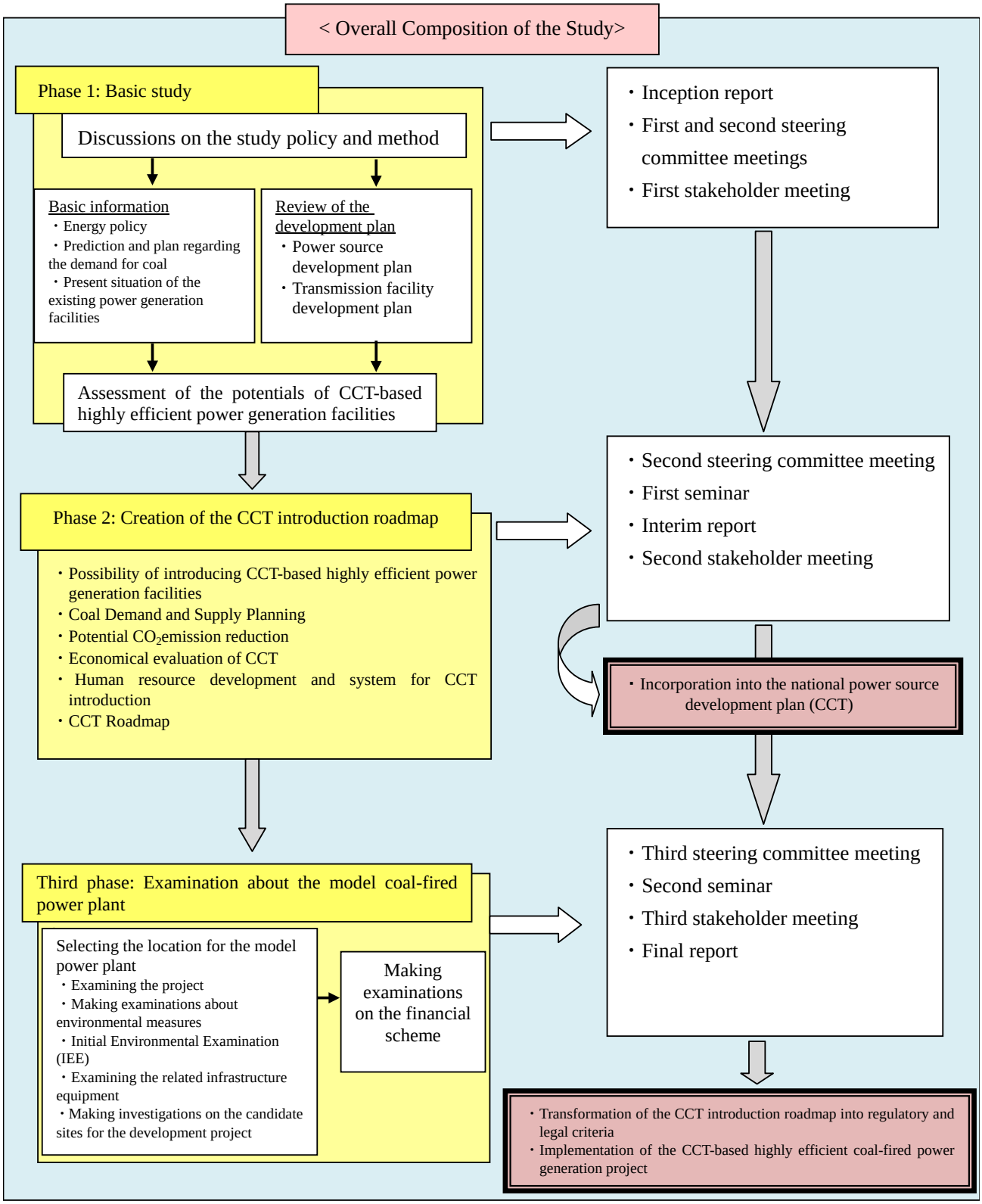


Figure 1.2 Overall composition of the study

Source: JICA Study Team

Chapter 2 Present Situation and Challenges Concerning the Energy policies

2.1 Energy policy

(1) Policy on power development

In light of the abundance of energy resources, such as oil, coal, gas, geothermal and hydropower, Indonesia thought it possible to acquire foreign currency by exporting fossil fuel resources while meeting domestic demand for the resources. As for oil, however, in response to an increase in domestic demandand the stagnant growth of the output, Indonesia changed its past idea and began to regard it as a limited fossil fuel resource to be exported and to be used as essential raw material in the domestic production of industrial products. Accordingly, the country decided to diversify energy resources for the optimal and efficient use of energy and to reduce the depletion of fossil fuels.

The development of energy sources replacing oil is being promoted focusing on coal, which is available in a large amount at a low cost and expected to help the country obtain foreign currency through export while meeting domestic demand for the resource. As for fossil fuels, Indonesia is also rich in natural gas, but the supply area is far from the demand area and most of the resource is exported in the form of LNG.

Indonesia is also proactively introducing renewable energy based on its power source diversification policy, as described in the national energy policy (2004) and the president's order (2006). In line with the policy, the development of geothermal energy and hydropower has been promoted, but the use of these power sources has not been fostered compared with the use of coal for thermal power generation, because of the smaller resource reserve, higher development cost and problems concerning locations.

As for the policies to decrease dependence on oil and diversify energy sources, the Indonesian government enacted the National Energy Policy in 2004, National Energy Management Blueprint in 2005, and the Executive Order on National Energy Policy in 2006. In August 2007, it enacted the Energy Law in order to legislate these policies and carry out a comprehensive energy administration.

1) National Energy Policy (KEN) (Ministerial ordinance, National Energy Policy 2003-2020: KEN, No. 0983, K/16/MEM/2004)

The National Energy Policy envisions assurance of the supply of energy sufficient to assure the national interest. Its main components are increase in the energy supply capacity, optimization of energy production, and energy conservation. It posts targets for the year 2020.

Table 2.1 Outline of the National Energy Policy (KEN)

Targets	- Electrification rate of 90% by 2020 - Increase in the share of the total energy supply occupied by renewable energy (excluding large-scale hydropower) to at least 5% by 2020 - Decrease in energy consumption per GDP unit (i.e., energy intensity) by 1% annually - Reduction of dependence on overseas energy sources through expanded use of domestic resources and effective use of domestic human resources
Major measures	- Reinforcement of energy supply commensurate with national development and population growth - Diversification of energy to achieve the best and most economical energy mix - Promotion of energy conservation

Source: National Energy Policy 2003-2020, 2004

2) National Energy Management Blueprint, 2005 – 2025

The National Energy Management Blueprint is based on the National Energy Policy. It presents forecasts for primary energy supply and sets forth the evolution (roadmap etc.) of constituent energy technology to 2025. Figure 2.1 shows the targets for primary energy mix in 2025.

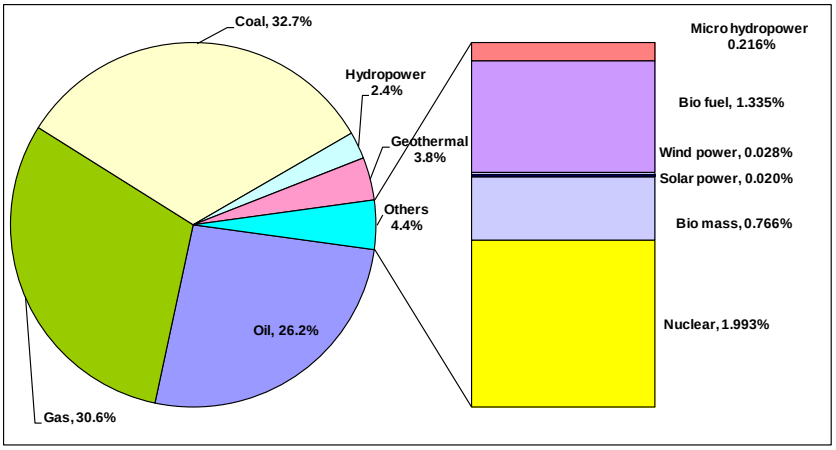


Figure 2.1 Scenario for optimization of the national energy mix in 2025

Source: National Energy Management Blueprint, 2005 – 2025

3) Executive Order on National Energy Policy (No. 5, 2006)

The aforementioned National Energy Policy and National Energy Management Blueprint were ordinances issued by the Ministry of Minerals and Energy Resources (MEMR). The purpose of promulgation as an executive order was to heighten their legal grounding. Numerical targets were revised upward with a view to promoting use of oil-alternative energy and renewable energy.

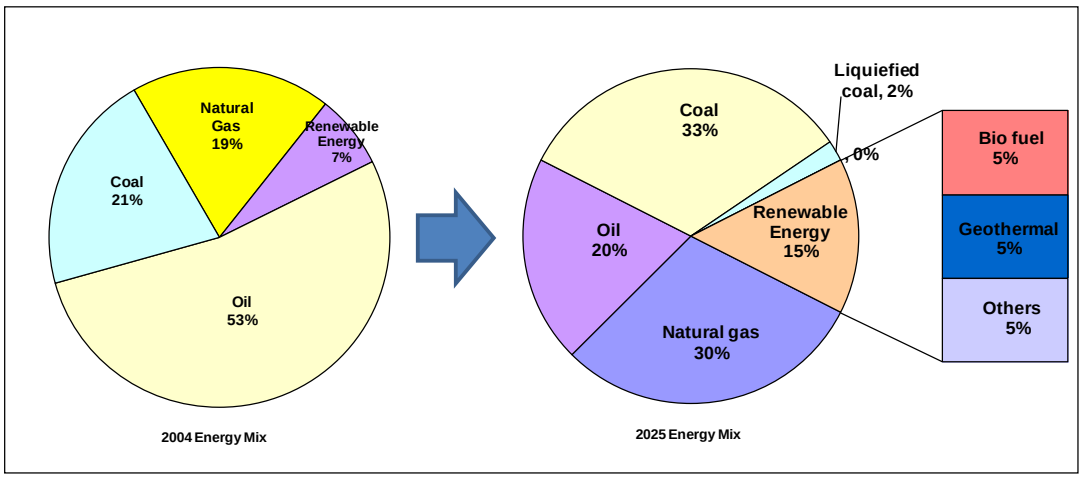


Figure 2.2 Targets for the primary energy mix in 2025

Source: Executive Order on National Energy Policy (No. 5, 2006)

4) Energy Law

The Energy Law was enacted in August 2007. Laws and regulations had been enacted for different types of energy separately (including oil and gas taken together, electrical power, and geothermal energy), but there was a need for enactment of a law to cover and interrelate all types, and to govern energy policy as a whole.

The Energy Law provided for institution of the National Energy Council (Dewan Energi Nasional; DEN). Formerly, national energy policy had been formulated by the National Energy Adjustment Committee (BAKOREN). DEN took over and expanded the functions of BAKOREN (BAKOREN was chaired by the MEMR minister, but DEN is headed by the president).

The National Energy Plan (RUEN) is drafted by the Department of Energy and Mineral Resources and enacted by the National Energy Council (DEN). The Energy Law shows the basic policies on the implementation of energy measures, and the details are stipulated by governmental ordinances and ministerial orders. In November 2009, the ordinance on energy conservation was enacted.

2.2 Policy on power development

(1) Electricity Law

The Electricity Law was enacted in 2002. In the law, the principle of competition was adopted by separating generation, transmission and distribution in competitive area (Java-Bali area). However, the "introduction of the principle of competition" was found to infringe Section 2 of Article 33 of the Constitution, which provides that "the national government will operate and manage those industrial sectors that exert useful effects of lives of peoples" and the Constitutional Court ruled that the Law was invalid. It abolition was followed by deliberation over a new such law, and a bill to this effect passed the national assembly on September 8, 2009.

The New Electricity Law basically follows the 1985 Electricity Law (No. 15, 1985) predating the 2002 Law. While having responsibility for power supply rest with the national government, it

delegates a certain amount of authority to local governments, with consideration of policy for decentralization. There are also procedural differences. Formerly, the MEMR minister had the authority to approve the General National Power Plan (RUKN). Under the new law, however, the RUKN must be approved by the national assembly. Similarly, the national assembly's approval (or that of the local assembly for areas at local discretion) is now also required for power tariff revisions, which formerly only needed to be approved by the president.

Table 2.2 presents a comparison with the former law.

Table 2.2 Comparison of old and new Electricity Laws (amendment items)

	Electricity Law No.15/1985 (old law)	Electricity Law No. 30/2009 (new law)
Power development plans	Formulation of the RUKN by the national government	Formulation of the RUKN by the national government, subject to approval by the national assembly. Formulation of RUKDs (local power development plans) based on the RUKN by local governments.
Project responsibility	Execution by the PLN under the control of the national government	Execution under the supervision of the national government, but division of responsibilities between national and local governments.
Project authorization	National government	National goverment (except in provinces where grids do not span two or more provinces or regencies where grids do not span two or more regencies -- virtually national authorization in fact)
Project execution	Execution by the PLN, but exceptional permission for execution by cooperatives in areas not reached by a PLN grid	Permission for execution by public corporations (such as those operated by the regency business bureau), private enterprises, cooperatives, and citizen groups as well as the PLN, but the PLN takes priority
Rural electrification	Execution by the PLN as a general rule, on the responsibility of the national government	Obligation for execution by the PLN when execution by public corporations, private enterprises, cooperatives etc. is impossible
Power tariffs	Uniform nationwide, national (presidential) authorization	Setting of power tariffs by the national government upon approval by the national assembly; local governments may set power tariffs for their locale upon approval by the local assembly (i.e., power tariffs may differ depending on the area)

Source: JICA Study Team (based on the materials provided by the JICA expert to the MEMR)

(2) Outline of power development plans

Power development plans consist of the aforementioned RUKN and RUPTL. Whereas the RUKN is a master plan for power development based on national energy policy, the RUPTL is a plan for power supply by the PLN reflecting individual projects.

As a result of the 2009 amendment of the Electrical Power Law, the RUKN became subject to approval by the national assembly. As a result, the RUKN must undergo time-consuming deliberation in the national assembly, and has not been revised since 2008. The RUPTL, on the other hand, is a plan for PLN facilities and is prepared on a yearly basis. However, it is formulated in response to revision of the RUKN, and there have been years when new RUPTL editions could not

be released because the RUKN was not revised. In September 2010, the PLN announced the 2010 edition of the RUPTL prepared by using the 2008 RUKN as a reference. Table 2.3 profiles the latest RUKN and RUPTL editions.

Table 2.3 RUKN (2008 edition) and RUPTL (2011 edition)

	RUKN (General National Power Plan)	RUPTL (Electrical Power Supply Business Plan)
Formulating institution	Ministry of Energy and Mineral Resources (MEMR)	State power enterprise (PLN)
Outline of the plan	The master plan for power development prepared by the national government, containing demand forecasts, primary energy outlooks, power plans, requisite funding, etc.; has a term of 20 years	The power supply plan prepared by the PLN based on the RUKN; has a term of 10 years
Updating	Revised periodically (every year), but the last revision was in June 2006	After revision of the RUKN (prepared on the basis of the RUKN)
Latest revision	Oct. 13, 2008 (officially promulgated on Dec. 23, 2008)	Dec. 30, 2011

Source: JICA Study Team (based on the materials provided by the JICA expert to the MEMR)

(3) Features of the 2011 edition of the RUPTL

(a) The edition shows an electric power supply business plan for the period from 2011 to 2020, including the first and second crash programs. Table 2.4 outlines the new power development plan for the Java-Bali system.

(b) As in the case of the RUKN, the demand forecast figures are on the high side. The RUPTL foresees demand growth averaging 8.5 percent annually (7.8 percent in the Java-Bali system) over the ten-year period ending in 2020. It predicts that the 2020 demand will reach 328 TWh, for a 2.25-fold increase from 2010, when it amounted to 145.7 TWh (actual figure).

(c) This will require the development of 55.4 GW in additional capacity over the ten-year period toward 2020. (This is equivalent to 1.85 times the installed capacity of 30 GW in 2010.) Of the additional output, coal-fired power plants will account for 35.6 GW (64%). In the Java-Bali system, the additional output will be 32.1 GW, of which 22.6 GW or 70% will be provided by coal-fired power plants. Table 2.4 shows the power development plan for the Java-Bali system. Of the output, 60% will be provided by PLN and the remaining 40% by IPPs.

(d) In the second crash program, the development of renewable energy is planned, but as for the development of geothermal, it took longer time than expected for the resource survey, FS and fundraising. Accordingly, compared with the RUPTL of last year, the schedule is far behind. In hydropower development, focus will be placed on pumped-storage generation.

(e) The total amount of investment (PLN + IPPs) over the ten-year planning term is put at 96.2 billion dollars (for an average of 9.6 billion dollars per year). In the Java-Bali system, the ten-year investment will total 49.8 billion dollars for PLN and IPPs and amount to 33.6 billion dollars for PLN alone.

Table 2.4 Power development plan for the Java-Bali system

unit : MW

Tahun	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
PLN											
PLTU	3,535	2,965	1,050	660	660		1,000	600	600	1,000	12,070
PLTP											-
PLTGU	444	743		-		-			750	750	2,687
PLTG				150				400		400	950
PLTM											-
PLTA					210	62	37				309
PS						1,040			450	950	2,440
PLTGB				3	3						6
Total	3,979	3,708	1,050	813	873	1,102	1,037	1,000	1,800	3,100	18,462
IPP											-
PLTU	660	815		380	1,660	3,520	2,860	600			10,495
PLTP			60		385	325	270	815	855	165	2,875
PLTGU	150										150
PLTG											-
PLTM	9	4	68	18							100
PLTA					47					18	65
PS											-
PLTGB											-
Total	819	819	128	398	2,092	3,845	3,130	1,415	855	183	13,685
PLN+IPP											-
PLTU	4,195	3,780	1,050	1,040	2,320	3,520	3,860	1,200	600	1,000	22,565
PLTP	-	-	60	-	385	325	270	815	855	165	2,875
PLTGU	594	743	-	-	-	-	-	-	750	750	2,837
PLTG	-	-	-	150	-	-	-	400	-	400	950
PLTM	9	4	68	18	-	-	-	-	-	-	100
PLTA	-	-	-	-	257	62	37	-	-	18	374
PS	-	-	-	-	-	1,040	-	-	450	950	2,440
PLTGB	-	-	-	3	3	-	-	-	-	-	6
Total	4,798	4,527	1,178	1,211	2,965	4,947	4,167	2,415	2,655	3,283	32,147

Source: RUPTL 2011- 2020

Chapter 3 Environmental and social considerations

3.1 Regulations of guidelines on environmental management and assessment

Law on Environmental Protection and Management

The Law on Environmental Protection and Management stands as the Indonesian basic law concerning the environment. The law first came into force in 1982 and underwent a large revision in 1997. Then, it was amended again in 2009 and promulgated as a new law into effect. In the new law, the conduct of 'Strategic Environmental Study', KLHS in Bahasa Indonesia, is newly required by Article 15 through Article 19. It stipulates that the Government and regional governments shall prepare KLHS to ascertain that the principles of sustainable development should be underlying and integrated in the national and regional development policy, plan and/or program, including layout plans (RTRW), long-term development plans (RPJP), and medium-term development plans (RPJM) of respective levels (Article 15). The Ministry of Environment (MOE) is currently preparing the pertinent government regulation and concrete guidelines.

Environmental Impact Assessment (EIA/AMDAL)

Environmental impact assessment (EIA) is called AMDAL (Analisis Mengenai Dampak Lingkungan) in Indonesia. Currently, 'Government regulation on EIA (No.27 of 1999)' is the basic law for the system.

Table 3.1 Primary Indonesian regulations and guidelines regarding environmental management and EIA

Category	Type of legislation	Legislation
Environmental Management	Basic law	Law on environmental protection and management (No.32 of 2009) - Enforced with Law No.4 of 1982, and major amendment in Law No.23 of 1997. It was amended again and promulgated as the new law that took effect on October 3, 2009.
	Relevant regulations	Joint circular letter between Minister of Home Affairs and State Minister of Environment concerning reorganization of local government environmental institutions (No.061/163/SJ/2008 AND SE-01/ MENLH/ 2008)
Environmental Impact Assessment	Basic law	Government regulation on environmental impact analysis (No.51 of 1993, amendment No.27 of 1999)
	Decrees and Regulations	MOE Regulation on the types of business and/or activities required to prepare EIA (No.17 of 2001, amendment No.11 of 2006) - There are guidelines relevant to the regulation.
		MOE Regulation on guidelines for preparing EIA (No.08 of 2006) - This regulation is the enactment of 'Decree of the Head of BAPEDAL(No.09 of 2000)'
		MOE Regulation on appraisal guidance of EIA document (Decree No.02 of 2000, Regulation No.24 of 2009)
		MOE Regulation on guidelines for strategic environmental assessment (No.27 of 2009)

Category	Type of legislation	Legislation
		MOE Regulation on environmental management and monitoring measures and statement for environmental management and monitoring capacity (No.13 of 2010) - MOE Decision on guidelines for environmental management and monitoring measures (No.86 of 2002)
		MOE Decision on AMDAL preparation guidelines for development activities in wetland areas (No.05 of 2000)
		MOE Decree on guidelines for establishment of EIA evaluation committee of regencies/ municipalities (No.41 of 2000)
		Decree of Head of BAPEDAL on public involvement and information disclosure in the process of EIA (No.8/ 2000)

Source: Edited by the Study Team with documents collected at MOE, GOI

Spatial Plan

In Indonesia, Spatial Plans are prepared and determined for the utilization, development and management of land, oceanic and air space. This legal institution started with relevant presidential decrees between 1976 and 1992. Then, the Law No. 26 of 2007 on Spatial Planning was enacted as the pertinent basic law. Under the government regulations and presidential decrees associated with the Law, the Central Government and local governments as province, regency and municipality are obliged and authorized to formulate a respective basic plan for utilization and management of jurisdictional area, by which spatial zoning is laid out according to different purposes such as conservation and development.

Table 3.2 Primary Indonesian regulations regarding spatial planning

Category	Type of legislation	Legislation
Spatial Plan	Basic law	Law on spatial planning (No. 26 of 2007)
	Relevant regulations	Government Regulation regarding the national spatial plan (No. 26 of 2008)
		Presidential Decree on the coordination team for the national spatial management (No. 57 of 1989)
		Presidential Decree on management of protected areas (No. 32 of 1990)
		Government Regulation on implementation of the rights and obligations, and forms and procedures for community participation in spatial planning (No. 69 of 1996)

Source: Edited by the Study Team with documents collected at MOE, GOI

Regarding environmental pollution control in general and regarding environmental measures and standards for business activities of coal-fired power plants among specific business sectors, the primary Indonesian regulations and guidelines are listed on the Table 3.3.

Table 3.3 Primary Indonesian regulations on general environmental pollution control and on environmental measures for business activities of coal-fired power plants

Category	Legislation
Air Pollution Control	Government Regulation on air pollution control (No. 41 of 1999) - MOE Decree on air pollution control (1993) - Relevant Guidelines are issued in the MOE Regulations concerned, and environmental standards are set on this government regulation No.41 of 1999
	MOE Decree on environmental standards of emission gases from stationary sources (No.13 of 1995)
	MOE Decree on environmental standard index of air pollution (No. 45 of 1997)
	MOE Regulation on environmental standards of emission gases from stationary emission sources of Boiler (No. 07 of 2007)
	MOE Regulation on environmental standards of emission gas from stationary emission sources of thermal power plant enterprises and / or activities (No. 21 of 2008)
	MOE Regulation on implementation of regional air pollution control (No. 12 of 2010)
Water Pollution Control	Government Regulation on water quality management and water pollution control (No. 82 of 2001) - Relevant Guidelines are issued in the MOE Regulations concerned, and environmental standards are set on this government regulation No.82 of 2001
	Government Regulation on control of marine pollution and destruction (No.19 of 1999)
	MOE Decree on environmental standards of effluent wastewater quality from industrial activities (No.51 of 1995, amendment No. 122 of 2004)
	MOE Decree on environmental criteria for coral reef damage (No. 04 of 2001)
	MOE Decree on the method of surface water quality analysis and surface water sampling (No. 37 of 2003)
	MOE Decree on guidelines for determination of carrying capacity of water pollution charges in water resources (No.110 of 2003)
	MOE Decree on sea water quality standard (No.51 of 2004, amendment No. 179 of 2004)
	MOE Decree on standard criteria and guidelines for determination of mangrove damage (No. 201 of 2004)
	MOE Decree on environmental standards of waste water quality from coal mining enterprises and /or activities (No. 113 of 2003)
	MOE Regulation on environmental standards of waste water quality from thermal power plant enterprises and /or activities (No. 08 of 2009)
Noise	MOE Decree on environmental standards of noise levels (No. 48 of 1996)
Vibration	MOE Decree about environmental standards of vibration levels (No.49 of 1996)
Odor	MOE Decree on environmental standards of odor levels (No.50 of 1996)
Solid Waste Management	Law on solid waste management (No. 18 of 2008)

Source: Edited by the Study Team with documents collected at MOE, GOI

3.2 Trend and Challenge of Environmental and Social Considerations (ESC)

Points to note from the aspect of ESCs for developing coal-fired power plants in Indonesia

The ESCs for development plans is showing the clear trend that it is required to start the ESC-process in an earlier phase of planning process either internationally or in Indonesia. In Indonesia, legal provisions on strategic environmental assessment are prescribed in the basic environmental law and the MOE is currently preparing administrative guidelines to actualize the law requirements. To date, the DGE and the PLN have called into account the timing of initiating ESCs from the aspect of enabling the AMDAL approval before project implementation. For the future, it will be vital for the planners and environmental management staffs in the both organs to fit in the concept of initiating ESCs in the earlier phase of planning process and to steer their implementation scheme in such direction.

Initiating measures for social considerations at an earliest phase

It is essential for confirming the wills of concerned people and land acquisition issue on a sufficiently early stage of the process to start involvement of, information disclosure to and discussion with stakeholders at an earliest phase of planning process. On the other hand, the implementing organ is concerned if the information disclosure to general public at an early phase of planning might raise speculative activities around the pertinent project site or inappropriate requests of unspecified public. With such concern they have a tendency of hesitating to initiate the early onset of information disclosure and necessary explanation and consultation about the plan to stakeholders. However, it is the lesson from foregoing plans and projects that the delay with this reason may delay project implementation in the end, and that early initiation of stakeholders meeting and land ownership survey is essentially important.

Chapter 4 Electricity business - current status and issues

4.1 Outline of the power generation business

Installed Capacity

PLN, its subsidiaries Indonesia Power (IP) and PJB (Persero) and independent power producers (IPPs) are engaged in the power generation business. Table 4.1 shows the installed capacity of the Java-Bali system as of the end of 2011. By fuel, coal-fired power generation accounts for the largest 46.5%. Shift from oil fuel has been promoted in response to soaring oil prices and to concerns about the depletion of oil resources, and the development of coal, which is available at low prices, has been promoted. Power generated by the use of coal as fuel was 3,520 MW out of 3,730 MW developed over two years (2010 and 2011).

The operation of oil-fired power plants will be discontinued starting with aged low-efficiency ones, and also for diesel-fired power generation, the output is 2,465 MW and accounts for less than 10% of the total. Also, although the country plans to develop renewable energy in a proactive manner, the actual output is small due to the high development cost, and the output from hydropower and geothermal energy totals 3,581 MW and accounts for only about 13%.

Table 4.1 Installed Capacity of the Java-Bali System by Power Source

As of Dec. 2011

Power source	Installed capacity (MW)	Share (%)
Coal-fired	12,390	46.5
Gas-fired	1,640	6.2
Gas- and oil-fired	6,569	24.7
Oil- and diesel-fired	2,456	9.2
Hydropower	2,536	9.5
Geothermal	1,045	3.9
Total	26,636	100.0

Source：PLN reference materials

The following table shows the installed capacity by electric utility

Table 4.2 Installed Capacity of the Java-Bali System by Electric Utility

As of Dec. 2011

Electric Utility	Installed capacity（MW）	Share (%)	Major power plant
PLN	6,113	23.0	Tanjung Jati B、Indramayu
Indonesia Power（IP）	9,646	36.2	Suralaya、Tambak Lorok
PJB	6,902	25.9	Gresik、Cirata
IPP	3,975	14.9	Cilacap、Cikarang Listrindo
Total	26,636	100.0	—

Source：PLN reference materials

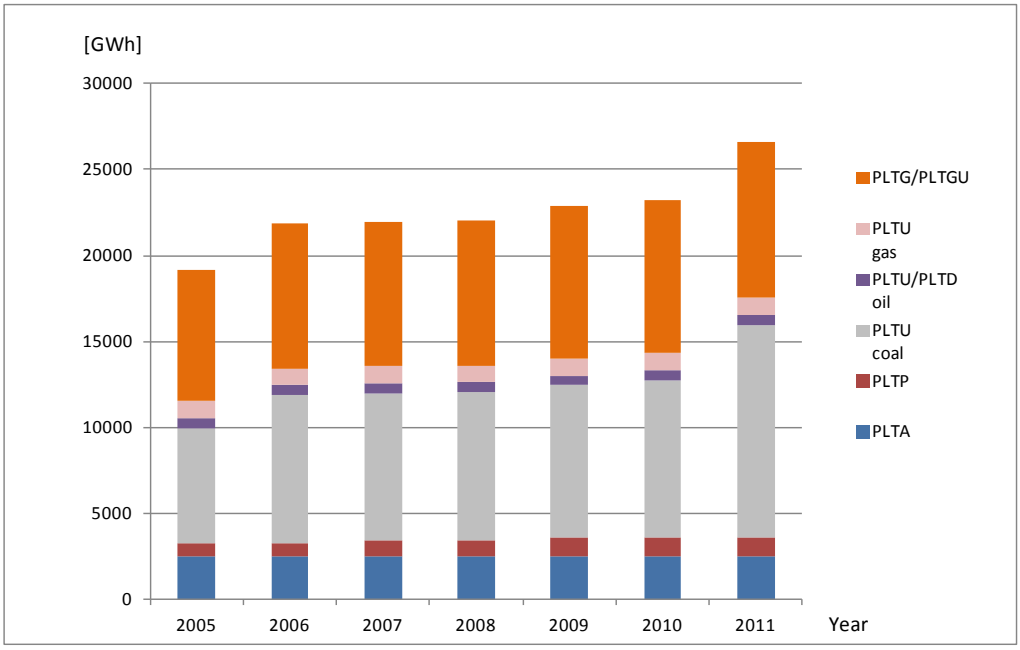


Figure 4.1 Changes in Installed Capacity

Source：PLN reference materials

Output

The total output came to about 170 TWh in 2010, of which coal-fired power generation accounts for the largest percentage of 41.1%. The total output in 2011 has not yet been calculated, but the output of 3,220 MW was added in the year by coal-fired power generation and the share will further increase in the future.

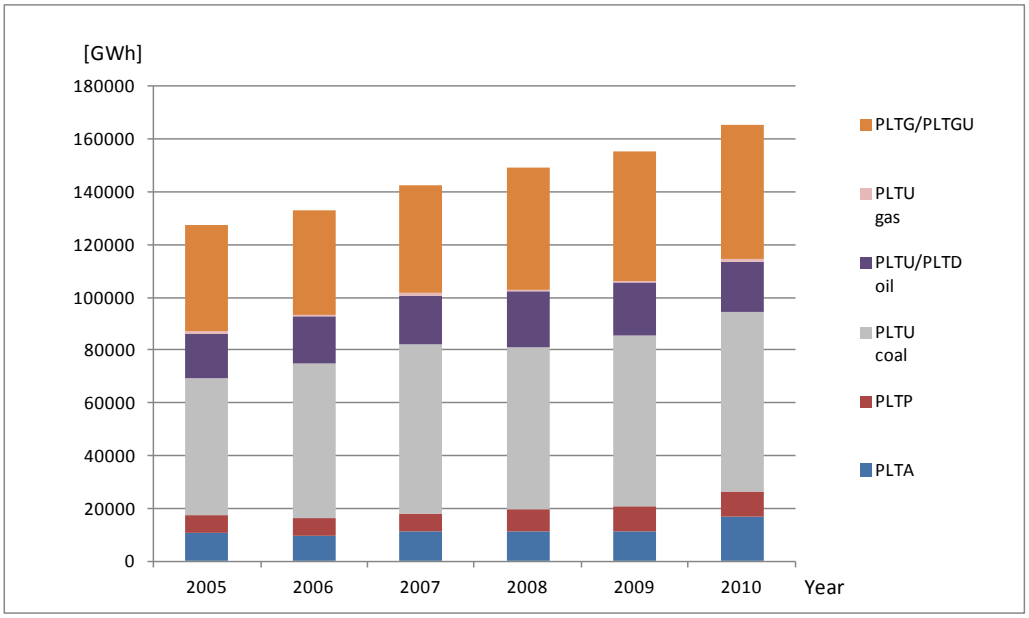


Figure 4.2 Changes in production of electricity

Source：Statistic Electricity 2011

4.2 Present situation and challenges concerning coal-fired power plants

The history of coal-fired power development in Indonesia is comparatively short. As an oil-producing country, Indonesia has supplied power generated mainly by oil-fired plants (including diesel-powered ones) as well as hydropower plants drawing on its abundant hydropower resources. It began to introduce coal-fired plants in response to the gradual depletion of its oil resources and jump in oil prices.

The first coal-fired power plant constructed in the country was the PLN Suralaya power plant, with its No.1 unit (400 MW) starting operation in 1986. In 2011 the No. 8 unit (625 MW) started operation, increasing the total output of the plant to 4,025 MW. Subsequently the construction of the Paiton and Tanjung Jati B plants was carried out.

Under the first crash program, a total of 10,000 MW coal-fired power plants will be newly established across the country by 2014, and for the Java-Bali system, 300 MW coal-fired power generation was newly started in 2010 and 3,220 MW in 2011 (Table 4.3). As a result, the installed capacity came to 12,390 MW at the end of 2011, of which IPPs accounted for 3,030 MW.

Table 4.3 PLN coal-fired power plants (Java-Bali system)

Plant	Type			Fuel	Installed Capacity [MW]	Nett Capacity [MW]	COD Year	Owner
Suralaya	PLTU	1	steam	coal	400	371.5	1985	IP
		2	steam	coal	400	371.5	1989	IP
		3	steam	coal	400	371.5	1989	IP
		4	steam	coal	400	371.5	1989	IP
		5	steam	coal	600	575.2	1997	IP
		6	steam	coal	600	575.2	1997	IP
		7	steam	coal	600	575.2	1997	IP
		8	steam	coal	625	600	2011	IP
Labuhan	PLTU	1	steam	coal	300	300	2009	PLN
		2	steam	coal	300	300	2010	PLN
Lontar	PLTU	1	steam	coal	315	300	2011	PLN
Indramayu	PLTU	1	steam	coal	330	300	2011	PLN
		2	steam	coal	330	300	2011	PLN
		3	steam	coal	330	300	2011	PLN
Cilacap	PLTU	1	steam	coal	300	281	2006	IPP
		2	steam	coal	300	281	2006	IPP
Tanjung Jati B	PLTU	1	steam	coal	660	660.8	2006	PLN
		2	steam	coal	660	660.8	2006	PLN
		3	steam	coal	660	660.8	2011	PLN
Rembang	PLTU	1	steam	coal	315	300	2011	PLN
		2	steam	coal	315	300	2011	PLN
Paiton	PLTU	1	steam	coal	400	370	1993	PJB
		2	steam	coal	400	370	1993	PJB
		5	steam	coal	610	610	1999	IPP
		6	steam	coal	610	610	2000	IPP
		7	steam	coal	615	615	1998	IPP
		8	steam	coal	615	615	1999	IPP
Total					12390	11946		

Source: JICA Study Team

4.3 The current situation and issues to finance power supply

(1) PLN's financial situation

In Indonesia, PLN's average supply cost of electricity is higher than its average sales price. The figure below illustrates electricity tariff and generation cost, the differences per kWh were 97.8 Rp. and 96.5 Rp. in 2009 and 2010, respectively. In order to compensate the gap between (i) the supply cost including transmission and distribution costs in addition to this generation cost plus PLN's margin and (ii) the average sales tariff, the government provides the large amount of the subsidies to PLN every year.

Despite provision of the subsidies, PLN's net income has been in deficit until 2008, but the it became positive after 2009. However, there are no changes in dependence on the subsidy and the net income will be negative if there are no subsidies.

Table 4.4 PLN's financial situation and subsidy from the government

(Unit: 1 billion Rp.)

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Government subsidy	4,739	4,097	3,470	12,511	32,909	36,605	78,577	53,720	58,108	93,178
Net profit	-6,060	-3,558	-2,021	-4,921	-1,928	-5,645	-12,304	10,356	10,087	7,193

(Source: PLN Consolidated Financial Statement 2011, PLN Annual Report 2008, 2009 and 2010, Japan Electric Power Information Center)

(2) Challenges to receive finance in case of IPP projects

Electricity demand in Indonesia is increasing and IPP projects are also increasing in power development together with PLN led projects over next 5 years.

Table 4.5 Generation volume

(Unit: GWh)

Year	2005	2006	2007	2008	2009	2010
PLN	98,177	101,664	107,984	113,340	115,434	123.477
IPP	26,088	28,639	31,199	31,389	36,169	38.076
Generation by lease	3,105	2,804	3,257	4,707	5,194	8.233
Total generation	127,370	133,108	142,440	149,436	156,797	169.786

Source: PLN Annual Report 2010

In the project list in 2nd crash program to accelerate power development (MEMR Ministerial degree 2010/02, 2010-2014), there are IPP projects with 6,235 MW[3] while PLN projects are 3,757MW[3]. On the other hand, according to RUPTL 2011-2020, electric power development until 2020 including 2nd crash program will be mainly led by IPP until 2018 after 2014 but this reliance will be decreased step by step the ratio to be developed by PLN will be higher than the one by IPPs in 2019. There are similar tendency for the coal-fired plants and in 2019, the ratio of PLN will be higher.

3 RUPTL 2011-2020

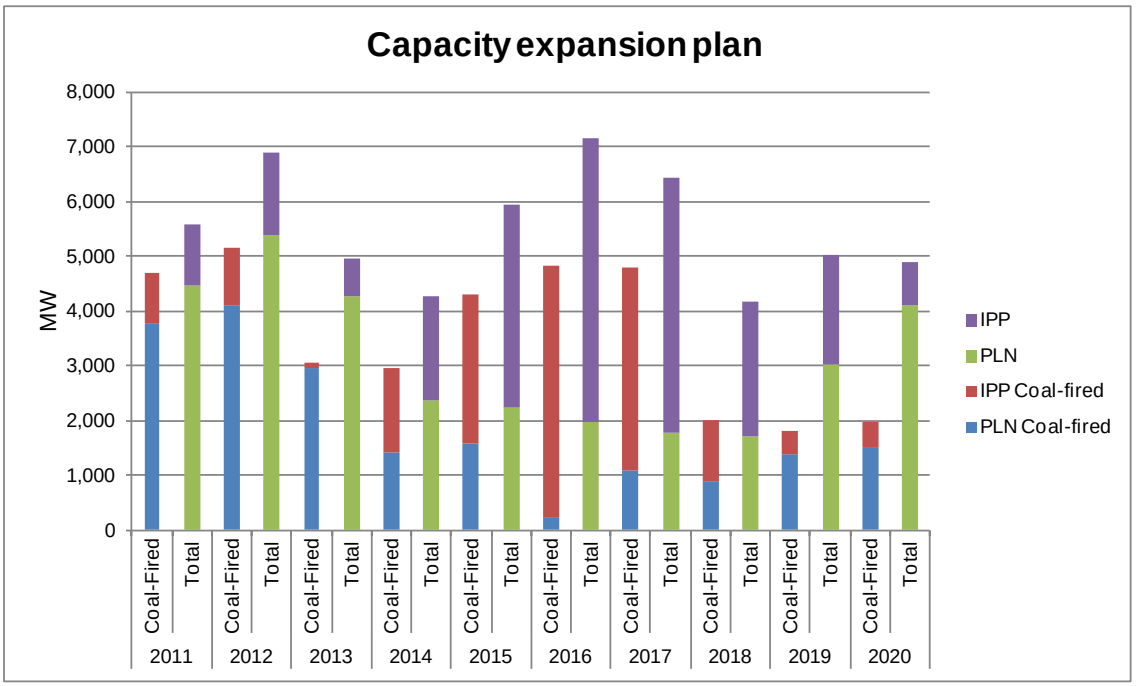


Figure 4.3 Capacity expansion plan

Source: Prepared by study team based on RUPTL 2011-2020

In order to promote international IPPs to get into the market, international banks require Indonesian government guarantee against PLN's credit risk for the bank finance. IPP projects can be based on PPP scheme following Presidential decree 67/2005 and Presidential decree 2010/13. However, this PPP scheme is still new in Indonesia as the 1st project just finished bidding and the establishment and improvement of the implementation process are expected in the future.

Chapter 5 Introduction of CCT roadmap

In Indonesia, demand for electric power has been increasing in accordance with the country's remarkable economic growth, and to meet the increasing demand, a range of power source development plans have been implemented in the country. In the power source diversification promoted based on the policy of decreasing dependence on oil in response to the feared depletion of the resource and to the soaring oil prices, coal-fired power generation, the output of which can be increased at lower costs, will play a central role in the future power source development. In particular in the Java-Bali area, it is planned to develop a total of 22.6 GW coal-fired power plants over 10 years from 2011 to 2020 (RUPTL2011), which accounts for 70% of the total output of 32.1 GW planned for the period. The country will not change its power source development policy also in and after 2021, and so coal-fired power generation will continue to be a dominant power source in the power source development plan.

On the other hand, CO_2 emissions from coal-fired power generation are characteristically large compared with other power sources. Indonesia upholds the target of reducing its GHG emissions by 26% relative to the business as usual (BAU) scenario by 2020, and needs to increase the efficiency of its power plants to meet this target. The improvement of efficiency will also help reduce the consumption of coal, which is now increasing in the country and lead to more effective use of coal resources.

In Japan the efficiency of coal-fired power plants has been improved and the introduction of the technology together with other environmental technologies to Indonesia is expected. The target of the technology to be introduced to the country for more efficient power generation will be the ultra-super critical (USC) and integrated gasification combined cycle (IGCC) technologies, and for the creation of a CCT introduction roadmap toward 2025, examinations will be made on the introduction timing in consideration of the situation in Indonesia from technological, policy and economic aspects.

The results of the examination made on the CCT introduction roadmap are concluded as follows.

(1) Technological aspect

In light of the fact that the introduction of USC coal-fired power generation has been promoted across the world with the maturity of the technologies, CCT is deemed to be a key to make economical efficiency and CO_2 emission reduction compatible. In Indonesia, construction of the Ultra Supercritical Critical pressure (USC) power plants are planed which the Central Java Coal-fired thermal power plant (1,000MW×2units, IPP, COD will be 2016 and 2017) and Indramayu Coal-fired thermal power plant (1,000MW×1unit, ODA projects, COD will be 2017).

As for IGCC, it is expected that the introduction of commercial IGCC power plants will start in and after 2020 and the technology is indeed highly promising. Before the introduction of the technology to Indonesia, it is necessary to examine the development results (construction cost) and operation results (O&M cost) in other countries. In particular, the use of low-grade coal with low ash melting points for power generation is expected, for which examinations need to be made, while avoiding technological risks by the use of LTSA(Long Term Service Agreement).

In Japan, there is a project to construct commercial IGCC power plants in 2020. If these projects are implemented as planned, the operation of commercial IGCC power plants will be started in 2025.

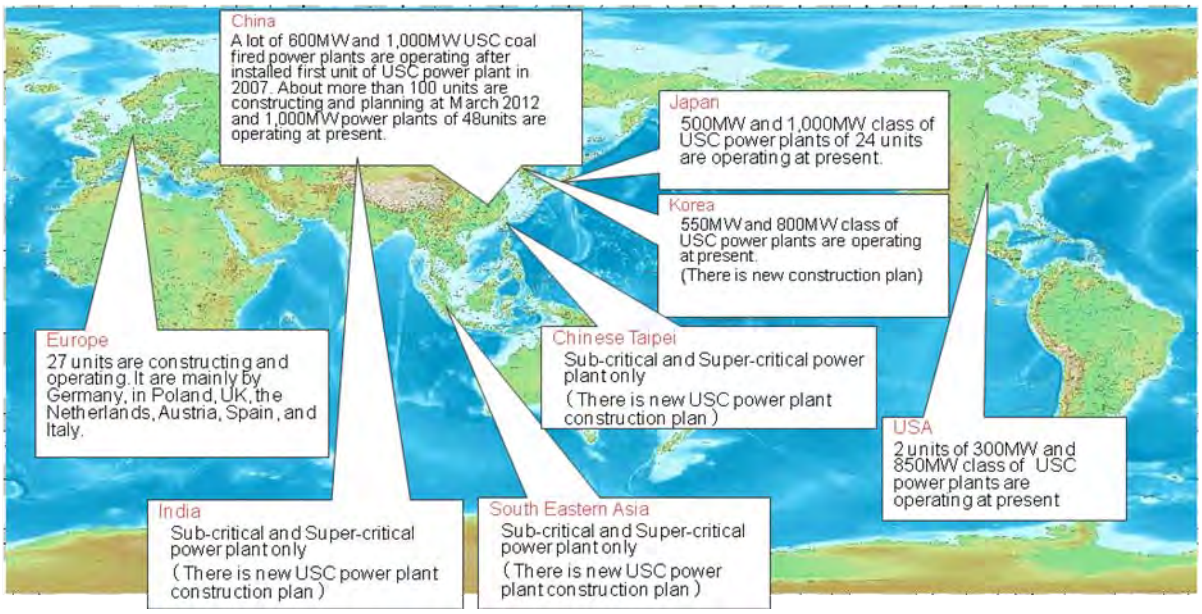


Figure 5.1 An operating USC Power Plants in major countries

Source：JICA Study Team

Table 5.1 Current situation of IGCC in the World

Majored IGCC plant in the world

Project name (country)	Type of Grassfire	Gas Turbibe	Rated out-put (MW)	Operation date	Continuous operation time (hr)
Puertollano ELCOGAS (Spain)	Prenflo (Oxygen)	Siemens V94.3	318	Nov.1997	984
Buggenum Nuon (Holland)	Shell (Oxygen)	Siemens V94.2	284	Jan.1994	3291
Wabash River (USA)	E-Gas (Dow) (Oxygen)	GE 7FA	296	Aug.1995	1560
Tampa Electric (USA)	GE (Texaco) (Oxygen)	GE 7FA	315	July.1996	1008

Under construction and Planed IGCC Project

Project Name (Country)	Owner	Fuel	Grassfire	GT	Rated out-put (MW)	Original commercial operation date	Situation
Edwardsport (USA IN)	Duke Energy (Electric utilization company)	Coal	GE	GE	618 (net)	2012	Under construction
GreenGen Stage1 (China Tenshin)	Green Gen (Hua Neng Dian Li Gong Si etc)	Coal	HCERI	Simens	265	2012	Under Construction
Korea IGCC R&D project (Korea)	IGCC RDD&D Organization	Coal	SHELL	Unclear	380	2016	Under construction
CPI-Langfang (China)	China Power Investment	Coal	Unclear	Unclear	400x2	N.A	FS

Note: FS（feasibility study）

CO_2 Reduction plant with IGCC

Project Name (Country)	Owner	Fuel	Grassfire	GT	Rated out-put (MW)	Original commercial operation date	Situation
Green Gen Stage2 (China)	Green Gen (Hua Neng Dian Li Gong Si etc)	Coal	Unclear	Unclear	400 + H2 Product	2015～20	FS
Kemper (USA MS)	Mississippi Power (Electric company)	Lignite	KBR	Siemens	524(net) + duct firing	2014	Under Construction
Don VALLEY (Eng)	TPG capital	Coal	SHELL	GE	900	N.A	FEED
Tilbury (Eng)	RWE (Electric company)	Coal	Unscheduled	Unscheduled	450	2014	FS
Clean Hydrogen Power Generation (USA CA)	Southern California Edison	Coal	Unscheduled	Unscheduled	500	2016	FS
Hydrogen Energy California (USA CA)	Hydrogen Energy California	Petocoke / Coal	MHI (oxygen method)	MHI	400 + Urea Product	2017	FEED
Texas Clean Energy (USA TX)	Summit Power (Electric company)	Coal	Siemens	Siemens	400 + Urea Product	2014	FEED Completed

Note: FEED（Front End Engineering & Design）,FS（feasibility study）

Source: Crean Coal Power Institute

http://www.ccpower.co.jp/igcc/foreign_situation.html

(2) Policy aspect

Figure 5.2 shows the general properties of low-rank coal and its characteristics when used. Low-rank coal has a low calorific value because of its high moisture content, low carbon content, and high oxygen content. Furthermore, owing to its porous structure and resultant large surface area, low-rank coal is highly pyrophoric. On the other hand, its high volatile content contributes to high combustibility. In addition, due to the high gasification reactivity and low ash melting point, low-rank coal is suited for entrained bed gasification. Therefore, in the future, it can be used as raw fuel for IGCC power plants.

Indonesia has the policy of using coal resources as the country's main energy source and on a long-term basis, the need for low-grade coal will increase for highly efficient coal-fired power generation.

Low-grade coal can also be used as raw fuel for IGCC power plants, and so the introduction of CCT is in line with the governmental policy.

Moreover, it has been confirmed that CO_2 reduction effects are higher for USC and IGCC than for SC and that the introduction of CCT will make contributions to GHG emission reduction.

Table 5.2 Properties of Indonesian Low rank coal

Coal	A	B	C	D
Region	S.Kalimantan	E.Kalimantan	E.Kalimantan	S.Sumatra
Moist. (%, GAR)	35	45	45	60
CV (kcal/kg, GAR)	4200	3400	3400	2400
AFT (℃; Reducing) Initial Deformation Hemispherical Fluid	 1126 1154 1192	 1179 1230 1289	 1228 1247 1268	 1120 1170 1380
Resources (million ton)	1,608	281	9,527	2,000

Source: JICA study team

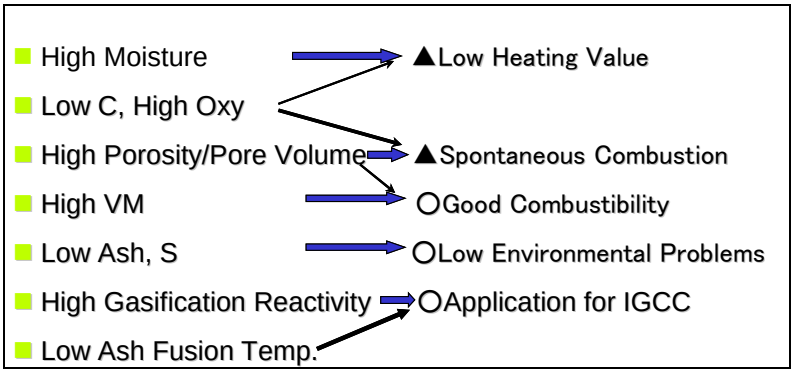


Figure 5.2 Properties of Low rank coal for Power Plant fuel

Source: Y. Otaka, （JCOAL Coal technology conference 2006）

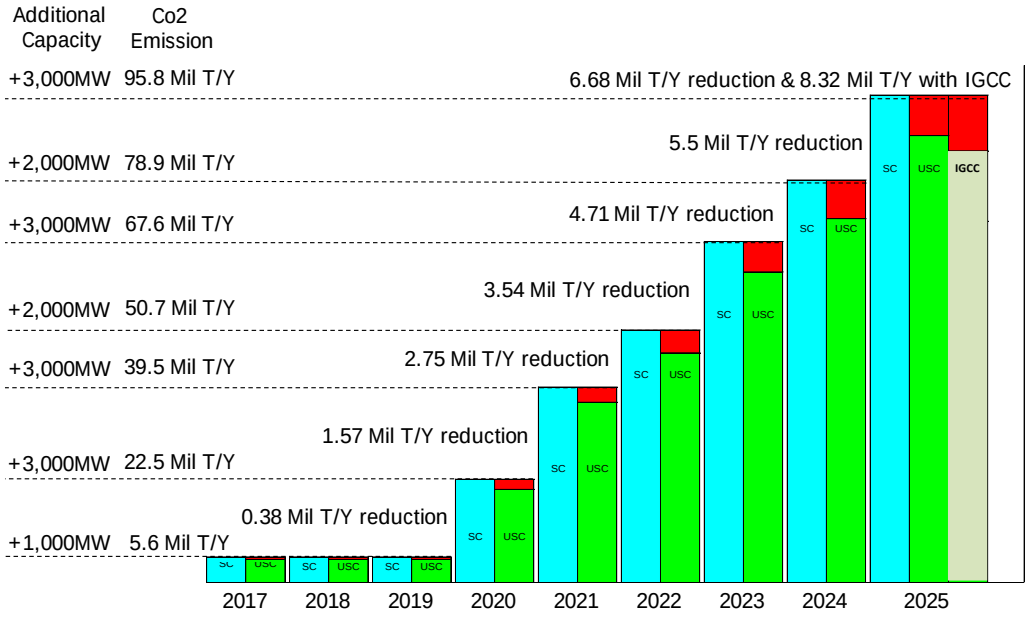


Figure 5.3 CO_2 reduction volume by introduction of CCT

Source: Prepared by the survey team

(3) Economic aspect

The evaluation of CCT was based on following prerequisite

(a) In plant thermal efficiency calculation, boiler efficiency decrease due to moisture in coal was considered.

(b) Increase of special lignite coal firing system and boiler furnace size increase were considered due to following reason.
The lignite coal calorific values are 2400/3000 kcal/kg [4]and special design of boiler, such as coal drying process and increase of flue gas volume have to be considered.

(c) The construction cost of IGCC was not so different between 2400kcal/kg and 3000kcal/kg, since gasification furnace size is almost same. Manufacturer's target cost was used for estimation of IGCC construction cost, because commercial operation of IGCC power plant does not yet start at this moment.

(d) A coal price at FY 2020 will be double of that at FY 2011.

Table 5.3 Prerequisite of Comparison for economical efficiency.
(construction cost, Plant thermal efficiency, O&M cost and Coal unit price)

Precondition of cost comparison		Sub Critical	SC	USC	IGCC	Coal Price ($/ton)	
Gross Power		1,000MW	1,000MW	1,000MW	1000MW Class	Y 2011	Y 2020
Plant Efficiency	4,200kcal/kg	36%	39%	42%	49%	53.8	107.6
	3,000kcal/kg	33%	36%	39%	45%	31.4	62.8
	2,400kcal/kg	30%	33%	36%	42%	21.7	43.4
Construction Cost	4,200kcal/kg	100% (Base)	106.5%.	108.5%	130.0%	-	-
	3,000kcal/kg	107.0%	111.0%	115.0%	130.0%	-	-
	2,400kcal/kg	110.5%	115.5%	119.0%	130.0%	-	-
Coal Consumption (kg/kWh.net)		100% (Base)	90%	84%	75%	-	-
O & M cost		2 .5%	3 %	3 %	3 .%	-	-

Source：JICA study team

Economical evaluation was carried out by comparison of electric power generation cost per kWh, taking difference of plant thermal efficiency, construction cost, consumption of coal and O&M cost of sub-critical, super critical, ultra- super-critical and IGCC plant into consideration.

The plant facilities costs were estimated by using coefficient of payback, which is identical during project period, and interest rate of the calculation condition of the capital collection coefficient are as

[4] The kind of coal is selected based on Indonesian Coal Index(IDI) in the Figure 5.3-9 and Table 5.3-1

follows.

(a) Project period: 30 years

(b) Interest rate: 12 percents

The construction cost thus calculated, the fuel cost estimated based on the plant efficiency and coal price, and the O&M cost set by plant type were summed up to calculate the total cost of power generation. For IGCC, for which no actual operation data was available, the calculation was made based on the results of interviews with the manufacturers and targeting the period of 30 years to provide reference values to be compared with the calculation results of other plants.

Figures of comparison of economical evaluation are shown below (Figure 5.4). The upper left graph in the figure shows the plant efficiency by heat value of coal and the upper right graph shows differences in the power generation cost as of 2010. The lower left and lower right graphs show differences in the power generation cost caused by changes in the coal price for 2010 and 2020, respectively.

According to coal prices in 2011, the USC power generation cost was lower than that of the Sub-Critical and SC power generation, which has proved the economic superiority of CCT.

Because coal prices will rise in 2021, the real power generation cost will also rise in the year, but as a result of this, the economic superiority of USC and IGCC power generation for which the use of coal can be reduced compared with Sub-C and SC power generation, will become clearer.

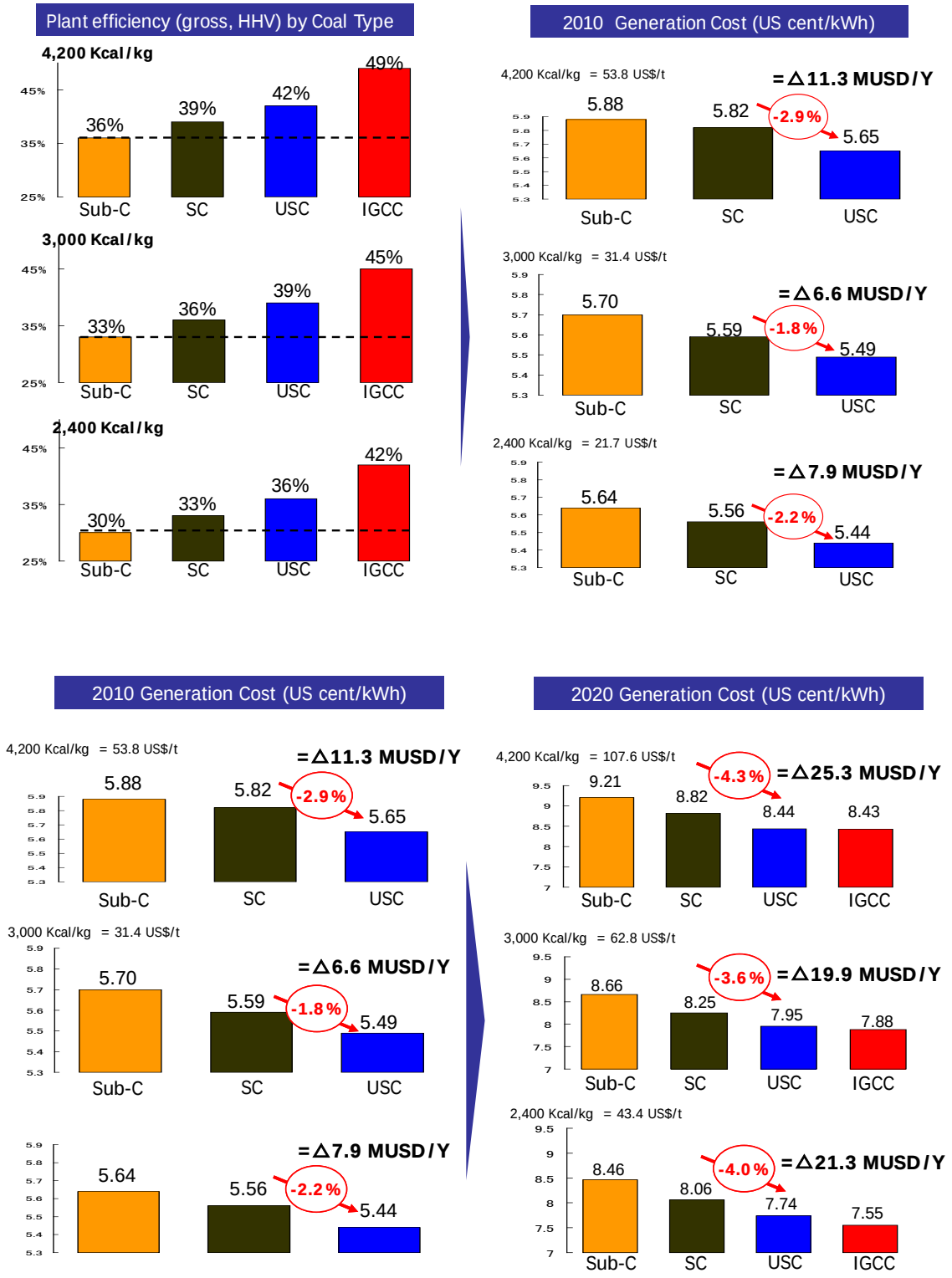
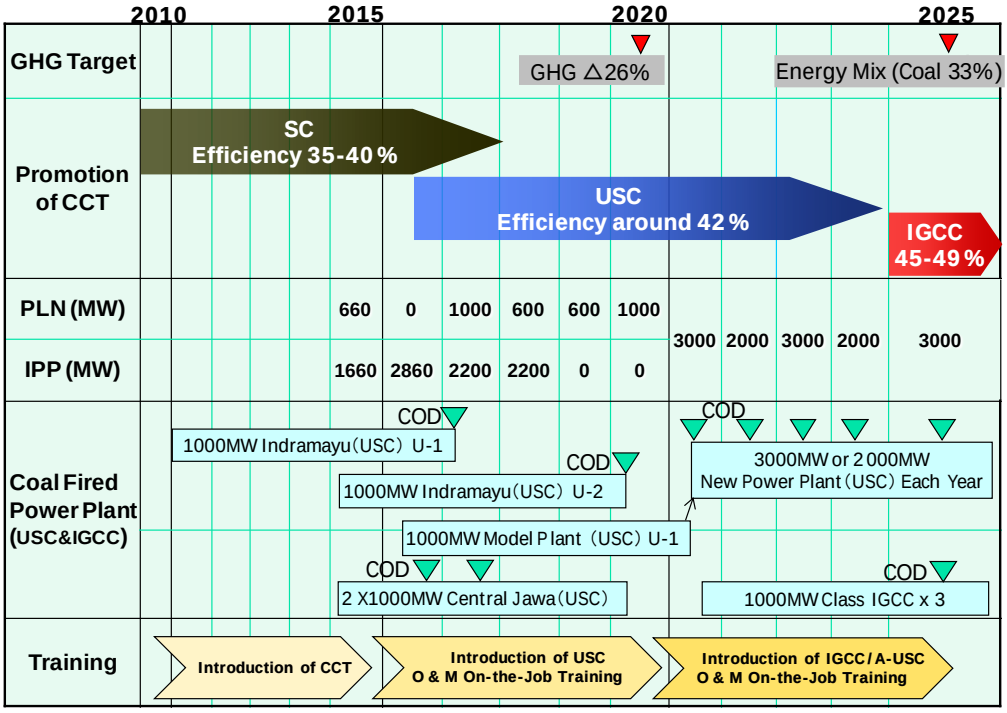


Figure 5.4 Comparison of economical efficiency

Source: JICA Study Team

Figure 5.5 shows the CCT introduction roadmap created based on the aforementioned conclusions. The output from the development of coal-fired power generation is assumed to be 13,000 MW based on the values planned by RUPTL (for up to 2020) and on the information obtained from PLN (for five years from 2021).

The CCT proposed in the roadmap will be incorporated in RUKN and RUPTL.



SC: Super Critical USC: Ultra Super Critical IGCC: Integrated coal Gasification Combine Cycle
COD: Commercial Operation Date

Figure 5.5 Finalized CCT Roadmap

Chapter 6 Study for model coal-fired power plant

While coal-fired power plant projects by the crash programs are progressing, all of those power plants' steam conditions are sub-critical or super critical, we reached the conclusion that it is very effective, from CO2 emission reduction and energy consumption point of view, to construct large capacity with high efficiency power plant in the future. Following this conclusion, we devised CCT introduction roadmap until 2025 with applying ultra super critical (USC) steam condition for coal-fired power plant.

Thus, JICA study team conducted preliminary feasibility study (Pre-FS) to build the next-generation coal-fired power station as Model Power Plant that has large capacity and high efficiency by Clean Coal Technology (CCT).

6.1 Selection of Pre-FS site for model power plant

In the selection of the site area for the model power plant, one area (Bojonegara) is selected from eleven (11) potential candidate sites which are new development area plans in RUPTL (2011-2020) and replacement/expansion area, considering technical aspects, environmental and social aspect and economical aspect.

Major specifications of the model plant are as follows.

(a) Fuel; Coal (Low rank coal)

(b) Steam condition; Ultra-Supercritical (USC)

(c) Capacity; 1,000MW x 1unit taking into account of possible extension of another 1000MW unit

(d) Commercial Operation Date (COD); around 2021

(e) Site location for Model coal power plant; Java Island

(Even in the future, it is not possible to install 1,000 MW unit in the other grid system other than Java-Bali.)

Figure 6.1 Model power plant sites

Source: JICA study team

6.2 Outline of Bojonegara Pre-FS site for model power plant

(1) Location

The selected study site is possessed by *PT. PLN* (State Owned Electric Company), located at *Terate* Village, *Kramatwatu* Sub-District, *Serang* District of *Banten* Province and being part of the *Jababeka* Industrial Estate.

The study site is located in latitude 6° 00' South and Longitude 106º 06' West, approximately 103 km (86 km linier) west far from the capital city of *Jakarta*, with approximate traveling time of 2 hours by car. The location map of the area is shown below.

Figure 6.2 Site location map

Source: JICA Study Team

(2) Design Requirements of Model Power Plant

The design requirements are as follows.

Table 6.1 Design Requirements for Model Power Plant

No.	Name of criteria	Unit	Data
1	Rated Output	MW	1000
2	Number of Unit	Unit	1
3	Plant Efficiency (HHV)	%	40
4	Plant Capacity Factor/Availability Factor	%	80/84
5	Annual Operating hours	h/ y	7,358
6	Annual Gross Generation Output	GWh/y	7,008
7	Auxiliary power consumption rate	%	8.0
8	Annual Net Generation Output (at Main Transformer end)	GWh/y	6,447
9	Boiler Efficiency (HHV)	%	>84
10	Turbine Efficiency	%	>47
11	Fuel Consumption		
a	Heating Value of coal (Gross as received)	kcal/kg	4,000
b	- Per hour (CF=100%)	t/h	538
c	- Per day (Averaged, CF=80%)	t/d	10,400
d	- Per month (Averaged, CF=80%)	t/month	314,000
e	- Per year (CF=80%)	t/y	3,767,000
f	- Coal storage yard capacity	days	36
12	Capacity of Ash disposal area	Years	5

Source: JICA study team

(3) Description of Power Plant Facility

1) Boiler

(a) Fuel: Indonesian Low Rank Coal (Supplementary fuel : diesel oil)

(b) Steam Condition: USC (605/623°C at boiler outlet)

(c) Boiler Type: Pulverized coal firing, ultra super critical one through boiler

(d) Other: Outdoor type, Balanced draft system, Ring Roller type coal pulverizer,

Low NOx burner, Two stage combustion

2) Turbine

(a) Steam Condition: USC (600/620°C at turbine inlet)

(b) Turbine Type: TC4F (Tandem Compound Four Flow), Reheat Regenerative cycle
High Pressure Turbine × 1, Intermediate Pressure Turbine × 1,
Low Pressure Turbine × 2

(c) Rotation Speed: 3,000 rpm

3) Generator

(a) Type: horizontal cylindrical rotating field type synchronous generator

(b) Cooling: Direct Hydrogen cooling (for Rotor), Direct Water cooling (for Stator)

(c) Capacity: 1,250MVA (Rated Condition)

(d) Power Factor: 0.8 delay (detail study carried out at FS stage)

(e) Rotation Speed: 3,000 rpm

(f) Frequency: 50 Hz

4) Balance of Plant (BOP)

BOP is the summary of all components and systems in a power plant, that are needed for harmonious, safe and efficient operation, such as Dust collecting facility, Coal Handling system, Ash Handling system, DeSOx system, DeNOx system, Cooling Water system, Water Treatment system, Waste Water Treatment system and so on.

(a) Water Treatment System: Desalination Plant, Demineralizer, portable water system

(b) Flue Gas Treatment System: Dust collecting system, flue gas desulfurization system

* DeNOx system: No need to install for this design coal. By applying Low NOx burner and Two Stage Combustion, emission meets Environmental laws and regulations. However, air dispersion simulation should be carried out at FS stage and then be finalized.

(c) Waste Water Treatment system: Centralized Waste Water Treatment

(d) Coal Handling system: Receiving Conveyor, Discharging Conveyor, Coal storage yard, Stackers/Reclaimer,

(e) Coal Unloading system: Unloading Jetty, Trestle, Coal Unloader

(f) Ash Handling system: Bottom ash handling system, Fly ash handling system, Fly ash silo

(g) Ash disposal area: Controlled landfill type ash disposal area for 5 years operation
Fly ash and bottom ash can be utilized and sold for cement admixture and fertilizer admixture. However, detail study should be carried out at FS stage.

(h) Cooling Water system: Cooling Water system (Seawater intake and outfall, pipes for intake and discharge, CW Pump)

(4) Plot Plan

The Bojonegara power plant (including BOP, coal storage yard, ash disposal area) should be allocated as shown in Figure 6.3.

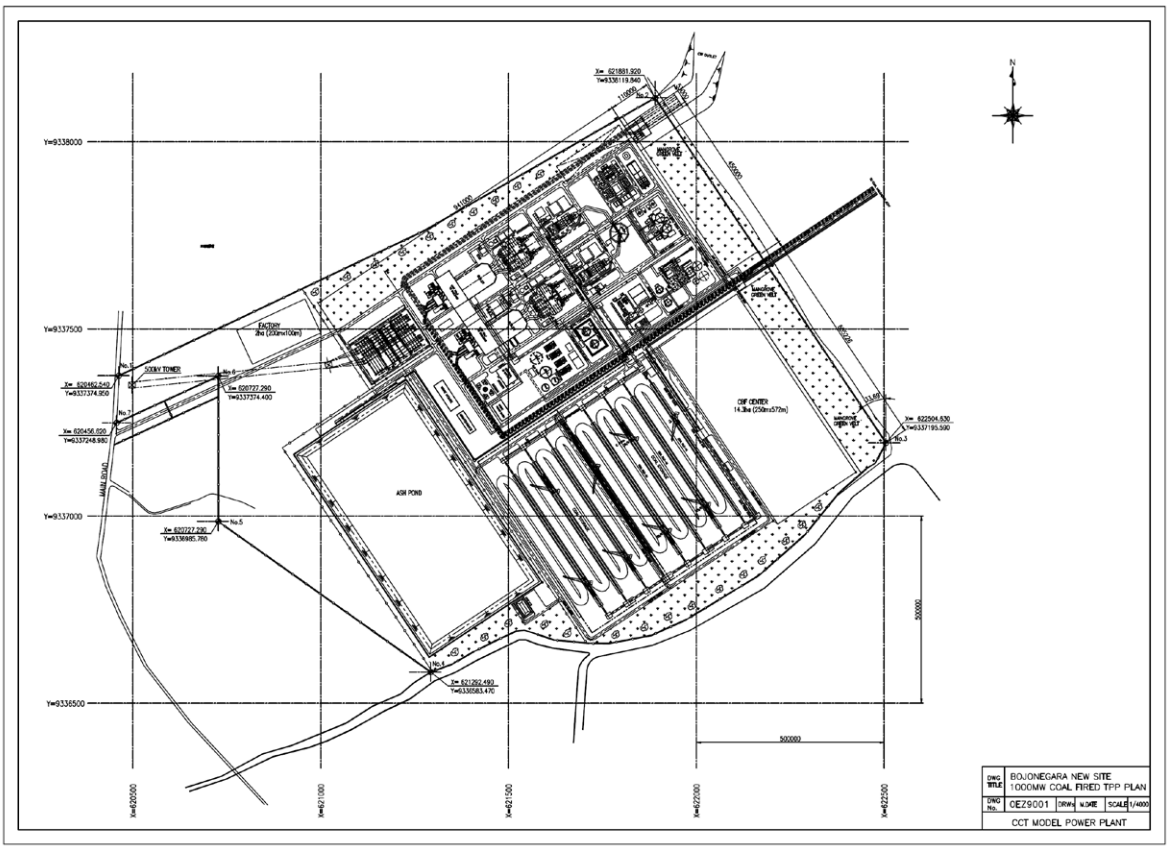


Figure 6.3 General Plant Area layout

Source: JICA Study Team

6.3 Environmental and social considerations

An initial environmental examination and evaluation study (IEE Study) has been conducted for the Bojonegara coal-fired power plant plan, along with the prefeasibility study on it. The following are the summary of most important results of the Study.

(1) Relevant plan of importance (Spatial Plan)

Environmental impact assessments are evaluated by local governments in Indonesia. Regarding the site selection of a large scale facility, it is important to agree with the upper-level superimposed plans of the concerned local governments, especially with their spatial plans. The spatial plans of Banten Province and Serang District that administers the concerned project site of Bojonegara directs the following policy for the area of the Project Site.

a. Spatial plan of Banten Province

- The Law No.26/2007 on National Spatial Plan and the Midterm Development Plan (2009-2014) of GOI designated 5 special economic zones (KEK) in the entire Indonesian territory. One of the 5 KEKs is the Special Economic Zones (KEK) Bojonegara that contains the concerned project site of model power plant. KEK Bojonegara is also approved by the

spatial plan of Banten Province in 2011.

- The concerned spatial plan places significance on the protection of coastal-seaside and riverside band area as greenbelt.

b. Spatial plan of Serang District

- KEK Bojonegara, which the project site is located in, is approved by the spatial plan of Serang District in 2011.
- As well as the provincial spatial plan, areas of seaside and riverside belt are important target of protection.
- Sub-districts of Kramatwatu where the project site locates and Bojonegara are contained in an industrial area, and the project site owned by PLN is inside the land for industrial use administered by Jababeka Industrial Estate Co.

(2) Environmental and social impacts

a. Provisions of spatial plans regarding concerned regions and landuse

The proposed project regarding power plant construction agrees with the landuse plan of spatial plans that are super-imposed plans by the respective administrations of the nation, the province and the district.

b. Poor, indigenous and ethnic people

No indigenous and ethnic minority people live in the surroundings of project site. No slums are identified in settlements around the project site.

c. Protected area and conservation area of the natural environment

A band of land aside shore and river should be protected as a greenbelt for the purpose of shore protection against erosion, protection of fish nursery and habitat, preserving the function as a pollutants-purifier. The width of band to be protected in the pertinent project site is determined as follows.

- 100 - 200 meters from the highest tide point landward from the shoreline
- 50 - 75 meters from the river bank

The concerned spatial plan contains a plan to conserve the currently plantation area, which stretches over hilly area westward in the peninsula of which the project site is located along the east coast, as protected forest. An area of Banten Bay offshore from the project site is designated as a marine conservation area with the spatial plan of Banten Province while it is not a conservation area in the concerned plan of Serang District.

d. Cultural heritage

There is a religious monument of Muslims, which is called Bukit Santri, a little more than 2 km north of the project-site-border, where worshippers are visiting from remote places.

e. Sensitive natural environment, biota and ecosystem

A colony of mangrove grows along the shoreline of the project site and around the mouse of river that flows down eastward along the south border of the site. A colony of coral with the stretch of

approximately 9 hectares is sighted about 1.7 km offshore from the project site. Besides, 7 km offshore of the site, there sit an island Panjang (Pulau Panjang), whose surroundings are a good local fisheries and seaweed cultivation area. The preservation of offshore coral reefs and greenbelt along the concerned river, river mouth and shoreline should be examined.

f. Geographical features, hydrographic conditions and bottom sediment

The area of project site is approximately 170 hectares. a large volume of land-fill material procurement will be required for land preparation. On the project-implementation stage, cares should be taken in the process of selecting borrow pits and its operators. The project site faces a recessed-section of gently-curved bay with long shoals off the shore. Since the layout plan assumes coal unloading berth and jetty facilities around 2.5 to 3.5 km long, hydrographic conditions of the sea might be affected if the facilities require dredging work.

g. Impacts related to land reclamation, dredging and ground subsidence, etc.

A large portion of the project site is low-lying wetland and partly submerged under water at the time of high tide, which necessitates earth-filling embankment for site preparation. The necessity of dredging for construction of coal unloading jetty facilities cannot be determined at the current study stage. The necessity of dredging for construction of coal unloading jetty facilities cannot be determined at the current study stage.

h. Air pollution

The USC-type power plant, which is chosen in this project, can reduce the amount of CO_2 emission in comparison with the conventional SC power plant, however, the emission of SO_2, NOx and dust cannot be relieved even in case of USC type plant. What is required are not only compliance with the emission gas standards of coal thermal power plant, but also the emission control measures that will reduce pollutant loads as much as possible.

i. Water pollution

Considering coastal and seabed topography and hydrographic conditions of the concerned site, thermal effluent water might be slow to disperse in comparison with the location that faces outer sea. It should be assessed with the simulation study of thermal effluent water diffusion in the following FS study, when the cooling water system and the discharge outlet of used cooling water are designed, for its discharge not to cause adverse stresses on adjacent coral reefs and other environment.

j. Pollution related to coal transportation and storage and coal ash management

The dispersion control system of coal dust will be important. The coal ash disposal area requires appropriate measures for leachate control to prevent pollution of groundwater and public water

source.

k. Noise and vibration, offensive odor

It is important to comply with the relevant environmental standards on the site border of the project. Therefore, the following measures are assumed necessary; that are environmental monitoring on the site border and the employment of standard devise for noise/vibration reduction or control, and sound shield measures at site border

l. Resettlement

Residents living in more than 100 houses along the south bank of river that flows down on the south border of project site. Strictly speaking, they are residents living outside the project site. Yet, it is recommended for the project proponent to have public dialog and consultation with the concerned residents and to take appropriate measures to support them so that they can keep non-degraded living and livelihood. Looking at the project site, though it is owned by PLN and under management of the Jababeka Industrial Estate Co., a slightly fewer than 60 people have currently temporary activities there as farmers engaging in rice and other crop farming and fish farmers running aquaculture inside the concerned project site of PLN land. Cares should be taken in their walk away process.

m. Water usage

The cooling water will use the sea water. Other water usages of industrial water, pure water and clean water, will be examined in the FS study. If deep wells are chosen as water source, it should be assessed in the FS/EIA study whether there are any impacts on local water resource and water usage.

n. Impacts on local economy, local resources and social infrastructure and services

In the FS/EIA study, at the time of planning coal-carrier ship, coal unloading berth and jetty facilities, the impacts should be assessed on sea traffic of fishing boats and on other sea traffic in the Banten Bay

o. Misdistribution of benefits and damages

In respect of the local area of the concerned project site, planned budgets should be considered to take measures for preserving living environment (ambient air and water environment), ecological environment (coastal and marine vegetation and ecosystems) and primary resources (fishery resources).

(3) Mitigation measures

Table 6.2 summarizes the mitigation measures that can be assumed necessary at the current study stage of project, in order to avoid or minimize the impacts stated in the previous section. All of those listed require detailed impact assessments in the EIA study on the Feasibility Study stage, where tangible mitigation measures to be examined.

Table 6.2 Mitigation Measures for Environmental and Social Impacts of the Project (Evaluation with the IEE study)

Items	Mitigation Measures
Natural protected area/conservation area	▪ Protection of greenbelt band on the site border ▪ Conservation of the planned protected forest area in the inland hilly area of the peninsula of which the project site is located along the east coast
Cultural heritage	▪ Protection of the religious monument, Bukit Santri
Sensitive natural environment, biota and ecosystem	▪ Preservation of mangrove trees and greenbelt band along the riverside and seaside ▪ Preservation of coral reefs
Geographical features	▪ Procurement of earth filling material from legitimate business operators of quary and borrow pits with legal clearance of AMDAL ▪ Measures in transportation of land-fill earth material for land preparation
Land reclamation, dredging and ground subsidence	▪ Prevention of ground subsidence and soil erosion associated with land reclamation and preparation
Air pollution	▪ Gas emission control measures: Simulation of emission gas diffusion and maximum ground concentration for SO2, NOx and Dust ▪ Compliance with the emission gas standards of coal thermal power plant (MOE Regulation No. 21/2008, Annex 1b) and environmental conservation
Water pollution	▪ Waste water treatment: Compliance with the effluent standards of thermal power plant (MOE Regulation No.8/2009) and environmental conservation
Coal transportation and storage and coal ash management	▪ Dispersion control system of coal dust: ▪ Prevention of leachate from coal ash disposal area
Noise and vibration	▪ Simulation of noise and vibration on the site borders of project
Resettlement	▪ Preparation of resettlement management plan for residents along the south bank of river that flows down on the south border of project site ▪ Consultation with and preparation of displacement plan for the people engaging in crop farming and fish farming inside the concerned project site of PLN land
Misdistribution of benefits and damages	▪ Planning and preparation of funding for local environmental improvement

Source: Prepared by the Study Team

(4) EIA matters with uncertainty of occurrence at present stage

Table 6.3 summarizes the items that requires a confirmation survey and a detailed assessment in the FS/EIA study in order to confirm the onset of preconditions for any concerned impacts and clarify predictable negative impacts. If impacts are identified in the confirmation survey and assessment on the matters on Table 6.3, planning of necessary mitigation measures is required.

Table 6.3 Confirmations and detailed assessments to be conducted in the FS/EIA study

Objectives of Confirmation Surveys and Detailed Assessments	Subjects of Confirmation and Assessment	Stage of the Project
Confirmation of the concerned marine conservation area with the provincial and district administration units charged with relevant spatial plans	▪ Purpose of setting the concerned marine conservation area ▪ Impacts on the conservation area of coal unloading berth and jetty facilities, and of thermal effluent water	In FS/EIA study
Confirming the need of dredging for installation of coal unloading berth and jetty facilities	▪ Impacts on hydrographic conditions of the sea, sea bed, nearby coral reefs and mangrove trees, ▪ Impacts of treatment and disposal of dredged soil if dredging is necessary	In FS/EIA study
Conducting diffusion simulation of discharged thermal effluent water	▪ Impacts on nearby coral reefs, benthos and other marine lives and ecosystems, including ones with floating period	In FS/EIA study
Survey on the distribution of fauna and flora and ecosystems to be protected in the Project Site and surrounding offshore area	▪ Preparation of fauna and flora list ▪ Existence or non-existence of rare species, endemic species and precious ecosystems to be protected ▪ Mitigation and protection measures when those living organisms requiring protection are identified	In FS/EIA study
Issuing an official letter to the Hazardous Management Division of MOE and confirming the special permission for ash-disposal site	▪ Confirmation of permission for installation position of coal ash disposal area	In FS/EIA study (on the early stage)
Design of plant water utilization (In case deep wells are chosen as its source)	▪ Impacts on local water resource and water usage	In FS/EIA study
Assessment and consideration of mitigation measures at the time of planning coal-carrier ship, coal unloading berth and jetty facilities	▪ Impacts on offshore fishery activities, including those around the Panjang Island, and marine transportation	In FS/EIA study

Source: Prepared by JICA Study Team

(5) Environmental and social considerations process after this Study

If the project proceeds to the feasibility (FS) study, the project proponent of Indonesian side should conduct an environmental impact assessment, called AMDAL in Indonesia, as required by Indonesian environmental regulations. Figure 6.4 shows the concerned procedure.

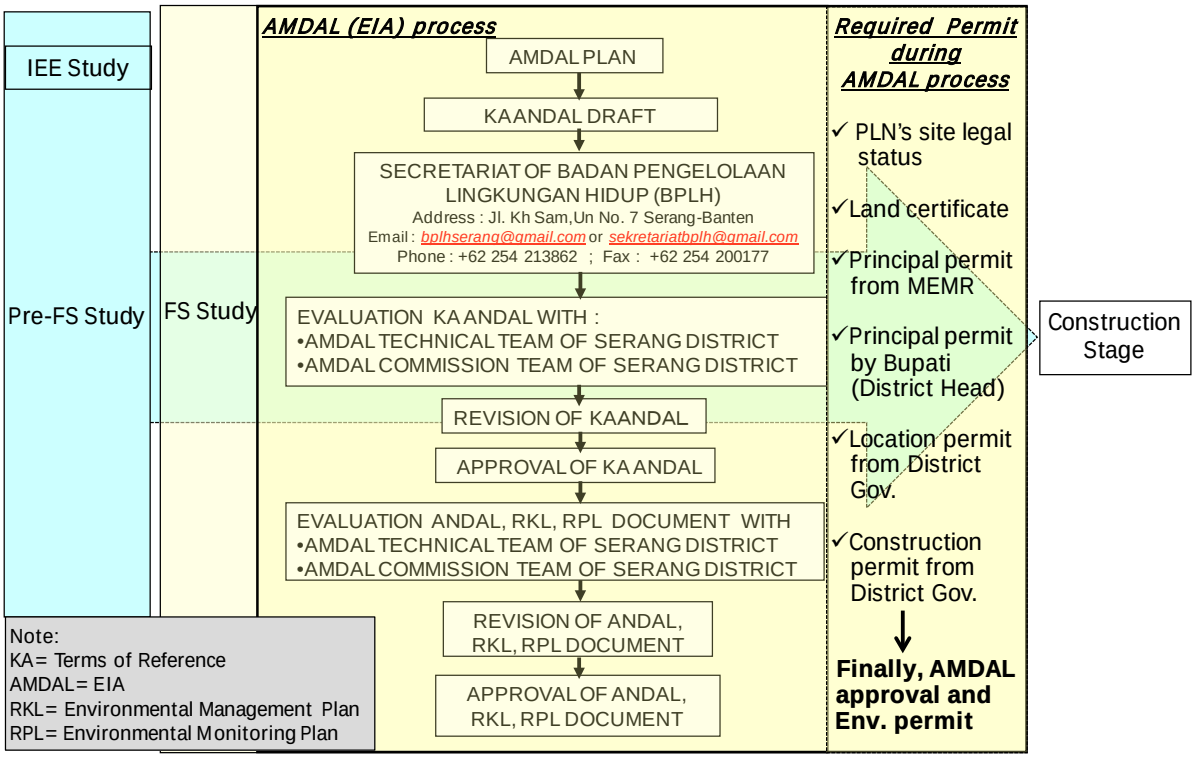


Figure 6.4 Environmental and Social Considerations Process after the Pre-FS and IEE study

Source: JICA study team

6.4 Project cost and Economic/Finance Analysis

(1) Project cost

JICA study team estimated the project cost based on the information in Indonesia such as IPP projects. The estimation results of construction for 1 unit and 2 units (both include the common facilities) are in Table 6.4. The estimation is based on the following assumption.

- The estimate for Baseline Cost for Power Plant assumes use of 3,700 kcal/kg to 4,300 kcal/kg coal.
- The land cost is not included in Baseline Cost for Power Plant.
- Baseline Cost for Power Plant doesn't include the tax and duty of Indonesia.
- Baseline Cost for Power Plant for 2 units is assumed to construct 2 units at once (2nd unit's construction is scheduled half year later after 1st unit's construction commencement).
- Environmental measures to observe the environment standard (e.g. wastewater treatment, sound insulation facilities, flue gas treatment facilities etc are included in the following cost estimate, but the cost for safeguard mitigation measures outside the power plant is not included, since these measures cannot be specified at this stage and their cost cannot be estimated.

Table 6.4 Project cost estimate

(US$ million)

Breakdown of Project cost		(i) Case 1 1 Unit × 1,000MW	(ii) Case 2 Units × 1,000MW
(A)	Construction cost for power plant (EPC)	1,548.9	2,788.0
(B)	Construction cost for transmission line	60.0	60.0
(C)	Price escalation for (A)& (B) [i)]	163.6	289.5
(D)	***Sub-Total: Construction cost: sum of (A) to (C)***	***1,772.4***	***3,137.5***
(E)	Consulting service cost	47.6	85.7
(F)	***Sub-Total: Baseline Project Cost: (D)+(E)***	1,820.0	3,223.2
(G)	Allowance for project: (F)*5%	91.0	161.2
(H)	**Budget for Total Project Cost:** (F)+(G)	**1,911.0**	**3,384.4**

[i)] ((A)+(B)) × (1.0245^4 – 1) : Based on the assumption that it will take 4 years to start construction and increase of 2.45% per year which is the 10 year average of US CPI.

Source: JICA study team

(2) Financial analysis

FIRRs for Case 1 and Case 2 in the base case are as follows:

Table 6.5 Results of Financial Analysis: Base case

	(i) Case 1 Unit 1 + Common facilities	(ii) Case 2 Unit 1 & 2 + Common facilities
Financial IRR	12.55%	13.84%
NPV (US$ million)	93.73	570.46

Source: JICA study team

They are higher than the hurdle rate if 12%, which PLN uses as the investment decision criteria, is the hurdle rate. On the other hand, FIRR for Case 2 in the base case is higher than Case 1 by more than 1% and it is easier to ensure the profitability. However, as examined in the sensitivity analysis, the tariff revenue increase in the same rate as the fuel cost increase is the premise in order to ensure this profitability. (This is the same structure as the existing Indonesian government's policy. Under the current Indonesian law, the government provides the subsidies to PLN for the difference between PLN's supply cost plus margin and the revenue collected from end users. Therefore, the fuel increase will be covered by the electricity sale revenue actually.)

The fluctuation of the total project cost also affects the profitability of Model Power Plant. For example, if the currently assumed price escalation component in the total project cost becomes lower than expectation and the total project cost becomes lower, FIRR for both Cases will improve. (e.g. price escalation is 50% of expectation.) On the other hand, if the total project cost exceeds the base case's assumption by 10%, FIRR for Case 1 will be lower than the hurdle rate, but FIRR for Case 2 can exceed the hurdle rate. In this way, 2 unit construction (Case 2) will be easier to ensure the

profitability than 1 unit construction (Case 1), even if there are changes in the assumptions.

(3) Economic Analysis

On the other hand, in economic analysis, economic IRRs for base case are as follows:

Table 6.6 Economic analysis, Base case

	(i) Case 1: 1 unit & Common facilities		(ii) Case2: 2 units & common facilities	
	Economic IRR (%)	NPV (mil US$)	Economic IRR (%)	NPV (mil US$)
Cost without externalities	18.59%	1,343	20.77%	3,066
Cost with local externalities	16.48%	976	18.50%	2,333
Cost with local/global externalities	15.20%	765	17.13%	1,911

EIRRs for both Cases exceed the hurdle rate and construction of the Model Power Plant is economically rational for the national economy. Furthermore, there is the certain tolerance against changes of construction cost or fuel cost as well and economic rationality can be ensured under these circumstances. Economic IRR in Case 2 is higher than Case 1 and the net benefit to the society in Case 2 is even higher than Case 1.