The Republic of the Union of Myanmar

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Data Collection Survey on Coal Fired Thermal Power Generation

Final Report

January 2013

Japan International Cooperation Agency

Japan Coal Energy Center

Content

Chapter 1 Introduction

1.1 Background of the survey

In Myanmar, insufficient and aging energy infrastructure including electric power infrastructure has a serious impact on people's lives, and planned blackouts have implemented and power supply has been restricted in many cities including Yangon, the largest city in Myanmar. The Japanese government has announced a policy "to provide a support to Myanmar in preparing infrastructure and system necessary for sustainable economic growth" as one of the pillars of its economic cooperation to the country in order to support efforts for democratization, national reconciliation and economic reform there. Especially, the electricity sector serves as the foundation of various industries and the Japanese government cites it as one of the critical issues.

Meanwhile, we don't have sufficient information on coal production and thermal power generation in Myanmar. To consider a direction of cooperation, the Japanese government expects JICA to enrich basic information of these areas in Myanmar.

1.2 Purpose of the survey

In the context of the above background, the purpose of this survey is to collect and compile information that are necessary for considering specific details of future cooperation in developing a coal-fired power plant in Myanmar. It is not intended to develop specific business plan.

1.3 Survey Organization

1.3.1 Implementation Institute of the Myanmar side

Implementation Institutes cooperating with this investigation work from Myanmar side is the following,

[Governmental agencies]

- No.(3) Mining Enterprise, Ministry of Mine
- Directorate General for Geological Survey Mineral Exploration, Ministry of Mine
- Hydropower Generation Enterprise (HPGE), Ministry of Electric Powe r[1]
- Departments and agencies related to electric transmission system, Ministry of Electric Power
- Ministry of Energy
- Ministry of Transportation
- Ministry of Environmental Conservation and Forestry

[Private sectors]

[1] Ministry of No1 Electric Power that covers Hydropower Generation and coal power generation is marged to the Ministry of No2 Electric Power that covers thermal power plant and electric transmission

・ Kalewa mine, Namma mine etc.

1.4 Composition and work sharing of the survey team

- Overall management and coal development 1 person
- Coal development 1
- Improvement of coal related infrastructure 3（including 2 persons in charge of coal supply-demand survey）
- Coal-fired thermal power development 1
- Coal-fired thermal power generation facilities 1
- Environmental facilities/Consideration to society 1

The survey team is consisted of eight people as shown above.

Form 4 Details of work assigned to each member

Name	Task	Description of work
Masafumi Uehara	General management/ Coal development	・ Management of entire survey ・ Coal mine development plan ・ Coal survey review (Coal mine survey)
Minoru Yoshida	Support of general management/Coal-fired thermal power development	・ Policies and development plan on coal-fired power plants ・ Review of current operation state of coal-fired power plants (Survey ・ Collection of basic information on areas for coal-fired power plant development
Hiroaki Hirasawa	Support of general management/ Coal development	・ Overview of coal resource, Improvement of laws and policies on coal policy ・ Coal mine development plan ・ Coal survey review (Coal mine survey)
Atsuo Sagawa	Coal-related infrastructure improvement I	・ International market trend, Latest information on coal trade The following issues in Southeast and South Asian countries - Future trend of coal supply-demand and price - Coal supply-demand forecast - Consideration of future coal supply volume - Organization of information on coal-fired power plant construction plan
Koichi Koizumi	Coal-related infrastructure improvement II	・ International market trend, Latest information on coal trade The following issues in Southeast and South Asian countries - Future trend of coal supply-demand and price - Coal supply-demand forecast - Consideration of future coal supply volume - Organization of information on coal-fired power plant construction plan
Haruo Inoue	Coal-related infrastructure improvement III	・ Survey on coal-related infrastructure improvement ・ Infrastructure improvement development plan such as coal transportation
Morikuni Miyagi	Coal-fired thermal power generation facilities	・ Related infrastructure development plan such as transmission system ・ Review of current operation state of coal-fired power plants (Survey on power plants) ・ Collection of basic information on areas for coal-fired power plant development
Kazuyasu Tsuda	Environmental facilities/ Consideration to environment and society	The following issues on coal development/coal-fired thermal power generation - Current situation of environmental conservation - Improvement of related laws, Review of Policies, Future prospects - Technological possibility of environmental conservation - Environmental conservation plan

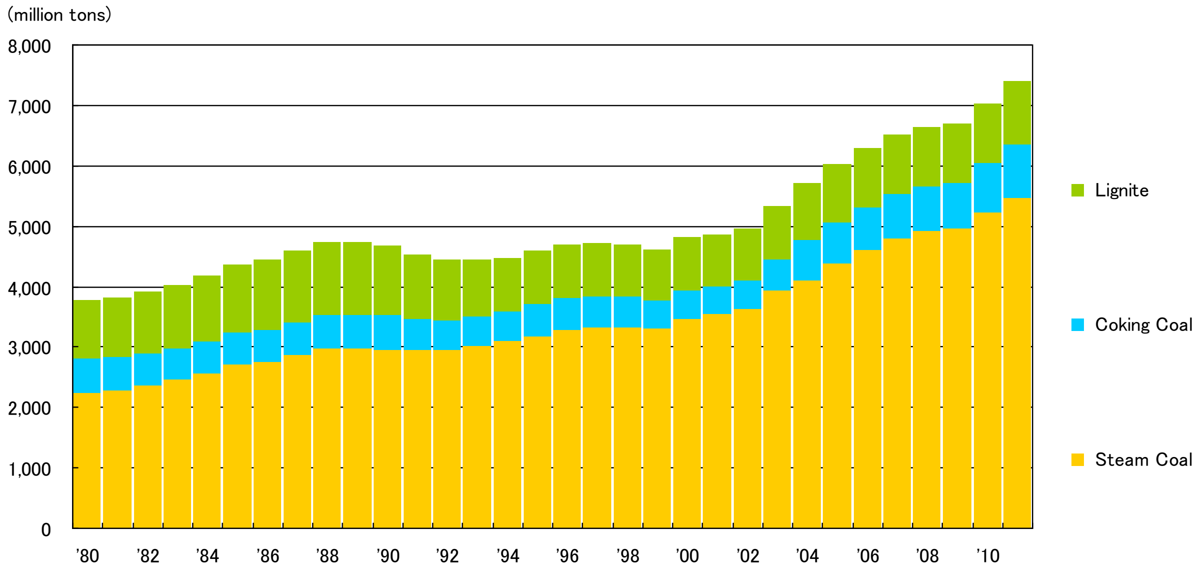
Chapter 2 Survey of international trends and forecasts for supply and demand of coal fuel resources

2.1 Latest information on the world's coal trade including the supply-demand situation of imported coal and price trends in the international market

2.1.1 Current situation of supply and demand of steam coal

(1) Current consumption situation

The world's coal consumption temporarily stagnated in the 1990s but demand started to soar in the 2000s. The coal consumption is estimated to reach 7,384 million tons in 2011. In recent years, steam coal used as fuel for power generation and heat for general industry as shown Fig. 2.1 accounts for three-fourths of coal consumption.



(million tons)

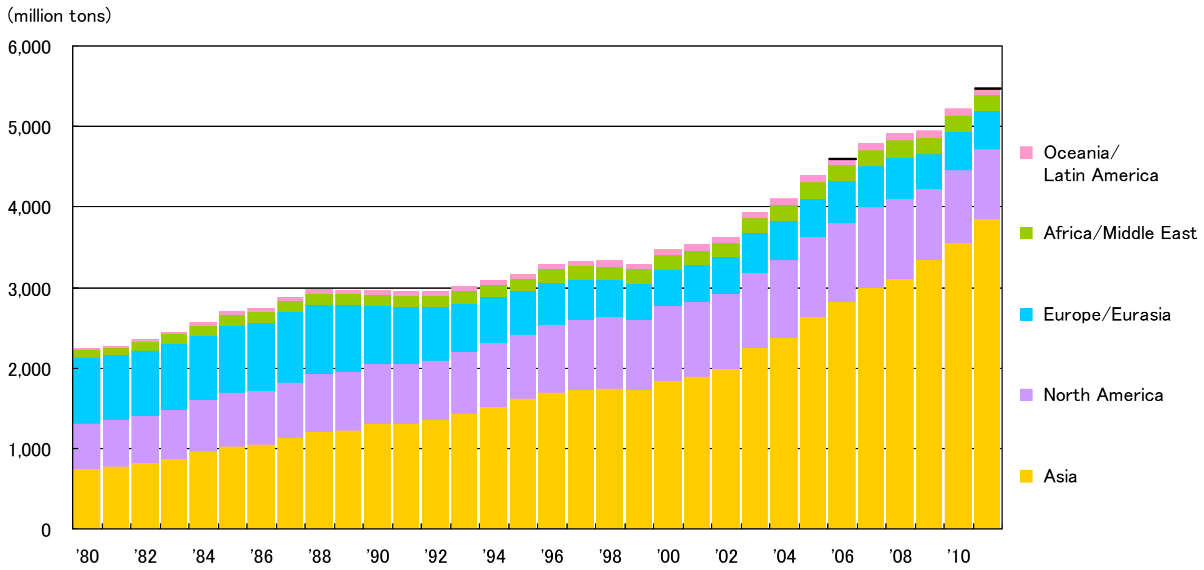
	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Steam coal	2,240 (60%)	2,696 (62%)	2,955 (63%)	3,163 (69%)	3,464 (72%)	4,383 (73%)	4,595 (73%)	4,791 (74%)	4,907 (74%)	4,947 (74%)	5,223 (75%)	5,470 (74%)
Coking coal	558 (15%)	533 (12%)	555 (12%)	534 (12%)	475 (10%)	674 (11%)	712 (11%)	742 (11%)	744 (11%)	765 (11%)	812 (12%)	878 (12%)
Lignite	957 (25%)	1,136 (26%)	1,155 (25%)	877 (19%)	862 (18%)	957 (16%)	966 (15%)	983 (15%)	986 (15%)	971 (15%)	976 (14%)	1,037 (14%)
Total	3,756	4,366	4,665	4,574	4,800	6,014	6,273	6,516	6,637	6,682	7,011	7,384

Note: 2011* is an estimate and steam coal includes anthracite. The percentage in parentheses shows the ratio of each type of coal.

Source: IEA, "Coal Information 2012"

Fig. 2-1 World's Coal Consumption

The consumption of steam coal by region as shown in Fig. 2-2 indicates a rapid increase in consumption in Asia since 2003. The consumption of steam coal in Asia was 740 million tons in 1980, which was lower than 811 million tons consumed in the European region (Europe and Eurasia) including the former Soviet Union. The consumption of steam coal in Asia in 2011, however, reached 3,837 million tons, which is 5.2-fold increase relative to 1980.



(million tons)

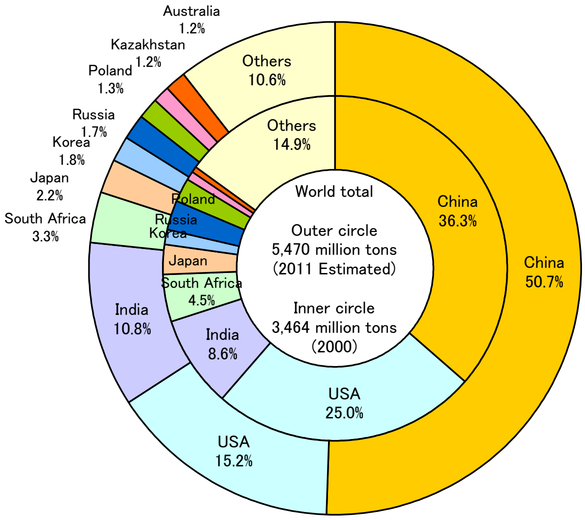
	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Asia	740 (33%)	1,008 (37%)	1,304 (44%)	1,604 (51%)	1,831 (53%)	2,621 (60%)	2,816 (61%)	2,990 (62%)	3,105 (63%)	3,336 (67%)	3,537 (68%)	3,837 (70%)
North America	571 (25%)	679 (25%)	740 (25%)	799 (25%)	925 (27%)	994 (23%)	980 (21%)	993 (21%)	985 (20%)	889 (18%)	913 (17%)	877 (16%)
Europe/Eurasia	811 (36%)	835 (31%)	722 (24%)	542 (17%)	458 (13%)	484 (11%)	510 (11%)	513 (11%)	506 (10%)	420 (8%)	471 (9%)	474 (9%)
Africa/Middle East	84 (4%)	129 (5%)	132 (4%)	158 (5%)	175 (5%)	196 (4%)	200 (4%)	205 (4%)	218 (4%)	212 (4%)	211 (4%)	205 (4%)
Oceania/ Latin America	35 (2%)	46 (2%)	56 (2%)	60 (2%)	75 (2%)	88 (2%)	90 (2%)	90 (2%)	93 (2%)	90 (2%)	91 (2%)	77 (1%)
Total	2,240	2,696	2,955	3,163	3,464	4,383	4,595	4,791	4,907	4,947	5,223	5,470

Note: 2011* is an estimate and steam coal includes anthracite. The percentage in parentheses shows the ratio of each region.
Source: IEA, "Coal Information 2012"

Fig. 2-2 World's Steam Coal Consumption

The consumption of steam coal by country in 2011 as shown in Fig. 2-3 indicates that China consumed 2,772 million tons (50.7 % of the world's consumption of steam coal), the US 832 million tons (15.2%), and India 591 million tons (10.8%). These three countries account for more than three-fourths of the total consumption. The rate of increase in the volume used by China stands out and its rate of increase of 7.4 % from 2000 to 2011 far surpasses the world's average of 4.2 %. The consumption of steam coal in Asia in 2011 was 3,837 million tons accounting for 70.1 % of the world's coal consumption. When compared to the year 2000, the increment is 2,060 million tons, which is an increase of 17.3 % over the world total.

Countries poor in coal resources such as Japan and Korea are also increasing the consumption of steam coal. The coal power generation plays an important role[2] in the composition of power generation in these countries and they rely on imports from overseas for nearly 100% of coal.



(million tons)

	1990	2000	2011 Estimated
China	971	1,259	2,772
USA	702	866	832
India	166	296	591
South Africa	119	155	179
Japan	50	96	122
Korea	33	52	98
Russia	186	98	92
Poland	102	70	72
Kazakhstan	56	31	66
Australia	6	23	65
Others	563	517	582
World total	2,955	3,464	5,470
Asian total	1,304 (44.1%)	1,831 (52.9%)	3,837 (70.1%)

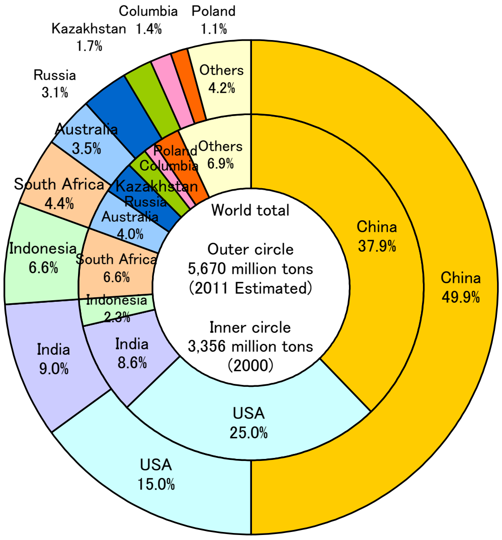
Note: Steam coal includes anthracite.
Source: IEA, "Coal Information 2012"

Fig. 2-3 World's Top Ten Countries in the Consumption of Steam Coal

(2) Current situation of production

Coal production volume steam coal in 2011 was 5,670 million tons as shown in Fig. 2-4 accounting for 73.8 % of the total coal production. China produces nearly half of the total steam coal followed by the US, India, Indonesia, South Africa, Australia, and Russia. The top three countries account for 73.9 % of the production in total steam coal volume. Coal production volume in 2011 in Asia was 3,812 million tons accounting for 67.2 % of the total production of steam coal, an increase of 16.7 percentage points relative to the year 2000.

[2] As of 2010, coal power generation accounts for around 25% in Japan and more than 40% in Korea of the total power generation.



(million tons)

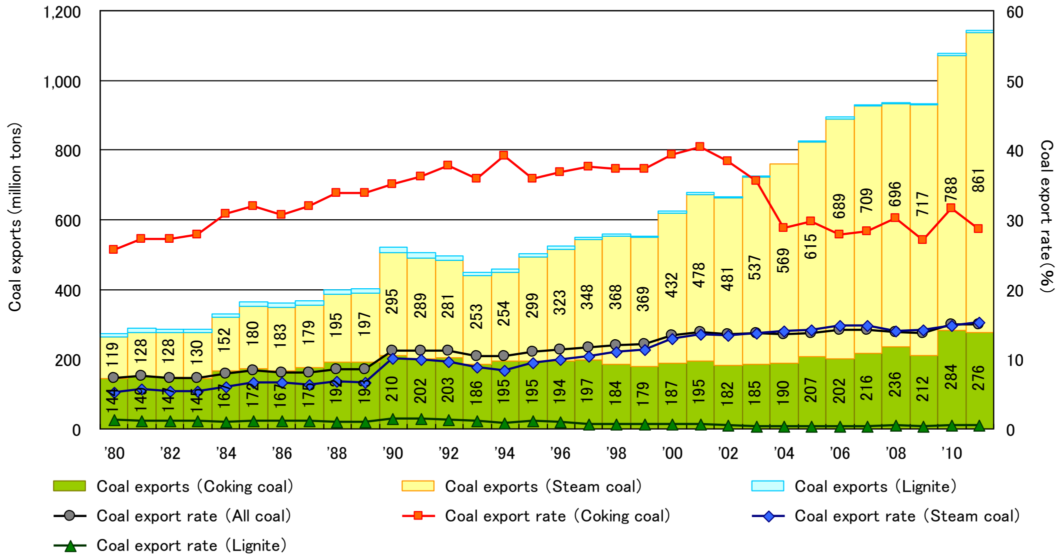
	1990	2000	2011 Estimated
China	965	1,271	2,831
USA	760	840	849
India	175	289	509
Indonesia	10	79	374
South Africa	165	221	250
Australia	94	136	199
Russia	152	102	178
Kazakhstan	98	64	98
Columbia	20	36	80
Poland	119	86	65
Others	380	233	237
World total	2,939	3,356	5,670
Asian total	1,228 (41.8%)	1,697 (50.5%)	3,812 (67.2%)

Note: Steam coal includes anthracite.
Source: IEA, "Coal Information 2012"

Fig. 2-4 World's Top Ten Countries in the Production of Steam Coal

(3) Coal trade

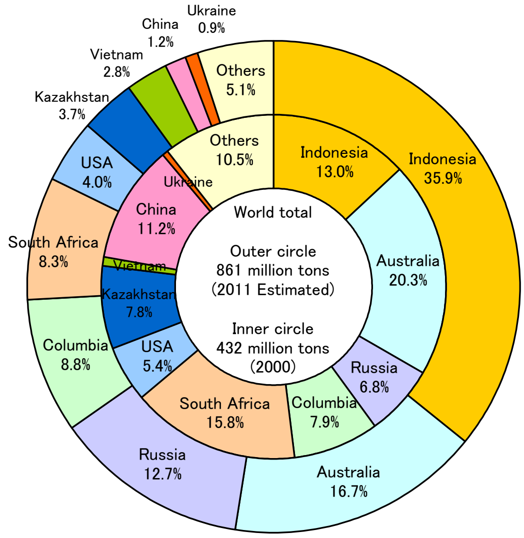
The world's coal trade is on the increase as shown in Fig. 2-5 with the increase in the demand of steam coal mainly used as a fuel for power generation. The volume of coal for trade, however, is small relative to the production and trade (export) only accounts for 14.9 % of the total production in 2011. According to the type of coal, coking coal accounts for 28.5 % and steam coal accounts for 15.2 %. It should be noted that steam coal and coking coal account for 75.4 % and 24.2 % of the world's coal trade volume, respectively.



Note: 2011* is an estimate and steam coal includes anthracite.
Coal export rate is calculated by the following formula, coal export rate = coal export volume / coal production volume.
Source: IEA, "Coal Information 2012"

Fig. 2-5 Coal Export Volume

The volume of the export of steam coal in 2011 in the world was 861 million tons and, as shown in Fig. 2-6, Indonesia is the largest exporter accounting for 35.9 % of the world's steam coal exports, followed by 16.7 % of Australia, 12.7% of Russia, 8.8 % of Columbia and 8.3 % of South Africa.



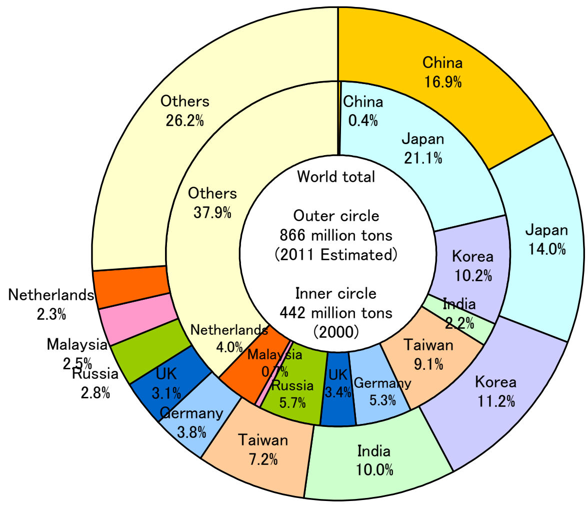
(million tons)

	1990	2000	2011 Estimated
Indonesia	4.6	56.2	308.9
Australia	45.6	87.8	144.1
Russia	24.5	29.4	109.4
Columbia	12.6	34.2	75.4
South Africa	46.3	68.2	71.6
USA	38.3	23.2	34.1
Kazakhstan	51.5	33.9	31.8
Vietnam	0.8	3.3	24.4
China	13.8	48.6	10.6
Ukraine	14.4	2.3	7.5
Others	42.3	45.5	43.6
World total	294.7	432.5	861.2
Asian total	19.9 (6.7%)	109.1 (25.2%)	360.0 (41.8%)

Note: Steam coal includes anthracite.
Source: IEA, "Coal Information 2012"

Fig. 2-6 World's Top Ten Steam Coal Exporting Countries

In terms of the volume steam coal imports, the volume of the world's steam coal imports in 2011 was 866 million tons accounting for 78.5 % of the total coal imports. China is the largest importer accounting for 16.9 % of the world's steam coal imports, followed by 14.0 % of Japan, 11.2 % of Korea, 10.0 % of India, and 7.2 % of Taiwan.



(million tons)

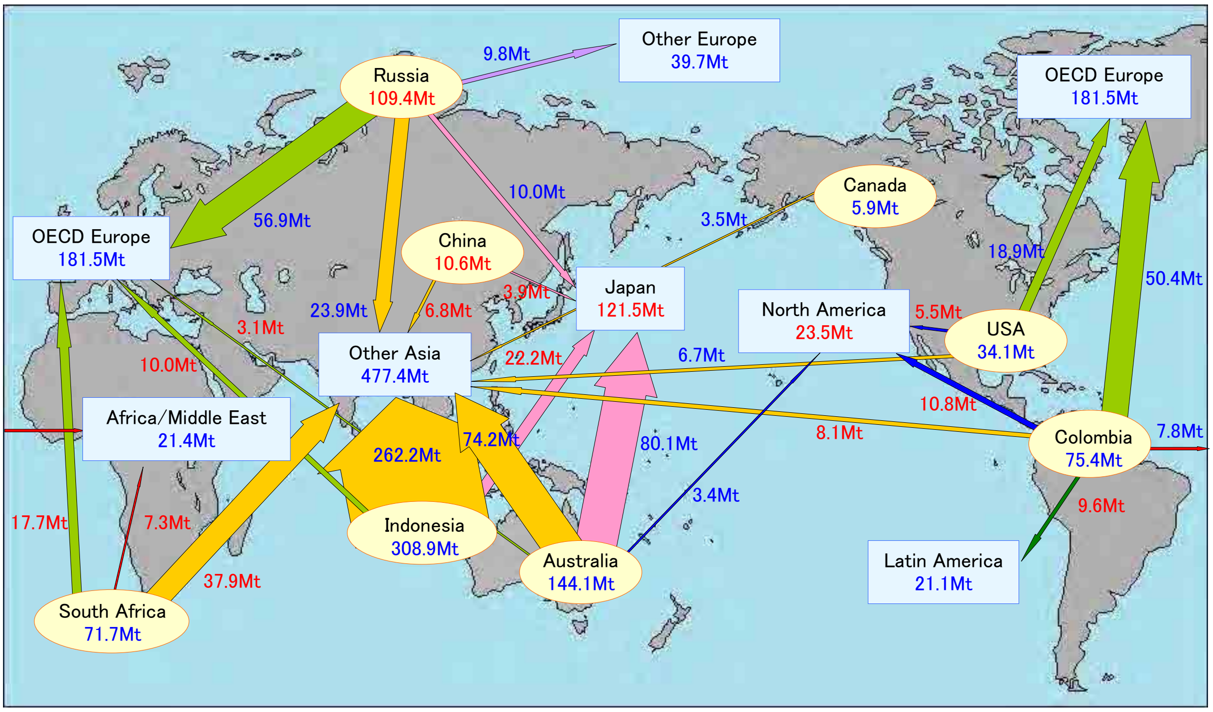
	1990	2000	2011 Estimated
China	1.8	1.8	146.4
Japan	42.0	93.3	121.5
Korea	12.4	45.3	96.9
India	0.2	9.9	86.4
Taiwan	14.3	40.3	62.5
Germany	11.9	23.3	32.5
UK	6.2	15.0	27.1
Russia	53.2	25.3	23.8
Malaysia	2.3	3.1	21.5
Netherlands	12.8	17.7	20.1
Others	165.3	167.5	226.7
World total	322.3	442.4	865.5
Asian total	85.1 (26.4%)	212.0 (47.9%)	581.2 (67.2%)

Note: Steam coal includes anthracite.
Source: IEA, "Coal Information 2012"

Fig. 2-7 World's Top Ten Steam Coal Importing Countries

From the middle of the 1990s to the middle of the 2000s Japan accounted for about 20 % of the world's steam coal imports. In recent years, however, China, India and Korea have notably increased import volumes and China has surpassed Japanese import volumes in 2011. The Japanese steam coal import volumes in 2011 were lower than that of the previous year because of a decrease in demand caused by the effect of the Great East Japan Earthquake. In the meantime, China has steadily expanded its economy and increased its demand for imported coal mainly for the industrialized coastal areas due to the fact that the price of imported coal is sometimes cheaper than that of domestic coal. New coal power stations have been launched in both India and Korea leading to an increase in demand for steam coal imports.

When compared the volumes of steam coal exports versus imports in Asia, export volume was 360 million tons compared to imports totaling 581 million tons in 2011 showing an excess of import over export of 221 million tons. Fig. 2-8 shows the flow of steam coal in 2011. Steam coal is mainly exported for Asia by Indonesia and Australia, and is also exported by South Africa, Russia, as well as China, Colombia, the US, and Canada, although the volume is smaller.



Note: The above figure does not show flows of less than 3 million tons. The blue-colored numbers show an increase relative to the previous year and the red-colored numbers a decrease relative to the previous year. The "North America" as an importer includes Mexico.

Source: IEA, "Coal Information 2012"

Fig. 2-8 Flow of Steam Coal (2011 estimate)

2.1.2 Price trends of steam coal

(1) Current situation of steam coal prices

Currently, the following main price Indices are available in Asian-Pacific coal market.

- NEWC Index (FOB price index for steam coal at New Castle port, Australia): globalCOAL

- RB Index (FOB price index for steam coal at Richards Bay, South Africa): globalCOAL
- API4 (FOB price index for steam coal at Richards Bay, South Africa): Argus/McCloskey
- API6 (FOB price index for steam coal at New Castle port, Australia): Argus/McCloskey
- NEX Spot Index (FOB price index for steam coal at New Castle port, Australia): Energy Publishing Inc.

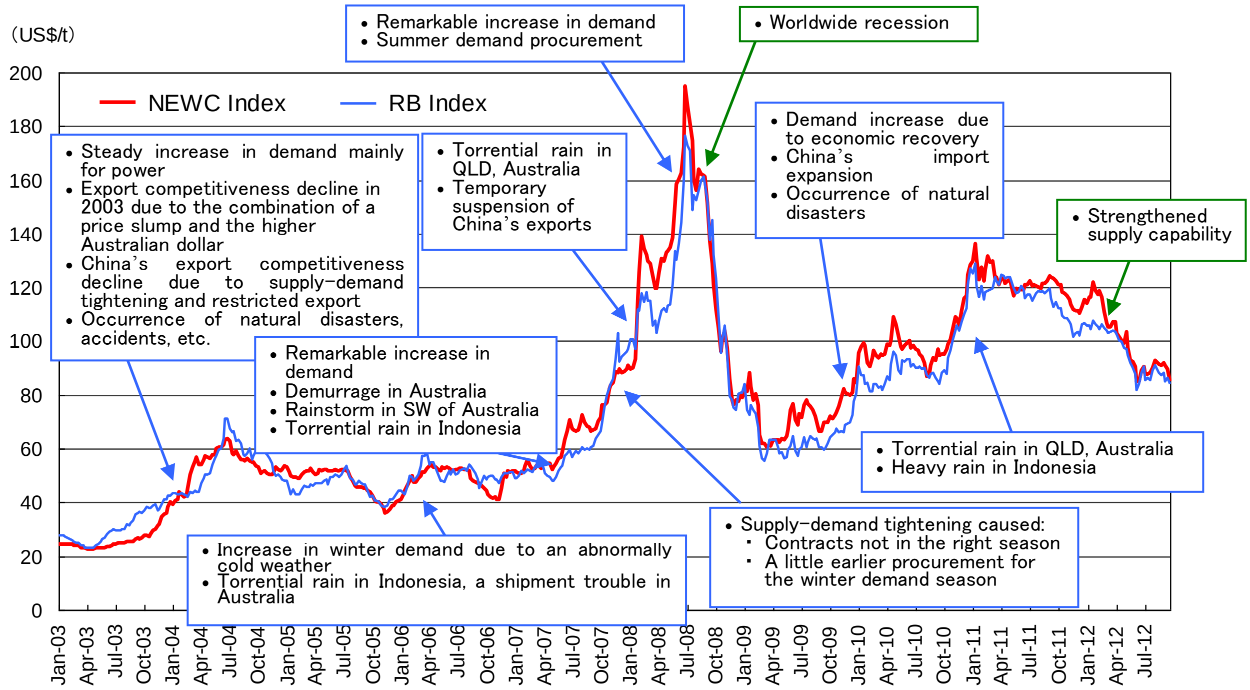
Although a practical transaction of coal is made based on the above price indices, contracts of sale and purchase of coal are mainly classified into long-term and spot contracts. Electric power companies, large users of steam coal such as Japan, Korea and Taiwan which are nearly 100% dependent on imported coal, give the highest priority to the stability and continuity of coal supplies and thus procure more than 70% of consumption volume based on long-term contracts (including one year contract) . In transactions of coal for use other than power generation, it is more popular to conclude a one-year or spot contract. Table 2-1 shows the characteristics of contracts by type of Japanese companies.

Table 2-1 Type of Coal Purchase Contract in Power and Steel Sectors of Japan

	Long-term contract*	Spot contract
Power	70 to 90%	10 to 30%
Steel	95 to 100%	0 to 5%
Merit	Secured contract volume	Highly flexible to a change in demand
Demerit	Less flexible to a change in demand	High risk of securing volume

Note: Long-term contracts generally mean three- or more-year ones but, here, include less than three-year contracts.
Source: JICA study team

Fig. 2-9 shows a transitional change in spot market prices of steam coal from 2003 based on the NEWC Index (FOB price index for steam coal at New Castle port, Australia) and the RB Index (FOB price index for steam coal at Richards Bay, South Africa) of the globalCOAL. The price of steam coal changes depending on the supply in the market and the demand for it in the same manner as many other commodities. When the supply decreases due to bad weather or accidents, or the demand increases, the price goes up. On the contrary, when the supply increases thanks to the progress in development, or the demand decreases, the price goes down.



Note: NEWC Index: FOB price index for steam coal at New Castle port, Australia
RB Index: FOB price index for steam coal at Richards Bay, South Africa
Source: Prepared by JICA study team based on the data contained in the Web site of globalCOAL

Fig. 2-9 NEWC Index and RB Index of globalCOAL

The NEWC Index fell below US$30 per ton till November of 2003. As the supply was less than demand since autumn in 2003 and the balance of supply and demand became tight, the NEWC Index rose and in July of 2004 reached US$60 per ton. Subsequently, it remained in the range between US$40 to US$60 per ton till May of 2007. Since June 2007, however, amidst a remarkable increase in demand, supply became very tight in part due to a temporary stoppage of supply because of storms and heavy rains in Australia, and the NEWC Index rose sharply reaching the price of US$190 per ton in July of 2008. Because of the effect of the global recession triggered by the Lehman shock, however, the demand for steam coal decreased and the NEWC Index fell to US$60 per ton. In October 2009, the NEWC Index started to rise thanks to the economic recovery and the increase of steam coal imports by China and this tendency continued till around January, 2011. Since then, the NEWC Index has gradually lost ground with the increase in steam coal supplies. Since April 2012, the economic worries in Europe and the stagnant economic growth of China and India further strengthened this tendency and the NEWC Index hovered around US$90 per ton since June 2012. Currently, it is around US$80 per ton.

Indonesia establishes and publishes the Coal Index Price (HBA, Harga Batubara Acuan) by grade (brand) every month[3]. This system has been introduced by the government of Indonesia in order to

[3] http://www.djmbp.esdm.go.id/index.php

prevent the producing companies from intentionally lowering the amount of royalties they pay which is called coal price fixing by the government of Indonesia. It should be noted however, that coal sale price fixing does not determine the coal purchase price of the users, but is considered an index of the sale price for coal producing companies and it is not directly reflected in the price of exports at present.[4]

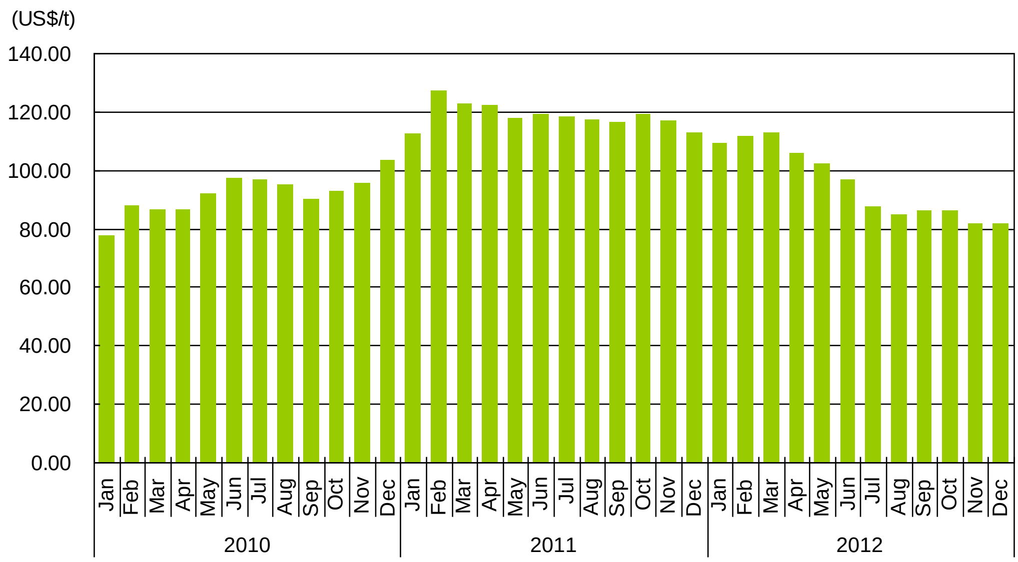
Fig. 2-10 shows the change in HBA since 2010. The HBA is calculated every month based on the following four steam coal price indices and they fluctuate nearly in the same manner as that of steam coal as shown in Fig. 2-9.

(1) Indonesian Coal Index (ICI, Argus)

(2) Steam coal Price Index of Platts

(3) Newcastle Export Index (NEX Spot Index, Energy Publishing Inc)

(4) Newcastle Global Coal Index (NEWC Index, globalCOAL)



Note: Standard specification: Calorific value 6,322kcal/kg (gross as received), total moisture 8% (as received), total sulfur 0.8%, and ash 15%

Source: Ministry of Energy and Mineral Resources, Indonesia Government

Fig. 2-10 Steam Coal Price Index of Indonesia (Standard Specification)

For example, in the case of September, 2012, the index prices of 69 brands of coal in the range between 2,995 kcal/kg (21.30 US$/ton) and 7,000 kcal/kg (92.58 US$/ton) are shown based on the standard specification of calorific value 6,322kcal/kg (gross as received), total moisture 8% (as received), total sulfur 0.8%, and ash 15%.

(2) Coal Price Outlook

The coal price is determined by the supply and demand situation at that time and it is difficult to

4 From the report on the "study on the degree of sophistication of overseas coal development in 2010 (Survey on the coal affairs in Indonesia)" compiled by New Energy and Industrial Technology Development Organization (NEDO)

predict future prices. Table 2-2 shows the import prices of steam coal shown in the "Asia and World Energy Outlook 2012" of the IEEJ.

Table 2-2 Energy Price Outlook (CIF Japan)

		2000	2011	2020	2030	2035
Crude oil	Real price	35	109	115	122	125
$/bbl	Nominal price	28	109	137	177	201
LNG	Real price	303	762	753	739	729
$/t	Nominal price	244	762	899	1,076	1,173
Steam coal	Real price	44	138	136	139	143
$/t	Nominal price	35	138	163	203	230

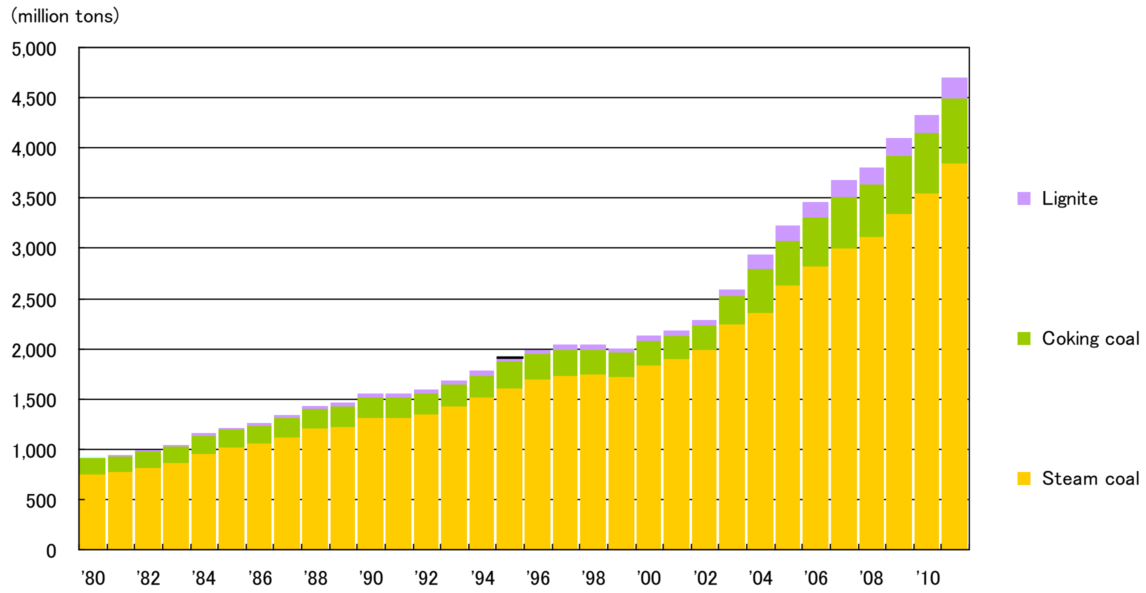
Note: Japanese CIF prices. Real prices are 2011's. Calculated, using an annual inflation rate of 2%.
Source: IEEJ, "Asia/World Energy Outlook 2012"

2.2 Trends and forecasts for supply and demand of coal in South East Asia and South Asian countries

2.2.1 Current situation of supply and demand of steam coal

(1) Supply and demand of steam coal in Asia

The quantity of coal consumed in Asia totaled 4,690 million tons in 2011. As shown in Fig. 2-11, steam coal accounts for the majority of consumption exceeding 80%.



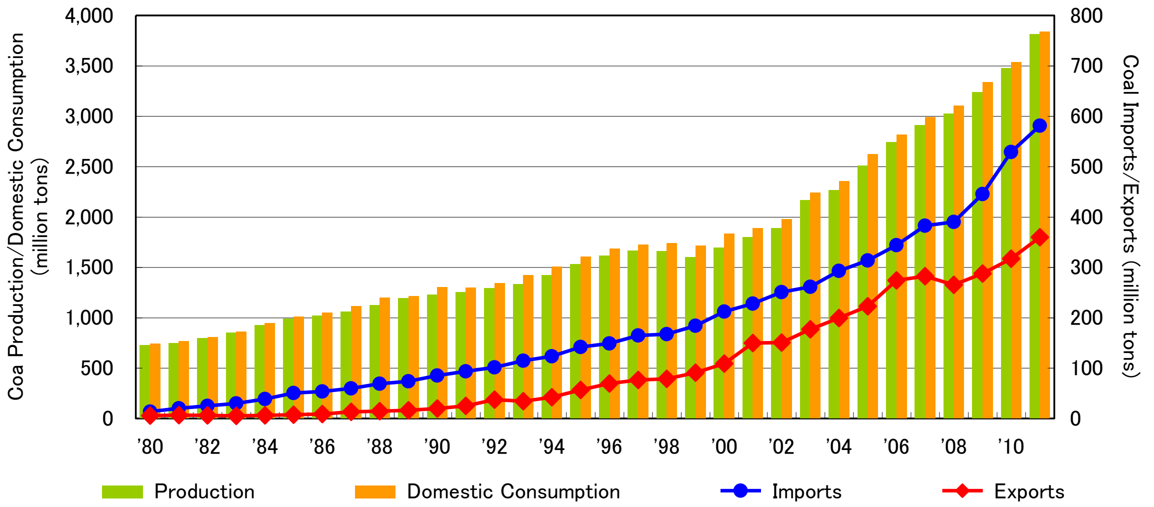
(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Steam coal	740 (81%)	1,008 (83%)	1,304 (84%)	1,604 (84%)	1,831 (86%)	2,621 (81%)	2,816 (81%)	2,990 (82%)	3,105 (82%)	3,336 (82%)	3,537 (82%)	3,837 (82%)
Coking coal	162 (18%)	180 (15%)	207 (13%)	262 (14%)	238 (11%)	452 (14%)	486 (14%)	511 (14%)	526 (14%)	576 (14%)	603 (14%)	647 (14%)
Lignite	11 (1%)	19 (2%)	34 (2%)	46 (2%)	49 (2%)	150 (5%)	156 (5%)	165 (4%)	168 (4%)	179 (4%)	187 (4%)	206 (4%)
Total	913	1,207	1,545	1,912	2,118	3,222	3,458	3,666	3,800	4,091	4,327	4,690

Source: IEA, "Coal Information 2012"

Fig. 2-11 Coal Consumption by Coal Type in Asia

Fig. 2-12 shows the supply and demand balance of steam coal in Asia. Steam coal consumption in the region since 1980 has always been in excess of production and it has been indispensable to import from outside the region. The consumption of steam coal for power generation (including in-house power generation, heat supply) in 1980 only accounted for 25 % of the total consumption of steam coal and it was mainly used for industrial purposes and consumer use. In the 2000s, however, the consumption of steam coal for power generation started to account for over 60% of the total and since 2006 it has accounted for around 70 %.



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	725	991	1,228	1,533	1,697	2,506	2,741	2,910	3,028	3,239	3,475	3,812
Imports	14	51	85	142	212	314	344	383	390	446	529	581
Exports	-6	-7	-20	-57	-109	-223	-274	-283	-265	-288	-317	-360
Stock Changes	7	-26	11	-15	32	24	5	-21	-47	-60	-149	-196
Domestic Consumption	740	1,008	1,304	1,604	1,831	2,621	2,816	2,990	3,105	3,336	3,537	3,837
for Power Generation	*186*	*297*	*484*	*786*	*1,066*	*1,738*	*1,932*	*2,110*	*2,176*	*2,284*	*2,416*	–
	25%	*29%*	*37%*	*49%*	*58%*	*66%*	*69%*	*71%*	*70%*	*68%*	*68%*	–

Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export
+ the change in stock
Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including number of items, in-house power generation, and heat supply) and the percentage relative to the domestic consumption of steam coal.
Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. 2-12 Balance of Supply and Demand of Steam Coal in Asia

(2) Situation of user countries (importing countries) of steam coal

Table 2-3 summarizes the volume of consumption and that of import of steam coal of China, Japan, Korean and Taiwan, user countries in the East Asia, and India, Thailand, Malaysia, Vietnam, the Philippines, and Bangladesh in the South Asia and South East Asia. A graph (data) showing a balance of supply and demand of steam coal of the ten countries surveyed is attached at the end of this report for reference.

Chinese steam coal consumption reached 2,772 million tons in 2011 and thus China is the world's biggest consumer of steam coal. In recent years, China has consumed roughly less than 70% of its steam coal for power generation. Although China had exported from 2001 to 2005 more than 70 million tons of steam coal, steam coal imports started to exceed exports in 2009 and it imported 146 million tons in 2011. The ratio of the imports accounted for only 5% of total consumption in 2011. The volume of Chinese steam coal imports is one-fourth the total Asian imports of 581 million tons.

Japan follows China and India in the consumption of steam coal and steam coal for use in power generation accounts for more than 70% of the total consumption in recent years. Japan imports nearly all its steam coal and it imported 122 million tons in 2011 after China.

The consumption of steam coal in Korea is about to reach 100 million tons of which 90% is used for power generation. Although anthracite produced in Korea is consumed for power generation, etc, the supply of steam coal depends on import.

Taiwan ranks fifth of the countries surveyed in steam coal consumption and more than 80% of this consumption is used for power generation. Taiwan produced steam coal domestically until 2000, but it has relied on imports for steam coal supply since then.

Steam coal consumption in India was 591 million tons. Thus, India is the third biggest coal consuming nation after China and the US in the world and second biggest country in Asia. More than 70% of steam coal consumption is for power generation. Import volumes of steam coal reached 86 million tons in 2011 and accounted for about 15% of total steam coal consumption.

The consumption of steam coal in Bangladesh was less than 2 million tons in 2011. Domestic steam coal production has been recorded since 2005 and steam coal consumption for use in power generation has been recorded since the same year. Steam coal import has continued, but the volume of imports has remained at 0.7 to 0.8 million tons since 2000.

There is a production of about 20 million tons of lignite in Thailand which is mainly consumed for power generation. There is no domestic production of steam coal and consumption of steam coal depends on imports. Steam coal import volumes have exceeded 15 million tons since 2008.

Steam Coal consumption in Malaysia exceeded 20 million tons in 2010, slightly less than 90% of which was used for power generation. It was entirely dependent on import for steam coal until 1987. Malaysia has produced and exported steam coal since 1988, although the volume is small. Currently, Malaysia is dependent on imports for 90 % of its consumption.

Although Vietnam is an exporter of anthracite, it widely uses anthracite domestically for fuel for power generation in the same way as steam coal. The consumption of steam coal (including anthracite) started to exceed 20 million tons in 2008 and about 30% of it was used for power generation. Vietnam gradually increased its steam coal imports from 2005, but the volume was as small as 1 million tons in 2011.

Steam coal is produced in the Philippines but consumption is greater than production. Although it has exported since 2007, the country is dependent on imports for 80% of its consumption. Except 2009 when the country was hit by the global recession, steam coal consumption steadily expanded reaching 15 million tons in 2011. Since 2000, 70 to 80% of its steam coal has been used for power generation.

Table 2-3 Volumes of Consumption and Import of Steam Coal in the Countries Surveyed

(million tons)

			'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
East Asia	China	Domestic Consumption	559.2	741.0	970.6	1,176.2	1,258.7	1,854.1	2,000.6	2,114.1	2,183.5	2,378.9	2,520.1	2,771.7
		for Power Generation	*126.5*	*179.0*	*301.9*	*500.5*	*644.9*	*1,167.1*	*1,332.4*	*1,459.0*	*1,503.5*	*1,593.1*	*1,697.8*	–
			23%	*24%*	*31%*	*43%*	*51%*	*63%*	*67%*	*69%*	*69%*	*67%*	*67%*	–
		Imports	2.0	2.1	1.8	1.6	1.8	19.0	33.5	44.8	33.5	91.4	122.9	146.4
			0%	*0%*	*0%*	*0%*	*0%*	*1%*	*2%*	*2%*	*2%*	*4%*	*5%*	*5%*
	Japan	Domestic Consumption	17.5	35.9	50.0	73.8	96.1	120.4	121.4	128.8	126.7	111.4	127.7	121.5
		for Power Generation	*9.6*	*23.8*	*31.1*	*47.6*	*64.9*	*92.3*	*89.5*	*94.3*	*90.2*	*86.4*	*90.0*	–
			55%	*66%*	*62%*	*64%*	*68%*	*77%*	*74%*	*73%*	*71%*	*78%*	*71%*	–
		Imports	6.3	24.2	42.0	67.6	93.3	120.4	121.4	128.8	126.7	111.4	127.7	121.5
			36%	*67%*	*84%*	*92%*	*97%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
	Korea	Domestic Consumption	23.8	35.5	33.0	28.3	52.4	61.4	64.0	70.3	78.9	85.7	92.8	98.1
		for Power Generation	*1.9*	*6.9*	*7.7*	*16.7*	*39.0*	*52.7*	*55.1*	*60.9*	*68.7*	*77.7*	*83.2*	–
			8%	*19%*	*23%*	*59%*	*74%*	*86%*	*86%*	*87%*	*87%*	*91%*	*90%*	–
		Imports	1.0	9.0	12.4	28.7	45.3	56.1	59.6	65.8	75.5	82.3	90.4	96.9
			4%	*25%*	*38%*	*101%*	*87%*	*91%*	*93%*	*94%*	*96%*	*96%*	*97%*	*99%*
	Taiwan	Domestic Consumption	4.4	8.5	13.1	22.0	41.5	54.8	57.4	60.5	58.0	55.8	57.8	62.5
		for Power Generation	*2.4*	*5.2*	*8.6*	*16.4*	*33.3*	*46.0*	*47.9*	*49.5*	*47.9*	*46.9*	*46.2*	–
			55%	*61%*	*66%*	*75%*	*80%*	*84%*	*83%*	*82%*	*83%*	*84%*	*80%*	–
		Imports	3.1	7.3	14.3	24.4	40.3	55.3	57.4	60.7	59.1	54.5	57.6	62.5
			70%	*86%*	*109%*	*111%*	*97%*	*101%*	*100%*	*100%*	*102%*	*98%*	*100%*	*100%*
South and Southeast Asia	India	Domestic Consumption	87.3	120.2	166.2	233.2	296.3	394.2	421.3	456.8	495.5	530.7	553.6	591.1
		for Power Generation	*38.2*	*66.3*	*109.9*	*178.3*	*244.3*	*316.4*	*339.5*	*367.8*	*385.3*	*397.1*	*406.0*	–
			44%	*55%*	*66%*	*76%*	*82%*	*80%*	*81%*	*81%*	*78%*	*75%*	*73%*	–
		Imports	0.0	0.0	0.2	3.1	9.9	21.7	25.2	27.8	37.9	48.6	65.1	86.4
			0%	*0%*	*0%*	*1%*	*3%*	*6%*	*6%*	*6%*	*8%*	*9%*	*12%*	*15%*
	Bangladesh	Domestic Consumption	0.24	0.10	0.56	0.64	0.66	0.74	0.95	0.90	1.26	1.26	1.26	1.85
		for Power Generation	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.04*	*0.24*	*0.19*	*0.44*	*0.44*	*0.44*	–
			0%	*0%*	*0%*	*0%*	*0%*	*5%*	*25%*	*21%*	*35%*	*35%*	*35%*	–
		Imports	0.24	0.10	0.56	0.64	0.66	0.70	0.70	0.70	0.80	0.80	0.80	0.85
			100%	*100%*	*100%*	*100%*	*100%*	*94%*	*74%*	*78%*	*64%*	*64%*	*64%*	*46%*
	Thailand	Domestic Consumption	0.09	0.21	0.25	2.31	3.68	8.48	11.10	13.84	15.89	15.48	17.38	16.43
		for Power Generation	*0.00*	*0.00*	*0.00*	*0.00*	*0.47*	*0.88*	*1.34*	*5.21*	*5.01*	*4.37*	*4.43*	–
			0%	*0%*	*0%*	*0%*	*13%*	*10%*	*12%*	*38%*	*32%*	*28%*	*26%*	–
		Imports	0.10	0.21	0.25	2.30	3.68	8.48	11.10	13.84	15.96	16.74	16.80	16.43
			101%	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*108%*	*97%*	*100%*
	Malaysia	Domestic Consumption	0.08	0.57	2.15	2.56	3.66	10.93	11.18	14.21	15.06	16.73	23.16	24.02
		for Power Generation	*0.00*	*0.00*	*1.29*	*1.52*	*2.37*	*8.79*	*9.11*	*11.88*	*12.80*	*14.56*	*20.54*	–
			0%	*0%*	*60%*	*59%*	*65%*	*80%*	*82%*	*84%*	*85%*	*87%*	*89%*	–
		Imports	0.08	0.57	2.26	2.52	3.08	10.49	10.82	13.36	15.43	14.48	20.74	21.49
			100%	*100%*	*105%*	*98%*	*84%*	*96%*	*97%*	*94%*	*102%*	*87%*	*90%*	*89%*
	Vietnam	Domestic Consumption	4.05	4.99	3.95	5.92	7.81	14.49	15.42	16.54	20.51	22.40	26.15	21.57
		for Power Generation	*1.36*	*1.78*	*1.59*	*1.27*	*2.05*	*5.34*	*6.19*	*6.41*	*6.46*	*6.57*	*8.64*	–
			33%	*36%*	*40%*	*21%*	*26%*	*37%*	*40%*	*39%*	*31%*	*29%*	*33%*	–
		Imports	0.01	0.00	0.00	0.00	0.00	0.51	0.64	0.67	0.68	0.72	0.88	1.47
			0%	*0%*	*0%*	*0%*	*0%*	*3%*	*4%*	*4%*	*3%*	*3%*	*3%*	*7%*
	Philippines	Domestic Consumption	0.56	2.42	2.57	3.00	8.60	9.91	10.07	10.32	11.79	10.06	13.32	14.79
		for Power Generation	*0.10*	*1.73*	*1.06*	*1.42*	*7.17*	*7.83*	*7.04*	*7.53*	*8.64*	*8.42*	*9.64*	–
			18%	*72%*	*41%*	*47%*	*83%*	*79%*	*70%*	*73%*	*73%*	*84%*	*72%*	–
		Imports	0.25	1.25	1.34	1.71	7.25	7.03	7.72	7.73	9.08	7.37	10.97	11.17
			46%	*52%*	*52%*	*57%*	*84%*	*71%*	*77%*	*75%*	*77%*	*73%*	*82%*	*76%*

Note: Steam coal includes anthracite. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including number of items, in-house power generation, and heat supply) and the percentage relative to the domestic consumption of steam coal. The import volume written in oblique characters shows the ratio of the import volume relative to domestic consumption volume.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Table 2-4 shows the volume of exports by destination of exporting countries which supply the above ten countries in 2011 with steam coal. Indonesia is the biggest steam coal exporter to China and accounted for 48% of total Chinese imports in 2011. Korea, Taiwan and India import also from Indonesia in the same manner as China. Ninety-six percent of the nearly 300 million tons in steam coal exports from Indonesia are for Asia. As the column of "others" of the exports from Indonesia exceeds 55 million tons, it is estimated that other countries without adequate data also import big quantities from Indonesia.

Australia is the second largest steam coal exporter to Asia after Indonesia and 97% of its steam coal is exported to Asia which totaled 140 million tons in 2011. Indonesian and Australian coal exports account for three-fourths of the steam coal imported by Asia. Australia exports the biggest quantity of steam coal to Japan. Its exports to China, Korea and Taiwan exceed 15 million tons, respectively, but its exports to India are smaller. India imports more coal from South Africa which is a shorter distance than Australia.

Russia exports more than 10 million tons of steam coal to Japan and Korea and ranks as the fourth largest exporter to Asia.

Table 2-4 Volumes of Export of Steam Coal in the Main Exporting Countries Surveyed in 2011

(million tons)

Export by destination	Export Countries							
	Indonesia	Australia	South Africa	China	Russia	Colombia	USA	Canada
China	70.98	17.32	12.24	—	6.23	1.44	0.88	1.31
	24%	*12%*	*29%*	—	*18%*	*55%*	*13%*	*23%*
Japan	29.41	66.96	0.85	4.21	12.12	0.23	0.61	2.04
	10%	*48%*	*2%*	*40%*	*36%*	*9%*	*9%*	*37%*
Korea	39.48	28.27	4.04	4.46	10.72	0.28	4.88	2.23
	13%	*20%*	*10%*	*42%*	*32%*	*11%*	*70%*	*40%*
Taiwan	26.63	20.12	3.86	1.87	3.61	0.66	0.00	0.00
	9%	*14%*	*9%*	*18%*	*11%*	*25%*	*0%*	*0%*
India	73.60	0.50	17.14	—	1.14	0.01	0.63	0.00
	25%	*0%*	*41%*	—	*3%*	*0%*	*9%*	*0%*
Bangladesh	Unknown	Unknown	Unknown	Unknown	Unknown	—	—	—
Thailand	Unknown	2.92	Unknown	Unknown	Unknown	—	0.00	0.00
		2%					*0%*	*0%*
Malaysia	Unknown	3.15	Unknown	Unknown	Unknown	—	0.00	0.00
		2%					*0%*	*0%*
Vietnam	Unknown	Unknown	Unknown	Unknown	Unknown	—	—	—
Philippines	Unknown	0.28	Unknown	Unknown	Unknown	—	0.00	0.00
		0%					*0%*	*0%*
Others	55.39	0.56	3.92	0.02	0.05	—	0.00	0.00
	19%	*0%*	*9%*	*0%*	*0%*	—	*0%*	*0%*
Asia Total	295.50	140.07	42.03	10.55	33.87	2.62	7.00	5.58
	96%	*97%*	*59%*	*100%*	*31%*	*3%*	*21%*	*94%*
Total exports	308.91	144.06	71.70	10.58	109.36	75.41	34.06	5.93

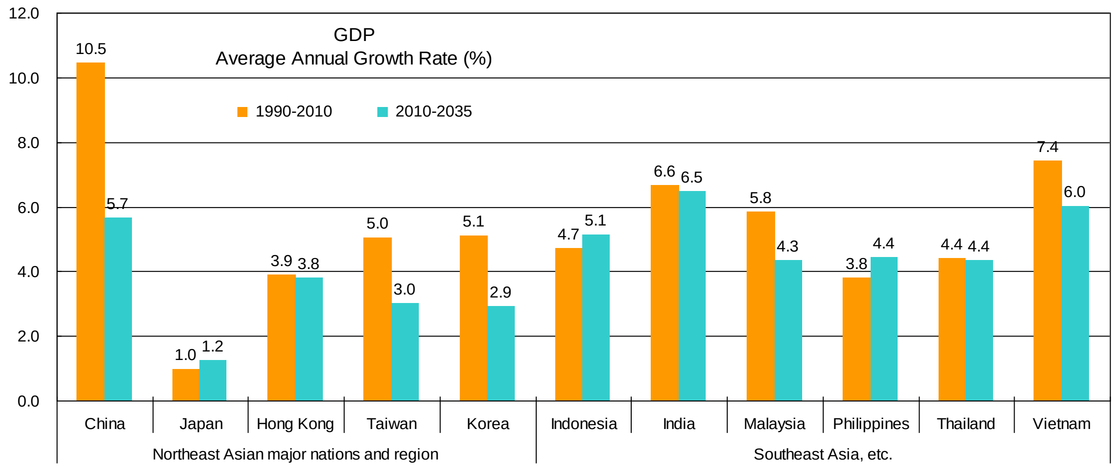
Note: Steam coal includes anthracite. The percentage in oblique characters shows the percentage of the volume of export to the countries surveyed relative to the export volume of steam coal to Asia (total of Asia). The percentage in oblique characters in the total column of Asia represents the percentage of the export volume of steam coal to Asia (total of

Asia) relative to the total volume of export of each exporting country. When the volume of export is unknown, this figure is added to the column of "others".

Source: IEA, "Coal Information 2012"

2.2.2 Coal demand forecast

This study has completed a demand forecast of steam coal until 2035 based on the "Asia / World Energy Outlook" published every year by the Institute of Energy Economics, Japan. When forecasting, the economic growth rate used in the "Asia and World Energy Outlook 2012" was used[5]. In addition, the amount of power generation and its composition which are important elements for a steam coal demand forecast, the predictions by the "Asia and World Energy Outlook 2012" were basically used and some corrections were made based on coal demand forecasts of the countries which were under study. In order to look at the situation of cement and chemistry which are the fields with a large steam coal demand, the forecast was made by segment such as cement, chemistry and others in industry sector. It should be noted that the year 2010 is taken as the base year for the forecast because of the availability of actual data. With regard to 2011 and 2012, corrections were made to match the actual situation. The following shows the forecast results.



Source: JICA Study Team

Fig. 2-13 Economic Growth Rate

(1) Steam coal demand forecast in Asia

Steam coal demand in Asia will increase from 2010 to 2035 at an annual growth rate of 2.4 %, and will increase by 1.8 times from 3,730 million tons in 2010 to 6,652 million tons by 2035. Table 2-5 and Fig. 2-14 show a steam coal demand forecast in Asia. Steam coal demand in China will not show such a rapid growth as it did during the 2000s, but as demand for electricity is expect to increase with economic growth in the future, the demand for power generation should increase. The demand in India for steam coal will increase at an annual growth rate of 3.7% to 2035 due to a rapid increase in

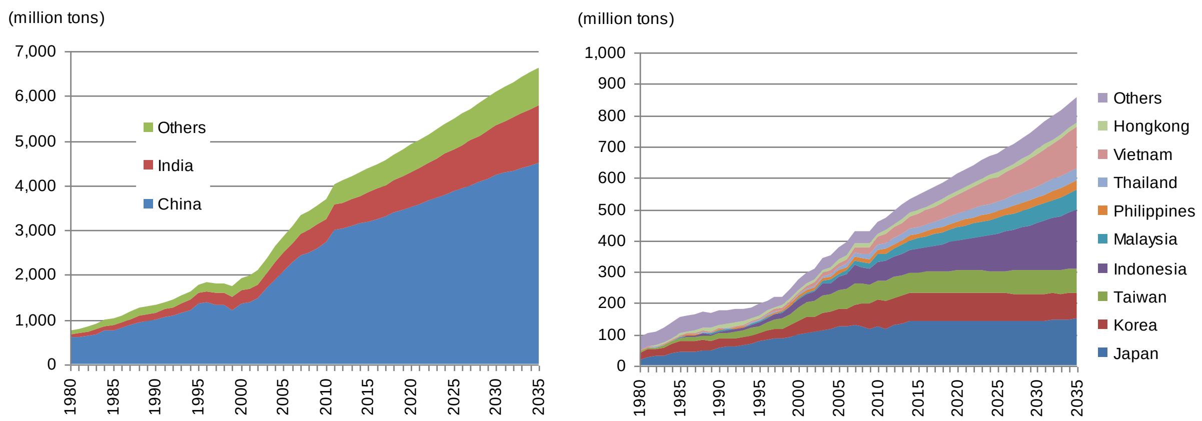
5 The forecast is based on the prediction of international research institutions such as Asia Development Bank, economic development plans published by the respective governments (regions) and potential growth rates of the respective countries (regions)

demand for power generation and India is expected to consume up to 1,297 million tons in 2035, which is a 2.5-fold increase relative to 2010. In ASEAN countries, in order to meet the increasing demand for power generation, it is expected that they will use cheap coal power and that coal demand will increase. Specially, in Indonesia, which is building a coal power generation station using low grade coal produced domestically, steam coal demand will close to 100 million tons in 2020 and increase to 190 million tons in 2035. Steam coal dmand in Vietnam will increase to 132 million tons in 2035 by the increment of coal power. The consumption of steam coal in other countries will increase by 2 to 3 times relative to that in 2010. On the contrary, Japan, Korean and Taiwan which have widely used steam coal for power generation will still experience increases in demand, but their growth is expected to slow down.

Table 2-5 Steam Coal Demand Forecast in Asia

	2010	2015	2020	2025	2030	2035	20/10	30/20	25/10	35/10
					(million tons)					(%)
China	2,720.8	3,199.2	3,523.4	3,869.8	4,230.7	4,497.6	2.6	1.8	2.4	2.0
India	527.5	642.8	782.0	941.9	1,105.7	1,296.6	4.0	3.5	3.9	3.7
Japan	123.5	142.9	142.7	142.3	142.0	148.9	1.5	-0.0	0.9	0.8
Korea	84.9	89.0	89.3	87.4	86.1	84.4	0.5	-0.4	0.2	-0.0
Taiwan	63.0	65.4	70.8	72.3	74.9	76.0	1.2	0.6	0.9	0.8
Indonesia	59.9	75.2	95.5	120.1	150.8	189.7	4.8	4.7	4.7	4.7
Malaysia	23.4	33.1	42.2	49.5	56.4	62.9	6.1	2.9	5.1	4.0
Philippines	13.3	15.5	18.5	21.8	25.6	29.7	3.3	3.3	3.3	3.3
Thailand	17.1	21.2	25.8	31.2	35.6	40.4	4.2	3.3	4.1	3.5
Vietnam	26.1	41.8	60.2	77.7	104.1	131.7	8.7	5.6	7.5	6.7
Hongkong	10.3	12.5	13.2	13.7	13.9	13.6	2.5	0.5	1.9	1.1
Others	37.2	46.4	54.6	62.6	71.4	80.2	3.9	2.7	3.5	3.1
Total	3,707.3	4,385.1	4,918.2	5,490.3	6,097.1	6,651.7	2.9	2.2	2.7	2.4

Source: The actual data is from the IEA data and the forecast was made by the JICA Study Team



Source: The actual data is from the IEA data and the forecast was made by the JICA Study Team

Fig. 2-14 Steam Coal Demand Forecast in Asia

(2) Steam coal import forecast in Asia

Steam coal import volumes in Asia will increase from 2010 to 2035 at an annual growth rate of 3.2%, and will increase by 2.2 times from 524 million tons in 2010 to 1,142 million tons by 2035 (Table 2-6, Fig. 2-15). Steam coal import volumes in China which have shown rapid increases for the past few years, will slow, but exports are expected to increase with rising steam coal demand. Import volumes, however, will be affected by the difference between the price of domestic steam coal and the market price in Asia. The country which is expected to increase its import volume on a large scale is India. Because the domestic coal has an ash rate as high as 40 %, and the supply capacity has not caught up with the increase in demand, India is expected to greatly increase its import volumes. It is thought that the import volume of India will surpass that of China in the 2020s, accordingly. In ASEAN countries, Malaysia, the Philippines, Thailand and Vietnam,[6] which are poor in coal resources, will increase steam coal imports to meet increasing demand for power generation with overseas imports.

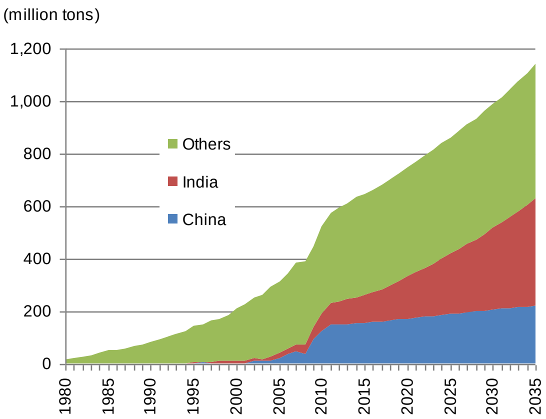
As above, the neighboring country of Myanmar is expected to increase import volume and it is thought to procure coal mainly from Indonesia, because the transportation distance is shorter.

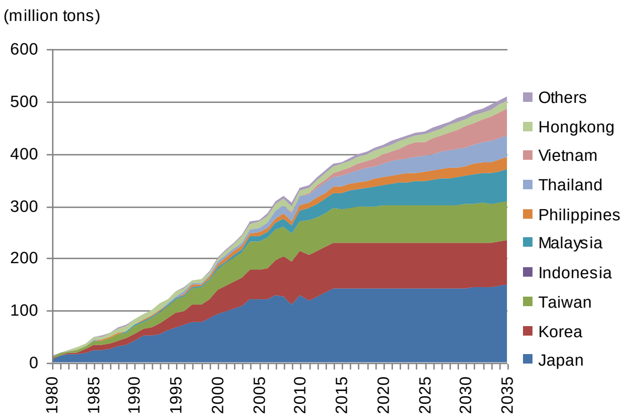
Table 2-6 Steam Coal Import Forecast in Asia

(million tons) (%)

	2010	2015	2020	2025	2030	2035	20/10	30/20	25/10	35/10
China	122.9	155.7	171.5	188.3	205.9	218.9	3.4	1.8	2.9	2.3
India	65.1	106.9	159.4	232.5	309.5	413.7	9.4	6.9	8.9	7.7
Japan	127.7	141.7	142.2	142.1	142.0	148.9	1.1	-0.0	0.7	0.6
Korea	85.4	87.3	88.2	86.7	85.9	84.4	0.3	-0.3	0.1	-0.0
Taiwan	57.6	65.4	70.8	72.3	74.9	76.0	2.1	0.6	1.5	1.1
Indonesia	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-
Malaysia	20.7	30.8	39.9	47.2	54.1	60.6	6.8	3.1	5.6	4.4
Philippines	11.0	12.4	14.4	17.0	20.0	23.7	2.8	3.3	3.0	3.1
Thailand	16.8	21.2	25.8	31.2	35.6	40.4	4.4	3.3	4.2	3.6
Vietnam	0.9	8.7	17.9	26.6	39.9	53.7	35.1	8.3	25.5	17.8
Hongkong	10.3	12.5	13.2	13.7	13.9	13.6	2.5	0.5	1.9	1.1
Others	5.4	4.7	5.5	6.4	7.3	8.1	0.3	2.7	1.2	1.7
Total	523.9	647.4	748.8	864.1	988.9	1,141.9	3.6	2.8	3.4	3.2

Source: The actual data is from the IEA data and the forecast was made by the JICA Study Team





Source: The actual data is from the IEA data and the forecast was made by the JICA Study Team

Fig. 2-15 Steam Coal Import Forecast in Asia

2.2.3 Consideration on future coal supply

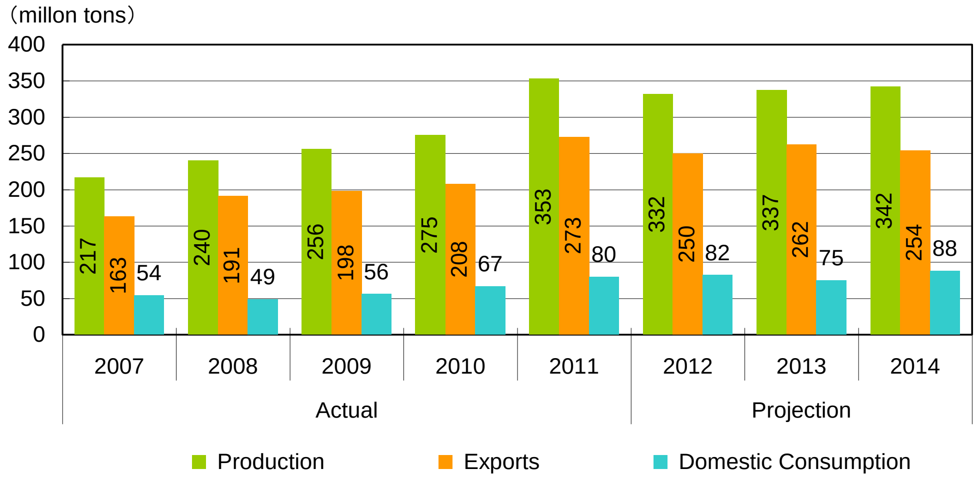
Now, we will study the prospects of the export capacity of Indonesia, Australia and South Africa

6 In the northern Vietnam, there exists anthracite which is exported. With the increase in demand for power generation in the future, domestic supply will not be sufficient and in the southern Vietnam coal is planned to be imported.

which are most likely to export steam coal to Myanmar.

(1) Indonesia

According to the statement[7] of Mr. Wibowo of the Ministry of Energy and Mineral Resources, Directorate of Mineral and Coal of Indonesia in the Clean Coal Day 2012 - International Conference on Coal Utilization" held on September 4 and 5, 2012, both the coal production and export volumes will not continue in the medium term at such an expansion as that experienced so far and will remain stable as shown in Fig. 2-16. In addition, according to the statement[8] of Mr. Kamandanu of the Indonesian Coal Mining Association delivered at the IEA's workshop "Coal Market's Outlook" held on April 14, 2011 in China, a continuous expansion of coal production in the long term is expected as shown in Fig. 2-17. As the domestic demand for coal is expected to increase, however, the export volume will remain at the level of 240 to 260 million tons and such an export expansion as that experienced so far will not continue.



(million tons)

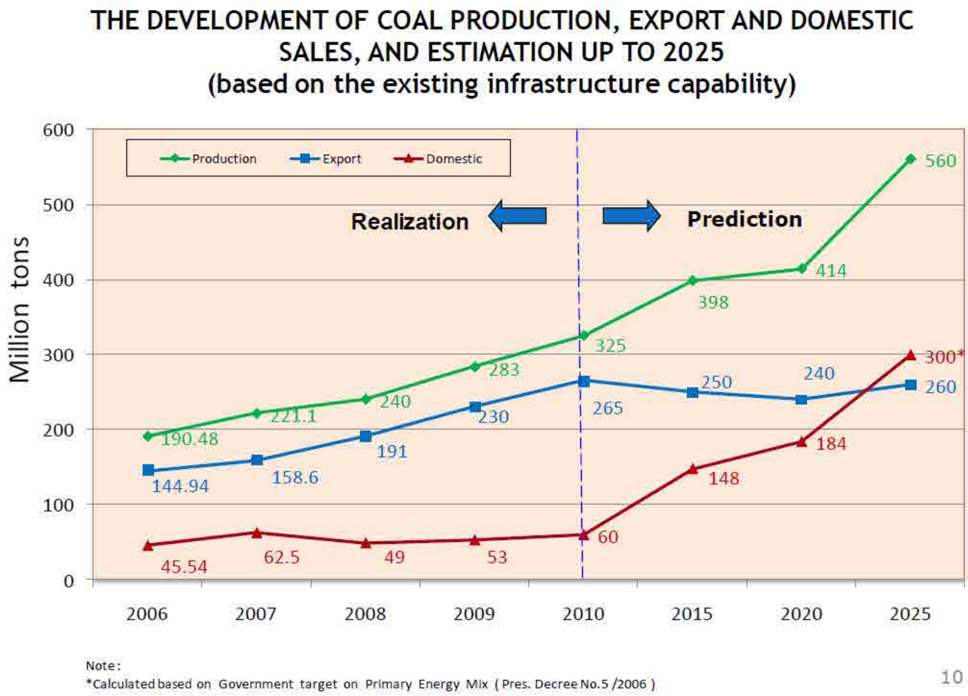
	Actual					Projection		
	2007	2008	2009	2010	2011	2012	2013	2014
Production	217	240	256	275	353	332	337	342
Exports	163	191	198	208	273	250	262	254
Domestic Consumption	54	49	56	67	80	82	75	88

Source: Prepared by JICA Study Team based on the data of the International conference on Coal Utilization 2012 - Clean Coal Day 2012, celebrated on September 4, 2012

Fig. 2-16 Mid-term Coal Demand Forecast in Indonesia

7 "Coal Policy and The New Mining Law No. 4/2009 in Indonesia"

8 "Indonesian Coal Mining Outlook"



Source: Seminar data of the IEA workshop on the “Coal Market’s Outlook” held on April 14, 2011

Fig. 2-17 Long-term Coal Demand Forecast in Indonesia

Table 2-7 shows the summary[9] of the plans to increase production of the existing mines and the plans to develop new mines published from last year to this year in an information magazine[10]. The addable supply capacity from 2012 to 2014 is 121 million tons (107 million tons of steam coal and 14 million tons of coking coal) and that to 2015 is 134 million tons (107 million tons of steam coal and 28 million tons of coking coal)

Table 2-7 Plans to Increase Coal Production of Indonesia

(million tons)

		2012	2013	2014	2015	2016	2017-
Total		33.8	45.0	42.0	13.5	3.0	6.0
	Steam Coal	29.3	35.5	42.0	0.0	0.0	6.0
	Coking Coal	4.5	9.5	0.0	13.5	3.0	0.0
Cumulative Total		33.8	78.8	120.8	134.3	137.3	143.3
	Steam Coal	29.3	64.8	106.8	106.8	106.8	112.8
	Coking Coal	4.5	14.0	14.0	27.5	30.5	30.5

Note: This data does not cover all the plans to increase production of the existing mines and plans to develop new mines in Indonesia.
Source: JICA Study Team

As shown in Fig. 2-16 for the medium term forecast, an increase in coal consumption is not expected during 2011 to 2014 and thus the additional supply capacity of 121 million tons is excess export capacity. In other words, there will be about 100 million tons of excess export capacity in 2014.

9 TEX Report (released by The TEX Report Ltd., http://www.texreport.co.jp/xenglish/index.html)
10 This data does not cover all the plans to increase production of the existing mines and plans to develop new mines in Indonesia.

On the other hand, according to the long-term coal demand forecast (Fig. 2-17), consumption volume is expected to increase by 90 million tons during 2010 to 2015. As a result, there will be about 40 million tons of excess export capacity of coal in 2015. As the domestic demand for coking coal is very small in Indonesia and the additional coking coal supply capacity is expected to be for export purposes, it is possible to conclude that about 15 million tons of excess export capacity for steam coal will be available.

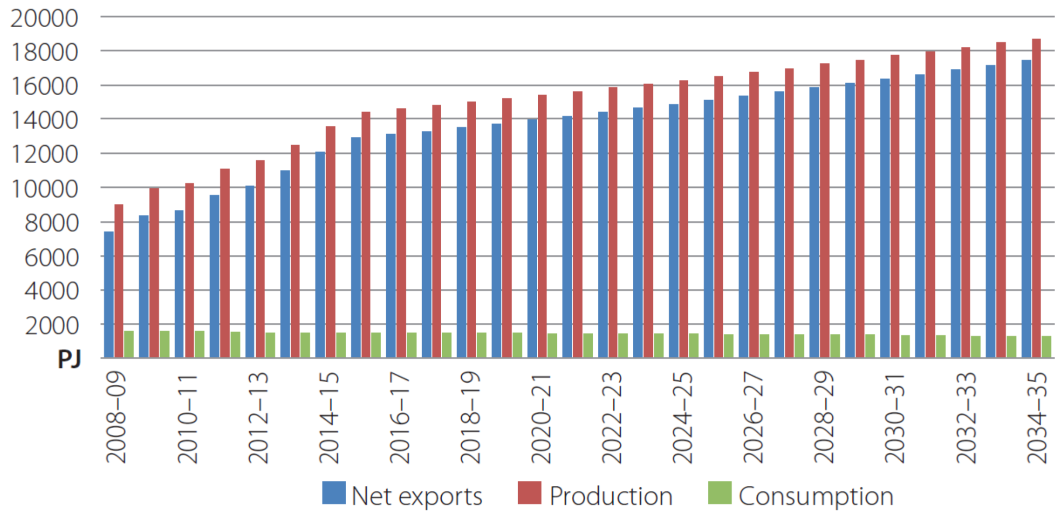
(2) Australia

According to the "Australian energy projections to 2034–35" published in December, 2011 by the Bureau of Resources and Energy Economics (BREE) which is a research institute under the Australian government, as shown in Table 2-8 and Fig. 2-18, the production volume of black coal (bituminous coal combining steam coal and coking coal, etc) is expected to increase from 300 million tons in 2008/2009 (9,004 petajoules) to 623 million tons in 2034/2035 (18,676 petajoules) at an annual growth rate of 2.8%. As the domestic demand for coal is predicted to decrease in the future, export volume will increase with the increase in production volume. The coal export volume is predicted to increase from 247 million tons (7,411 petajoules) of 2008/2009 to 581 million tons (17,415 petajoules) in 2034/2035 at an annual growth rate of 3.3%.

Table 2-8 Coal Demand Forecast of Australia

		2008/09		2019/20		2034/35	
		(million tons)	(PJ)	(million tons)	(PJ)	(million tons)	(PJ)
Production	Black Coal	300	(9,004)	506	(15,185)	623	(18,676)
	Brown Coal	66	(647)	66	(647)	29	(281)
		366	(9,651)	572	(15,832)	651	(18,957)
Domesiti Consamption	Black Coal	53	(1,593)	49	(1,460)	42	(1,260)
	Brown Coal	66	(647)	66	(647)	29	(281)
		119	(2,240)	115	(2,107)	71	(1,541)
Exports	Black Coal	247	(7,411)	458	(13,725)	581	(17,415)
	Brown Coal	0	(0)	0	(0)	0	(0)
		247	(7,411)	458	(13,725)	581	(17,415)

Source: Prepared by JICA Study Team based on "Australian energy projections to 2034–35, December 2011" released by BREE



Source: BREE, "Australian energy projections to 2034–35, December 2011"

Fig. 2-18 Black Coal Demand Forecast of Australia

In the "Resources and Energy Major Projects, October 2012" published by the BREE on its web site in November of 2012, a total of 100 (23 projects are under construction[11]) consisting of 45 expansion projects of the existing mines (18 are under construction) and 55 new development projects (5 are under construction) are featured altogether. When the additional coal supply capacity which will become available from 2012 according to the plans to increase coal production as shown in the list is added up, it will be possible for Australia to have a new coal supply capacity of 640 million tons consisting of 450 million tons of steam coal and 190 million tons of coking coal in 2017 (Table 2-9). BREE states that the actual coal production of 2011 (coal products except lignite) was 348 million tons. If this volume is simply added up to the coal supply capacity, it will be 990 million tons in 2017. BREE predicts the coal production volume except lignite for 2019/2020 at 506 million tons. Thus, if the projects to increase coal production as shown in the "Resources and Energy Major Projects, October 2012" are smoothly implemented, there will be enough supply capacity to meet the predicted target, even if some existing mines were closed due to coal depletion.

11 Projects under construction include the approved projects and completed projects.

Table 2-9 Plans to Increase Coal Production in Australia

(million tons)

		2012	2013	2014	2015	2016	2017+
NSW		12.0	15.6	34.5	21.5	8.1	30.9
	Steam Coal	9.0	8.0	26.1	16.0	1.6	26.0
	Coking Coal	3.0	7.6	8.4	5.5	6.5	4.9
QLD		7.5	33.7	108.0	158.1	38.9	165.6
	Steam Coal	1.7	5.0	78.8	144.3	7.0	122.2
	Coking Coal	5.8	28.7	29.3	13.8	31.9	43.4
West Australia		0.0	0.0	2.5	0.0	0.0	0.0
	Steam Coal	0.0	0.0	2.5	0.0	0.0	0.0
	Coking Coal	-	-	-	-	-	-
Total		19.5	49.3	145.0	179.6	47.0	196.5
	Steam Coal	10.7	13.0	107.4	160.3	8.6	148.2
	Coking Coal	8.8	36.3	37.7	19.3	38.4	48.3
Cumulative Total		19.5	68.8	213.8	393.4	440.4	636.9
	Steam Coal	10.7	23.7	131.1	291.4	300.0	448.2
	Coking Coal	8.8	45.1	82.8	102.1	140.5	188.7

Source: Prepared by JICA Study Team based on the "Resources and Energy Major Projects, October 2012 " released by BREE

According to BREE, the coal exported in 2011 by Australia was 281 million tons, of which 133 million tons, equivalent to 47%, was steam coal and 148 million tons, equivalent to 53% was coking coal[12]. If this ratio is applied to the export volume of black coal shown in Table 2-8 as shown in Table 2-10, the export volume of steam coal will increase to 241 million tons in 2019/2020 and 305 million tons in 2034/2035.

Table 2-10 Coal Export Forecast by Coal Type of Australia

(million tons)

		2011 Actual	2019/20	2034/35
Exports	Steam Coal	148	241	305
	Coking Coal	133	217	275
		281	458	581

Note: Actual value is based on the statistics of BREE.
Source: JICA Study Team

(3) South Africa

As there is no available governmental data in respect of South Africa similar to the coal demand forecasts published by the government-related institutions of Indonesia and Australia, their addable coal supply capacity is obtained based on the plans to increase production of the existing mines and the plans to develop new mines published in an information magazine[13] in order to predict an exportable quantity of coal based on the obtained value.

12 BREE website, "Resources and Energy Statistics - December Quarter 2011 - Commodity Historical Data Tables"
13 TEX Report (released by The TEX Report Ltd.,)

Table 2-11 shows the summary[14] of the six plans to develop new mines in South Africa published from last year to this year in an information magazine. The addable supply capacity from 2012 to 2015 is 19 million tons (18 million tons of steam coal and 1 million tons of coking coal). As the volume of coal produced in 2011 was 253 million tons[15], their supply capacity will increase to about 270 million tons in 2015, if there is no decrease in production due to the closure of mines. Of the additional coal supply capacity, all of coking coal will be exported, while 80% of steam coal is expected to be exported. The additional supply capacity of 10 million tons in 2014 will be for domestic purposes, they are excluded here. Table 2-12 shows a forecast of the volume of coal for export based on this estimate. The steam coal export volume of South Africa is expected to increase by 6 million tons from 72 million tons in 2011 to 78 million tons in 2015.

Table 2-11 Plans to Increase Coal Production in South Africa

(million tons)

		2012	2013	2014	2015
Total		0.8	6.2	12.1	0.0
	Steam Coal	0.8	5.2	12.1	0.0
	Coking Coal	0.0	1.0	0.0	0.0
Cumulative Total		0.8	6.9	19.0	19.0
	Steam Coal	0.8	5.9	18.0	18.0
	Coking Coal	0.0	1.0	1.0	1.0

Note: This data does not cover all the plans to increase production of the existing mines and plans to develop new mines in South Africa.
Source: JICA Study Team

Table 2-12 Coal Export Forecast by Coal Type of South Africa

(million tons)

		Actual					Projection			
		2007	2008	2009	2010	2011*	2012	2013	2014	2015
Exports	Steam Coal	66.1	56.6	51.4	65.6	71.6	72.2	76.3	78.0	78.0
	Coking Coal	0.9	1.3	0.6	0.8	0.2	0.2	1.2	1.2	1.2
		67.0	57.9	52.0	66.4	71.7	72.3	77.4	79.1	79.1

Note: Actual value is based on the “Coal Information 2012” of IEA, and the value of 2011 is an estimate.
Source: JICA Study Team

2.2.4 Construction project status of coal power generation in the neighboring countries

The additional equipment capacity of coal fired power plants in the neighboring countries is summarized below based on the power development plans or reported data.

(1) Thailand

According to the “Summary of Thailand Power Development Plan 2012-2030 (PDP2010: Revision 3)” published in June of 2012, while new equipment capacity of 55,130 MW will be added between

[14] This data does not cover all the plans to increase production of the existing mines and plans to develop new mines in South Africa.

[15] IEA, “Coal Information 2012”

2012 and 2030, old equipment capacity 16,839 MW will be abolished. As a result, the capacity of power generation equipment will increase from 32,395 MW as of December of 2010 to 70,686 MW to the end of 2030. Of this additional equipment capacity of 55,130 MW, coal fired power plants will be 4,400 MW[16]. Besides, as coal fired power plants, Hongsa Power Plant (lignite fired power plant, 491 MW x 3 (to be purchased by Thailand)) under construction in Laos will start to operate in 2015 and 2016. In addition, the replacement (600 MW x 1) of the 4th to the 7th units (150 MW x 4) at the Mae Moh Power Plant (lignite fired power plant) is planned and the power plant is expected to start to operate in 2018.

(2) Malaysia

According to the report[17] at the "APEC Clean Fossil Energy Technical and Policy Seminar" held in February, 2012, coal fired power plant has been started to introduce in 1988 and its capacity is 7,680 MW (four places with a capacity of 7,200 MW in the Malay peninsula and two places with a capacity of 480 MW in the Sarawak province) of the total capacity of the power generation equipment of 24,257 MW in Malaysia as of December of 2011. According to the plan, a USC coal fired power station of 1,000 MW will be built in the Malay Peninsula in 2015 and 2016, respectively and the capacity of the coal fired power generation equipment in the Malay Peninsula will be 9,200 MW by 2020.

(3) India

According to the twelfth 5-year plan as from April 2012, India plans to increase the equipment by 95,500 MW in the same period, of which coal fired power generation will be 62,700 MW. In addition, in the thirteenth 5-year plan, it plans to increase its capacity by 93,400 MW, of which thermal power generation will be 63,400 MW[18].

The UMPP (Ultra Mega Power Plan) aimed at building a 4,000 MW-class coal fired power plant (800 MW x 5) in India is under way. In principle, 9 places were under study, but there are now 16 places.

(4) Indonesia

According to the "RUPTL2011-2020" published in the beginning of 2012, the equipment capacity to be increased during the 10 years from 2011 to 2020 will be 55,346 MW, of which 35,573 MW will correspond to coal fired power generation, while, of 35,573 MW, 19,036 MW will correspond to PLN and 16,537 MW to IPP. It is expected that the amount of power generation by coal will increase from 93,049 GWh in 2011 to 238,432 GWh in 2020 and its ratio relative to the total power generation

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16 GEECO-ONE Co., Ltd. 660 MW (2012), National Power Supply Co., Ltd. 270 MW×2 (2016, 2017), EGAT 800 MW×4 (2019, 2022, 2025, 2028)

17 *Somasundram Ramasamy,* Senior Undersecretary (Electricity Policy), Ministry of Energy, Green Technology and Water, Malaysia

18 The total capacity of power generation equipment of India as of 2011 is 181,557 MW, of which the capacity of coal power generation equipment is 99,503 MW (55 % of the total)—From the February 2012 report of the "APEC Clean Fossil Energy Technical and Policy Seminar"

volume will increase from 50% in 2011 to 64% in 2020.

(5) Vietnam

According to the "National Power Development Plan (the Seventh National Power Development Plan) in the period of 2011 to 2020 of the National Power Development Plan up to 2030", the government of Vietnam sets the targets of power generation volume and power import volume at 330 to 362 TWh in 2020 and 695 to 834 TWh in 2030, respectively. The power generation by coal will be 156 TWh (47% of the total power generation volume) in 2020 and 394 TWh (56 % of the same) in 2030, and the equipment capacity will be about 36,000 MW and 70,000 MW[19], respectively.

(6) The Philippines

According to the report[20] delivered at the "APEC Clean Fossil Energy Technical and Policy Seminar" held in February, 2012, the total capacity of power generation equipment as of the end of 2010 of the Philippines is 67,795 MW, of which 23,039 MW correspond to that of coal fired power generation equipment. A further 4,126 MW coal fired power generation capacity is said to be planned in the future.

(7) Bangladesh

According to JICA's survey "Power System Master Plan 2010 (PSMP2010) on coal-fired power plants of the People's Republic of Bangladesh"[21], the demand for electricity (peak demand) in the Government Policy Scenario is estimated to increase from 6,454 MW in 2010 to 33,708 MW in 2030. In order to cover this demand, it will be necessary to increase the power generating equipment, of which coal power will reportedly account for 19,350 MW.

[19] The capacity of coal power generation equipment as of October of 2010 is 4,390MW.

[20] *Somasundram Ramasamy,* Senior Undersecretary (Electricity Policy), Ministry of Energy, Green Technology and Water, Malaysia

[21] February, 2011

2.3 Outline of coal resources

2.3.1 Outline

Coal production had started in the era of royalism in the 1800s, and 18.36 thousand tons of coal was produced in the period between 1855 and 1863. The Country had been a British colony from 1890 to 1948, and then, adopted the socialism system, which continued until 1988. The Country produced 154.35 thousand tons of coal during the time when colonized by Britain, and 527.48 thousand tons during the era of socialism from 1949 to 1988. In 1988, the socialism regime, which had continued for 26 years, collapsed as a result of the nationwide pro democracy demonstration. After that, the national army, which quelled the demonstration, organized the Sate Law and Order Restoration Council (SLORC) and seized political power. Under the control of national army government, the coal production amounted to 8.323 million tons during the period between 1988 and 2009. However, the annual coal output has been less than 1 million tons in recent years, as small as the size of production in Japan. The Myanmar Government is planning to increase the coal production to prepare for a rapid increase in domestic and electric power demands. It is also accelerating a shift from nation-owned mines to private companies.

2.3.2 Geological conditions and coalfields

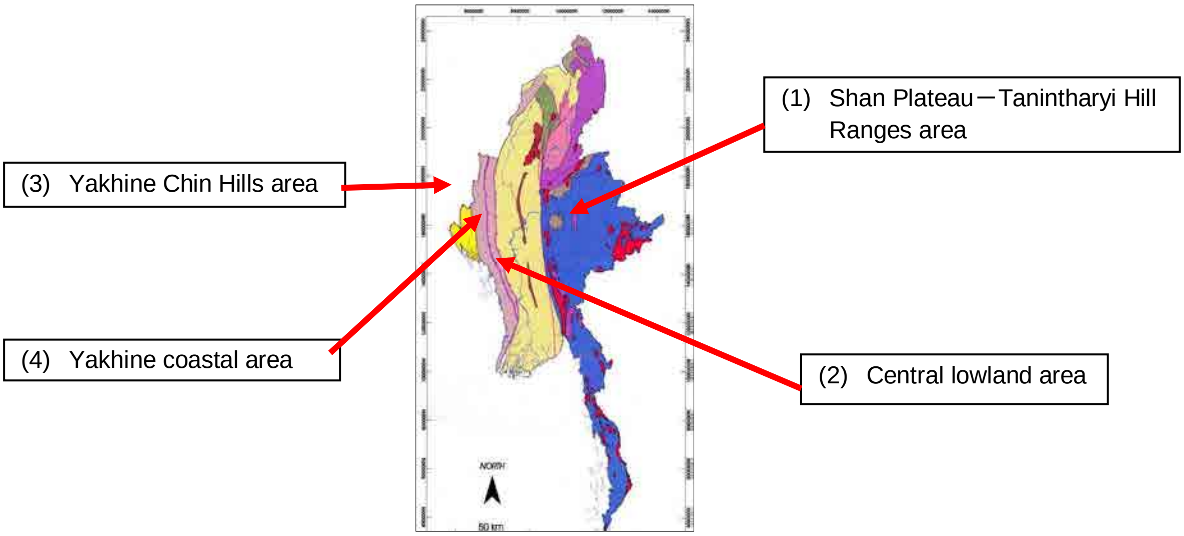
Myanmar has a geological structure that runs from south to north. As shown in Fig. 3-1, Myanmar can be divided into four areas: (1) Shan Plateau and Tanintharyi Hill Ranges area, (2) Central lowland area, (3) Yakhine Chin Hills area, and: (4) Yakhine Coastal area.

Myanmar is known for its abundance of coal sources. Major coal production areas in Myanmar include mines along Ayeyawady and Chindwin rivers basin, in southern part of Myanmar, basin in the mountains and a series of isolated mines in Shan state.

While most of its coal resources were deposited in the Tertiary period, some production includes coal of the Mesozoic in the limited areas in the eastern part of the Country (Shan state). The southern part of Shan state produces coal in the Jurassic mainly. In terms of amount, the coal in the Tertiary is the most important in Myanmar.

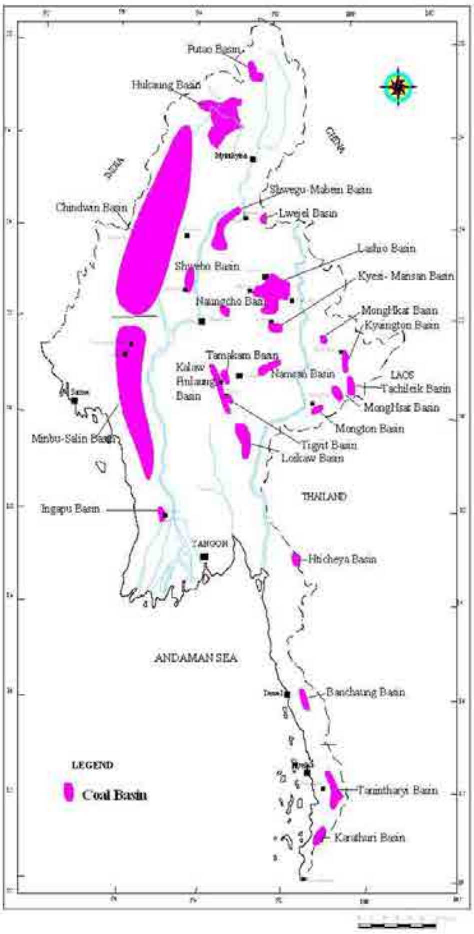
The coal deposit of the Mesozoic in Myanmar is located in the narrow, long and thin area that lies from the north of Minpalaung to the south of Kalaw in the southern part of Shan state. It contains a Jurassic Loi an coal-bearing formation that consists of sandstone, siltstone and shale. Each layer is steeply inclined and scattered with steep fold. Coal of the Mesozoic has a quality of subbituminous coal in Myanmar. Well-known coal deposits of the Mesozoic are Minpalaung and Kyatsakan.

According to the results of surveys up to date, there are 25 major basins and 495 coal deposits in Myanmar. Fig. 3-2 shows majors basins.



Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-19 Geological Structure in Myanmar



COAL BASIN

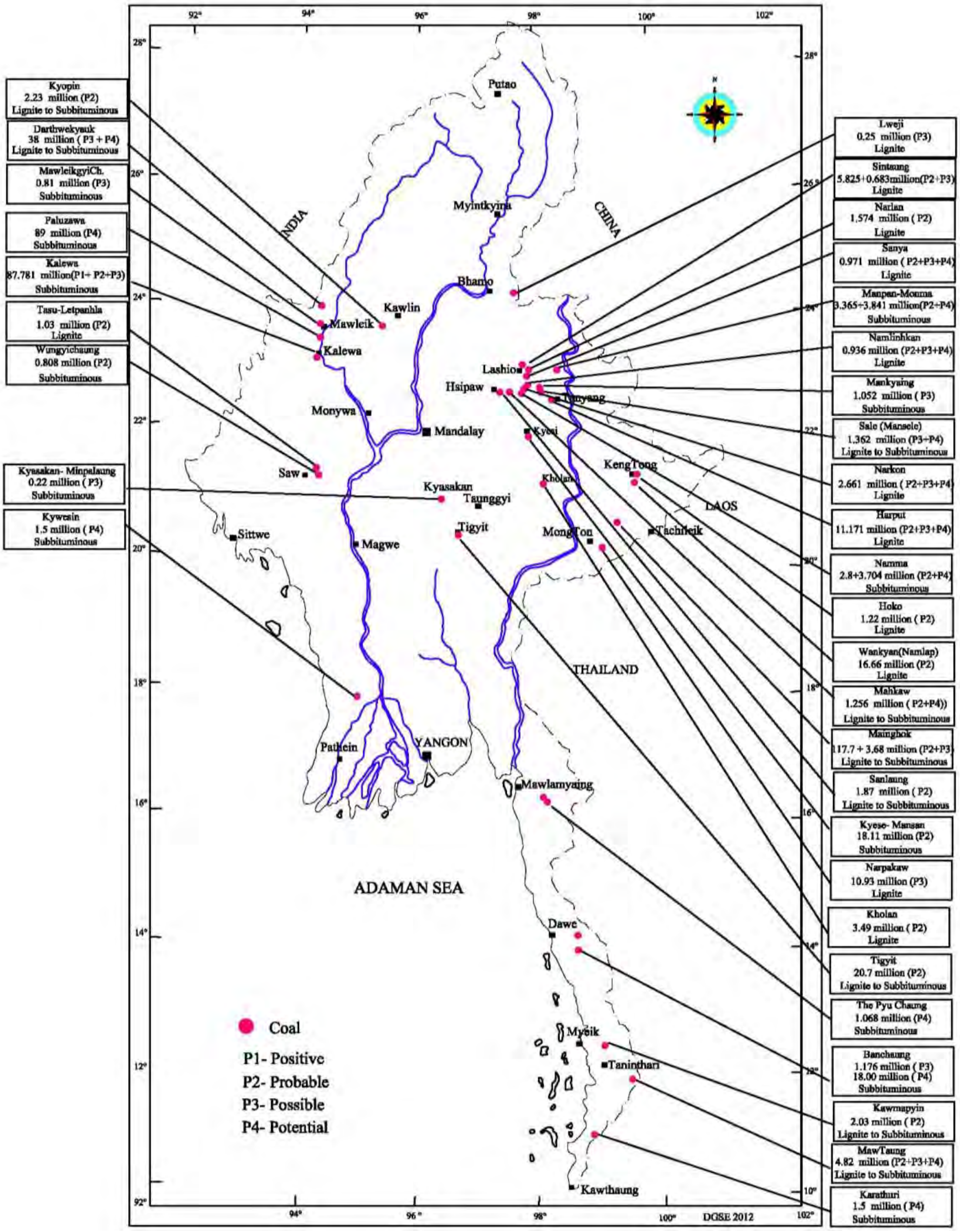
1 .	Putao Basin
2 .	Hukaung Basin
3 .	Shwgu-Mabein basin
4 .	Lwejel Basin
5 .	Chindwin Basin
6 .	Shwebo Basin
7 .	Lashio Basin
8 .	Naungcho Basin
9 .	Kyesi-Mansan Basin
10 .	MongHkat Basin
11 .	Kyaington Basin
12 .	Tamakam Basin
13 .	Kalaw Pinlaung Basin
14 .	Namsan Basin
15 .	Tachileik Basin
16 .	MongHsat Basin
17 .	Mongton Basin
18 .	Tigyit Basin
19 .	Loikaw Basin
20 .	Minbu-Salin Basin
21 .	Ingapu Basin
22 .	Hticheya Basin
23 .	Banchaung Basin
24 .	Tanintharyi Basin
25 .	Karathuri Basin

Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-20 Major Basins in Myanmar

2.3.3 Coal resources and its amount of deposit

Exploration was conducted for 34 major coal deposits nationwide and the results were recorded. The estimated amount of deposit is approximately 480 million tons across a diversity of categories. The amount of coal resources in Myanmar is estimated to be 510 million tons. Fig. 3-3 shows the locations of 34 coal deposits and Table 3-1 shows the amount of deposit.



Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-21 Coal Deposits and the Amount of Major Coal Deposits

Table 2-13 The Amount of Coal Deposit at Major Coal Deposits in Myanmar

(As of May 28, 2012)

Source: Department of Geological Survey and Mineral Exploration (DGSE)

No.	Location	Township	State / Region	Tonnage (Million)	Category	Coal Rank
1.	Kalewa	Kalewa	Sagaing	4.615 17.831 65.335	Positive Probable Possible	Sub-bituminous Sub-bituminous Sub-bituminous
2.	Darthwekyauk	Tamu	Sagaing	33.0 5.0	Possible Potential	Lignite to Sub-bituminous
3.	Paluzawa	Mawlike	Sagaing	89.0	Potential	Sub-bituminous
4.	Mawleikgyi Ch.	Mawlike	Sagaing	0.81	Possible	Sub-bituminous
5.	Kyopin	Kawlin	Sagaing	2.23	Probable	Lignite to Sub-bituminous
6.	Lweji	Bamoh	Kachin	0.2	Possible	Lignite
7.	Kawmapyin	Tanintharyi	Tanintharyi	2.03	Probable	Lignite to Sub-bituminous
8.	Mawtaung	Tanintharyi	Tanintharyi	1.80 1.80 1.22	Probable Possible Potential	Lignite to Sub-bituminous
9.	Karathuri	Bokpyin	Tanintharyi	1.50	Potential	Sub-bituminous
10.	Banchaung	Dawe	Tanintharyi	1.175 18.00	Possible Potential	Sub-bituminous
11.	ThePyuchaung	Kyainseikkyi	Kayin	1.068	Potential	Sub-bituminous
12.	Wungyichaung	Seikphyu	Magwe	0.808	Probable	Sub-bituminous
13.	Tasu-Letpanhla	Pauk	Magwe	1.03	Probable	Lignite
14.	Kyesi-Mansan	Kyesi-Mansan	Shan (South)	18.11	Probable	Sub-bituminous
15.	Kholan	Namsam	Shan (South)	3.49	Probable	Lignite
16.	Tigyit	PinLaung	Shan (South)	20.70	Probable	Lignite to Sub-bituminous
17.	Kyasakan- Minpalaung	Ywangan	Shan (South)	0.22	Possible	Sub-bituminous
18.	Mankyaung	Tanyang	Shan (North)	1.052	Possible	Sub-bituminous
19.	Manpan-Monma	Tanyang	Shan (North)	3.365 3.841	Probable Potential	Sub-bituminous Sub-bituminous

No.	Location	Township	State / Region	Tonnage (Million)	Category	Coal Rank
20.	Harput	Tanyang	Shan (North)	5.24 0.469 5.462	Probable Possible Potential	Lignite to Sub-bituminous
21.	Sale (Mansele)	Lasio	Shan (North)	0.149 1.213	Possible Potential	Lignite to Sub-bituminous
22.	Sanya	Lasio	Shan (North)	0.048 0.072 0.851	Probable Possible Potential	Lignite
23.	Sintaung	Lasio	Shan (North)	5.825 0.683	Probable Possible	Lignite
24.	Namma	Lasio	Shan (North)	2.80	Probable	Sub-bituminous
25.	Narkon	Lasio	Shan(North)	0.692 1.044 0.925	Probable Possible Potential	Lignite
26.	Narlan	Lasio	Shan (North)	1.574 0.20 0.826	Probable Possible Potential	Lignite
27.	Namlinhkan	Lasio	Shan(North)	0.048 0.339 0.549	Probable Probable Potential	Lignite
28.	Sanlaung	Thipaw	Shan(North)	1.87	Probable	Lignite to Sub-bituminous
29.	Mahkaw	Thipaw	Shan (North)	1.00 0.256	Probable Potential	Lignite to Sub-bituminous
30.	Wankyan (Namlap)	Kyaington	Shan (East)	16.66	Probable	Lignite
31.	Hoko	Kyaington	Shan (East)	1.19	Probable	Lignite
32.	Mainghkok	Maingsat	Shan (East)	117.70 3.68	Probable Possible	Lignite to Sub-bituminous
33.	Narparkaw	Maington	Shan (East)	10.93	Possible	Lignite
34.	Kywesin	Ingapu	Ayeyawadi	1.50	Potential	Lignite to Sub-bituminous
	Total			482.992		

According to the Ministry of Mines, depending upon the amount of exploration work completed and degree of accuracy in ore reserve estimation, the ore reserve has been classified in four categories namely Positive, Probable, Possible and Potential ore reserves.

- Positive ore reserve (P1)

Ore reserve calculated from ore body whose length, width and depth have been systematically measured and closely sampled so that reserve and grade are quite accurate and block out ore is also defined as P-1.

- Probable ore reserve (P2)

Ore reserve calculated from ore body whose measurement and sampling in three dimensions has been supplemented by some geological deduction. Ore reserve calculation of the ore body which length, width and depth must be systematically measured and all the representative samples should be taken within fairly close interval.

- Possible ore reserve (P3)

Ore reserve calculated from ore body whose measurement and sampling in two dimensions has been largely supplemented by geological deduction and samples should be taken within acceptable close interval.

- Potential ore reserve (P4)

Ore reserve for which quantitative estimate is based largely on broad knowledge of geologic character of the deposit where there is very little actual measurement and sampling.

Potential ore reserve (P4) can be defined as Inferred Ore Reserve.
Possible ore reserve (P3) can be defined as Estimated Ore Reserve.
Positive ore reserve (P1) and Probable ore reserve (P2) can be defined as Measured Ore Reserve.

In the assessment of the amount of deposit, most coal deposits have less than 10 million tons of deposit including P1 to P4. It is very small in terms of the amount. That means the number of boring is extremely small. They need to conduct more boring to increase the amount of deposit. Figure 3-3 shows the coal deposits that have the amount of deposit exceeding 10 million tons.

Table 2-14 Coal Deposits that Have the Amount of Deposit Exceeding 10 Million Tons

(Unit: million tonnes)

Deposit	State/Region	Township	Category	Coal rank	Reserves
Darthwekyaut	Sagaing Region	Kalewa	P3, P4	Sub-bituminous, Lignite	38
Palzawa	Sagaing Region	Kalewa	P4	Sub-bituminous	89
Kalewa	Sagaing Region	Kalewa	P1, P2, P3	Sub-bituminous	87
Harpu	Shan State	Lasio	P2, P3, P4	Lignite	11
Kyese-Mansan	Shan State	Lasio	P2	Lignite	18
Tyigit	Shan State	Tigyit	P2	Lignite, Sub-bituminous	20
Wankyan	Shan State	Shan (South)	P2	Lignite	16
Mainghok	Shan State	Shan (South)	P2, P3	Lignite, Sub-bituminous	117
Narpakaw	Shan State	Shan (South)	P3	Lignite	10

Source: Department of Geological Survey and Mineral Exploration (DGSE)

2.3.4 Coal exploration state

The Geological Survey Mineral Exploration Agency is responsible for research and exploration of mineral resources including coal.

Since 1965, the Agency has implemented the systematic coal deposit exploration plan in many areas in Myanmar. The comprehensive coal exploration was conducted in Sagaing Division in 1970, 1980 and 2010, in Magwe Division in 1998 and 2002, in Kachin in 2000, 2004 and 2010, in Tanintharyi in 1980, 1995, 2002 and 2003, in the southern part of Shan state in 1980 through 2010, in the northern part of Shan state in 1982, 2001 through 2004, and 2012, and in the eastern part of Shan state in 1994 and 2001 through 2008. DGSE (Department of Geological Survey & Mineral Exploration) plans to explore coal deposits in the areas with potential of coal production nationwide, centering on the northern part of Shan state.

2.3.5 Quality of coal

Coal of the Tertiary varies from brown coal to subbituminous coal in Myanmar. As it contains large amounts of volatile substances and water, it has a lower calorific value in general and in most cases it isn’t suitable for fuels that burn in a normal firebox of steam engine and locomotive in the state of raw coal. Another disadvantage of most of such type of coal is that it breaks up into small pieces when it contact with the air. The coal of the Tertiary in Myanmar is subbituminous coal. Table 3-3 shows the qualities of coal of the coal deposits found in Myanmar.

Table 2-15 Chemical Analysis of Coal

Source: Department of Geological Survey and Mineral Exploration (DGSE)

No.	**Location**			**Chemical Analysis**					
	Region	**Township**	**State/Division**	**Fixed Carbon %**	**Volatile %**	**Moisture %**	**Ash %**	**Calorific Value Btu/lb**	**Sulfur %**
1.	Kalewa	Kalewa	Sagaing	52.51	38.62	9.70	8.87	11720	
2.	Darthwekyauk	Tamu	Sagaing	50.00			1.00	12000	< 1
3.	Paluzawa	Mawlike	Sagaing	41.47	45.32				
4.	Mawlikegyi	Mawlike	Sagaing	49.70	43.85	8.60	6.40	11800	1.12
5.	Kyopyin	Kawlin	Sagaing	31.00	34.40	8.30	34.40	8174	1.48
6.	Lweji	Bamoh	Kachin	17.59	38.90	14.36	43.49	6396	0.69
7.	Kawmapyin	Taninthayi	Tanintharyi	36.66	34.82	5.51	21.75	9977	2.00
8.	Mawtaung	Tanintharyi	Tanintharyi	43.59				9754	2.24
9.	Karathuri	Bokpyin	Tanintharyi	37.60				9810	0.32
10.	Wungyichaung	Seikphuy	Magwe	31.71	41.80		26.40	8365	3.60
11.	Tasu-letpanhla	Pauk	Magwe	34.60	48.40		16.90	9349	2.50
12.	Kyesi-Mansan	Kyesi	Shan (South)	35.60	48.98	13.29	15.36	10153	2.56
13.	Kholan	Namsan	Shan (South)	14.77	56.26	21.32	28.90	7355	
14.	Tigyit	Pinlaung	Shan (South)	33.81	34.40	18.51	13.27	9169	
15.	Makyaning	Tayang	Shan (North)	26.86	50.86	12.65	22.27	9187	1.08

No.	Location			Chemical Analysis					
	Region	Township	State/Division	Fixed Carbon %	Volatile %	Moisture %	Ash %	Calorific Value Btu/lb	Sulfur %
16.	Manpan-Monma	Tayang	Shan (North)	35.58	55.00	19.45	9.33	9889	0.80
17.	Harput	Tayang	Shan (North)	27.57	56.26	28.40	13.16	8244	0.99
18.	Sale (Mansele)	Lasio	Shan (North)	33.00	54.02	15.98	12.98	9881	1.40
19.	Sanya	Lasio	Shan (North)	35.47	58.32	17.77	6.21	10420	0.64
20.	Sintaung	Lasio	Shan (North)	33.67	96.99	28.28	9.34	8770	2.56
21.	Namma	Lasio	Shan (North)	34.54	44.31	8.64	20.69	10083	1.44
22.	Narkon	Lasio	Shan (North)	38.01	59.49	15.98	2.52	11080	0.64
23.	Narlan	Lasio	Shan (North)	33.42	41.83	16.57	17.14	9370	6.97
24.	Namlinhkan	Lasio	Shan (North)	35.71	52.97	13.25	11.32	10440	4.69
25.	Sanlaung	Thipaw	Shan (North)	30.52	51.36	12.16	18.06	9772	5.82
26.	Mahkaw	Thipaw	Shan (North)	35.26	61.30	19.88	6.43	10430	0.64
27.	Wankyan	Kyaington	Shan (East)	23.00	23.00	40.00	8.50	5890	0.40
28.	Hoko	Kyaington	Shan (East)	44.45	56.50		15.41	11233	1.17
29.	Mainghkok	Maingsat	Shan (East)	45.00			1.86	10185	
30.	Narparkaw	Maington	Shan (East)	25.93 ～28.07	26.31 ～31.89		14.83 ～15.39	7720 ～8370	0.96
31.	Kywesin	Ingapu	Ayeyawadi	41.10	18.24	1.16	40.70	8163	0.93
32.	Kami	Dawei	Taninthayi	42.30	48.80		9.51	8885	0.74
33	Banchaung	Dawei	Taninthayi	40.87	38.95	7.49	20.05	11345	1.47
34	Thepyu chaung	Kyainseikgyi	Kayin	39.90	35.56	8.2	19.77	10390	1.35

Source: No.(3) Mining Enterprise

2.4 Preparation of policies and laws on coal

2.4.1 Policies related to coal

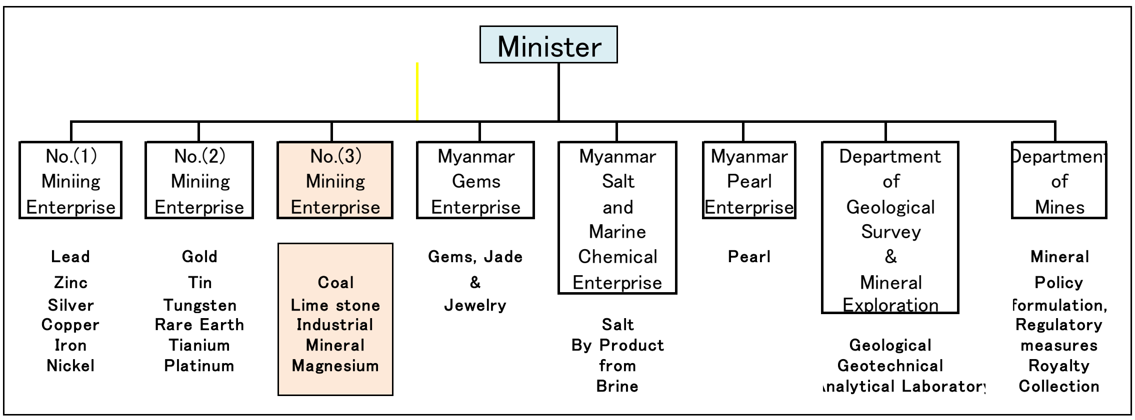
Current coal policy is as follows:

- collect data on production and consumption of coal by state-owned and private sector;
- increase coal production and consumption so that coal based energy be increased in energy mix;
- control pollution caused by coal in accordance with the policy of Environmental law;
- lead and take responsibility on international cooperation on coal; and
- implement APAEC (ASEAN PLAN OF ACTION FOR ENERGY COOPERATION) and AFOC (ASEAN FORUM ON COAL) work plans.

As one of the coal strategies to achieve the above targets of its coal policy, Myanmar became a member of the ASEAN Forum on Coal (AFOC). The nationwide committee on AFOC was established in 2000. The roles of the committee include: (a) to cooperate with ASEAN member countries in development of coal resources; (b) to exchange technologies to manufacture coal briquette as the replacement of charcoal that uses wood in order to stop forest destruction; and (c) to cooperate with ASEAN member countries toward the construction of coal-fired power plants that utilize the clean coal technology. The vice minister of the Ministry of Mine serves as the Chairman of this nationwide committee, and the secretary of the Mine Agency serves as the clerk. Other committee members include the secretary general of DGSE, the representative of the No.(3) Mining Enterprise and the chiefs of other relevant departments. The 9th meeting of the AFOC administrative board was held in Nay Pyi Taw in Myanmar on August 4 and 5, 2011.

While Myanmar doesn't import coal, it has a policy not to place import taxes if it imports coal as a political measure. Figure 3-4 shows the organizational chart of Ministry of Mine. Coal is supervised by No.(3) Mining Enterprise, Department of Geological Survey and Mineral Exploration and Department of Mines.

Fig. 2-22 Organization Chart of Ministry of Mine



2.4.2 Preparation of laws associated with coal

(a) Law and regulation for coal production

Legal framework for coal production is based of the Union of Myanmar Foreign Investment Law for the purpose of investment by the foreign companies for the development of Myanmar's mining sector, which was enacted in November 1988, the Union of Myanmar Mines Law (promulgated in September 1994) and Mining Rules related to the Mining Law followed in December 1996.

In Mining Law, coal is defined as Industrial Mineral and royalty of Industrial Mineral is 1% to 3%. To fulfill the present situation Union of Myanmar Foreign Investment Law and Union of Myanmar Mines Law revising at present.

The Ministry of Mines is responsible for formulation of mining policy, exploration, production and extraction of minerals, metals, Jade and gems, including coal. There are two departments and 6 Enterprises. Department of Geological Survey and Mineral Exploration is responsible for geological mapping, prospecting and exploration of minerals including coal. Department of Mines is responsible for mining policy formulation, granting exploration permit and coordination of mining sector. The exploration and production permits are issued to private companies in accordance with the Myanmar Mines Law. Depending on the ore reserve, large scale and small scale mining permits are issued to mining companies.

The state owned No.(3) Mining Enterprise is responsible for production of coal by practicing production sharing contract (PSC) system. Participation of private sector in coal mining started along with the adoption of market oriented economic system, accelerated by promulgation of Myanmar Mines Law 1994 and gained momentum at present occupying a major share in production as well as consumption and trading activities.

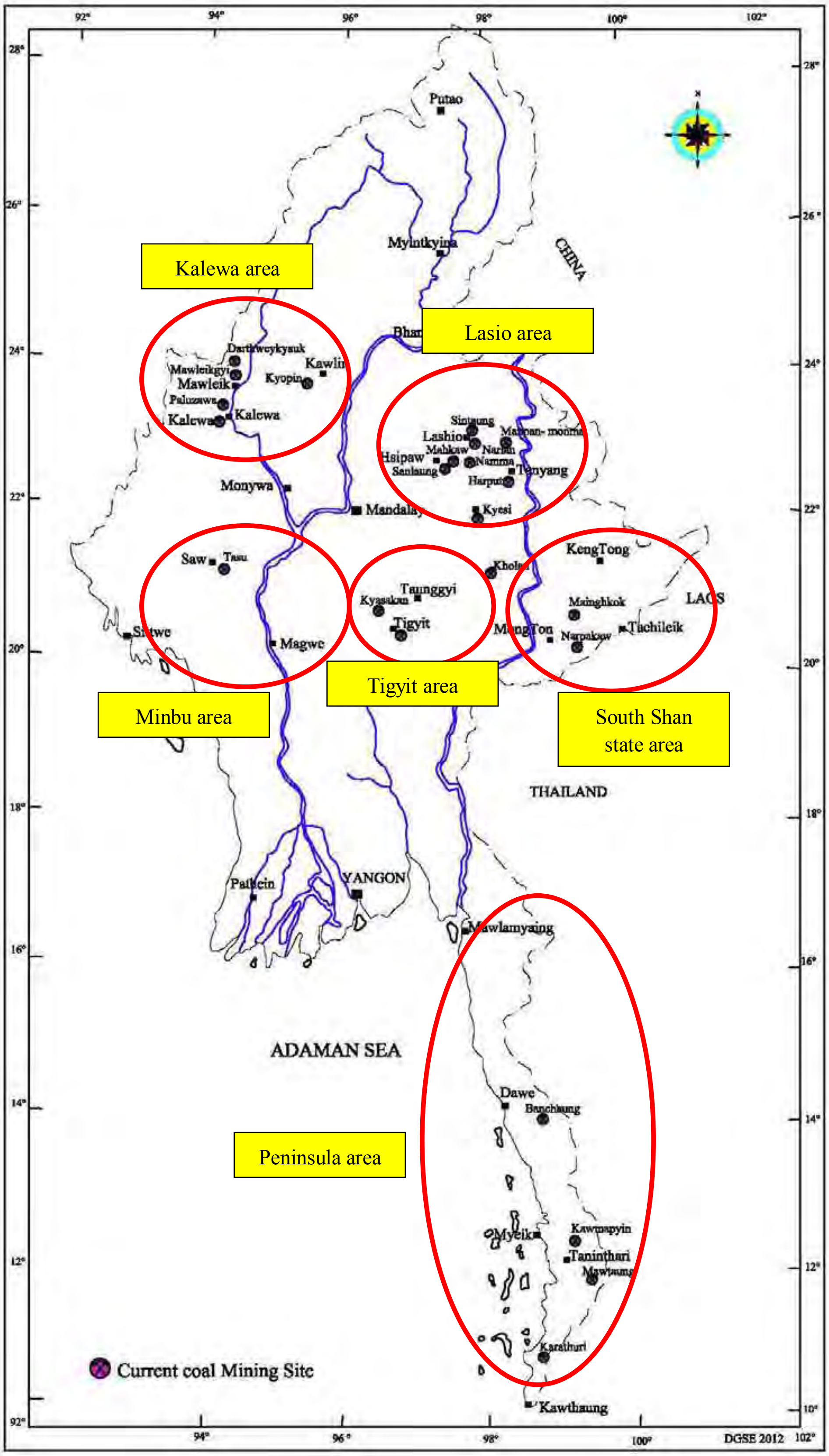
(b) Mining property, exploration license and mining license

For Coal mining, small scale mining permit area is 1 km^2 and large scale mining permit area is depend on the size of coal deposit and coal distribution. Coal exploration permit area is about 3,150 km^2 as prescribed in Myanmar Mines Rules.

As of 2012 March, there are 32 large scale mining permits, 10 small scale mining permits and 98 exploration permits were being issued to the private companies. (Source: ME(3) and DOM)

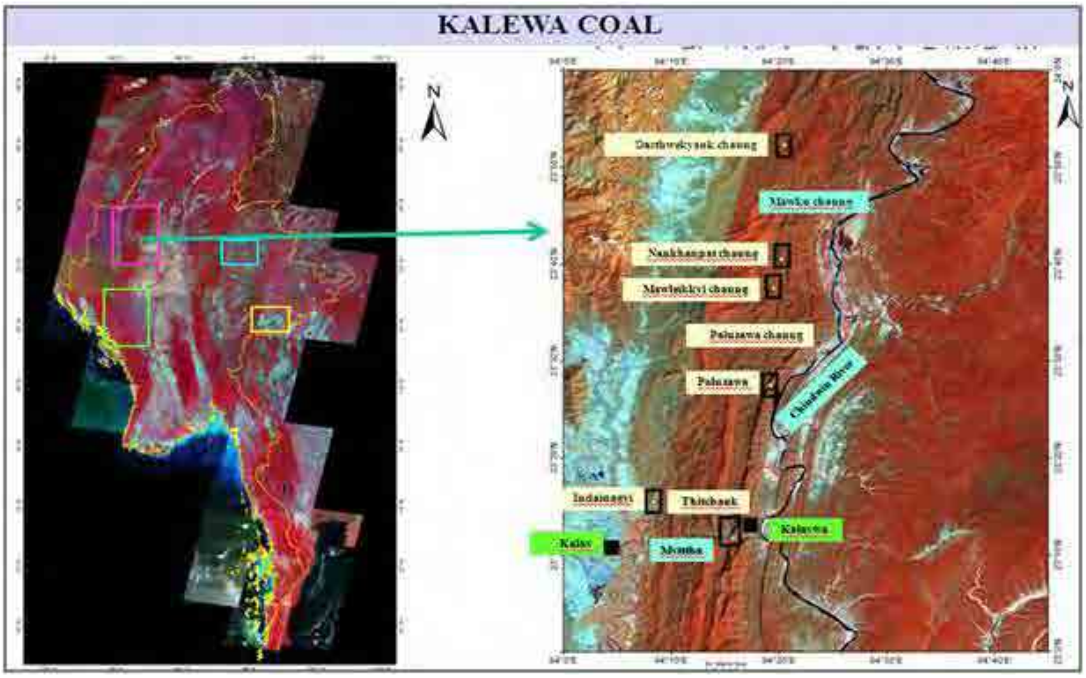
(c) Outline of production sharing contract for coal mining

Coal Production Sharing Contract (PSC) system in which 100% percent of investment is borne by the private companies and the agreed split ratio is shared between No.(3) Mining Enterprise and company. The average PSC is the ratio of 30% for the Government and other 70% for private contractor. Besides PSC, there are 3% royalty, 5% of commercial tax and 2% of income tax is applied.



(1) Kalewa area

In this area, the coal bed has been developed along Chindwin River. Kalewa is the name of city and coal produced nearby area is called Kalewa coal. In the northern suburbs, there are Puluzawa coal mine and Datwaykyauk coal mine. There is a large amount of high quality coal deposit in Kalewa area. Spreading of quality coal with the thickness of 0.6 m to 3.6 m is reported in Datwaykyauk coal mine, which is regarded as higher quality in Kalewa. The government-managed coal mine development started early in this area. In recent years, mine sites are owned by companies of Myanmar, such as Max Myanmar Co., Ltd. (a major company in Myanmar that is engaged in gasoline, cement and construction businesses), Geo Asia Co., Ltd. (a machinery and equipment company), Asia World Co., Ltd. (a cement and construction company), Htoo Co., Ltd. (a major trading company), Tun Thwin Co., Ltd. (a mine company in Myanmar with a good record) and Myanmar Economic Holding, Ltd. (owns a port of Yangon), although only part of coal mines produces coal. Produced coal is transported to Mandalay and cement and refining companies in the suburbs of Mandalay on purges and trucks. Figure 3-6 shows the outline of the area.

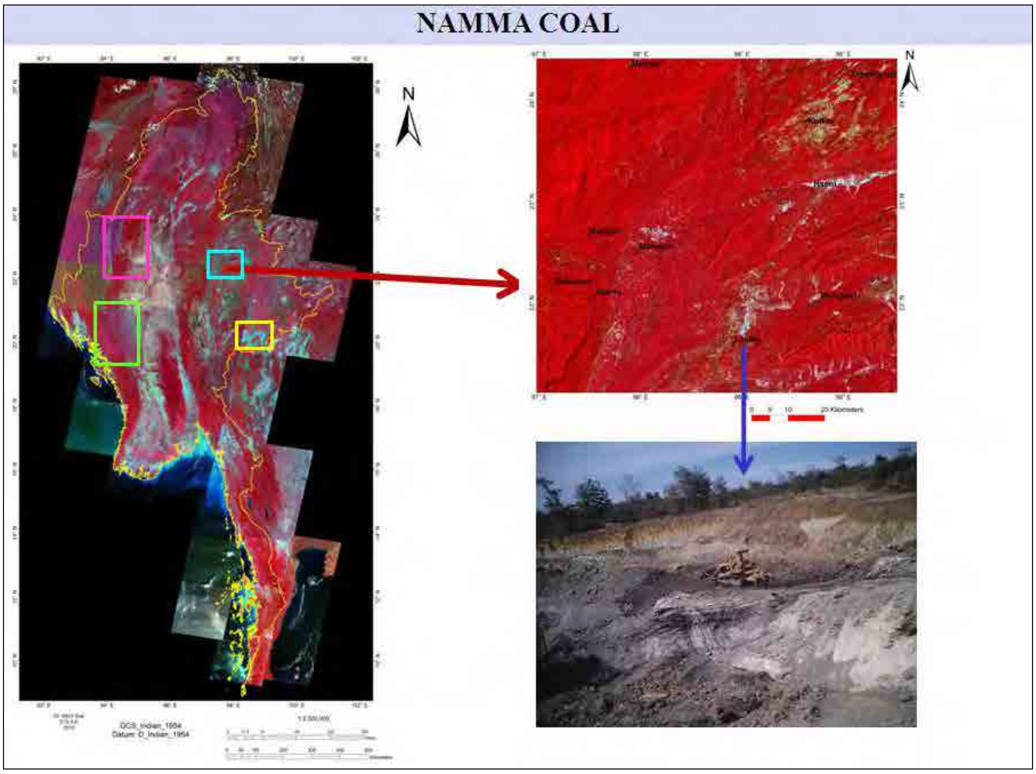


Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-24 Overall Condition of Kalewa Area

(2) Lasio area

Small coal mines are operated in Lasio to produce coal. From long ago, coal has been exported to China. In recent years, with a recent economic development, coal is transported to Mandalay and cement and refining companies in the suburbs of Mandalay as is the case with Kalewa area. The means of transport is truck. Figure 3-7 shows the state of Lasio area.



Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-25　Overall Condition of Lasio Area

(3) Tyigit area

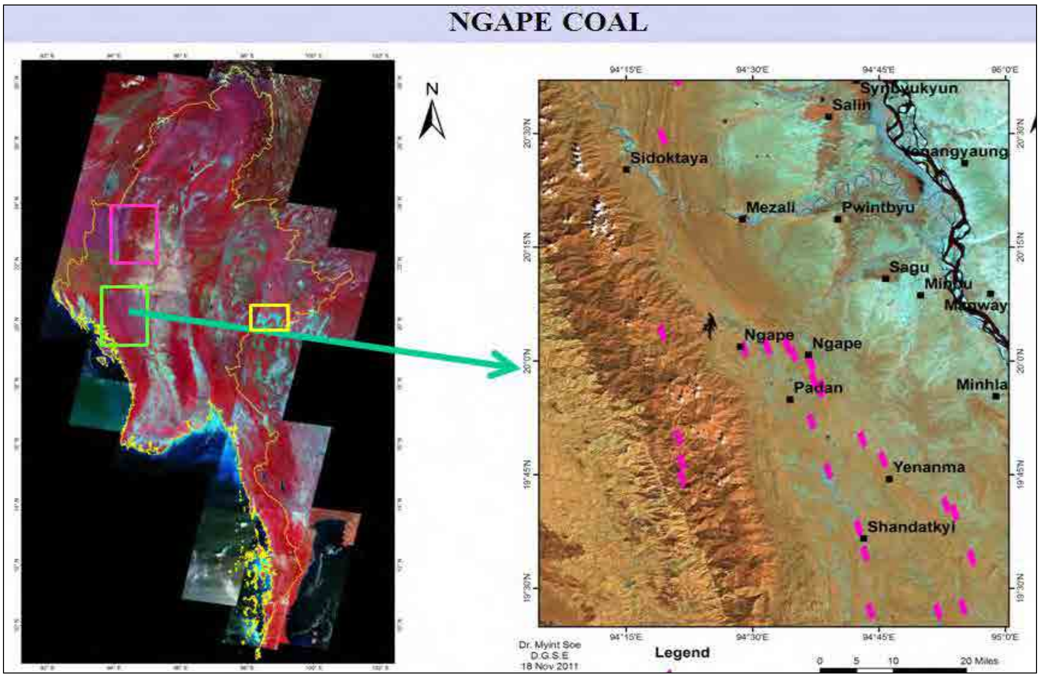
Tyigit coal mine is in operation in Tyigit area. Although Tyigit coal mine provides coal to the adjacent coal-fired power plant (80,000 kw × 2 units), the amount is approximately 300,000 tons per year, much below the designed coal use amount of 640,000 tons per year due to the trouble of the power plant. However, it is a coal mine that produces almost half of the coal production in Myanmar. Tygit coal mine has good access to Hehio airport, the important airport in the area. It takes less than one hour to get there. This coal mine is managed by a private company named Eden Energy & Natural Resources Development Company Limited. The Company has entered into the coal mining business based on the PSC (Production Sharing Contract) with Myanmar government. It is a member of a middle-sized company group in Myanmar, which owns banks and construction companies. It started to produce coal on September 20, 2004 and had produced 3.05 million tons of coal until June 2012. The quality of coal is between 4,000 kcal and 5,000 kcal, which has not achieved the standard heat quantity of the power plant of 5,500 kcal. The mining method is a surface mining with truck and shovel and four power shovels with a bucket of 4.6 m^3 are operated. There is only on layer of coal which is as thick as 10 m to 20 m. Joints are developed in the coal layer, which allows coal mining with backhoe without blasting. However, it is extremely hard with HGI 27. The exploration of this coal mine is conducted by Department of Geological Survey and Mineral Exploration (DGSME). The exploration with the total of 174 times has completed.

Figure 3-8 shows the condition of Tygit coal mine.

Fig. 2-26　Condition of Tyigit Coal Mine

(4) Minbu area

Minbu area is a recently developed area. The road from Naypyidaw has been improved and has very good access: four-hour drive takes you there. Figure 3-9 show the condition of Minbu area.

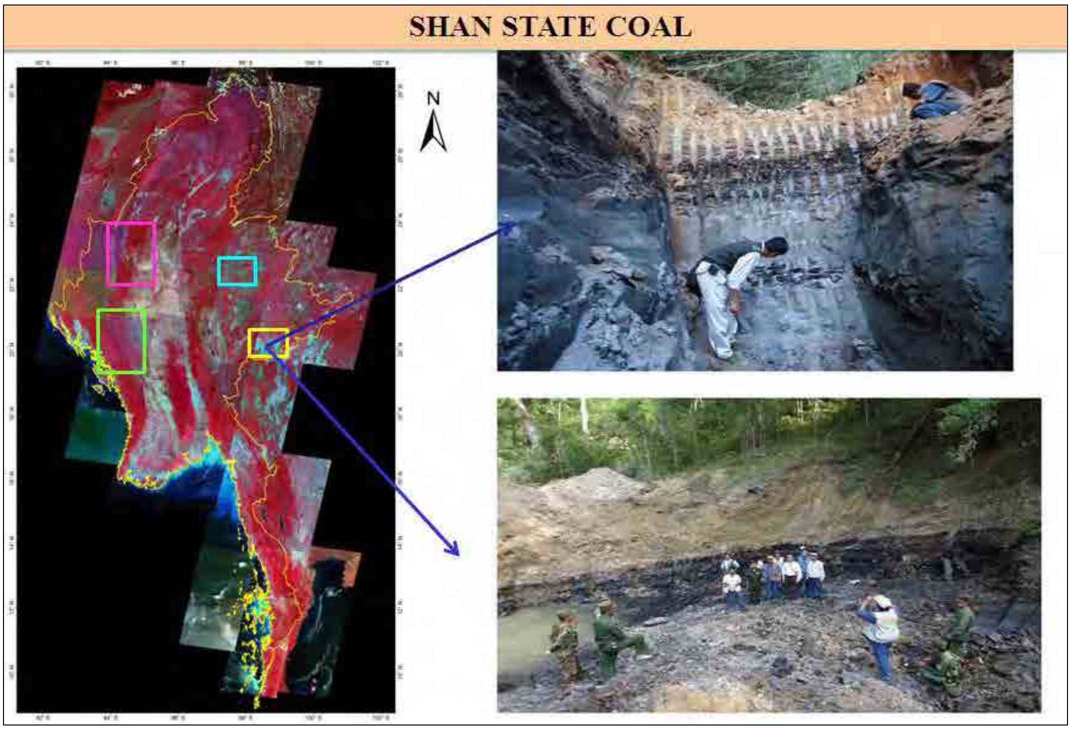


Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-27　Condition of Coal mines in Minbu Area

(5) South Shan state area

The development of coal has advanced also in South Shan state area. According to the material on the amount of coal deposit created by Department of Geological Exploration and Mineral Exploration (DGSE), three deposits with the coal deposit exceeding 10 million tons have been confirmed and are in the process of exploration. It is located near the border with Thailand and the possibility of export to Thailand is under consideration besides export to the local cement companies. Figure 3-10 shows the condition of South Shan state.

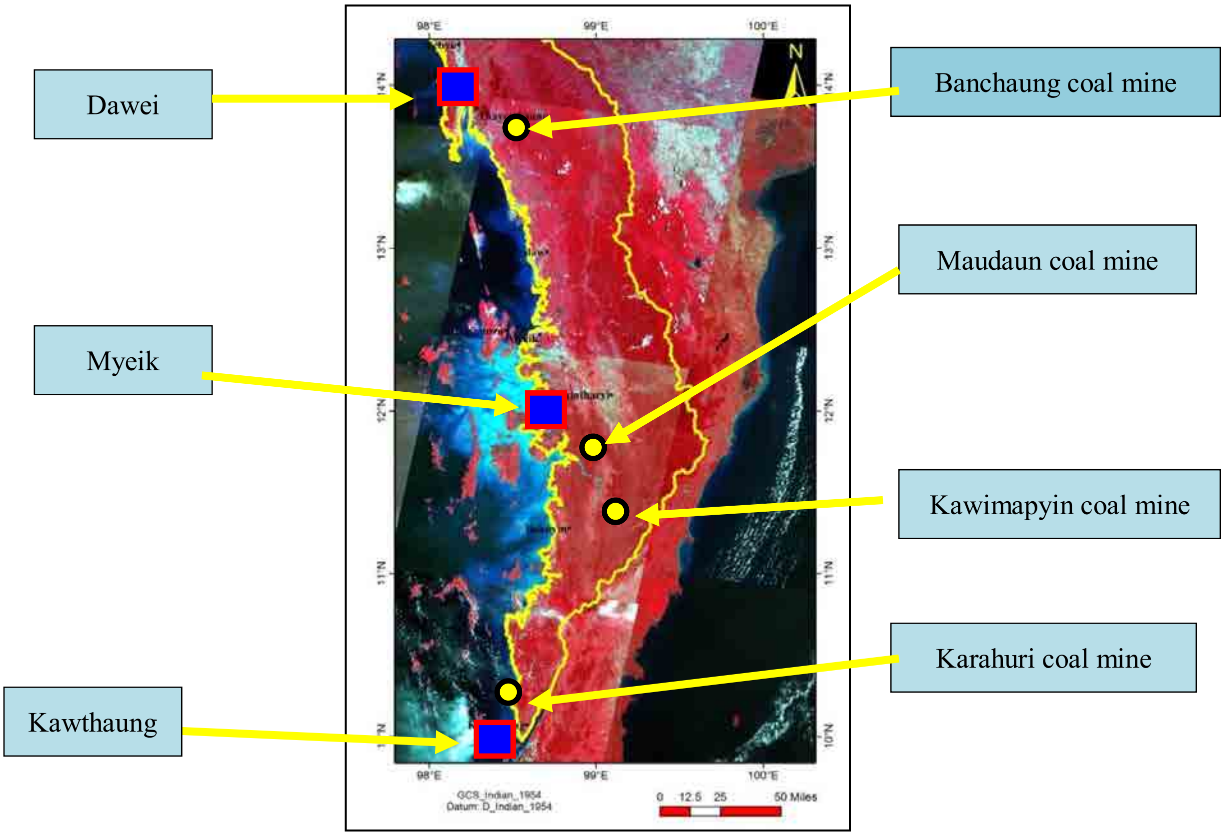


Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-28 Conditions of Mines in South Shan State Area

(6) Peninsula area (Tanintharyi Division)

There are Maudaun coal mine and Kawimapyin coal mine in Tanintharyi Division in the peninsula area, which have been developed to export coal to Thailand. The exploration of coal and the development of coal mine are conducted by a Thai developer company, Italian-Thailand Company. The Company owns brown coal mines in Thailand with an experience in the coal development, which allows it to develop coal mines. In the southernmost point of Myanmar, Kawthaung, Than Phyo Thu Mining Company of China constructed the coal-fired power plant with 8 MW and planned to transmit electricity to Thailand. Despite its completion, it can’t be operated due to the objections of the residents. The coal-fired power plant with 8 MW is also planned in the southern part of Myeik, which is said to be planned also by Than Phyo Thu of China according to the information we obtained. Figure 3-11 shows the condition of the peninsula area.



Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-29 Condition of Coal Mines in the Peninsula Area

(c) Coal output

The actual yearly coal production in Myanmar is shown in Table 3-4 and the amount of coal production by coal mine is shown in Tbale 3-5. The maximum coal production of 1.42 million tons was marked in the period between 2006 and 2007. Then, it decreased and increased slightly in 2010-2011 to 690,000 tons. The biggest cause of decrease was a drop in export. Unexpectedly low domestic consumption also affected the result.

Table 2-16 Actual Coal Production

(1,000 tons)

Year	Coal output
2005-2006	1,150
2006-2007	1,420
2007-2008	1,000
2008-2009	532
2009-2010	450
2010-2011	692

Source: Department of Geological Survey and Mineral Exploration (DGSE)

Table 2-17 Coal Production by Coal Mine

Source: Department of Geological Survey and Mineral Exploration (DGSE)

(Unit: ton)

No.	Coal mine	Company	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Total
1	Kalaywa Coal Mine	No.(3) Mining Enterprise	8,888	6,884	8,572	9,250	12,008	9,132	9,737	9,752	12,999	16,123	13,808	11,773	17,091	15,002	12,250	7,870	6,016	6,012	8,946	2,000			**544,993**
2	Namma Coal Mine	No.(3) Mining Enterprise	26,949	30,031	24,276	21,730	22,700	21,601	19,642	20,784	29,100	34,910	30,200	40,000	55,000	55,000	55,400	42,800	25,000	12,600	17,601	1,300			**837,408**
3	Lwejel Coal Mine	Arawaddy Myit Phya Co., Ltd.	5,225	7,976	2,474	1,075							7,000	3,200	1,700	2,400	700				30,000		4,500		**66,250**
4	Samlong Coal Mine(Large Scale)	Triple 'A' Cement International Co., Ltd.								20,400	15,992	64,781	44,731	60,800	111,000	119,400	67,800	99,898	72,000	60,000	48,000	46,000	92,887	12,499	**936,188**
5	Maw Taung Coal Mine	Myamma Economic Coporation		9,163	30,837	31,728						482,245	531,248	431,375	771,819	799,878	623,295	515,206	228,592	43,085					**4,498,471**
6	Ti-gyit Coal Mine	Edin Energy Natural resources Develpoment Co., Ltd.														58,095	324,906	553,089	466,136	244,136	206,549	290,097			**2,143,008**
7	Ma Khaw Coal Mine	UE Export Import Co., Ltd.														3,232	6,768	12,320	35,801	15,025	28,400	5,130	6,500	3,200	**116,376**
8	Paluzawa Coal Mine	Tun Thwin Mining Co., Ltd.															30,000	87,050	20,250	10,245	15,096	20,065	15,915	1,110	**199,731**
9	Samlong Coal Mine(Small Scale)	Triple 'A' Cement International Co., Ltd.														35,000	28,912	61,521	60,000	40,000	27,000	36,092	25,889	5,733	**320,147**
10	Na-Shan Coal Mine	Ming Htet Co., Ltd.																2,000	22,440	25,000	9,800	39,000	24,639	5,253	**128,132**
11	Mapan/Mongma Coal Mine	Ming Htet Co., Ltd.																31,500	35,000	37,000	15,100	39,000	54,286	18,313	**230,199**
12	Kongbaung/Nakon Coal Mine	Ngweyi Pale Mining Co., Ltd.																6,550	33,450	37,090	30,040	38,940	55,145	31,800	**233,015**
13	Maw Leik kyi Chaung Coal Mine	Geo Asia Industry and Mining Co., Ltd.																		2,200	5,000	12,000	11,116	2,000	**32,316**
14	Dah Thway Kyauk Coal Mine	Yangon City Development Committee																						5,000	**5,000**
15	Mine Khoke Coal Mine	Myanma economic Coporation																							**0**
16	Ban Chaung Coal Mine	May Flower Mining Enterprises Ltd.																					20,000	6,700	**26,700**
17	Kywe Tayar Taung Coal Mine	Myanmar Naing mining Group Co., Ltd.																							**0**
18	Kyak Sakhan Coal Mine	Yangon City Development Committee																					2,700	31,000	**33,700**
19	Kyauk Ohn Chaung Coal Mine	Myanma economic Coporation																			1,137	24,407	3,480		**29,024**
20	Dah Thway Kyauk & Pazun Seik Coal Mine	Dagon Mining Co., Ltd.																						4,000	**4,000**
21	Nang Tang Coal Mine	Tun Kywel Paw Co., Ltd.																					2,016	695	**2,711**
22	Thantaung Kywin Coal Mine	Shwe Ohn Pwint Co., Ltd.																					300	700	**1,000**
23	Paluzawa Coal Mine	Shwe Taung Mining Co., Ltd.																						5,623	**5,623**
24	Dah Thway Kyauk Coal Mine	G4 Mining Co., Ltd.																						100	**100**
25	Miinpalaung Coal Mine	G4 Mining Co., Ltd.																						100	**100**
26	Wah-Ye Chaung Coal Mine	Max Myanmar Co., Ltd.																			12,500	137,109	17,400	1,850	**168,859**
27	Three Small Scale Mines	Dragon Cement Co., Ltd.																				1,011.50	12,641.83		**13,653**
28	Pinlong Coal Mine	Mega Stremgth Co., Ltd.																				278.00			**278**
29	Kyak Sakhan Coal Mine	Thukha Panthu Co., Ltd.																				472.00			**472**
30	Sintaung Coal Mine	UE Export Import Co., Ltd.																					12,500	3,300	**15,800**
31	Kyak Sakhan Coal Mine	Young Investment Grop Industry Co., Ltd.																							**0**
32	Dah Thway Kyauk Coal Mine	Young Investment Grop Industry Co., Ltd.																							**0**
33	Thit Chauk & Labin Chaung Coal Mine	Htoo Interantional Industry Grop Co., Ltd.																						600	**600**
34	Harput Coal Mine	Ruby Garden Mining Co., Ltd.																					2,000	1,580	**3,580**
35	Maw Ku Coal Mine	Geo Asia Industry and Mining Co., Ltd.																					1,000	2,000	**3,000**
36	Hein Latt Coal Mine	Yuzana Cement Industrial Co., Ltd.																							**0**
37	Kaung Pong Chaung Coal Mine	Ngweyi Pale Mining Co., Ltd.																					300	1,350	**1,650**
38	Nan Pan Moon chaung Coal Mine	Mandalay Distribution and Mining Co., Ltd.																					900	10,200	**11,100**
39	Loon Taung Coal Mine	Myanmar Kauntoun Industry																							**0**
40	Kholan Coal Mine	Min Anawyahta Grop Co., Ltd.																							**0**
41	Na-ngwe Coal Mine	Ngweyi Pale Mining Co., Ltd.																					500	1,600	**2,100**
42	Mahu taung Coal Mine	Shwe Innwa Mining & Industry Co., Ltd.																					800	1,200	**2,000**
43	Pharso & matpaing Coal Mine	Shan Yoma Goal & Product Co., Ltd.																					900	1,250	**2,150**
44	Kyauk Sak Coal Mine	Thunder Lion Mining Co., Ltd.																						750	
		Total	**41,062**	**54,054**	**66,159**	**63,783**	**34,708**	**30,733**	**29,379**	**50,936**	**58,091**	**598,059**	**626,987**	**547,148**	**956,610**	**1,088,007**	**1,150,031**	**1,419,804**	**1,004,685**	**532,393**	**45,169**	**692,902**	**368,315**	**159,506**	**10,620,184**

Note: The accumulated coal production of 10,620,184 tons includes the amount of production from 1957 to 1991 as shown in the previous table.

(d) State of mining companies

The No.(3) Mining Enterprise, a governmental agency which is responsible for coal production in Myanmar, is promoting the Production Share Contract (PSC) with private companies in recent years. A mine area which spreads at least 50 mile (approximately 80.4km) is given to them. Under this type of contract, the investment is fully made by private companies, but the Government requires a certain amount of money allocation, in the sense that it provides coal resources that are state properties. Thirty-five companies have concluded the contract up to the present. Although major 13 coal mining group companies developed coal resources in 2010, they were issued a notification on May 4, 2010 that ordered them to supply coal to: (1) cement plants; (2) coal-fired power plants; and (c) CNMC to produce ferronickel.

PSC companies are recruited regularly by the No.(3) Mining Enterprise. They are required to report the operating and safety state of coal mine and the coal development plan, and placed under the supervision of the Government. An improvement order is issued when needed. There also is a supervisor organization, which supervises the coal mines. However, no supervisor is stationed in local areas. In their system, a supervisor is sent from the central governmental organization to local areas to inspect coal mines. Table 3-6 shows 35 companies that concluded the PSC with the Government. Figure 3-12 shows the locations of coal mines of the companies in operation.

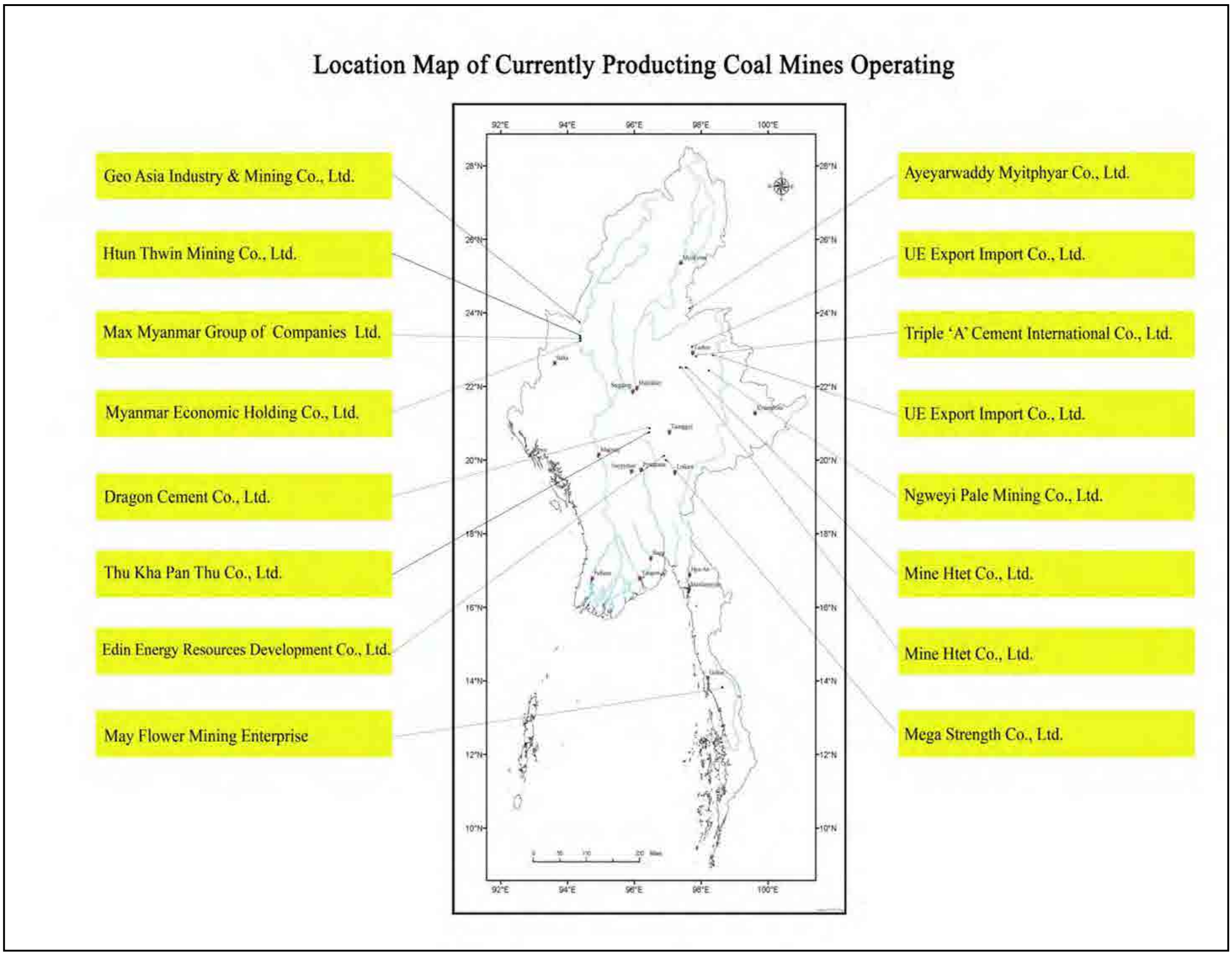
Table 2-18 Companies that Concluded PSC in Myanmar

Sr No.	Mine	Company
1	Lwejel Coal Mine	Arawaddy Myit Phya Co., Ltd.
2	Samlong Coal Mine (Large scale)	Triple 'A' Cement International Co., Ltd.
3	Ma Khaw Coal Mine	UE Export Import Co., Ltd
4	Paluzawa Coal Mine	Tun Thwin Mining Co., Ltd
5	Samlong Coal Mine (Small Scale)	Triple 'A' Cement International Co., Ltd.
6	Na-Shan Coal Mine	Ming Htet Co., Ltd.
7	Manpan¥Mongma Coal Mine	Ming Htet Co., Ltd.
8	Kongbaung / Nakon Coal Mine	Ngweyi Pale Mining Co., Ltd.
9	Maw Leik Kyi Chaung Coal Mine	Geo Asia Industry and Mining Co.,Ltd.
10	Dah Thway Kyauk Coal Mine	Yangon City Development Committee
11	Mine Khoke Coal Mine	Myanma Economic Corporation
12	Ban Chaung Coal Mine	May Flower Mining Enterprises Ltd.

Sr.No	Mine	Company
13	Kywe Tayar Taung Coal Mine	Myanmar Naing Mining Group Co., Ltd.
14	Kyak Sakhan Coal Mine	Yangon city Development Committee
15	Kyauk Ohn Chaung Coal Mine	Myanma Economic Corporation
16	Dah Thway Kyauk & Pazun seik Coal Mine	Dagon Mining Co., Ltd.
17	Nang Tang Coal Mine	Tun Kywel Paw Co., Ltd.
18	Thantaung Kywin Coal Mine	Shwe Ohn Pwint Co., Ltd.
19	Paluzawa Coal Mine	shwe Taung Mining Co., Ltd.
20	Dah Thway Kyauk Coal Mine	G4 Mining Co., Ltd.
21	Minpalaung Coal Mine	G4 Mining Co., Ltd.
22	Wah-Ye Chaung Coal Mine	Max myanmar Co., Ltd.
23	Sintaung Coal Mine	UE Export Import Co., Ltd.

	Mine	Company
24	Kyak Sakhan Coal Mine	Young Investment Grop Industry Co., Ltd.
25	Dah Thway Kyauk Coal Mine	Young Investment Grop Industry Co., Ltd.
26	Thit Chauk & Labin Chaung Coal Mine	Htoo International Industry Grop Co., Ltd.
27	Maw Ku Coal Mine	Geo Asia Industry and Mining Co., Ltd.
28	Hein Latt Coal Mine	Yuzana Cement Industrial Co., Ltd.
29	Kaung Pong Chaung Coal Mine	Ngweyi Pale Mining Co., Ltd.
30	Nan Pan Moon Chaung Coal Mine	Mandalay Distribution and Mining Co., Ltd.
31	Loon Taung Coal Mine	Myanmar Kauntoun Industry
32	kholan Coal Mine	Min Anawyahta Group Co., Ltd.
33	Na-ngwe Coal Mine	Ngweyi Pale Mining Co., Ltd.
34	Mahu Taung Coal Mine	Shwe Innwa Mining & Industry Co., Ltd.
35	Pharso & Matpaing Coal Mine	Shan Yoma Goal & Product Co., Ltd.

Source: Department of Geological Survey and Mineral Exploration (DGSE)



Source: Department of Geological Survey and Mineral Exploration (DGSE)

Fig. 2-30 Currently Operating Companies

(e) State of coal consumption

The actual coal consumption is shown in Table 3-7. Coal has been consumed in the cement industry, iron-related usage (a heat source for iron dissolution and ore refining) and coal briquette (coal is also used as household fuel) in Myanmer. Since December 2004, a coal-fired power plant (60 MW × 2 units) had been constructed at Tigyit in Pinlaung County in the southern part of Shan state to start operation of the first coal-fired power plant in Myanmar.

In 2009-2010, 386,740 tons of coal was consumed in total, out of which 207,850 tons was used for coal-fired power generation, 102,080 tons in the cement industry, 26,550 tons at steel works and 20,260 tons for coal briquette. In 2010-2011, 692,901 tons of coal was consumed in total, out of which 290,097 tons was used for coal-fired power generation, 362,347 tons in the cement industry, and 40,475 tons for other use. That means 42% of the total consumption was used for power generation, 52% was consumed as fuel the industry sector needed and 6% was used as fuel households need for cooking and heating.

In addition, to supplement an increasing demand for electricity, construction of the following coal-fired power plants has been discussed for a long time, but has not been realized yet.

· Yangon coal-fired power plant in 2013 (270 MW), Yangon Division
· Kalewa coal-fired power plant (600 MW), Sagain Division Kalewa
· Kawthaung coal-fired power plant (6 MW), Tanintharyi DivisionKawthaung

Table 2-19 Actual Coal Consumption

Source: Department of Geological Survey and Mineral Exploration (DGSE) (thousand tons)

Year	Amount of consumption					Total
	Cement	Steel	Briquette	Electric power	Other	
1998-1999	24.79	26.08	13.03	Nil	0.40	64.30
1999-2000	17.53	24.68	7.06	Nil	1.08	50.35
2000-2001	64.83	20.78	42.70	Nil	4.40	132.71
2001-2002	64.83	7.76	26.90	Nil	2.18	101.67
2002-2003	76.12	9.33	28.71	Nil	6.24	120.40
2003-2004	133.78	10.82	38.26	Nil	5.30	188.16
2004-2005	51.34	24.08	25.63	88.64	2.43	192.12
2005-2006	136.87	20.44	30.46	340.26	31.17	559.20
2006-2007	140.52	25.67	39.64	507.19	85.39	798.41
2007-2008	202.16	15.36	48.12	472.76	150.30	888.70
2008-2009	227.25	18.61	30.47	245.06	43.09	564.48
2009-2010	102.08	26.55	20.26	207.85	30.00	386.74
2010-2011	362.34			290.09	40.47	692.90

(f) Coal export

Table 3-8 shows the amount of coal export from Myanmer for each fiscal year. The areas along the borders with China and Thailand in Shan state and that along the border with Thailand in the peninsula area have exported coal to China and Thailand. The amount of export increased to 730,000 tons in 2003-2004, and then, decreased to around 30,000 tons in 2009-2010 due to a drop in demand in the both countries.

Mawdaung coal mine in Tanintharyi Division exported 4.5 million tons of coal to neiboughing Thailand in the period between 1992 and 2009. In the period between 1991 and 2010, 66.25 thousand tons of coal was exported from the boarder area with China.

Table 2-20 Actual Coal Export

Source: Department of Geological Survey and Mineral Exploration (DGSE) (thousand tons)

Year	Amount of export
1999-2000	90.36
2000-2001	401.88
2001-2002	531.25
2002-2003	439.87
2003-2004	737.26
2004-2005	799.88
2005-2006	623.30
2006-2007	515.21
2007-2008	228.59
2008-2009	43.09
2009-2010	30.00

(g) Coal price

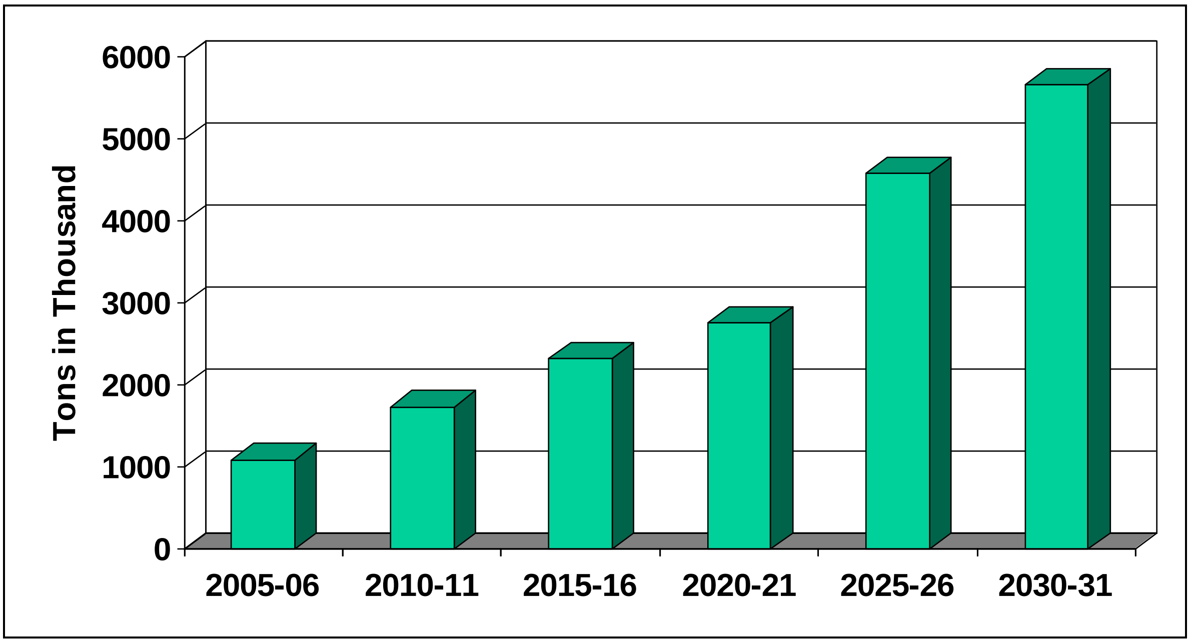
The price of coal is a market price: 7,000 to 25,000 Kyats (approximately 627 to 2,242 yen when calculating with a rate of 1 Kyats = 0.0897 yen) per ton in Shan state and 40,000 Kyats (approximately 3,588 yen when calculating with a rate of 1 Kyats = 0.0897 yen) in Kalewa area. The difference in price is a difference in calorific value of coal.

(h) Future coal production plan

The estimated amount of coal production is shown in Fig. 3-13. The government of Myanmar is preparing a plan to increase coal production in response to an increase in coal demand with the future social development. It expects the annual coal production of 5 million tons in total for 2030. This figure is provided in the coal production plan for coming 30 years in 2006/2007, which assumes around 40% increase in coal production every year.

Thousand tons

Year	Amount of production	State-owned	JV	Private
2005-2006	1,093.8	48.8	135.0	910.0
2010-2011	1,743.8	48.8	761.0	925.0
2015-2016	2.326.0	50.0	1,086.0	1,190.0
2020-2021	2,761.0	50.0	1,406.0	1,305.0
2025-2026	4,593.0	55.0	3,218.0	1,320.0
2030-2031	5,654.0	55.0	4,264.0	1,335.0



Source: No.(3) Mining Enterprise

Fig. 2-31 Coal Production Forecast

(i) Coal utilization technologies

The Government plans to promote the clean coal technology and is trying to apply the CCT technologies to each coal mine.

Ministry of Mine is promoting the construction of coal-fired power plants in cooperation with Ministry of Electric Power No.(1) and private companies. The coal-fired power plant with 120,000 kW generation capacity has been in operation at Tigyit in South Shan state since 2004.

2.6 Infrastructure development plan including transportation

2.6.1 Railways

(a) Railways in Myanmar

Railways in Myanmar are operated by Myanmar Railways controlled by Ministry of Railways and Transportation. The total length of railway tracks in Myanmar is 5,844 km as of October 2012. In general, they are consisted of the railway tracks spreading in the south-north direction with branch lines spreading in the east-west direction. The width of railway track is 1,000 mm and the axle load is 12 tons. The total number of passengers in fiscal 2011-2012 was 64.35 million people and the total cargo transportation volume was 3.58 million tons.

(b) Railways construction/enhancement plan

According to the Government, the five-year railways development plan in and after fiscal 2011-2012 is as shown below.

(1) Fiscal 2011-2012

- Enhancement of existing railway tracks
- Production of concrete sleeper and beam with enhanced strength and steel beam
- Construction of the following new railway lines

  Pwintpyu – Sinpyukyun (23 miles)
  Sinthe – Yeoo (19.3 miles)
  Ywataw – Natmauk (35.42 miles)
  Zalun – Danupyu – Setkawk (31.75 miles)
  Setkawk – Shansu (7.19 miles)
  Moetargyi – Cahungwa – Kyanukkyi (21 miles)
  Railway line approaching Arrawaddy Bridge (Pakuakku)
  Installation of tracks on Sinkhan Bridge (Banmaw) (3 miles)
  Railway line approaching Arrawaddy Bridge (Malon)

(2) Fiscal 2012-2013

- Enhancement of existing track for the entire railway line network
- Production of sleeper with enhanced strength at 11 sleeper production plants (8 plants are producing sleeper, 1 plant is under construction and 2 plants are planned to be constructed in the future.)
- Installation of tracks for Natmauk – Kanpya Line (25 miles) and Shansu – Hlaingthayar Line (14 miles)

- Construction of bridges in Sittwe – Kyauktaw Line
- Construction of one new locomotive assembly plant at Naypyidaw. Construction of new dolly and freight car assembly plant at Myitnge near Mandalay.
- Provision of the best services to the passengers and the shippers with raising the fares.

(3) Fiscal 2013-2014

- Enhancement of existing tracks for the entire railway line network
- Production of concrete sleeper and concrete and steel beam.
- Construction of the following lines: Kathar – Banmaw, Pyawbwe – Natmauk – Magwe, Minbu – Ann – Sittwe, Pathein (Begayat) – Yangon (Hlaingthayar) and Hinthada – Nyaungtone.
- Replacement of worn-out wood sleeper with concrete sleeper in the existing lines, especially in Yangon – Mandalay, Mandalay – Myitkyina and Bago – Mawlamyaing lines.
- Enhancement of the existing lines, especially Yangon – Mandalay, Mandalay – Myitkyaina, Bago – Mottama – Mawlamyaing – Ye – Dawei and Yangon – Pyi lines.
- Production of new locomotives, dollies and freight cars.
- Purchase of replacement parts of in-use locomotives, dollies and freight cars to improve ride quality.
- Increase in train speed between Yangon and Mandalay. Decrease of railway accidents. Facilitation of block system.

(4) Fiscal 2014-2015

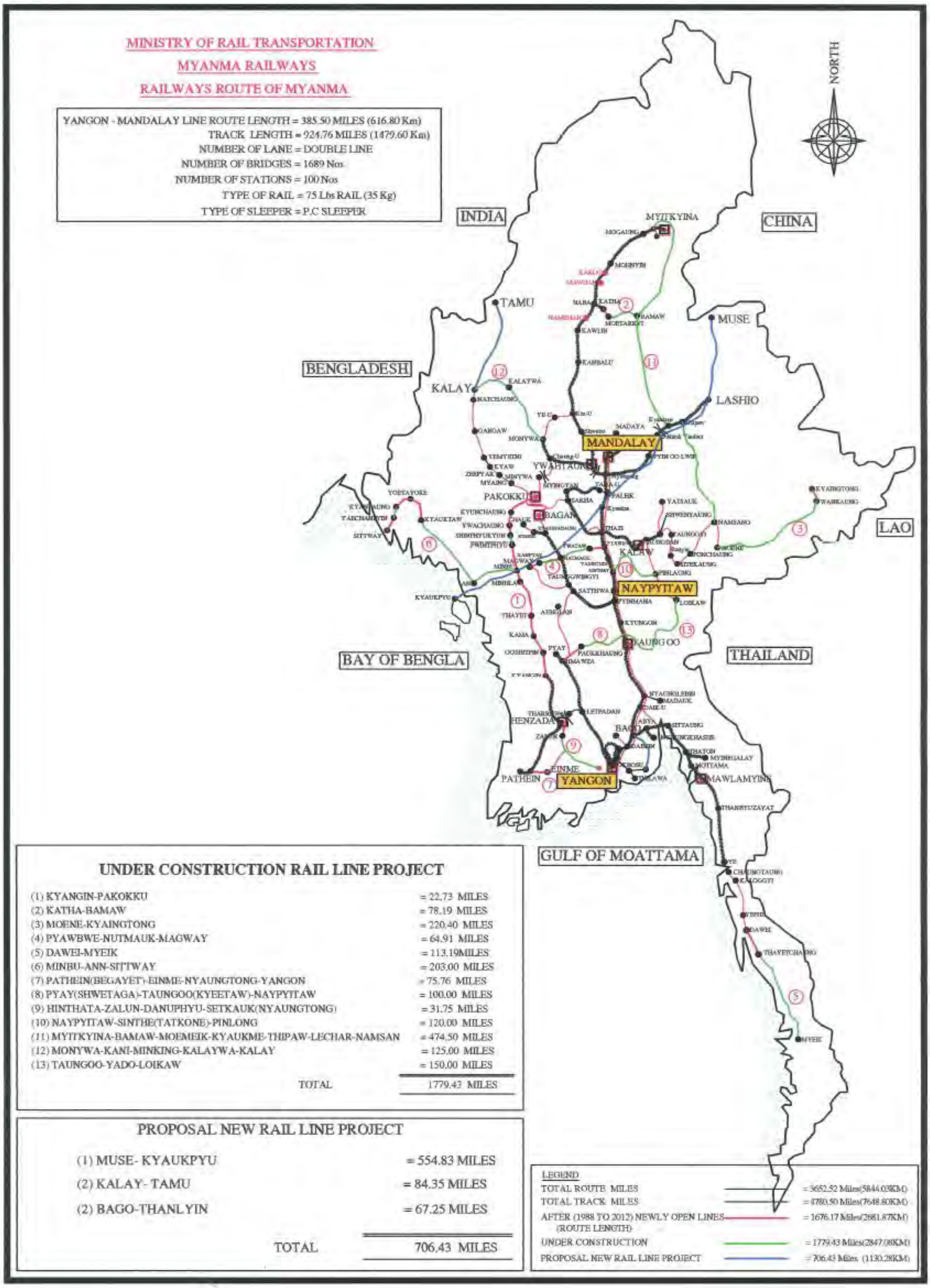
- Enhancement of tracks of the entire railway line network.
- Production of clamping materials such as dog nails and tools
- Continued construction of the following lines: Katha – Banmaw, Pyawbwe – Natmauk – Magwe, Minbu – Ann – Sittwe and Pathein – Yangon.
- Continued production of concrete sleeper.
- Continued enhancement of the following lines: Yangon – Mandalay, Mandalay – Myitkyina, Bago – Mottama – Mawlamyaing – Ye – Dawei and Yangon – Pyi.
- Continued production of locomotives, dollies and freight cars to meet an increase in traffic volume demand
- Purchase of parts that are necessary at the maintenance facilities of locomotives and dollies/freight cars to repair and maintain existing cars.

(5) Fiscal 2015-2016

- Continued enhancement of the following lines: Yangon – Mandalay, Mandalay – Myitkyina, Bago – Mottama – Mawlamyaing – Ye – Dawei and Yangon – Pyi.

- Continued construction of the following lines: Katha – Banmaw, Pyawbwe – Natmauk – Magwe, Minbu – Ann – Sittwe and Pathein – Yangon.
- Purchase of parts that are necessary at the maintenance facilities of locomotives and dollies/freight cars to repair and maintain existing cars.

The map of existing and newly planned routes obtained from Myanmar Railways is shown in Fig. 3-14.



Source: Myanmar Railways

Fig. 2-32 Map of Existing and Planned Routes of Myanmar Railways

(c) Coal transportation by rail

The coal transportation by rail in Myanmar had been conducted until fiscal 2010-2011 based on the application by the No.(3) Mining Enterprise. Coal produced at Namma coal mine, which had been operated by the No.(3) Mining Enterprise in Lasio area, Shan state until May 2010, was transported by rail from Lasio to Pyinoolwin, Mandalay state, a distance of approximately 146 mile (approximately 235 km). The unit train for coal transportation was consisted of seven coal freignt cars, and one unit train transported approximately 200 tons of coal.

However, since Namma coal mine stopped operation in May 2010, coal has not been transported by rail in Myanmar, as no application for coal transportation was made by the No.(3) Mining Enterprise.

For your reference, the transportation volume of Namma coal by Myanmar Railways is shown for each fiscal year in Table 3-9. The fiscal year starts in April and ends in March in Myanmar.

Table 2-21 Railway Transportation Volume of Coal by Fiscal Uear

(Unit: ton)

Fiscal year	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Railway transportation volume	21,336	10,977	9,047	1,007	22,176	18,704	12,156	12,079	9,698	9,472	1,152	0

Source: Myanmar Railways

(d) Railways construction cost

The data on railways construction cost in Myanmar obtained from Myanmar Railways is shown in Table 3-10.

Table 2-22 Railways Construction Cost

(Unit: US$ million)

	Hilly terrain area	Plain area
Railways construction cost (1 mile)	1.338	0.555
Railways construction cost (1 km)	0.831	0.345

Source: Myanmar Railways

(e) Standards for railways construction in Myanmar

While the existing railways had been constructed based on the Indian Railways Standards, new railways that will be constructed in the future are to be based on the ASEAN Railways Standards.

2.6.2 Road

(a) Road in Myanmar

Major arterial roads in Myanmar (Union Highways and Township network roads) are controlled by Public Works which is under the supervision of Ministry of Construction. Most roads except for the major arterial roads are supervised by Ministry of Boarder Area Ethnic Development. As of June 2011, the total length of roads in Myanmar is 142,395 km, 21.7% of which, i.e. 30,879 km, is paved.

The length of road by category is as shown below.

- Union Highways: 18,740 km
- Township network road: 19,045 km
- Major city roads and other roads: 26,427 km
- Village and boundary area roads: 78,183 km

The numbers of register vehicles and the total road length for each fiscal year in Myanmar are shown in Table 3-11.

Table 2-23 Numbers of Registed Vehicles and Road Length

Year	Registered Vehicles	Road Length (KM)
2001	445,167	69,732
2002	461,692	73,843
2003	476,350	78,266
2004	960,341	90,713
2005	978,522	92,859
2006	991,566	104,058
2007	1,024,372	111,737
2008	1,997,358	125,355
2009	2,067,839	127,942
2010	2,298,677	130,050
2011 June	2,331,663	142,395

Source: Public Works Public Corporation, Ministry of Construction

Three major roads in Myanmar are as below.

- Yangon – Mandalay Highway (695 km)
- Yangon – Pyay Road (288 km)

・Western Union Highway (Part of Pathein – Monywa Road which is planned to be constructed)

Other important roads are as below.

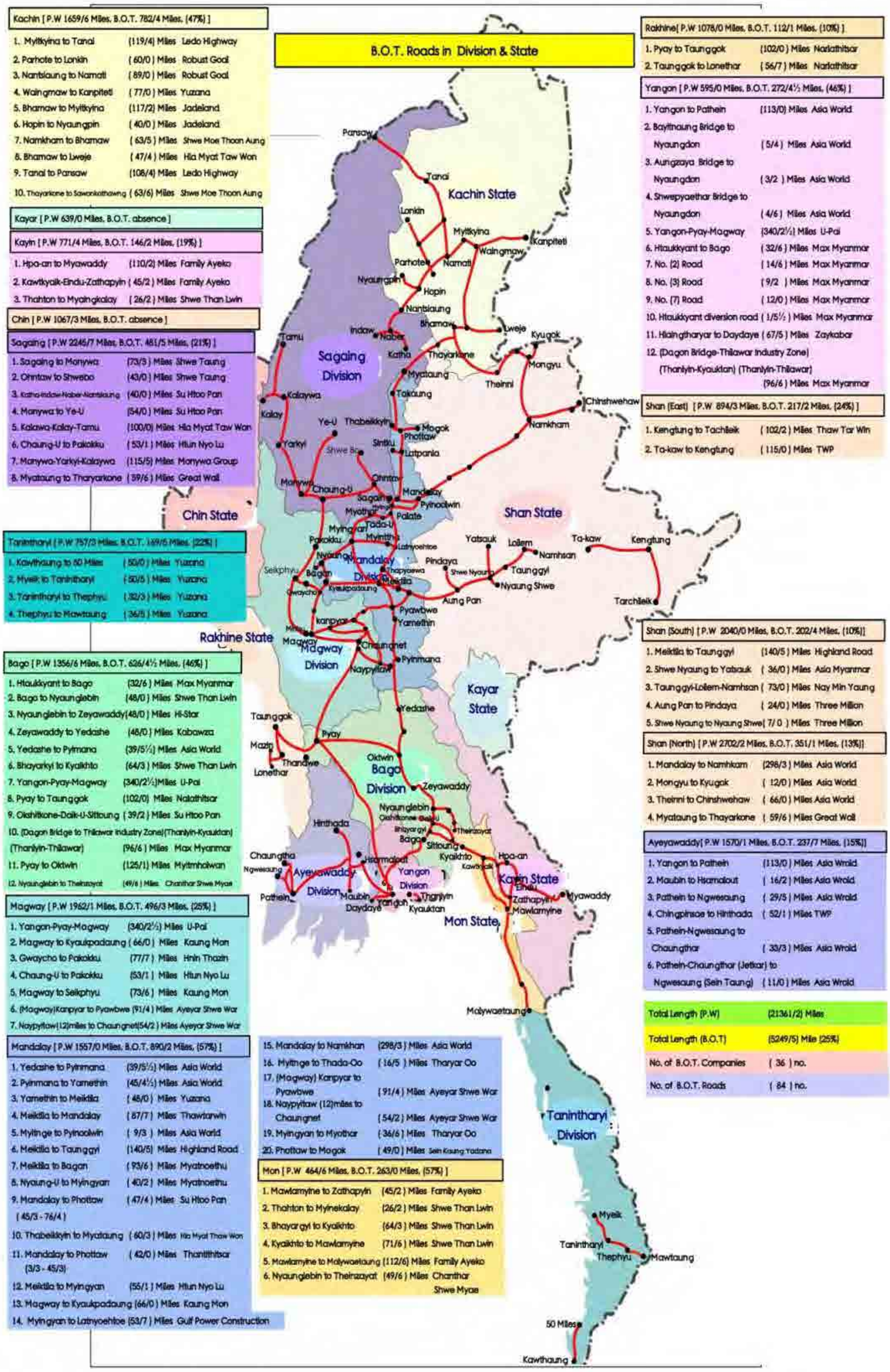
・Mandalay – Lasio Road (262 km)
・Meiktila – Taunggyi Road (205 km)
・Pyay – Magway Road (202 km)

It is said that conditions of roads in Myanmar are not good generally, except for some roads, such as Yangon – Mandalay Highway, Yangon – Pyay Road and Mandalay – Lasio Road.

(b) Construction of road by Build-Operate-Transfer (BOT)

Roads in Myanmar have been constructed by BOT since 1996. As of October 2012, 61 roads were constructed by BOT and the total length is 3,663.6 mile (approximately 5,895 km).

Figure 3-15 shows a list of roads constructed by BOT.



Source: Public Works Public Corporation, Ministry of Construction

Fig. 2-33 Roads Constructed by BOT

(c) Road construction plan

Road development master plan

The master plans on road construction have been developed in Myanmar. As shown below, there are six road development plans from the First Five-Year Plan that started in 2001 to the Sixth Five-Year Plan.

- First Five-Year Plan (2001 – 2006)
- Second Five-Year Plan (2006 – 2011)
- Third Five-Year Plan (2011 – 2016)
- Fourth Five-Year Plan (2016 – 2021)
- Fifth Five-Year Plan (2021 – 2026)
- Sixth Five-Year Plan (2026 – 2031)

For your reference, the contents of the Third to Sixth Five-Year Plans are shown in Table 3-12.

Table 2-24　Contents of the Third to Sixth Five-Year Plans

Five-Year Plan	Period	Contents	Length (mile)
Third	2011-2016	Link to international transportation roads	5,665.0
		Existing projects	4,482.6
		Construction of new roads	1,052.8
Fourth	2016-2021	Main implementation projects	2,772.1
Fifth	2021-2026	Link to international transportation roads	5,970.0
Sixth	2026-2031	Main implementation projects	3,323.6

Source：Public Works Public Corporation, Ministry of Construction

Main National Highways construction plan to link to the international roads

Nine main roads that Myanmar Government plans to link to the international roads are as shown below.

- Shwebo- Myitkyina road (476 km)
- Mawlamyine- Ye- Dawei- Meik- Kawthaung road (934 km)
- Meikhtila- Taunggyi- Kyaingtong- Tacheleik road (677 km)
- Monywa- Pale- Gangaw- Kalaymyo road (311 km)
- Monywa- Kalewa road (186 km)
- Mandalay- Thabeikkyin- Tagaung- Bhamo road (282 km)
- Minbu- Ann- Sittwe road (477 km)
- India- Myanmar- Thai Tripartite road
- Ruili- Kyaukphyu road

(d) Road construction cost and construction standards

Table 3-13 shows the construction cost of 12 ft-width paved road (Bitumen) for each State/Region obtained from the Public Work Public Corporation of Ministry of Construction.

Table 2-25 Construction Cost of 12 ft-width Paved Road (Bitumen) for Each State/Region

(Unit: million Kyat/mile)

State / Region	Construction cost
Kachin State	187.00
Kayah State	187.50
Kayin State	157.00
Chin State	181.00
Sagain Region	148.00
Tanintharyi Region	176.00
Bago Region	182.30
Magwe Region	154.50
Mandalay Region	127.00
Mon State	183.00
Rakhine State	202.00
Yangon Region	243.00
Shan State (East)	190.50
Shan State (South)	157.00
Shan State (North)	178.00
Ayeyarwaddy Region	206.40
Naypyitaw Region	148.33

Source: Public Works Public Corporation, Ministry of Construction

In the construction standards for major roads such as National Highways are established by the Public Work Public Corporation of Ministry of Construction in Myanmar.

(e) Construction of new roads for coal transportation

All coal is transported on trucks using roads from the coal mines operating in Lasio area, Shan state to the coal users. When the construction or enhancement of the roads between the coal mines and the existing roads becomes necessary, the cost for construction/enhancement is to be owed by coal mines.

In the case of a coal mine operating in Lasio area, the cost required to develop a site for the 36-mile road to link to the existing road is approximately 8 million kyat per 1 mile.

(f) Toll with truck transportation of coal

To transport coal on truck from coal mines to the coal users, the trucks run on the existing roads such as

National Highways. However, there is no special toll for the coal transportation on truck, being handled in the same way as ordinary cars.

Chapter 3 Electricity Sector and Coal-Fired Power Plant in Myanmar

3.1 Electricity sector in Myanmar

3.1.1 Energy policy

Under the current energy policy, the following issues are being considered: Efficient development of utilizable energy in Myanmar and the promotion of efficient energy use such as spreading of energy-saving in terms of demand. In addition, the government plans to expand the use of renewable energy as well as reducing the consumption of non-commercial energy such as firewood to protect forests.

In the existing energy policy, the following six points are picked up as important items.

- Increase an energy self-sufficiency rate.
- Develop hydraulic power proactively to utilize domestic resources.
- Improve the electricity sector to help economic development (to resolve power outage)
- Promote the use of renewable energy.
- Promote the efficient energy use such as promoting energy-saving.
- Reduce the use of non-commercial energy such as firewood.

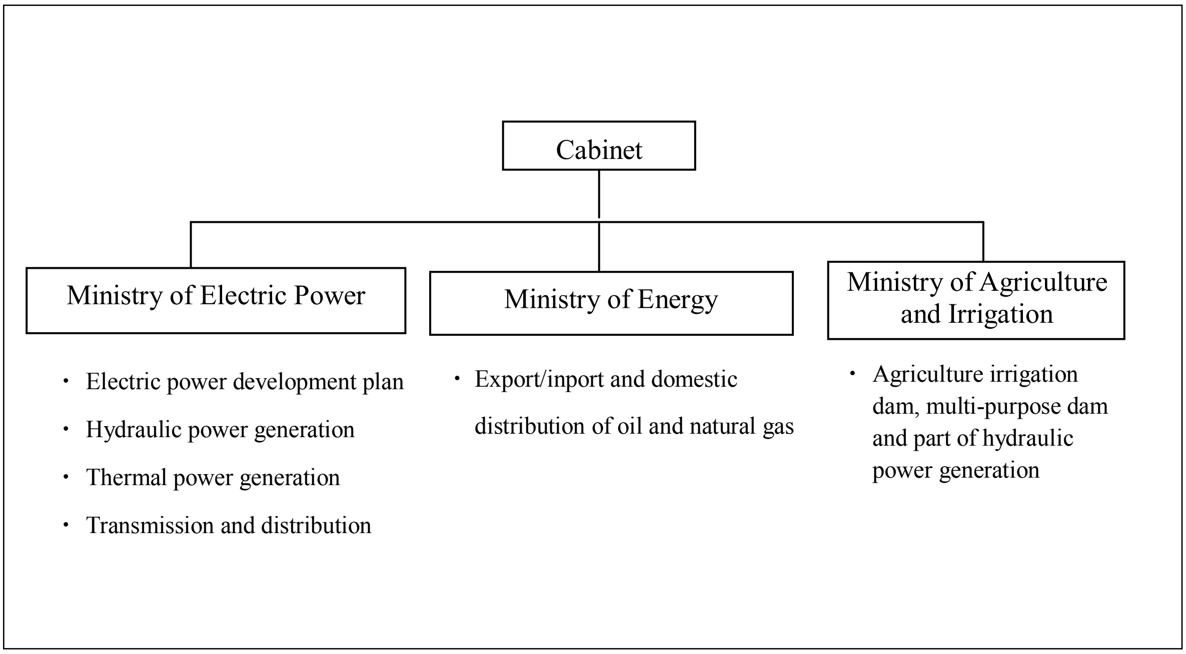
As to the electric policy, the following five items are picked up as emergency issues.

- Short-term plan：Install additional gas turbines to stop planned blackout.
- Mid- to Long-term plan: Develop water resources that are abundant within the Country to resolve electric power shortage as well as exporting electricity to neighboring countries.
- Expand and improve electricity transmission and distribution facilities.
- Decrease the loss rate of electricity transmission and distribution as well as spreading energy-saving measures.
- Develop new energy and renewable energy.

3.1.2 Composition of electricity sector

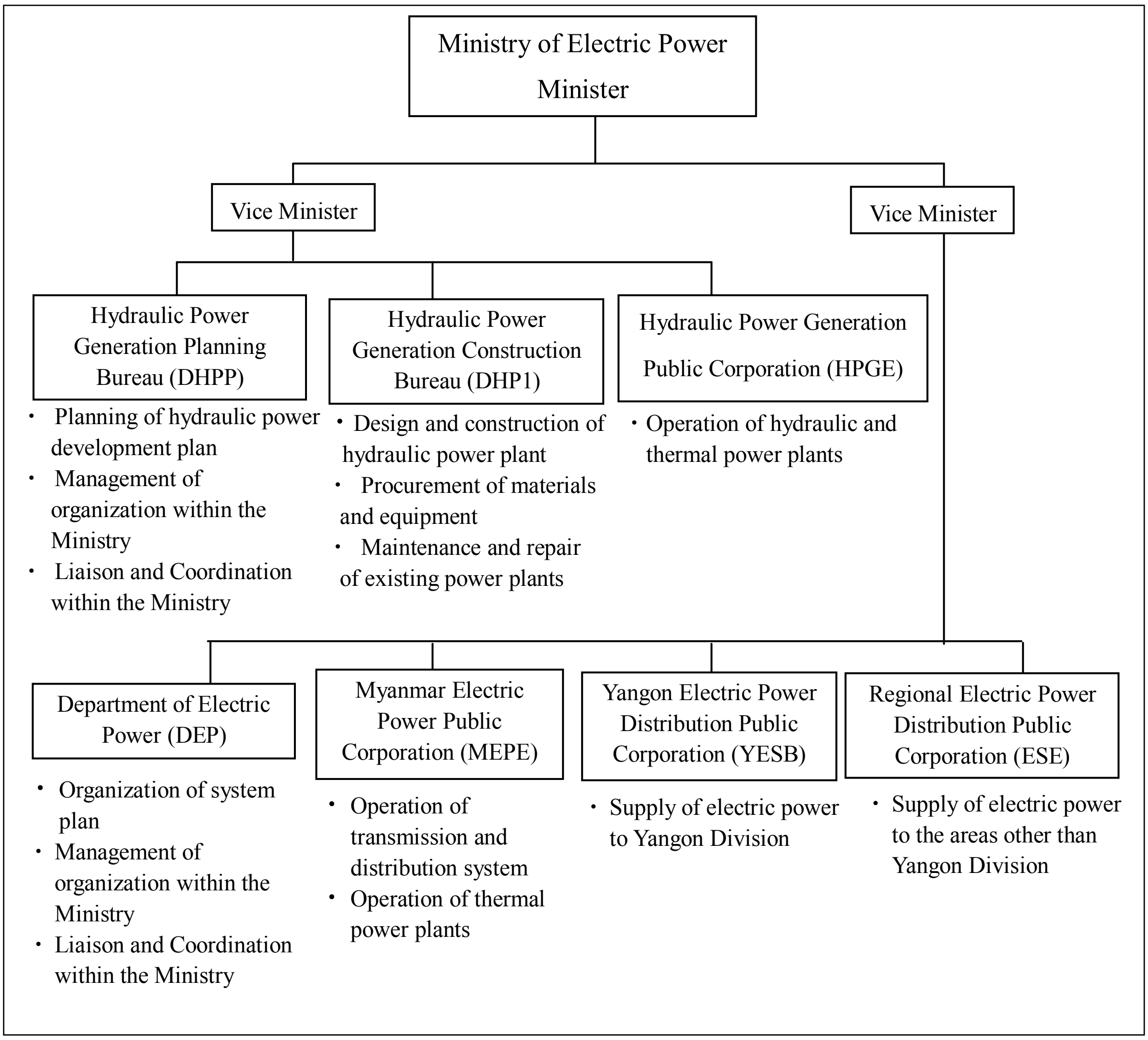
The Electricity Supply Act was established in 1948, when Myanmar became fully independent from United Kingdom. Electric utilities in each area were nationalized based on the ACT and the Burma Electricity Agency was established in 1951.

In 1972, the electric utilities across the country were consolidated into Burma Electricity Public Corporation (later Myanmar State Electricity Corporation). Then, Ministry of Electric Power was established in 1997. With the organizational changes of governmental agencies in May 2006, the Ministry was divided into two: Ministry of Electric Power No.1 and Ministry of Electric Power No.2. Ministry of Electric Power No.1 was to supervise hydraulic power development and power plants, and Ministry of Electric Power No.2 was to supervise thermal power development, transmission and distribution of electricity and sales. Yangon Distribution Public Corporation and Regional Distribution Public Corporation were placed under Ministry of Electric Power No.2. The Myanmar Government considered that a centralized supervision system was necessary for appropriate electric power generation and supply and reviewed the existing organizational system in September 2012 to consolidate the two ministries to establish Ministry of Electric Power. The relevant electric power/energy ministries, the organization of Ministry of Electric Power and the electric power supply system are shown in Figs. 4-1, 4-2 and 4-3 respectively.



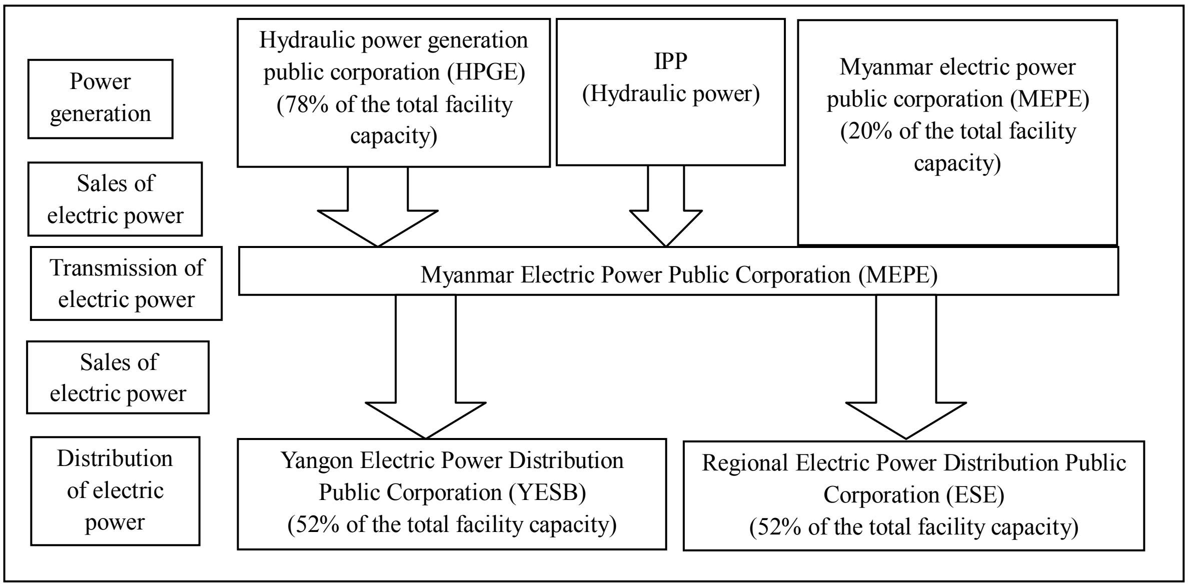
Source: Japan Electric Power Information Center, Inc.

Fig. 3-1 Relevant Electric Power/Energy Ministries



Source: Japan Electric Power Information Center, Inc.

Fig. 3-2 Organization of Ministry of Electric Power



Source: Japan Electric Power Information Center, Inc.

Fig. 3-3 Electric Power Supply System

3.1.3 Electric power supply and demand and generated power

Table 4-1 shows the power demand forecast. The maximum power in fiscal 2010 and 2011 is 1,371 MW and 1,588 MW each. In fiscal 2012, it is expected to be 1,850 MW. Ministry of Electric Power assumes that the maximum power will increase by 15% year-on-year in fiscal 2013 and later.

Table 3-1 Power Demand Forecast

Year	Max. Power Demand (MW)	Increased (%)
2010	1371	---
2011	1588	15.8
2012	1850	16.49
2013	2128	15
2014	2447	15
2015	2814	15
2016	3236	15

Source: Ministry of Electric Power

There were 30 existing power plants as of August 2012 and their total output was 3,495 MW. As to the composition of power source, 76.1% is for hydraulic power, 3.4% for coal fire and 20.5% for gas fire (including gas turbines). When compared to 1,684 MW, a total output of the existing power plants in 2006, it is enhanced to about 2.1 times. The amounts of power generated by electric utilities in 2009 to 2011 were

6,829,865 MWh, 7,810,780 MWh (an year-on-year increase of 14%), and 10,033,556 MWh (an year-on-year increase of 28%) each, increasing with the enhancement of the facilities.

However, as shown in Table 4-2, 515 MW of the maximum electric power of 1,530 MW was suspended at the planned blackout on March 14, 2012, which shows a gap with the potential demand. While such a supply capacity shortage has being resolved gradually with starting of the operation of a new hydraulic power plant, the planned blackout still continues.

Table 3-2 Actual Planned Blackouts (March 14, 2012)

Covered consumer and area/ time		5:00-11:00	11:00-17:00	17:00-23:00	23:00-5:00
Commercial-scale consumer	Within Yangon	65 MW For industrial use 50%	65 MW For industrial use 50%	130 MW For industrial use 100% 20 MW For commercial use 15 MW For iron industry	
	Other areas	25 MW For industrial use 50%	25 MW For industrial use 50%	50 MW For industrial use 100% 50 MW Reverine pump 70 MW For commercial use 40 MW For iron industry	
Small-scale consumer	Within Yangon	100 MW	100 MW	80 MW	50 MW
	Other areas	110 MW	110 MW	60 MW	50 MW
Total		300 MW	300 MW	515 MW	100 MW

Source: Materials of Japan Electric Power Information Center, Inc. Oct. 18, 2012

3.1.4 Electric power rates

There are three types of retail electric power rates in Myanmar: the rate for governmental agencies, the rate for general users and the rate for religious and social facilities. The rate for general users is the rate on a kyat basis for people in Myanmar. The rate for foreigners is the rate on a US dollar basis for the companies and the representative offices using foreign exchange settlement and the foreign resident. The electric power rates in 2012 are shown in Table 4-3.

Table 3-3 Electric Power Rates (2012)

Category	Pay-as-you-go rate		
	Governmental agencies	**General**	**Religious/social facilities**
Domestic use	35 Kyats	35 Kyats	35 Kyats
Commercial use	35 Kyats	35 Kyats	35 Kyats
Industrial use	35 Kyats	75 Kyats	—
Foreigners	—	12 cents	—

Source: Materials of Japan Electric Power Information Center, Inc. Oct. 18, 2012

3.1.5 Power development plan for the entire nation of Myanmar

Ministry of Electric Power promotes enhancement of facilities as the short-term power development plan in response to an increase in the electric power demand that is expected in the period between 2013 and 2016. Specifically, the Ministry plans to install gas engines at the following power plants to respond to the demand expected in the summer season (from February to May) in 2013.

- Takeda 50 MW Installed by Myanma private companies
- Roga 50 MW Installed by Myanma private companies

As the long-term power development plan, the Ministry intends to promote the projects for the facilities to be completed in 2016 and later. Major power plants under contemplation are as shown in Table 4-4.

Table 3-4 Major power plants under contemplation

	Project		**Output** (MW)
Hydro Power (To be completed by 2016)			
1	Phyu Chaung	2 × 20; by 2013	40
2	Kun Chaung	3 × 20; by 2012?	60
3	Baluchaung (3)	by 2013	52
4	Upper Paunglaung	2 × 70; by 2014	140
5	Anyaphya		9
6	Upper Baluchaung	by 2014	29
7	Ann Chaung	2 × 5; by 2016	10
8	Saingdin		76.5
9	Thaukyegat (2)	3 × 40; by 2013	120
10	Chipwinge		99
11	Nancho	2 × 20; by 2013	40
		Subtotal	675.5
Thermal Power (To be completed by 2016)			

	Project	Output (MW)
1	Yangon Coal-fired Thermal Power Plant	270
2	Kalewa Coal-fired Thermal Power Plant	600
3	Kawthaung Coal-fired Thermal Plant	6
	Subtotal	876
	Total	1,551.5
Hydro Power (To be completed by 2021)		
1	Upper Yeywa by 2019	280
2	Shweli (3) by 2020	1,050
3	Hutgyi	1,360
4	Bawgata	160
5	Upper Kengtaung 3 × 17; by 2018	51
	Total	2,901

Source: ADB Report

3.2 Development plan for coal-fired power plants

Ministry of Electric Power explained us that the coal-fired power development plan and the coal-fired power generation plan by IPP as well as the policies for them are currently under consideration and specific policies will be determined though future discussions. The Ministry seeks for the development of Gas-fired power plant (CCGT and others) and coal-fired power plant by the private sector.

3.2.1 Coal-fired power plant development plan

According to Ministry of Electric Power, the plan for new coal-fired power plants is as shown in Table 4-5.

Table 3-5 Coal-fired Power Plant Development Plan

	Project	Output (MW)	Current Status
Coal fired Thermal Power Plant			
1	Yangon Coal-fired Thermal Power Plant	270	Planning
2	Kalewa Coal-fired Thermal Power Plant	600	Planning
3	Kawthaung Coal-fired Thermal Plant	6	Under Construction
4	Not specified (south region)	500	Planning

(Source: ADB report and interview)

3.2.2 Procedures for the development of coal-fired power plant

Procedures for application and approval for the development of new coal-fired power plant are as below.

- After a utility has decided a desirable development point, power generation scale (output and number of unit) and fuel (domestic or overseas), it applies for Ministry of Electric Power and concludes MOU with the Ministry.
- Utility conducts FS after the conclusion of MOU. Economic performance is provided in FS and electric power selling prices should also be provided.
- When a project is further promoted based on the result of FS, MOA and Ministry of Electric Power should be concluded.
- The procedures toward the construction of power plant are taken after the conclusion of MOA.
- As a basic rule, a power plant should continue its operation for forty years.
- In case of the investment from foreign countries, the BOT system based on JV with local company is used. (JN/BOT).
- The electric power rate of IPP is determined by the Regulation Committee for each project.

3.3 Infrastructure development including transmission system

3.3.1 Current conditions of transmission system

The existing transmission lines in Myanmar are consisted of the systems with the voltages of 230kV, 132kV and 66kV. In rural areas, there are some transmission lines that are not part of the state transmission line network. Figure 4-6 and Figure 4-7 show the existing transmission lines and the existing transformation lines respectively.

Table 3-6 Existing Transmission Lines

Voltage (kV)	**Length** (km)
230	3,251
132	2,383
66	3,614
Total	9,247

Source: Materials of Japan Electric Power Information Center, Inc. Oct. 18, 2012

Table 3-7 Existing transformation lines

Voltage (kV)	**Number of transformer stations**	**Capacity** (MVA)
230	25	3,280
132	25	1,579
66	96	1,983
Total	146	6,842

Source: Materials of Japan Electric Power Information Center, Inc. Oct. 18, 2012

3.3.2 Transmission system enhancement plan

Ministry of Electric Power (MEPE) promotes enhancement construction to complete the construction of facilities included in the transmission line plan and the transformer station plan as shown in Fig. 4-8 and Fig. 4-9 in accordance with the five-year (from 2011 to 2016) expansion plan for the transmission network.

Table 3-8 Transmission Lines under Contemplation

Voltage (kV)	**Number of transmission lines**	**Length** (km)
500	6	2,724
230	80	9,483
132	12	660
66	33	1,966
Total	131	14,834

Source: Materials of Japan Electric Power Information Center, Inc. Oct. 18, 2012

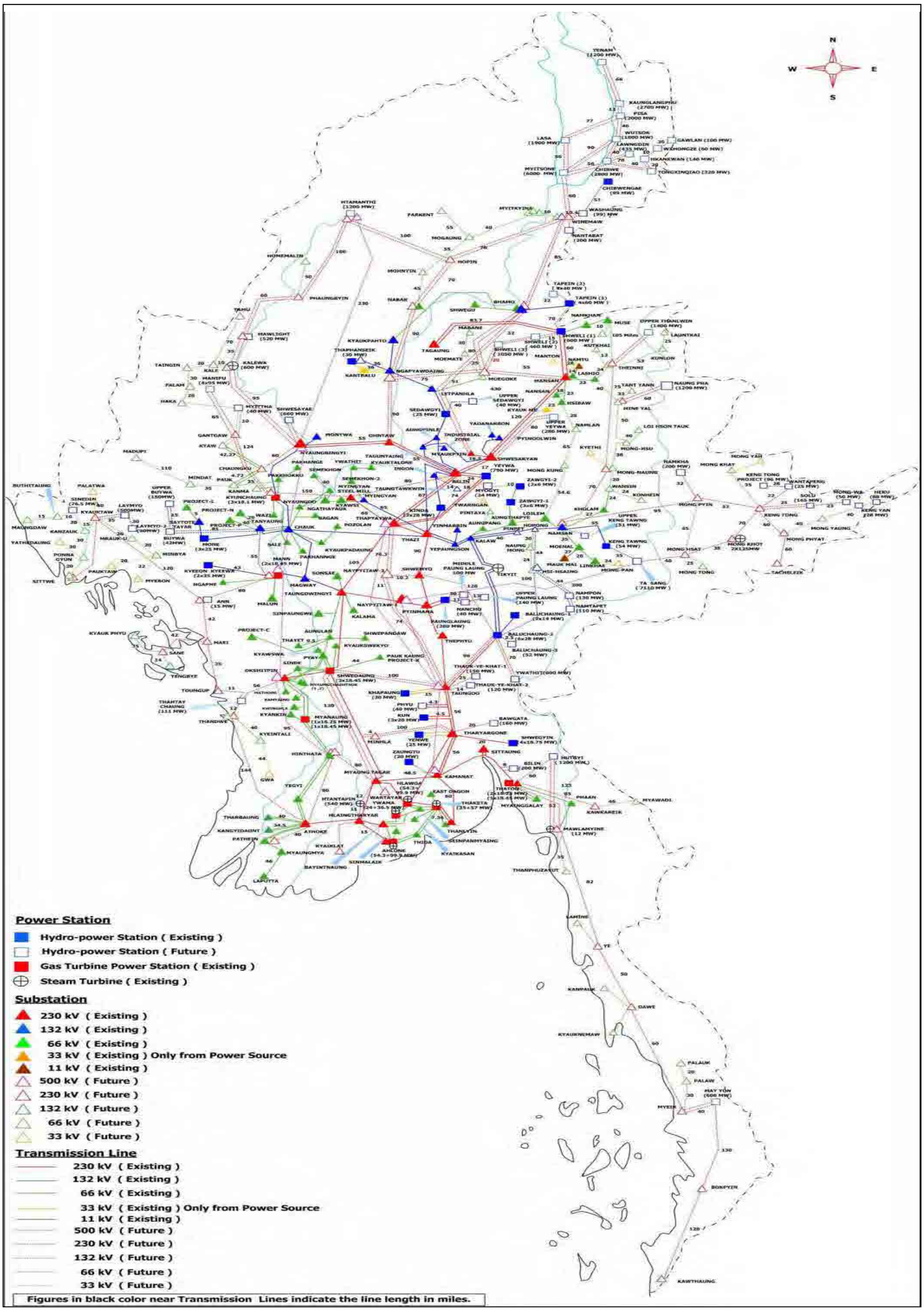
Table 3-9 Transformer station under contemplation

Voltage (kV)	**Number of transformers**	**Length** (km)
500	10	5,000
230	25	2,360
132	10	675
66	31	340
Total	76	8,375

Source: Materials of Japan Electric Power Information Center, Inc. Oct. 18, 2012

The transmission system development plan for the entire nation of Myanmar is as shown in Fig. 4-4.

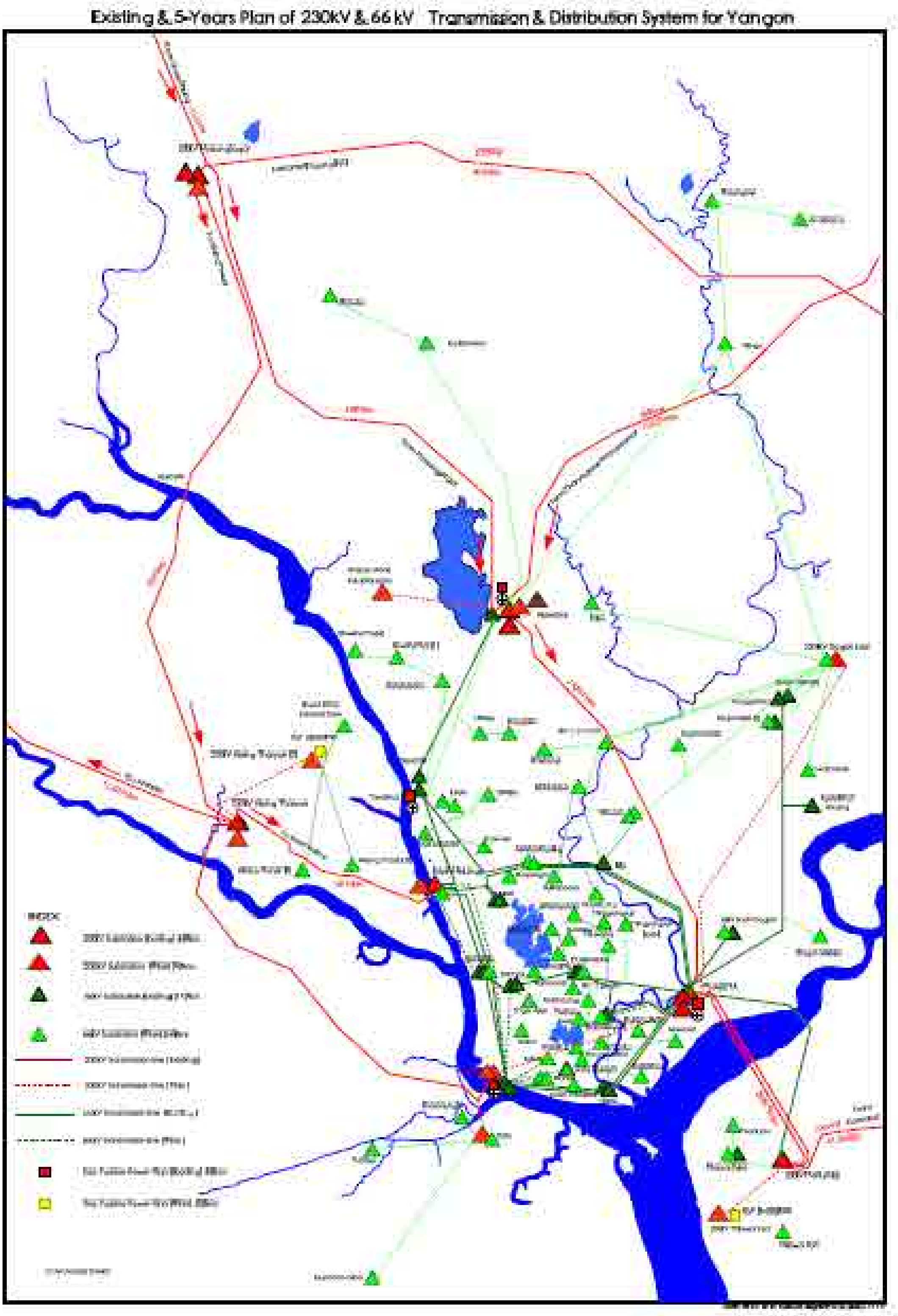
Fig. 3-4 Transmission Line System Development Plan (for the Entire Nation of Myanmar)



Source: Ministry of Electric Power

The transmission system development plan in Yangon area is as shown in Fig. 4-5.

Fig. 3-5 Transmission System Development Plan (Yangon Area)



Source: Ministry of Electric Power

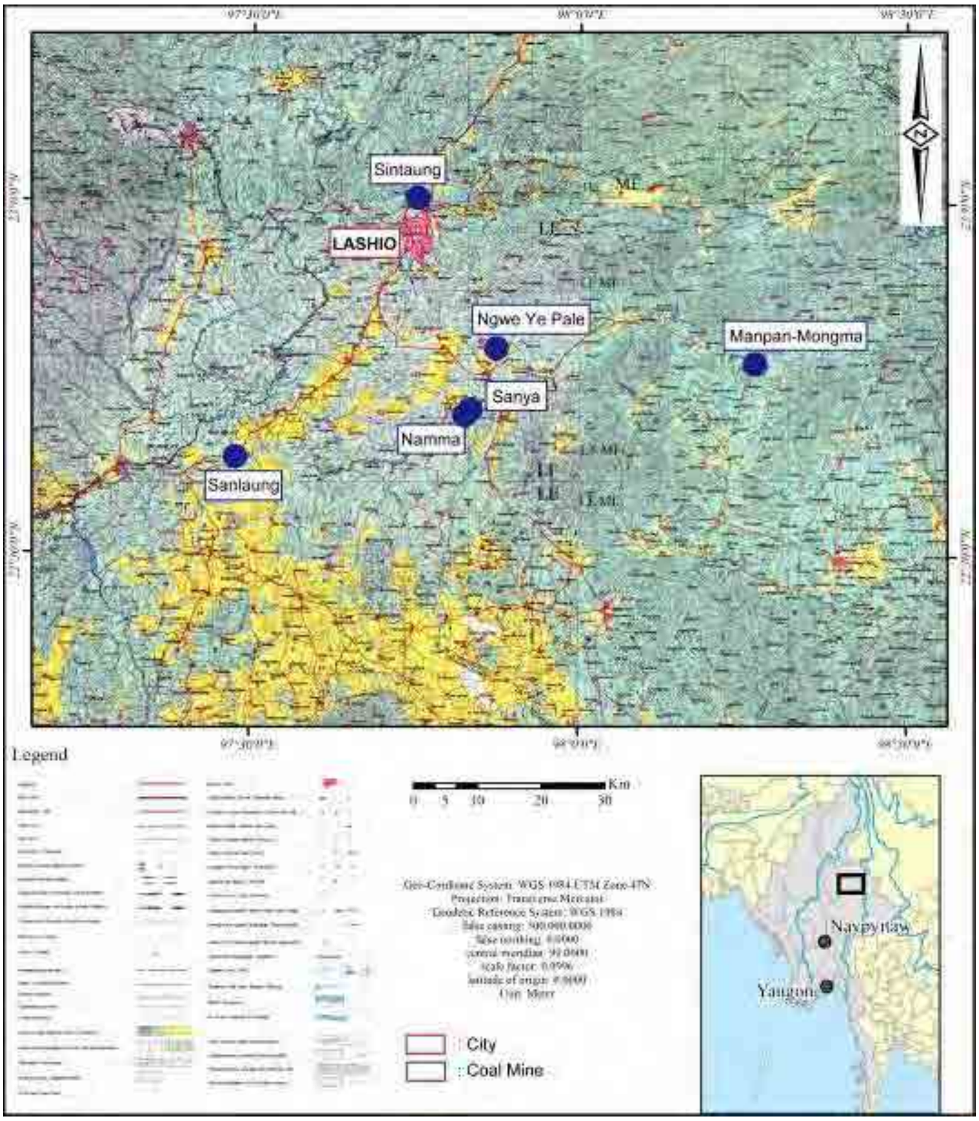
Chapter 4 Environmental facilities/environmental and social considerations on coal development and coal fired power plant

4.1 Current state of environmental conservation

4.1.1 Current state of environmental conservation at coal mine sites

For the purpose of investigating the current state of environmental conservation in the Lasio region, the Initial Environmental Examination (hereinafter referred to as IEE) will be conducted according to JICA's Environmental Guidelines. Originally, the IEE is intended to conduct a preliminary evaluation of a project at the planning stage to contribute to the basic design of the project. We will conduct an IEE to investigate to the current state of environmental conservation at the coal mine sites that operate in this region. The location map of the coal mines in this region is shown in Fig. 4-1.

The IEE procedure includes grasping of the content of the target project plan and the situation of the site, screening, scoping, survey of the situation of sites, impact prediction, impact assessment, necessary environmental conservation planning and monitoring planning. The flow of IEE is shown in Fig. 4-2.



Source: Prepared by the investigation group

Fig. 4-1 Location Map of the Coal Mines in the Lasio Region

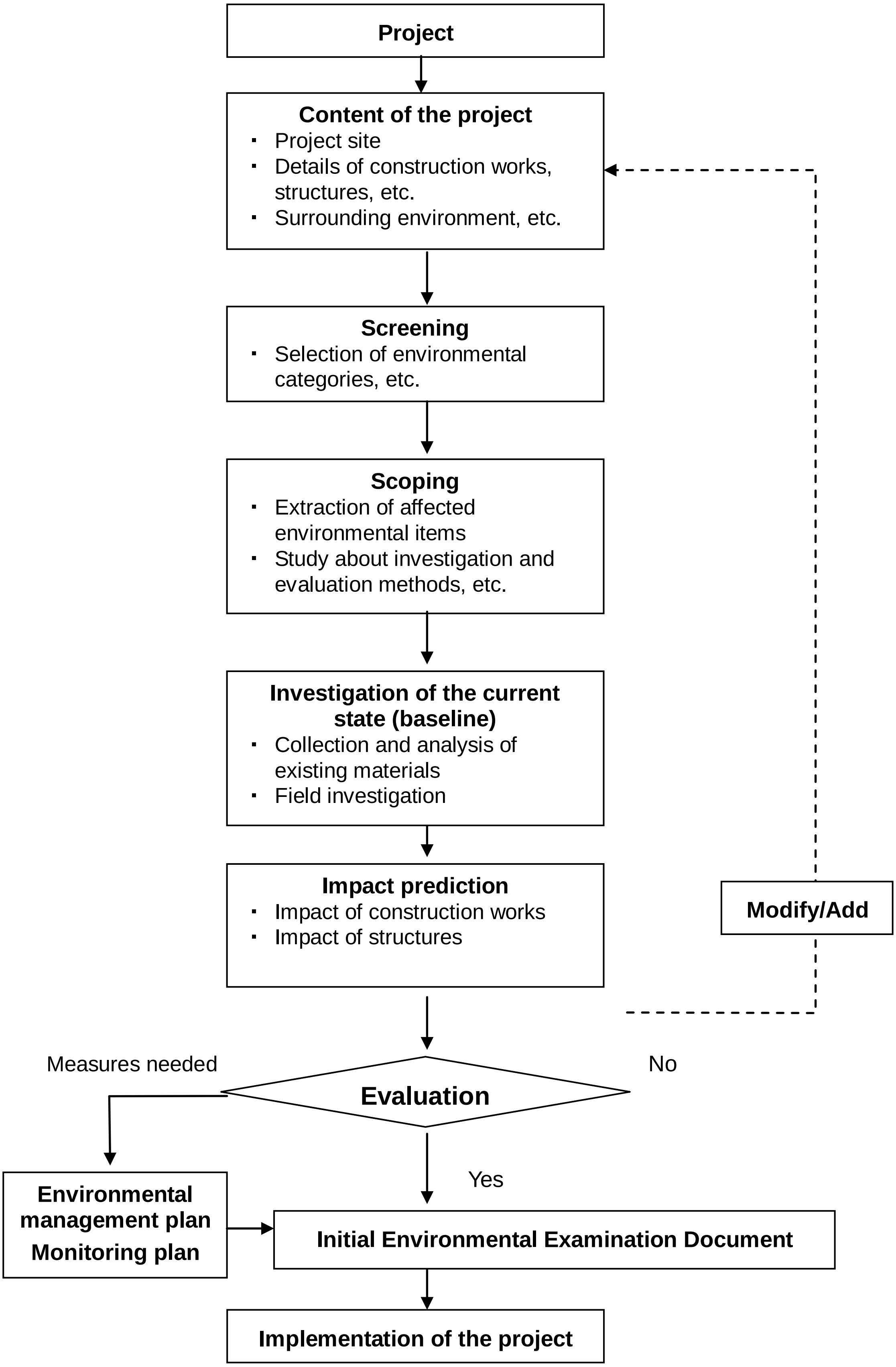


Fig. 4-2 Flow of IEE

(a) Screening

The result of screening in the Lasio region is shown in Table 4-1.

Table 4-1 Result of Screening in the Lasio Region

No.		Environmental item	Content	Evaluation	Remark
Social environment	1	Relocation of residents	Relocation associated with land occupation (transfer of residence right/land ownership)	Yes・No・Unknown	At some places, relocation of residents is conducted. At present, there is no particular effect.
	2	Economic activity	Loss of production opportunities on land, change of economic structure	Yes・No・Unknown	Increase of job opportunities
	3	Transportation and facilities for living	Effects on the existing traffic such as traffic congestion or detour, effects on schools and hospitals	Yes・No・Unknown	Use of the existing roads. There is no facility around the site.
	4	Community severance	Severance of the local community by traffic block	Yes・No・Unknown	No particular effect
	5	Remains or cultural properties	Loss or reduction of remains, buried cultural properties, or natural monuments	Yes・No・Unknown	There are no remains or cultural property around the site.
	6	Water right and commonage	Impairment of fishery right, water right or forest commonage	Yes・No・Unknown	No particular effect
	7	Health and sanitation	Degradation of sanitation and environment by generation of garbage and insect pests	Yes・No・Unknown	Garbage from the facility will generate but have little effect.
	8	Wastes and wastewater	Generation of construction wastes, surplus soils, waste oil and general/industrial wastes during construction works, wastewater from surrounding houses around the site	Yes・No・Unknown	No particularly large effect
	9	Disaster (risk)	Increase of risk such as ground failure or ground fall and accidents	Yes・No・Unknown	No increase of risk
Natural environment	10	Topography and geology	Alteration of valuable topography and geology by excavation or banking	Yes・No・Unknown	No particular alteration of valuable land
	11	Soil erosion	Outflow of top soil due to rainwater after land formation or deforestation	Yes・No・Unknown	There is a possibility of outflow of top soil due to continuous rainfall in the rainy season, but there is little effect.
	12	Ground water	Pollution by discharge water in excavation work, pollution by effusion water	Yes・No・Unknown	There is a possibility of pollution by effusion water.
	13	Lake and river basin	Change of flow rate or river-bed by landfill or inflow of drainage	Yes・No・Unknown	There is a possibility of temporary change, but the effect is relatively small.
	14	Seacoast and sea area	Coast erosion or deposition by landfill and change in the state of sea	Yes・No・Unknown	The site does not border any seacoast.
	15	Animals and plants	Inhibition of breeding or extinction of species due to change of habitat conditions	Yes・No・Unknown	There is a possibility of temporary change, but the effect is relatively small.
	16	Weather	Change of temperature or wind by large-scale structures and buildings	Yes・No・Unknown	No particular effect

	17	Landscape	Change of landform due to land development, inhibition of harmony by structures	Yes・No・Unknown	Placement of facilities may have effect on landscape.
Living environment	18	Air pollution	Pollution by exhaust gas or noxious gas from vehicles and plants	Yes・No・Unknown	Exhaust gas of air pollutant gas from vehicles, etc. is generated.
	19	Water pollution	Pollution by inflow of soil and industrial wastewater	Yes・No・Unknown	There is a possibility of inflow of soil and wastewater from facilities.
	20	Soil pollution	Pollution by dust and asphalt emulsion	Yes・No・Unknown	There is a possibility of pollution by dust, etc.
	21	Noise and vibration	Generation of noise and vibration caused by vehicles, aircrafts or plants.	Yes・No・Unknown	There is a possibility of generation of noise and vibration by vehicles, etc.
	22	Ground subsidence	Subsidence of ground surface associated with ground change or groundwater level	Yes・No・Unknown	No particular effect
	23	Odor	Generation of exhaust gas and malodorous substances	Yes・No・Unknown	There is a possibility of generation of odor.
Overall Evaluation: Is the IEE-level or EIA-level investigation required for this project?				Yes・No	IEE-level investigation: Required

(b) Scoping

The result of scoping in the Lasio region is shown in Table 4-2.

Table 4-2 Result of Scoping in the Lasio Region

No.	Factor of impact / Environmental item		During construction work											In service of facilities after construction			Selection item
			Carrying-in of materials and equipment	Cutting of grass or trees	Excavation of surface soil	Laying of access road	Construction of plant	Laying of drainage channel	Construction of bridges	Earth cutting/Banking work	Setting of sewerage facility	In-site garbage/surplus soil removal	Water pumping/conveying facility	Water pumping/conveying	Purification/drainage, etc.	Product/shipping, etc.	
1	Social environment	Relocation of residents (or existence of landowner)	—	—	—	—	○	—	—	—	—	—	—	—	—	—	◎

2		Economic activity	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3		Transportation and facilities for living	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4		Community severance	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5		Remains or cultural properties	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6		Water right and commonage	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7		Health and sanitation	—	○	○	—	○	○	—	—	○	○	○	○	○	—	◎
8		Wastes and wastewater	○	○	○	—	○	○	—	—	○	○	○	○	○	—	◎
9		Disaster (risk)	○	○	○	○	○	—	—	○	○	○	○	○	○	○	◎
10	Natural environment	Topography and geology	—	○	○	○	○	—	—	○	—	—	○	○	—	—	◎
11		Soil erosion	—	○	○	○	○	○	—	○	○	○	○	○	○	○	◎
12		Groundwater	—	○	○	—	—	○	—	○	○	○	○	○	○	—	◎
13		Lake and river basin	—	—	—	—	—	—	—	—	—	—	○	○	—	—	◎
14		Seacoast and sea area	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15		Animals and plants	○	○	○	○	○	○	—	○	—	—	○	○	○	○	◎
16		Weather	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17		Landscape	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	Living environment	Air pollution	○	—	—	○	○	—	—	—	—	—	—	—	○	○	◎
19		Water pollution	○	○	○	○	○	○	—	○	○	○	○	○	○	○	◎
20		Soil pollution	○	○	○	○	○	—	—	○	○	○	○	○	○	○	◎
21		Noise and vibration	○	—	—	○	○	—	—	—	—	—	—	—	—	○	◎

22		Ground subsidence	—	—	—	—	—	—	—	—	—	—	○	○	—	—	◎
23		Odor	○	○	○	○	○	○	—	○	○	○	—	—	—	○	◎

* ○: It has negative effects. —: It has a minimal effect or no effect.

(c) Investigation of the current state (baseline)

Investigation of the current state (baseline) is intended to collect and analyze existing related materials and information and to grasp the natural environment, social environment and living environment at the site.

As the environmental items, 1) relocation of residents, 2) health and sanitation, 3) wastes and wastewater, 4) disaster (risk), 5) topography and geology, 6) soil erosion, 7) groundwater, 8) lake and river basin, 9) animals and plants, 10) air pollution, 11) water pollution, 12) soil pollution, 13) noise and vibration, 14) land subsidence and 15) odor were selected based on the scoping result, and their effects were estimated. Therefore, in the IEE-level investigation for environmental and social considerations, the above 15 items are studied.

(1) Relocation of residents

The coal mines operating in the Lasio region are Manpan-Mongma Coal Mine (100 km southeast from Lasio), Ngwe Ye Pale Coal Mine (about 65 km south-southeast from Lasio), Sanya Coal Mine (about 45 km southeast from Lasio), and Sintaung Coal Mine (10 km north from Lasio) (Fig.5-1). Each mine lot is located mostly along the existing roads, but no house is found close to the operation site.

In Manpan Village located about 5 miles west from Manpan-Mongma Coal Mine, about 3,000 people, mainly from the Shan tribe, live. About 100 people (about 20 households) live in Pensan Village (where mainly rice is grown) near Ngwe Ye Pale Coal Mine. Near Sintaung Coal Mine, about 200 households live in Shenkeng village (1 mile east from the coal mine) and about 300 households live in Sonque village (1.5 miles northeast from the coal mine).

(2) Health and sanitation

Each village near the coal mines in the Lasio region generally has only a small-scale medical institution such as clinic (less than two doctors) and has no ambulance. According to the hearing, Manpan Village located about 5 miles west from Manpan-Mongma Coal Mine has a clinic where 3 to 4 doctors reside.

(3) Wastes and wastewater

In the villages near each coal mine in the Lasio region, no facility for wastes or wastewater is found. At some of the operating coal mines, wastes such as vinyl were found. According to the hearing, however, treatment of wastes in compliance with the regulations is conducted, but we couldn't confirm that at the site.

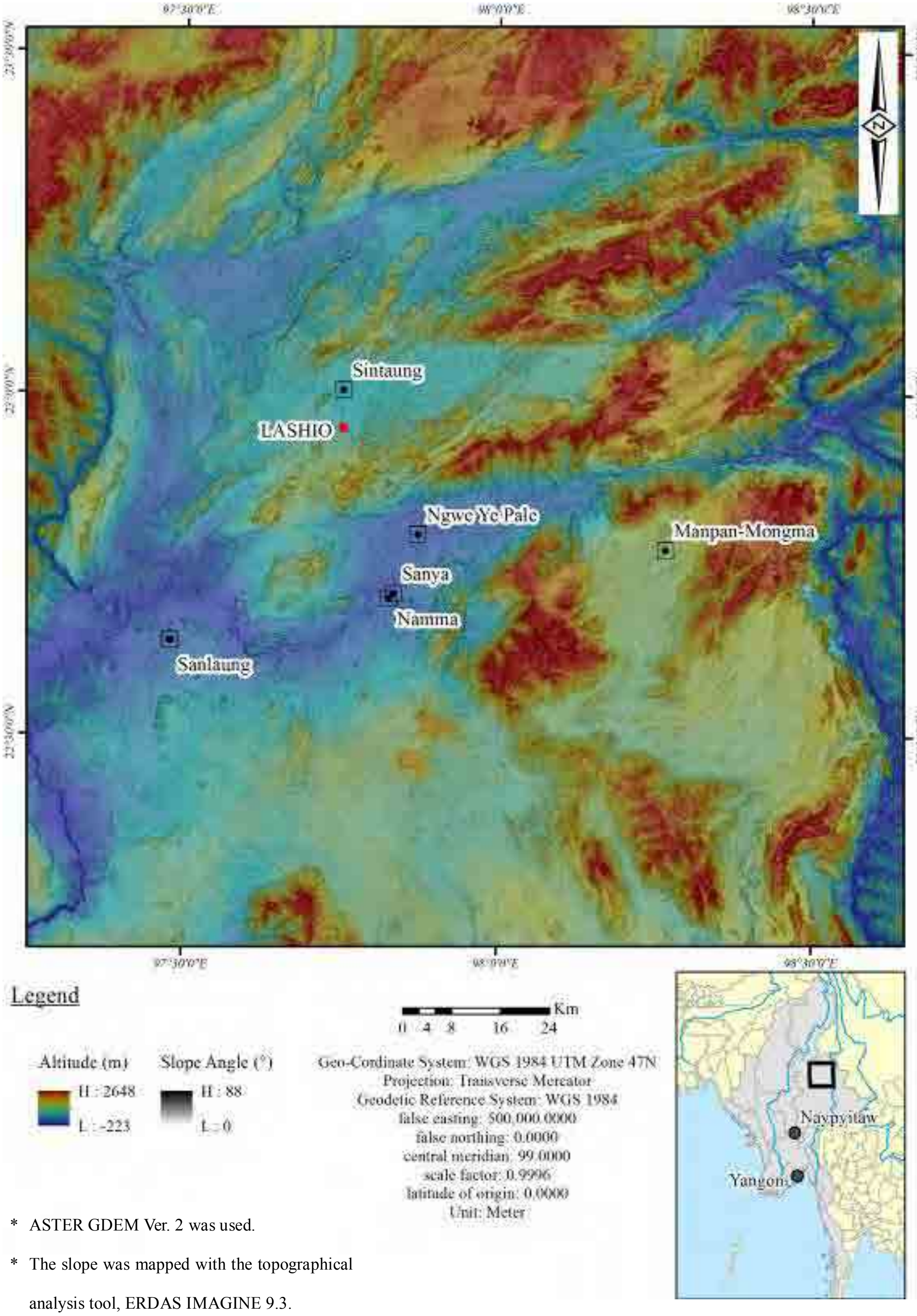
(4) Disaster (risk)

They say that some roads flood at rainfall in the rainy season in the Lasio region and small-scale earth slides occur. No large-scale disaster has been known.

(5) Topography and geology

① Topography

The topography of the Lasio region is generally formed with east-west mountains. The width of the mountains is from 10 to 20 km. The relatively deeply dissected topography having about 700 to 1,000m of altitude above sea level is found in the Nam Ma River basin. Major coal mines in this region are concentrated in the Nam Ma River basin. The terrains formed in the relatively late mature stage which have over 1,000 to 2,100m of altitude above sea level are found around Manpan-Mongma Coal Mine and present a clearly circular landform (See Fig. 4-5).

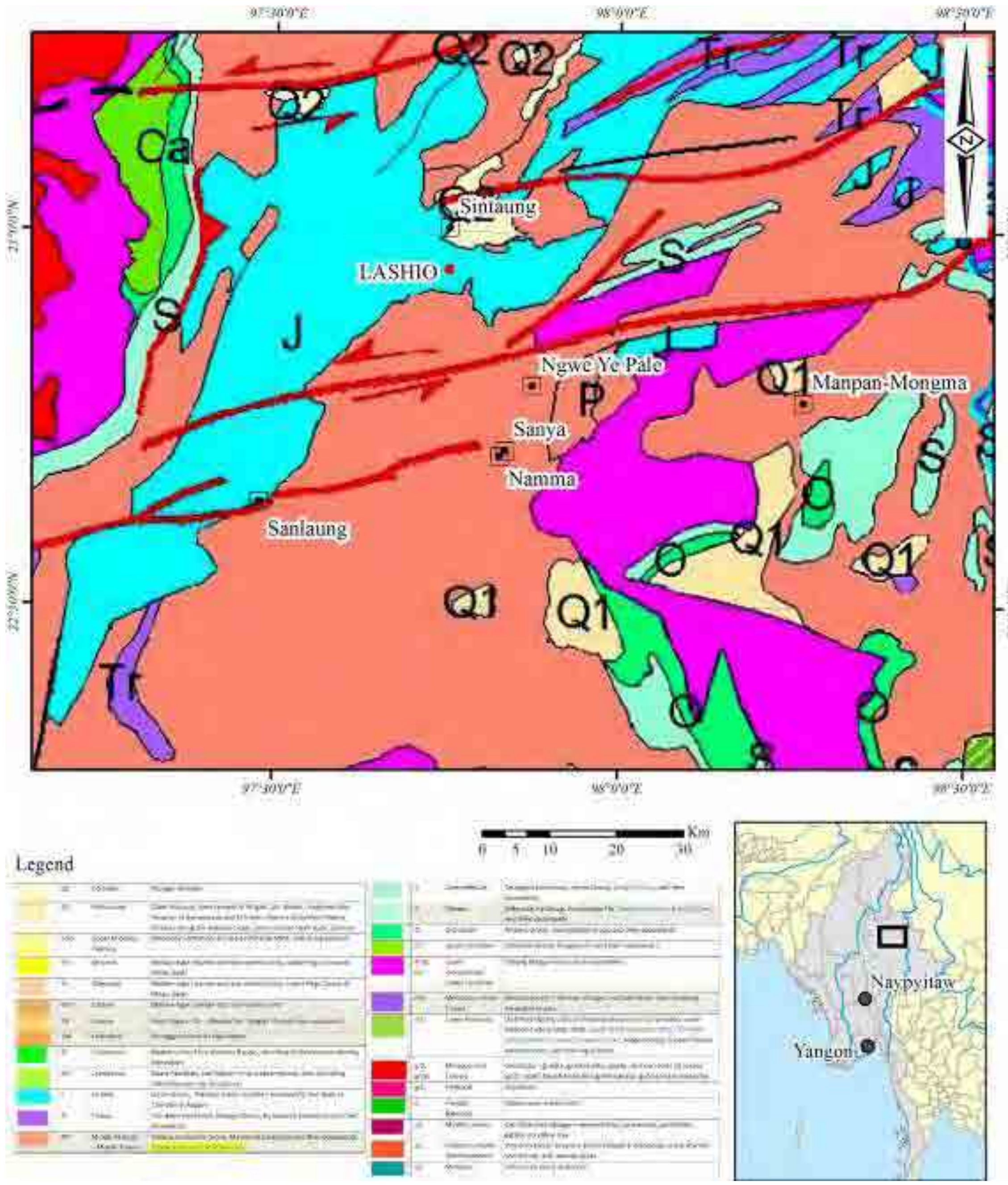


Source: Prepared by the investigation group

Fig. 4-3 Overlaid Map of Slope (Angle) and Altitude for the Lasio Region

② Geology

The geology of the Lasio region consists of, from the lower part, greiss, quartzite and phyllite sedimented from the Precambrian period to the Upper Cambrian period, limestone from the Debonian Period to the Permian Period, red mud stone in the Jurassic period, and sandstone and mudstone layers in the Tertiary period which are mainly coal-bearing layers. The top part is covered with alluvial. Each layer generally presents an east-west distribution harmonic with the geological structure, and the distributions of the major coal mines has the trends of presenting east to west and northeast to southwest (see Fig. 4-4).



Source: Prepared by the investigation group

Fig. 4-4 Geology of the Lasio Region

(6) Soil erosion

In the Lasio region, soil erosion caused by frequent heavy rains in the rainy season has been found, especially, in the areas having relatively steep terrains at elevations above 1,000 to 2,100m around Manpan-Mongma Coal Mine.

(7) Groundwater

The state of groundwater in the Lasio region is unknown. In each village, however, there are wells at various places, and they are used for water for living.

(8) Lake and river basin

The river basins at the major coal mines in Lasio region are classified under three main groups (see Fig. 4-5): starting at the north, Nam Yao River basin (basin area: about 1,498 km^2) where Sintaung Coal Mine is located; Nam Ma River basin (basin area: about 2,804 km^2) where Ngwe Ye Pale Coal Mine, Sanya Coal Mine, Namma Coal Mine and Sanlaung Coal Mine are located; and Nam Pang River basin (basin area: about 3,222 km^2) where Manpan-Mongma Coal Mine is located.

(9) Animals and plants

The state of animals and plants in the Lasio region is unknown. However, as the typical flora, the plant species such as dicotyledon and monocotyledon have been observed.

(10) Air pollution

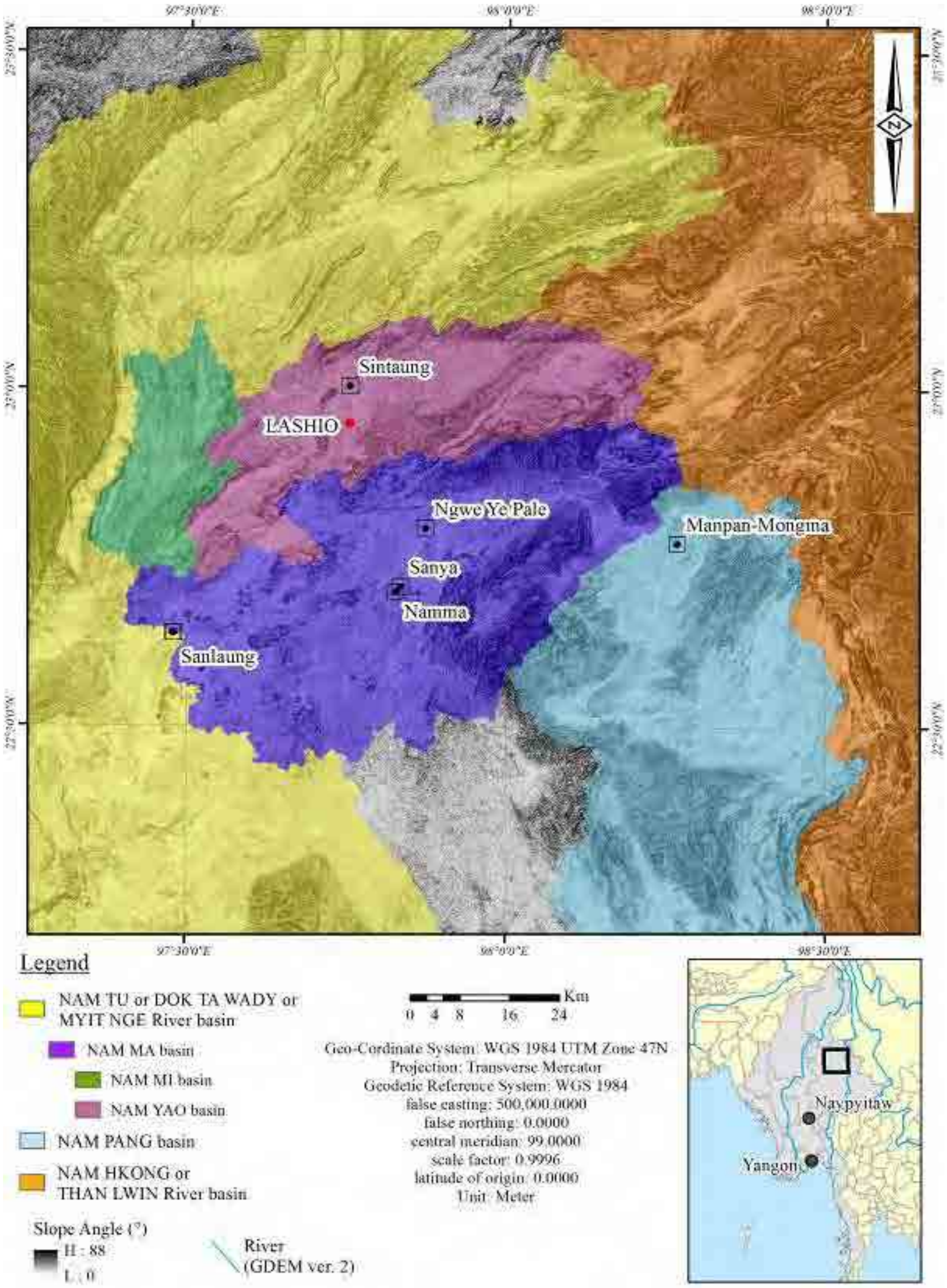
The state of air quality around the major coal mines in the Lasio region is unknown. Except two coal mines, Namma Coal Mine and Sanlaung Coal Mine, which are not operating, four coal mines have been in operation, but they have no specific emission standard set for environmental standard values. Therefore, monitoring with specific numeric value settings has not been performed in any coal mine. The actual highest frequency of transportation by truck with the coal carrying capacity of 12 tons was 70 tons a day.

(11) Water pollution

The state of water quality around the major coal mines in the Lasio region is unknown. Except two coal mines, Namma Coal Mine and Sanlaung Coal Mine, which are not operating, four coal mines have been in operation, but they have no specific emission standard set for environmental standard values. Therefore, monitoring with specific numeric value settings has not been performed in any coal mine.

(12) Soil pollution

The state of soil pollution around the major coal mines in the Lasio region is unknown. Except two coal mines, Namma Coal Mine and Sanlaung Coal Mine, which are not operating, four coal mines have been in operation, but they have no specific emission standard set for environmental standard values. Therefore, monitoring with specific numeric value settings has not been performed in any coal mine.



* ASTER GDEM Ver. 2 was used.

* River basins and river systems were mapped with reference to Nogami et al. (1998).

Source: Prepared by the investigation group

Fig. 4-5 Extraction Result of the Major River Basins around the Lasio Region

(13) Noise and vibration

The state of noise and vibration around the major coal mines in the Lasio region is unknown. Except two coal mines, Namma Coal Mine and Sanlaung Coal Mine, which are not operating, four coal mines have been in operation, but they have no specific emission standard set for environmental standard values. Therefore, monitoring with specific numeric value settings has not been performed in any coal mine. The actual highest frequency of transportation by truck with the coal carrying capacity of 12 tons was 70 tons a day.

(14) Land subsidence

The state of land subsidence around the major coal mines in the Lasio region has not been currently observed. However, there is concern about land subsidence due to traffic of large vehicles such as trucks in mining activities.

(15) Odor

The state of odor around the major coal mines in the Lasio region is unknown. Except two coal mines, Namma Coal Mine and Sanlaung Coal Mine, which are not operating, four coal mines have been in operation, and the actual highest frequency of transportation by truck with the coal carrying capacity of 12 tons was 70 tons a day. In addition, sulphur odor generating from coals was observed at some coal mines. In this hearing, there was no comment about odor, but there is concern about generation of exhaust gas from vehicles in mining activities and malodor such as sulphur odor from coals.

4.2 Development of related laws, review of policies, future expectation

4.2.1 Development of related laws, review of policies

In December 1994, the Myanmar government adopted the environmental policy from the viewpoint of protection of interests for the present and the future generations, stating that the government and the people have responsibility for preservation of natural resources and “environmental protection should be placed at the highest priority” in development. In addition, the “Myanmar Agenda 21” was developed in 1997 toward implementation of “environmental considerations” in future national development projects and establishment of an effective environmental management system. In March 30, 2012, the Environmental Conservation Law was enacted, which serves as a basis for general environmental conservation following the principles of the both government’s policies (programs).

In addition, as the current laws on conservation of natural resources relating to coal development, the Myanmar Mines Law (enforced in September 1994) and the Myanmar Mines Rules (enforced in December 1996) were established for the purpose of encouraging investment by foreign companies for development of Myanmar’s mining sector. Concerning environmental protection for natural resources, the provision specifies that "environmental protection activities shall be conducted to reduce adverse effects caused by operation of mines (Article 13 of the Mines Law)".

The overview of the major related environmental laws and regulations is described below.

(a) Forest Law, 1992

Article 3 of the Forest Law stipulates that the Myanmar government shall develop and promote environmental conservation policies, Article 4 stipulates that the yield of forest products shall be maintained in consideration of environmental conservation, and Article 5 stipulates the purposes of designation of communal forest reserve other than forest reserve shall be as follows:

- Protection of water areas and soil
- Conservation of Dry-Zone Forests
- Conservation of mangrove woods
- Conservation of environment and biodiversity
- Sustainable production of forest products

(b) Conservation of Water Resources and Rivers Law, 2006

The purposes of the Conservation of Water Resources and Rivers Law are conservation and protection of water resources and rivers for beneficial use by the people and reduction of environmental loads. To that end, the prohibited conducts are stipulated in Articles 8, 9, 11, 13, 14, 22 and 24 of the same Law as follows:

- Destruction of water resources, rivers and creeks or change of water passage
- Intentional reduction of volume of water
- Overall or partial destruction of training wall of river, damage to training wall or collision with ship
- Damage to the environment by disposal of engine oil, chemical substance, toxic substance or other substances or throwing away of explosives from bank or from ship under way or on berth, stranded ship or sunken ship
- Suction of sand, dredging of sand, excavation of sand, suction of gravel of river, use of gold pan for obtaining gold dust, dredging without permission of the Directorate of Water Resources and Improvement of River Systems for the purpose of obtaining minerals such as gold at boundaries of river or creek, bank or riverside or production of any resources for commercial purpose
- Suction of sand, dredging of sand, excavation of sand, suction of gravel of river, use of gold pan to obtain gold dust, dredging for the purpose of obtaining minerals such as gold, or production of any resources for commercial purpose in prohibition area or water passage at sand bank, river or creek reserved for construction of training wall of river
- Building up of sand, gravel or other heavy materials at bank or riverside for commercial purpose
- Violation of ship traffic terms and conditions at river or creek designated by the Directorate of

Water Resources and Improvement of River Systems for the purpose of conservation of its water resources, the river or the creek

- Violation of terms and conditions specified by the Directorate of Water Resources and Improvement of River Systems for the purpose of prevention of pollution of water resources, rivers and creeks and prevention of change of their water passages

(c) Protection of Wildlife and Conservation of Natural Area Law, 1994

The Wildlife and Conservation of Natural Area Law specifies the following prohibited conducts:

- Hunting without license
- Violation of terms on game license
- Fattening for commercial purpose, without license, of wild animals protected throughout the year or seasonally
- Pollution of water zone or air in natural area, damage to water passage or throwing of poison in water passage
- Carrying or throwing away of contaminants or mineral pollutant in natural area or destruction of ecosystem or natural condition in natural area

(d) Protection and Preservation of Cultural Heritage Regions Law, 1998

Article 20 of the Protection and Preservation of Cultural Heritage Regions Law specifies the following prohibited conducts:

- Destruction of ancient remains
- Intentional change of original shape or structure or initial state of ancient remains
- Excavation for the purpose of exploration of ancient remains
- Exploration of oil, natural gas, precious stones or minerals

Article 21 of the same law specifies the following prohibited conducts in cultural heritage regions unless the prior permission based on this law is obtained:

- Restoration or maintenance of ancient remains
- Excavation for archaeological purpose
- Construction or stretching of road, bridge, irrigation canal or bank
- Excavation or enlargement of well, pond or fishpond

(e) Yangon Port Law, 1905

Article 65 of the Yangon Port Law specifies that the Yangon Port Authority can set a comprehensive ordinance concerning removal of shipwreck from port or river, cleaning of port, river and riverbank and control of disposal of dirt or garbage in them.

(f) Port Law, 1908

Article 21 of the Port Law specifies the following prohibited conducts:

- Disposal in port of ballast, waste or other objects that may form bank or bar or interfere sailing
- Disposal in port of oil or water containing oil

4.2.2 Overview of Organization of the Ministry of Environmental Conservation and Forestry and the Environmental Conservation Department

The Ministry of Environmental Conservation and Forestry having control over environmental conservation operations consists of four departments and one government-owned enterprise as shown in Fig. 4-6. Based on the Environmental Conservation Law that was enacted on March 30, 2012, the Environmental Conservation Rules is planned to be developed. The Environmental Conservation Department which was just newly established in October 2012 controls over the operation of these Rules, and the Ministry of Environmental Conservation and Forestry has the following important missions:

- Implementation of government's environmental projects
- Development of short-term, mid-term and long-term environmentally harmonious strategies, policies or plans based on the sustainable development process
- Supervision on conservation and sustainable use of natural resources
- Supervision on water pollution, air pollution and soil pollution for the purpose of maintaining sustainable environment
- Cooperation with government organizations, communities and public or international organizations for the purpose of contributing to environmental conservation

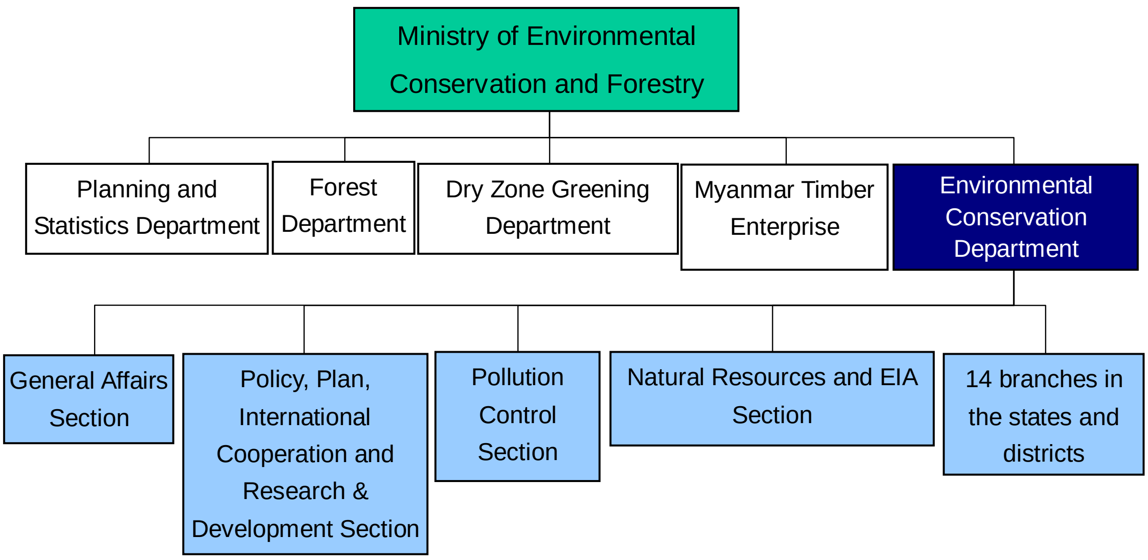


Fig. 4-6 Organization Chart of the Ministry of Environmental Conservation and Forestry and the Environmental Conservation Department

The Environmental Conservation Department has four sections and 14 branches which have control over the respective states and districts as shown in Fig. 4-6. The roles of each section are described below.

(a) General Affairs Section

The roles of the General Affairs Section belonging to the newly established Environmental Conservation Department are as follows:

- Clerical work for staff members
- General affairs for offices
- Financial operations

(b) Policy, Plan, International Cooperation and Research & Development Section

The roles of the Policy, Plan, International Cooperation and Research & Development Section belonging to the newly established Environmental Conservation Department are as follows:

- Planning and implementation, review and preparation of report
- Development of laws related to rules and guidelines
- Supervision of environmental conservation activities
- Approval and report for industry and implementation of project
- Planning for alleviation and adaptation of desertification and destruction of ozone layer associated with climate change
- Preparation of report by country based on international agreement
- Implementation of operations that contribute to research, development and progress

(c) Pollution Control Section

The roles of the Pollution Control Section belonging to the newly established Environmental Conservation Department are as follows:

(1) Industrial environment

- Development of guidelines for promotion of clean technology in industrial field
- Systematic management of industrial wastes including hazardous wastes

(2) City environment and rural environment

- Promotion of latest technologies related to collection, treatment and recycling of wastes
- Monitoring of environmental pollution

(3) Environmental standards

- Assessment management for environmental standards
- Development of standard environmental criteria in close liaison with related organizations
- Prevention of environmental pollution through waste management

(4) Natural Resources and EIA Section

The roles of the Natural Resources and EIA Section belonging to the newly established Environmental Conservation Department are as follows:

① Conservation of Natural Resources

- Assessment of natural resources in liaison with related departments and agencies
- Protection of eco-system, nature preservation area and biodiversity
- Protection of sustainable wetlands and rivers

② EIA

- Development of EIA proceedings and rules for minimizing environmental impacts
- Environmental conservation monitoring
- Review of EIA report on proposed project

4.2.3 Future expectation

(a) Development of related laws

By the hearing conducted at the Ministry of Environmental Conservation and Forestry, the future plan about the Environmental Conservation Rules, etc. was clarified as follows:

- Based on the Environmental Conservation Law established on March 30, 2012, the draft version of the Environmental Conservation Rules was developed. The Myanmar's Supreme Court is now checking its content. The checking work will be finished around the end of 2012.
- The contents covered by the Environmental Conservation Rules will be announced by the Ministry of Environmental Conservation and Forestry which is the competent authority, after approval at the Parliament.
- The Environmental Conservation Rules will also cover "SIA (Social Impact Assessment)" and "HIA (Health Impact Assessment)" according to the international standards and will include detailed information (about the environmental and emission standards and EIA proceedings).

(b) Implementation system

The future plan concerning the implementation system of the Ministry of Environmental Conservation and Forestry, mainly of the Environmental Conservation Department which was just newly established in October 2012, is as follows:

- Concerning all matters related to environmental conservation in construction of hydraulic power generation, development of coal mine and construction of larger-scale plant, the Ministry of Environmental Conservation and Forestry will serve as the competent authority and promote closer cooperation with the authorities concerned.

- Concerning all matters related to environmental conservation in projects under the authority of the Ministry of Mines, Ministry of Electric Power and Ministry of Industry (such as construction of hydraulic power generation, development of coal mine and construction of larger-scale plant), the Ministry of Environmental Conservation and Forestry will internally conduct detailed check on three items: ①EIA (Environmental Impact Assessment); ②SIA (Social Impact Assessment); and ③HIA (Health Impact Assessment) and will request additional submission of any missing item.
- The Environmental Conservation Department has about 40 staff members now. In the future, the number of staff members is planned to be increased up to 403 (see Fig. 4-7. However, details about the numeric figures are unknown.)

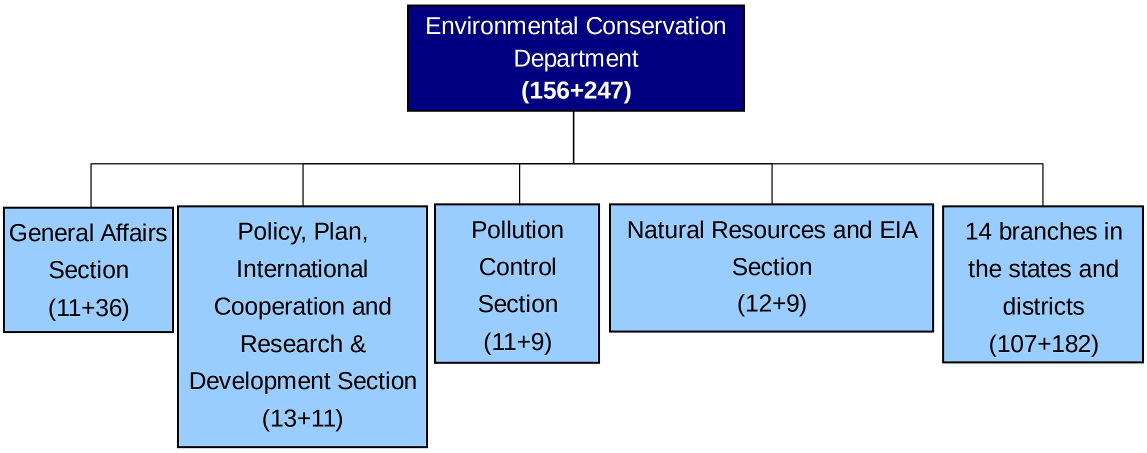


Fig. 4-7 Staff Increase Plan for the Environmental Conservation Department (Future Target)

4.3 Technical feasibility of environmental conservation

The most important thing is early establishment of the environmental conservation system with the Environmental Conservation Department newly established in October 2012 at the center thereof, and the preconditions are ① enactment of the Environmental Conservation Rules, and ② early achievement of the staff increase plan for the Environmental Conservation Department and assignment of the staff members to their stations. Specifically, when the points listed below are cleared, the feasibility of environmental conservation technologies will be dramatically heightened.

- Improvement of the degree of understanding of the environmental and social considerations guidelines
- Implementation of the EIA ability strengthening training (OJT) at the site mainly for the staff of the Natural Resources and EIA Section and 14 branches in the states and districts
- Introduction of materials and equipment and technology transfer

4.4 Environmental Conservation Plan

4.4.1 Prediction of impact on environmental social aspect

The qualitative prediction of impacts on the surrounding environment around the major coal mines in the Lasio region was conducted for the same items as the environmental items of the scoping result and the current state (baseline) investigation. The result is as follows:

- Relocation of residents: There is a possibility of relocation at some areas, and slight impact is predicted.
- Health and sanitation: In order to minimize negative impacts, considerations to residents around the site and employees are continuously required.
- Wastes and wastewater: In order to minimize negative impacts, considerations are continuously required.
- Disaster (risk): Landform will alter, but its impact is expected to be small.
- Topography and geology: Landform alteration and geological impact are expected to be very small.
- Soil erosion: Since the impact caused by landform alteration is small, the impact on soil erosion is expected to be small.
- Groundwater: Residents around the site use well water for living use. In order to minimize negative impacts, considerations are continuously required.
- Lake and river basin: Since the landform alteration area is limited, the impact on river basin, etc. is expected to be very small.
- Animals and plants: Animals' habitats and plants' distribution areas are unknown. In order to minimize negative impacts, adequate research and measures are considered to be required for securement of fauna and flora diversity.
- Air pollution: There are concerns about air pollution by exhaust gas from vehicles associated with mining activities. It is considered that investigation of the current state of air pollution substances is needed.
- Water pollution: There are concerns about outflow of oil from large vehicles associated with mining activities and discharge of untreated domestic wastewater. It is considered that investigation of the current state of water pollution substances is needed.
- Soil pollution: It is assumed that there is no particular use of pollutant, and it is predicted that the possibility of soil pollution is low.
- Noise and vibration: Since some coal mines have production increase plans, measurement of noise and vibration is required.
- Land subsidence: There is concern about occurrence of land subsidence arising from rainfall and traffic of large vehicles. In order to minimize negative impacts, considerations are continuously required.
- Odor: There is concern about exhaust gas from vehicles associated with mining activities and sulfur

odor from coals. It is considered that investigation of the current state of air pollution substances is needed.

4.4.2 Environmental conservation plan based on the environmental prediction

The environmental conservation plan based on the result of the Initial Environmental Examination around the major coal mines in the Lasio region is as follows:

(a) Environmental conservation measures

Based on the result of the Initial Environmental Examination around the major coal mines in the Lasio region, it is considered that reevaluation (re-examination) in conformance with the environmental criteria of the Environmental Conservation Rules according to the Environmental Conservation Law, which is planned to be enforced early in 2013, is needed. Especially, concerning animals and plants, air pollution, water pollution, noise and vibration and odor, the following specific investigations are proposed for contribution to sustainable development and promotion on environmental and social considerations:

- Investigation of environmental impacts on habitats and populations of animals and plants
- Investigation of air pollution substances and water pollution substances
- Investigation of noise and vibration

(b) Monitoring

Concerning animals and plants, air pollution, water pollution, noise and vibration, and odor, it is important to implement initial examination before operation and conduct monitoring during and after operation. Monitoring (proposal) is shown in Table 4-3.

Table 4-3 Monitoring on Environmental Impact Assessment (Proposal)

Target item	Content	Purpose
Animals and plants	Investigations of documents on fauna and flora and inhabiting populations (species) and habitats shall be implemented, and periodical investigations of populations and habitats shall be also conducted after construction and during development of mines.	To contribute to evaluation of securement of diversity on fauna and flora
Water pollution	Mainly around the villages in the vicinity of the project site, the current state (after heavy rainfall, etc.) shall be checked through site reconnaissance during and after construction of roads and others that includes earthwork (such as banking and cutting earth), and periodical water quality	To minimize negative impacts for water pollution arising from outflow of oil from large vehicles associated with mining activities and discharge of untreated domestic wastewater in the areas around the project site

	measurement shall be monitored at fixed point.	
Air pollution Odor	Mainly around the villages in the vicinity of the project site, air pollution substances such as carbon hydride (HC), carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx) and suspended particulate matter (SPM) as well as the traffic volume shall be periodically measured.	To minimize negative impacts for air pollution and odor due to increase of large vehicles associated with mining activities in the areas around the project site
Noise and vibration	Mainly around the villages in the vicinity of the project site, noise and vibration as well as the traffic volume shall be periodically measured.	To minimize negative impacts for noise and vibration due to increase of large vehicles associated with mining activities in the areas around the project site

(c) Stakeholder conference

Around the major coal mines in the Lasio region, a good relationship between coal mine development and residents has been maintained. However, no organizational and systematic consultation has been held but individual consultations are conducted. Some coal mine developing companies implemented the production increase plans and the expansion of their mining lots. It is considered that it is important to positively implement stakeholder conferences between companies that promote development and residents together with officers from state and district branches of the Environmental Conservation Department. We consider that by making the content of the overall project and each environmental item known to people, fully understanding opinions of local residents and communities and reflecting them to the project, we can establish sustainable development with considerations given to environmental society.

Chapter 5 Results of Surveying Coal Mines and Ports

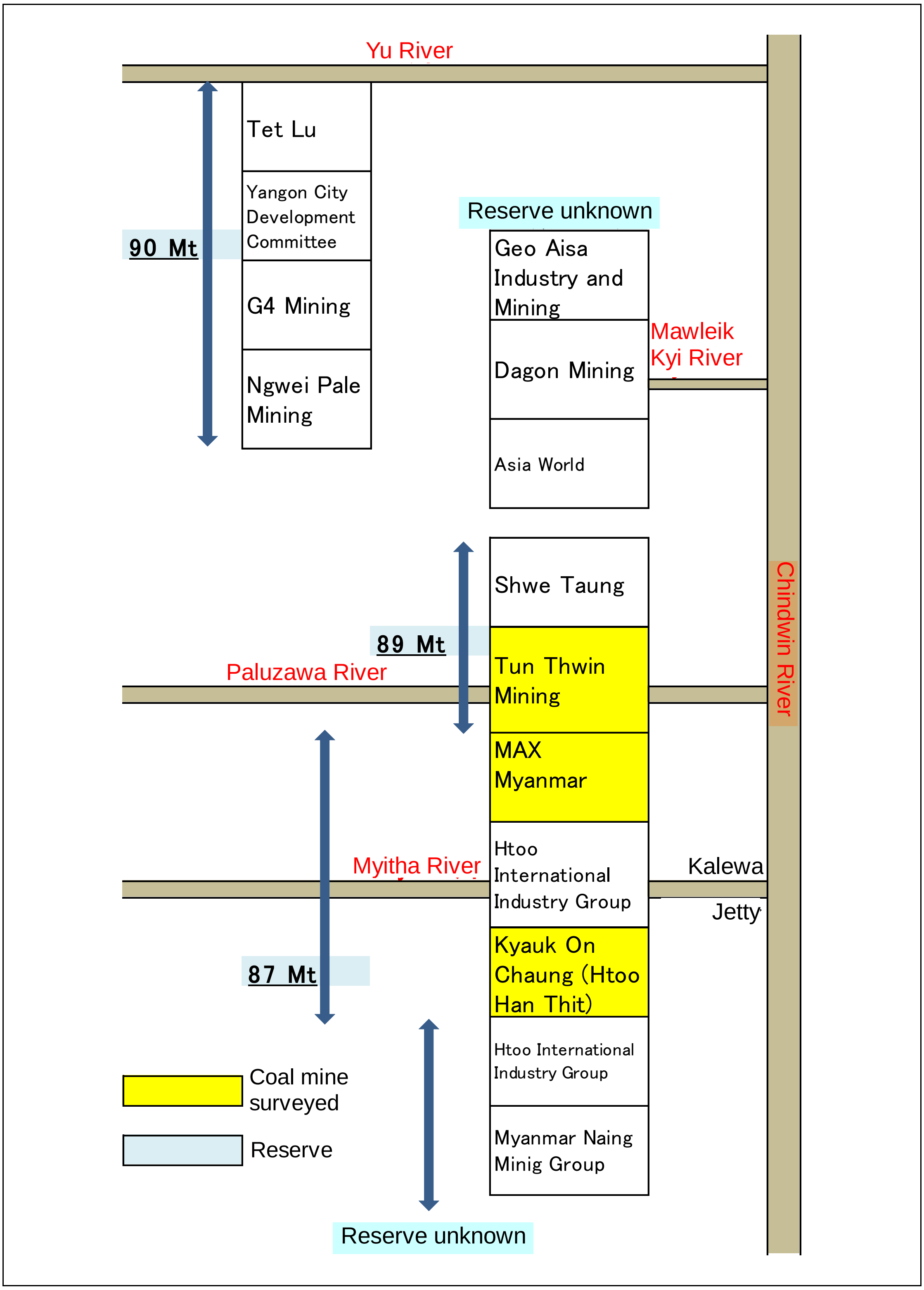
5.1 Results of surveying coal mines

5.1.1 Kalewa District

(a) Overview

Coal beds of the Tertiary period have developed along the Chindwin River. They are called the Chindwin coalfield. A jetty is found for coal shipment on the Chindwin River in the Kalewa district. The coalfield is subdivided in the Datwaykyauk zone (seven mining areas) in the northern area, the Puluzawa area and in a southern area (seven mining areas) on the Myitha River. The mining areas total 14. The coal properties in these mining areas are almost the same, which ranges from lignite to sub-bituminous coal. The Datwaykyauk zone in the north area has relatively high grade coal beds of the Eocene epoch. However, it is regarded that no coking coal is present in the zone. Since coal in these areas is shipped at the jetty in Kalewa, the coal in these areas may be collectively called "Kalewa Coal." In a narrow sense, however, the southern area on the Myitha River is called "Kalewa."

We surveyed three coal mines, namely the Kyauk On Chaung coal mine in the Kalewa area, a coal mine owned by Tun Thwin Mining, a mining company, and a coal mine owned by MAX Myanmar, a mining company, in the Pulzawa area. We visited and surveyed the Kyauk On Chaung coal mine. However, we were unable to visit the coal mine of Tun Thwin Mining and the coal mine of MAX Myanmar because of poor conditions of roads to access. Thus, we visited the coal mine offices of these two mines to conducted hearings. Fig. 5-1 illustrates the distribution of the mining areas in the Chindwin coalfield.



Source: Prepared by the survey team

Fig. 5-1 Distribution of Mining Areas in the Chindwin Coalfield

The seven mining areas are found in a south area of the Myitha (Kalewa area) and in the Pulzawa area. They are, from north to south, ① Shwe Taung, ② Tun Thwin Mining, ③ MAX Myanmar, ④ Htoo International Group, ⑤ Kyank On Chaung (Htoo Han Thit), ⑥ Htoo International Group and ⑦ Myanmar Naing Group. The MAX Myanmar Group at ③ has two mining areas owned by mining companies of the group. Specifically, the group concluded a PSC agreement in 2011 with No.(3) Mining Enterprise for the Wayechaung Coal Plot in south Kalewa. These mining areas, however, engaged in no production so far. Reserves of the Htoo Group at ④ are 10.2326 Mt at P2 and 3.4116 Mt at P3. The group engaged in production from 1952 and has ceased production nowadays. Reserves of Htoo Han Thit at ⑤, which is the only group engaging in production nowadays, are 19.6301 Mt at P2 and 4.4614 Mt at P3. Reserves of the Htoo Group at ⑥, which we visited for survey, are 9.815 Mt at P2 and 1.837 Mt at P3. The Naing Group at ⑦, which engaged in no production, has not been surveyed by us.

(b) Kyauk On Chaung Coal Mine (Thit Chau area)

(1) Information on the location and owner of the coal mine

The coal mine is located at a place two miles inland from the south bank of the Myitha River. Access to the south bank is via ferry from the national road. The mining area has a space of 5,165 acres. Mining is conducted by Htoo Han Thit, a subcontractor, who has hired the license granted to MEC (Myanmar Economic Corporation) owned by military-affiliated Myanmar Holding Company. The subcontractor pays MEC 30% of the coal mined in kind, as fees for hiring the license. MEC pays the Myanmar Government only 3% of the 30% as royalty plus tax. Htoo Han Thit has the principal office in Yangon.

(2) Geological and exploration sates of the coal mine

The mining targets are three layers, namely, from upper to lower, a 4 ft layer, a 4 ft layer, and a 9 ft layer of the Tertiary period. The coal beds dips range from 40 to 45 degrees. Since no detailed geological surveys, such as test drilling, have been conducted, the recoverable reserve is unknown. Although the presence of the coal beds has been confirmed up to a 300 m depth from the ground, a groundwater zone has been found in a shallow part beneath the ground. Thus, countermeasures are necessary in mining.

(3) Coal reserve (positive, probable, possible, potential) and resource quantities

The coal reserves are 19.6301 Mt at P2 and 4.4614 Mt at P3. The recoverable reserve is approximately 800,000 ton in open pit mining.

(4) State of production

Development has begun since 2009. When open pit mining is completed in a short time, a new pit is developed in the strike direction to continue production. The present pit has started production since

October 2011, already produced 6,000 ton of coal, and will continue production until 2013. To reach the coal yard of the coal mine, it takes some one hour on the Asian Highway Network from Kalewa before going aboard a ferry boat (no bridge at this place) to cross the Myitha River. Although the Asian Highway is paved, some of the pavements are in a poor condition. Poorly paved road often submerge in up to one-meter high flood in rainy seasons. Branches of the Myitha River have many bridges that have a withstand load of 23 ton on a single traffic lane, resulting in difficulty to transport coal on a large truck. It seems that coal production in this area began relatively early. The production scale is small. It is said that there was a minimal coal-fired power plant near the coal mine but discontinued nowadays. The coal mine has a production of 200 ton/day and can produce more, depending on the demand. However, it cannot be operated during rainy season from June through September. Shovels, backhoes, and bulldozers are used to explore coal. Produced coal is transported on a 10-ton truck into the coal yard 3 km away from the pit.

[Number of machineries]

Shovel and backhoe:	7 units, new, made by Hitachi Construction Machinery and VOLVO
Bulldozer:	4 units, used, made by Komatsu
10-ton truck:	12 units, used, made in Japan and Korea
FEL:	one unit, new, for coal yard

The number of workers totals 75. They work on a single 12-hour shift system of five workdays per week. The pit can engage in production increase on a continuous two 12-hour shift system in dry season. Most of the workers live near the pit. Managerial officers commute from Kalewa on company-owned vehicles.

The exploration depth of the present pit is above SL+170 m, while the surface of the pit is above SL+210 m. Thus, the pit is approximately 40 m below the surface of the earth. Since a groundwater zone is found 3 m lower than the present exploration depth, no deeper exploration is possible but advances horizontally in the strike direction. The present soil stripping ratio is 1: 12 to 13.

10-ton trucks transport coal from the mine onto a 3-mile distant bank of the Myitha River to stock. The coal stock yard has a capacity of 3,000 ton. Another coal yard is also found along the transportation road for increases in coal production in dry seasons.

The depth of the Myitha River varies greatly. It is 10 m deep in rainy season and about 1 m deep in dry season. Thus, vehicles can cross the river, depending on the location. In rainy season, a 1,700-ton barge can cross the river.

At the time when we surveyed the coal mine, workers loaded coal, by hand, into a 200-ton barge. The barge had a 1.5 m draft. A worker loads 12 VISS (approximately 20 kg) coal. Load cost amounts to 1,500 kyats/t in a high water level in rainy season and 1,700 kyats/t in a low water level in dry season. Loading coal into a 1,700-ton barge takes two to three days.

Stripped soil was accumulated in neighboring valleys. Although closed pits were restored with soil up to the road surface, no forestation is made. Raw waste water is discharged into the river where coal dust is accumulated on the river bed. The coal yard also discharges raw waste water into the Myitha River.

(5) Result of coal grade analysis

Our coal analysis in Yangon is as follows:

Moisture	8%
Volatile	50%
Ash	11%
Fixed carbon	30%
Calorific value	11,000 Btu/lb (6,111 kcal/kg)

(6) Mining cost, selling price, coal output plan and expansion plan

Coal is sold to a cement factory in Mandalay. In the recent years, however, demand for coal is on the decrease. Selling prices ranges from 40,000 to 50,000 kyats/t-FOB. Cargo handling expense is 1,500 kyats/t in rainy season and 1,700 kyats/t in dry season. Freight rate to Mandalay ranges from 14,000 to 15,000 kyats/t in rainy season and 20,000 kyats/t in dry season. Coal transportation takes four to five days in rainy season and ten days in dry season, or a week on the average. The coal mine can increase production, depending on the demand.

(c) Coal mine owned by Tun Thwin Mining

(1) Information on the location and owner of the coal mine

The coal mine is bound on the Pulzawa River. Tun Thwin Mining, a leading mining company in Myanmar, has engaged in the development of coal mines. An overview of the corporate information is available on the website of the company. In cooperation with a Chinese company, Tun Thwin Mining has been promoting the construction of a coal-fired power plant (600 MW) in the Kalewa district.

(2) Geological and exploration states of the coal mine

Three geological engineers of the contractor conducted a detailed survey in 2001 and began production in 2005. The survey was limited to a geological survey. Although a test pit was excavated, no drilling was made. Exploration targets coal beds that are the same with those in the Kyauk On Chaung coal mine.

(3) Coal reserves (positive, probable, possible, potential) and resources

The mining area is 16-mile wide in the north-south direction. The reserve is 30 Mt at P3.

(4) State of production

The coal mine has eight shovels, two bulldozers and 15 trucks at present. The number of workers totals

110 at maximum. The present coal beds are 80 to 50 ft deep. The soil stripping ratio is 1: 9 to 10.

The coal mine produced 2,000 t/month and 50,000 t/year in 2011. The coal mine plans to increase production to 70,000 to 100,000 t/year, depending on the demand. A 9 ft layer and a 4 ft layer are being explored. The mining area is 16-mile wide in the strike direction. The dip of the coal beds is 40 to 45 degrees. Underground mining was carried out in the British colonial period. Nowadays, however, no such mining is conducted.

(5) Result of coal grade analysis

Table 5-1 Coal Properties

Arrival basis		
		Tun Twin
Moisture	%	8.43
Volatile	%	41.98
Ash	%	6.07
Fixed carbon	%	43.52
Dry basis		
Volatile	%	45.84
Ash	%	6.63
Fixed carbon	%	47.53
Calorific value	kcal/kg	6,550
Sulfur	%	0.38
Specific gravity	%	1.34

Source: Local hearings

Dry coal may cause spontaneous combustion. No spontaneous combustion took place during transportation to Mandalay. However, there were several cases where a large volume of stock coal had spontaneous combustion.

(6) Mining costs, selling price, coal output plan and expansion plan

Coal is sold to a cement factory and a steel mill (manufacturing reinforced bars) in Kyauk Sen (in a suburb of Mandalay). Coal is transported by truck and barge. The selling price at the coal mine is 50,000 kyats/t. The truck transportation costs to the jetty in Kalewa and the barge transportation cost to Mongka amounts to 73,000 kyats/t.

(d) Coal mine owned by MAX Myanmar

(1) Information on the location and owner of the coal mine

The coal mine owed by MAX Myanmar is located in the south to the coal mine owned by Tun Thwin Mining and bound on the Pulzawa River. Max Myanmar is a leading company in Myanmar and engages in diverse types of business relating to gasoline, cement and construction.

(2) Geological and exploration states of the coal mine

The coal beds being explored are estimated to be in the coal-bearing formation that is identical with that of the two coal mines mentioned above. The coal mine explores a 9 ft layer and a 7 ft layer.

(3) Coal reserve (positive, probable, possible, potential) and resource quantities

The reserve is 25 Mt at P2.

(4) State of production

The coal mine started production in 2009. The present exploration is 100 ft deep. The soil stripping ratio is 1:5. During rainy season of July through October, the mine suspends production. The coal mine explores a 9 ft layer and a 7 ft layer and reaches a production volume of 3,000 to 3,500 t/month in rainy season. Coal is sold to the company's cement factory at a price of 50,000 to 52,000 kyats/t. Coal cannot be mined during rainy season because the pit submerges in flood water, etc. During rainy season, the cement factory purchases coal from other coal mines. The coal mine has four backhoes, two bulldozers, and eight dump trucks. The number of workers totals 29 to 50. After resuming production, the coal mine purchased four backhoes and 15 dump trucks and doubled production to 6,000 to 10,000 t/month. A license is required to operate heavy equipment.

(5) Result of coal grade analysis

No data is available.

(6) Mining costs, selling price, coal output plan and expansion plan

Trucks are used to transport coal from the pit mouth to the jetty in Kalewa, where coal is loaded into a 1,700-ton barge until Bagan. After coal is unloaded from the barge in a suburb of Pagan, coal is transported by truck to a cement factory in Nay Pyi Daw.

The cement factory produces 500 t/day of cement and is expanding the capacity to 1,000 t/day. In addition, the cement factory is building a new cement factory that can produce 1,000 t/day of cement. A worker earns 55,000 kyats/month. A skilled worker earns 90,000 kyats/month. The head of the coal mine earns 200,000 kyats/month.

5.1.2 Results of Coal Mines surveyed in the Lasio District

We were able to survey six coal mines in the Lasio area, namely the Manpan-Mongma coal mine, the Sanya coal mine, the Namma coal mine, the Ngwe Ye Pale coal mine, the Sanlaung coal mine, and the Sintaun coal mine. Refer to Fig. 4-1 for the locations of these coal mines.

(a) Manpan-Mongma coal mine

(1) Information on the location and owner of the coal mine

The coal mine is located in the south-east direction at a place 100 km distant by road to Lasio. It takes about four hours by car from Lasio. The coal mine is owned by AAA.

(2) Geological and exploration states of the coal mine

Exploration of this coal mine for development was conducted from May 2002 through March 2003. The mining company made 55 test drillings, reaching an excavation length of 5,542 ft (approximately 1,689 m) in total. A test drilling on the average remained at a shallow excavation length of approximately 100 ft (about 30 m).

This mine has a distribution of coal-bearing formation of the Tertiary period. The above exploration proved 18 layers of coal-bearing formation. The maximum thickness of a layer is 58 ft. The targeting coal bed for production is a single layer alone that is 40 ft (approximately 12 m) thick on the average.

It is said that the dip of the coal bed in the open pit mining area is 30°, while the dip of the area near the pit mouth of the underground mining area is 40°, which turns into a low-pitch dip at a depth of some 100 ft.

(3) Coal reserves (positive, probable, possible, potential) and resources

According to data prepared by the Department of Geological Survey & Mineral Exploration of the Ministry of Mines, this coal mine has the following reserves:

P2: 3.415 Mt; P4: 4.925 Mt 8.34 Mt in total

(4) State of production

This mine has started open pit mining since 2005 to produce coal. The annual production of coal in open pit mining totals 30,000 ton. Coal production in open pit mining lasts eight months except for rainy season (June through September). The coal mine has heavy equipment including two backhoes and one frontend loader.

In addition, this coal mine has also started underground mining of coal since 2011. The underground mining produces coal at two places. One more place is under development of underground mining. It is said that the production of coal in underground mining is 10,000 t/month (120,000 t/year supposed). Blasts are used in underground mining to produce coal. Underground mining has adopted three shifts/day × 8 hour/shift. Since the coal bed dip in the areas surrounding the pit mouth of the open pit mining is 40°, the development gallery from the pit mouth is steep. Besides, no lighting equipment for underground lighting is furnished. Although ventilation fans are installed, no movement of air is felt around the pit mouth, indicating probable ventilation problems.

The number of workers totals 400. Sixty of the workers engage in open pit mining, while 340 workers engage in underground mining.

(5) Results of coal grade analysis

Coal properties in this mine range from lignite to sub-bituminous coal. According to data prepared by Third Mining Corporation of the Ministry of Mines, the coal grade is as follow:

Moisture	19.45%
Volatile	55.00% (Dry basis)
Ash	9.33% (Dry basis)
Fixed carbon	35.58% (Dry basis)
Calorific value	9,889 Btu/lb (Dry basis) (5,494 kcal/kg)
Sulfur	0.80% (Dry basis)

(6) Mining costs, selling price, coal output plan and expansion plan

All the coal produced by this coal mine is delivered, without grinding and in a state of raw coal, to the company's cement factory located in Mandalay. 12-ton trucks transport raw coal from the coal mine to the cement factory in a 205 mile distance. The coal mine employs trucks on a lease basis. The freight rate by truck to the cement factory is 30,000 kyats/truck. The coal mine employs up to 70 trucks/day.

The coal mine has reinforced the existing road up to 3 miles from the coal mine at an expense of 100 million kyats.

Open pit mining is scheduled to produce 30,000 ton of coal per year, while underground mining is scheduled to produce 120,000 ton of coal per year.

(7) Mining costs and selling price

Unknown.

(b) Sanya coal mine

(1) Information on the location and owner of the coal mine

This coal mine is located in the south-east direction at a place some 45 km to Lasio. The coal mine is owned by Asia World Co. Ltd.

(2) Geological and exploration states of the coal mine

One coal bed is present in coal-bearing formation of the Tertiary period. The coal bed is 4 to 5 m thick and has a dip of 35° in the north-west direction.

(3) Coal reserves (positive, probable, possible, potential) and resources

According to data prepared by the Department of Geological Survey & Mineral Exploration of the Ministry of Mines, this coal mine has the reserves mentioned below. In connection with this, Asia World Co. Ltd., the owner of this mine, owns four mining areas (Kong Kao, Than Lwin, Naton, Nan Lin Khan) under the Nam Paung coal project, in addition to the Sanya coal mine. The recoverable reserves under the Nam Paung coal project are estimated to reach approximately 360,000 ton on the whole.

P2: 0.048 Mt; P3: 0.072 Mt; P4: 0.851 Mt 0.971 Mt in total

(4) State of production

The coal mine is under development (only surface soil stripped) and scheduled to start production in 2013. The mine plans to have an annual coal production of 15,000 to 20,000 ton. The number of workers and the shift system are unknown. The coal mine has heavy equipment including backhoes, dozers and trucks.

(5) Result of coal grade analysis

Coal in this coal mine ranges from lignite to sub-bituminous coal. According to data prepared by No.(3) Mining Enterprise of the Ministry of Mines, the coal properties are as follows:

Moisture	17.77%
Volatile	58.32% (Dry basis)
Ash	6.21% (Dry basis)
Fixed carbon	35.37% (Dry basis)
Calorific value	10,420 Btu/lb (Dry basis) (5,789 kcal/kg)
Sulfur	0.64% (Dry basis)

(6) Mining costs, selling price, coal output plan and expansion plan

All the coal produced by this coal mine is scheduled to deliver, without grinding and in a state of raw coal, to the company's cement factory located in Mandalay. The coal mine used 38-ton trucks to transport coal to the cement factory that is 225 miles distant from the coal mine. The freight rate by truck to the cement factory is 20,000 kyats/ton. The number of trucks used for transportation varies, depending on the day.

Although the mining costs are unknown, the selling price at the mine is 36,000 to 46,000 kyats/ton.

(c) Namma coal mine

(1) Information on the location and owner of the coal mine

This coal mine is located in the south-west direction some 50 km distant to Lasio. It takes approximately four hours by car from Lasio. No.(3) Mining Enterprise started operation of this coal mine in 1974 but discontinued in May 2010. The coal mine has been under control of the Ministry of Defense since two years ago. The mine has currently suspended coal mining. The pits that were in operation before have submerged in water.

(2) Geological and exploration states of the coal mine

The number of coal beds is unknown. It is said that the dip of the coal bed is 45°.

(3) Coal reserve (positive, probable, possible, potential) and resource quantities

According to data prepared by the Department of Geological Survey & Mineral Exploration of the Ministry of Mines, this coal mine has the following reserves.

P2: 2.8 Mt; P3: 0.2 Mt; P4: 3.7 Mt 6.7 Mt in total

(4) State of production

The coal mine has suspended operation nowadays. At the time of operation (open pit mining), the coal mine had an annual coal production of 35,000 ton on the average. The total production of coal amounts to 830,000 ton. The time to resume mining is undecided. The mining area area is also unknown.

(5) Result of coal grade analysis

According to data prepared by No.(3) Mining Enterprise of the Ministry of Mines, the coal properties are as follows:

Moisture	8.64%
Volatile	40.35%

Ash	20.94%
Fixed carbon	34.54%
Calorific value	10,081 Btu/lb (5,604 kcal/kg)
Sulfur	1.3% (Dry basis)

(6) Mining costs, selling price, coal output plan and expansion plan

Mining costs, selling price at the coal mine, and production facilities (heavy equipment, etc.) are unknown due to suspended operation. At the time of operation, the coal mine sold coal to steel mills and cement factories in Myanmar. However, the mine has stopped selling because of suspended operation. At the time of operation, the coal mine used trucks to transport coal to buyers. The coal output plan and expansion plan are unknown.

(d) Ngwe Ye Pale coal mine

(1) Information on the location and owner of the coal mine

This coal mine is located in the south-southeast direction at a place some 65 km distant to Lasio. The coal mine is owned by Ngwe Ye Pale Co. Ltd.

(2) Geological and exploration states of the coal mine

A coal bed is present in coal-bearing formation of the Tertiary period. The coal bed is 55 ft thick. A 5 ft thick clay stratum is caught in the coal bed whose dip is 38° in the north-west direction.

(3) Coal reserve (positive, probable, possible, potential) and resource quantities

According to data prepared by the Department of Geological Survey & Mineral Exploration of the Ministry of Mines, this coal mine has the following reserves:

P2: 0.692 Mt; P3: 1.044 Mt; P4: 0.925   2.661 Mt in total

(4) State of production

This coal mine has started production since 2006 and produced a total of 300,000 ton of coal by October 2012. The coal mine has an annual production of 50,000 to 55,000 ton nowadays and maintains the current production quantity in future although it can increase production. The number of workers of this coal mine is 72. Operation is in one shift/day (6:00 to 16:00).

The coal mine has heavy equipment including backhoes, dozers and 18-ton trucks. Two pumps discharge 150 to 200 gallons/day of waste water out of the pits. These pumps discharge all the day during rainy season.

(5) Result of coal grade analysis

According to data (average value of specimen Nos. KP-1 to KP-7) prepared by Ngwe Ye Pale Co. Ltd., this coal mine produces the following grade of lignite.

Moisture	24.72%
Volatile	58.48% (Dry basis)
Ash	6.87% (Dry basis)
Fixed carbon	35.64% (Dry basis)
Calorific value	9,460 Btu/lb (Dry basis) (5,256 kcal/kg)
Sulfur	0.96% (Dry basis)

(6) Mining costs, selling price, coal output plan and expansion plan

All the coal produced by this coal mine is delivered, without grinding and in a state of raw coal, to cement factories located in Mandalay, Nay Pyi Daw, Nao Chew and Chaosei. This coal mine uses 38-ton trucks to deliver coal to the cement factory in a distance of 150 miles (in case of Mandalay) from the coal mine. The freight rate by truck to the cement factory in Mandalay is 23,000 kyats/ton. The number of trucks used for transportation of coal varies, depending on the day. The coal mine has built a new road up to 36 mines for transportation of coal by truck at an expense of about 8,000,000 kyats/mile.

A new cement factory in Nao Chew, which is located some 70 miles distant to this coal mine, is scheduled to operate in December 2012. The coal mine plans to have an annual coal production of some 50,000 ton in open pit mining. Although the mining costs are unknown, the selling price at the coal mine is 32,000 kyats/ton.

In connection with this, Ngwe Ye Pale Co. Ltd. plans to operate a coal-fired power plant (output: 15 MW) in Nao Chew, together with the new cement factory, in December 2012. Details, however, are unknown. The company plan to use coal produced by the Ten Yang coal mine located in the south direction to the Man pan coal mine (calorific value: approximately 8,000 Btu/lb) for the above-mentioned coal-fired power plant.

(e) Sanlaung coal mine

(1) Information on the location and owner of the coal mine

This coal mine is located in south-west direction at a place some 50 km distant to Lasio. AAA, the owner of the coal mine, supplies coal to the company's cement factory.

(2) Geological and exploration states of the coal mine

The coal mine has seven coal beds. Dips of the coal beds are unknown.

(3) Coal reserve (positive, probable, possible, potential) and resource quantities

According to data prepared by the Department of Geological Survey & Mineral Exploration of the Ministry of Mines, this coal mine has the following reserves:

P2: 1.87 Mt   1.87 Mt in total

At present, the remaining reserve is estimated at approximately 0.7 Mt. The mining area area is unknown.

(4) State of production

This coal mine started production in 1999 in open pit mining. Mining in the pit is suspended nowadays because the pit has submerged in water due to an increase in groundwater in the pit that took place one year ago (2011). The coal mine's capacity to discharge groundwater was unable to catch up the increase in groundwater. At the time of operation, the coal mine used trucks to deliver coal to the company's cement factory. The coal mine had an annual coal production of 28,000 ton on the average until 2010. Since 1999, the coal mine has an annual coal production of 300,000 ton. The number of workers is unknown due to suspended operation.

(5) Result of coal grade analysis

According to data prepared by No.(3) Mining Enterprise of the Ministry of Mines, the coal properties are as follows:

Moisture	12.16%
Volatile	51.36% (Dry basis)
Ash	18.06% (Dry basis)
Fixed carbon	30.52% (Dry basis)
Calorific value	9,772 Btu/lb (Dry basis) (5,429 kcal/kg)
Sulfur	5.82% (Dry basis)

(6) Mining costs, selling price, coal output plan and expansion plan

At present, the coal mine is constructing a building for water discharge pumps (completion scheduled in November 2012). The coal mine plans to resume mining when water is discharged completely. The mining costs and production facilities (heavy equipment, etc.) are unknown due to suspended operation.

The selling price of coal at the coal mine is 35,000 kyats/ton. The coal mine used trucks to transport coal to the company's cement factory in Mandalay that is 144 miles distant from the coal mine. The freight rate by truck was 15,000 kyats/ton. The coal mine plans to resume production of coal as soon as water in the pit is discharged. It aims to have an annual coal production of 35,000 to 50,000 ton.

(f) Sintaung coal mine

(1) Information on the location and owner of the coal mine

This coal mine is located in the north 10 km to Lasio. It is owned by UE Export Import Co. Ltd.

(2) Geological and exploration states of the coal mine

This coal mine has a coal bed in the coal-bearing formation of the Tertiary period. The coal bed ranges from 14 to 44 ft thick and 27 ft (about 8.2 m) on the average. The dip of the coal bed is 20° in the south-east direction.

(3) Coal reserve (positive, probable, possible, potential) and resource quantities

According to data prepared by the Department of Geological Survey & Mineral Exploration of the Ministry of Mines, this coal mine has the following reserves:

P2: 5.825 Mt; P3: 0.683 Mt   6.508 Mt in total

(4) State of production

This coal mine has started coal production since 2005 and produced a total of 92,200 ton by October 2012. The present annual production is 12,500 ton and will maintain this volume in future. The coal mine suspends mining in rainy season of May through September because the coal mine has difficulty in discharging water out of the mine but engages in only soil stripping. The number of workers of the coal mine is 40. They work one shift/day (8:00 through 17:00).

The coal mine has heavy equipment including three backhoes, one dozer, and five 6.5-ton trucks. Two water discharge pump units discharge water out of the pit at a rate of 150 to 200 gallons/day.

(5) Results of coal grade analysis

This coal mine produces lignite. According to data prepared by No.(3) Mining Enterprise of the Ministry of Mines, the coal has the following properties:

Moisture	28.28%
Volatile	56.99% (Dry basis)
Ash	9.34% (Dry basis)
Fixed carbon	33.67% (Dry basis)
Calorific value	8,770 Btu/lb (Dry basis) (4,872 kcal/kg)
Sulfur	2.56% (Dry basis)

(6) Mining costs, selling price, coal output plan and expansion plan

All the coal produced by this coal mine is delivered, without grinding and in a state of raw coal, to the company's cement factory located in Mandalay. The coal mine uses 30-ton trucks to deliver coal to the cement factory in a distance of 225 miles from the coal mine. The freight rate by truck to the cement factory is 25,000 to 30,000 kyats/truck. The number of trucks used for transportation of coal varies, depending on the day. The coal mine has built no new roads for transportation of coal by truck.

The coal mine plans to continue having an annual production of 30,000 ton in open pit mining in future.

Open pit mining is scheduled to produce 120,000 ton/year of coal. Mining costs and selling price are unknown.

In connection with this, UE Export Import Co. Ltd., the owner of this coal mine, has the Makhaw coal mine at the place some 50 miles south to Lasio, in addition to the Sintaung coal mine. The coal mine has started production in open pit mining since 2004 at a production volume of 6,000 to 10,000 t/year. The calorific value of the coal is 10,500 Btu/lb.

5.1.3 Results of analyzing the quality of coal samples picked in the Kalewa District and Lasio District

Table 5-2 shows results of analyzing coal samples picked in the local coal mines. We analyzed four samples of coal picked in the Lasio district and three samples of coal picked in the Kalewa district. Results of our analyses indicated the samples of coal in the Kalewa district are better than those in the Lasio district. Concerning the calorific values of the coal samples in the Lasio district, the coal sample picked in the Sintaung coal mine indicated 3,800kcal/kg, whereas the rests of the coal samples indicated 4,740 kcal/kg to 5,800 kcal/kg. All the three coal samples picked in the Kalewa district indicated 6,220 kcal/kg to 6,550 kcal/kg, beyond 6,000 kcal/kg. In the Kalewa district, we analyzed the button number of one coal sample picked in the Datwaykyauk coal mine, hoping for use of coking coal. Unfortunately, however, the sample coal indicated no property of coking coal. Concerning moisture of coal, the coal samples in the Lasio district indicated 14.1 to 15.6%, whereas the coal samples in the Kalewa district were 6.1 to 7.1%, indicating advance in carbonization. The sulfur content of the coal samples picked in the Lasio district was above 1%. On the contrary, the coal samples picked in the Kalewa district remained within 1%, indicating a good performance. Concerning HGI that indicate the hardness of coal, the HGI of three of the four coal samples in the Lasio district was on a 20 level, indicating that they are very hard. The HGI of the coal samples in the Kalewa district was on a 34 to 42 level, indicating that their HGI is lower although they rather belong to a type of hard coal. This is supported in our coal ash analysis that the coal samples in the Lasio district indicated extremely much CaO.

Table 5-2 Results of Coal Analyses

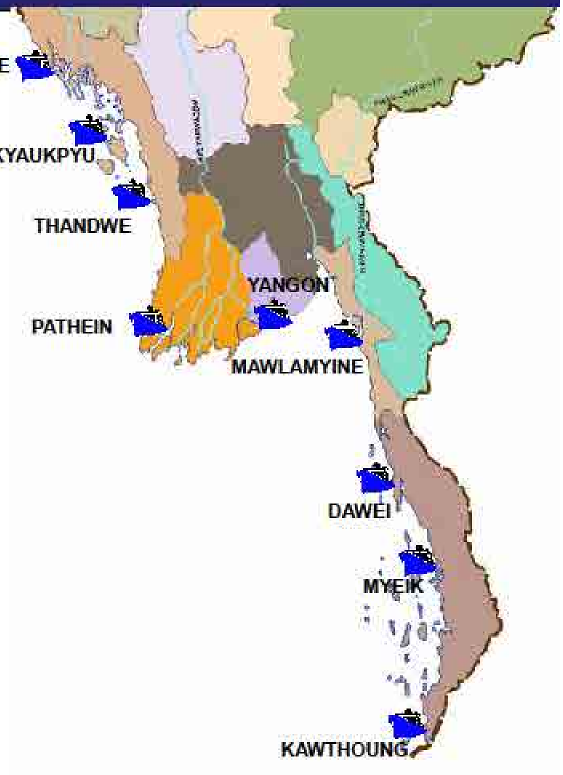
	Item	Unit	Standard	Lasio District				Kalewa District			Analytical method
				Manpan Mongma	Ngwe Ye Pale	Sanlong	Sintaung	Datwayky auk	Kyuauk On Chaung	Max Myanmar	
Calorific value	Higher calorific value	kj/kg	Air-drying	21,600	24,290	19,850	15,900	27,720	27,330	27,400	JIS M8814
		kcal/kg		5,160	5,800	4,740	3,800	6,620	6,530	6,550	
	Lower calorific value	kj/kg		19,990	22,620	18,270	14,500	26,320	25,790	25,900	
		kcal/kg		4,780	5,400	4,360	3,460	6,290	6,160	6,190	
Industrial analysis	Moisture	wt%	Air-drying	14.4	13.1	15.6	14.1	6.1	8.2	7.1	JIS M8812
	Ash			4.6	2.3	8.1	24.3	5.8	4.4	5.3	
	Volatile			41.3	43.8	41.5	35	40.2	42.7	43.9	
	Fixed carbon			39.7	40.8	34.8	26.6	47.9	44.7	43.7	
Fuel rate		-	-	0.96	0.93	0.84	0.76	1.19	1.05	1.00	-
Element analysis	Ash content	Wt%	Anhydrous	5.36	2.66	9.64	28.25	6.15	4.78	5.75	JIS M8819
	Carbon			64.21	68.35	61.17	47.22	70.69	70.46	70.32	
	Hydrogen			4.57	5.16	4.23	3.55	5.16	5.43	5.48	
	Nitrogen			1.09	1.07	1.11	1.09	0.99	1.02	1.00	
	Fuel sulfur			0.01	0.58	0.18	1.40	0.71	0.29	0.40	
	Oxygen			24.76	22.18	23.67	18.5	16.3	18.02	17.05	JIS M8813
	Total sulfur	Wt%	Anhydrous	0.39	1.02	1.04	2.76	0.78	0.52	0.60	JIS M8819
	Sulfur in ash		Ash	7.02	16.39	8.87	4.82	1.15	4.74	3.50	
Grindability (HGI)		-	Air-drying	24	20	27	39	42	34	-	JIS M8801
Button number (CSN)		-	Air-drying	-	-	-	-	0	-	-	JIS M8801
Ash melting temperature	Reducing atmosphere Deformation temperature	°C	Ash	1,290	1,280	1,290	1,130	1,380	1,250	-	JIS M8801
	Melting point			1,310	1,320	1,310	1,200	1,420	1,390	-	
	Melting flow point			1,330	1,340	1,330	1,230	1,440	1,460	-	
Ash composition	SiO_2	wt%	Ash	5.27	2.87	7.9	42.67	42.74	24.24	-	JIS M8815
	Al_2O_3			4.28	0.16	8.22	15.71	29.56	27.24	-	
	TiO_2			0.07	≤0.01	0.25	0.51	1.06	1.19	-	
	Fe_2O_3			7.63	17.18	6.07	11.48	12.41	10.74	-	
	CaO			63.75	31.68	51.42	11.46	5.22	12.91	-	
	MgO			1.15	5.99	1.76	2.21	3.39	6.07	-	
	Na_2O			0.08	0.12	0.07	0.08	0.08	0.12	-	
	K_2O			0.12	0.04	0.16	1.32	0.44	0.16	-	
	P_2O_5			0.04	0.08	0.06	0.06	0.05	2.02	-	
	Mn_3O_4			0.05	0.04	0.1	0.08	0.02	0.05	-	
	V_2O_5			≤0.01	≤0.01	0.01	0.02	0.07	0.07	-	
	SO_3			17.56	40.97	22.17	12.05	2.87	11.86	-	
	Total			100.00	99.13	98.19	97.65	97.91	96.67	-	

5.2 Results of surveying ports

Fig. 5-2 illustrates the present ports in Myanmar. All of them are river ports.

Ports of Myanmar

Port	Region/State
Yangon	Yangon
Sittwe Kyaukphu Thandwe	Rakhine
Pathein	Ayeyarwady
Mawlamyine	Mon
Dawei Myeik Kawthoung	Tanintharyi



Source: “Current Situation and Future Plans for Development on Ports in Myanmar” MYANMAR PORT AUTHORITY (MPA)

Fig. 5-2 Ports in Myanmar

5.2.1 Yangon Area

Some 85% or more of the imports and exports of Myanmar depend on the merchant service. Yangon Port (generic name) is the primary port in the country that handles some 90% of these imports and exports. Fig. 5-3 illustrates the location of ports in the Yangon surroundings.

Along the Yangon River, wharves of the Yangon City Terminal and of Thilawa Port are located on the riversides of the Yangon City side (north side) and the Thilawa district (east side).

The Yangon City Terminal and Thilawa Port are being developed with domestic and foreign capital along with increasing quantities of maritime trade. This has been resulted by the Government's introduction of market economy and democratic policy.

At present, the Yangon City Terminal has 18 international wharves, while Thilawa Port has six international wharves. A total of these 24 international wharves handle over 20 Mt of loading quantities of the Yangon City Terminal on the whole.

The present 24 wharves have reached almost 70% of the loading efficiency that seems appropriate (upper limit). Further development of wharves is urgent. The specification of the Yangon City Terminal is as follows:

- Location: Latitude 16°47", E longitude 96°15"
- Yangon City Terminal - Thilawa Port: 16 km (approximately 3 hours)
- Thilawa Port - Elephant Point 16 km (approximately 4 hours)
- Pilot station: 32 km before the Elephant Point

  (Ships of 200 GRT or over are required to take a pilot on board.)
- Average tide level: Spring tide: 19.3 feet (5.85 m)

  Neap tide: 8.4 feet (2.55 m)
- Flow velocity: 4 to 6 knots
- Waves: No problem in sailing

  (rarely 2 m or lower wave height)

Source: "Current Situation and Future Plans for Development on Ports in Myanmar" (MPA)

Fig. 5-3 Location of the Ports in the Yangon Surroundings

Along the advance waterway, two restricted zones (shoals) are set up between the river mouth and Thilawa-Yangon. The shoal near the Elephant Point is 5 m below the hydrographic datum (Chart Datum). The shoal near the Monkey Point is 4.5 m between Thilawa Port and the Yangon City Terminal.

(a) Yangon City Terminal

As indicated in Fig. 5-4, the Yangon City Terminal has 18 international wharves and three inland container depots (ICD) at present.

Source: "Current Situation and Future Plans For Development On Ports In Myanmar" (MPA)

Fig. 5-4 Yangon City Terminal

- Depth of water: 7 to 8 m (dry season: 6 m)
- Maximum ship to dock: 15,000 DWT (waiting for a favorable tide is necessary) (7,000 to 8,000 DWT or lower in low tide)

Survey Point

A place on the riverbank opposite to the Ahlone district in the Yangon City Terminal shown in Fig. 5-5 is a rice field where there are no buildings but high voltage transmission towers that are 100 m or taller. The place may reserve a land space of 50 ha (1 km × 500 m) or larger.

Access to this place from Yangon City located on the opposite bank of the river must go around Bayint

Naung Bridge located 10 km to the upper stream, or by ferry crossing the Yangon River.

A geological survey of this place (whether there is a supporting bedrock and thickness, etc.) is necessary. However, judging from the facts that the transmission towers have been built and that rocks are exposed on the riverside, the bedrock of this place could withstand to support the planned power plant.

Drawing water from the neighboring Yangon River to cool power generation facilities seems no problem in terms of water quantity even in dry season. River water, however, runs back during high tide. Because of this, the planned power plant must draw water from the Yangon City side and discharge into the branch river on its rear side, or must adopt a cooling tower system that draws underground water depending on the result of simulating warm waste water diffusion.

Source: Photographed by a member of the Survey Team

Fig. 5-5 Survey Point in the District Opposite to the Yangon City Terminal

(b) Thilawa Port

As shown in Fig. 5-6, Thilawa Port has a backland area, namely a 2,400 ha special economic zone (SEZ) behind the port. Thilawa Port has a 200-m long wharf behind which a 750-m deep dedicated backland space is reserved. The backland space is divided into 37 lots, each of which has a 15 ha space. The details are as follows:

- In operation: 10 lots (MITT: 5; MIPL: 1; Shipyard: 4)
- Crane terminal: 3 lots
- General freight wharf: 5 lots

- Reserved: 11 lots
- Under examination (F/S): 5 lots
- Empty: 3 lots

Source: Myanmar International Terminals Thilawa (MITT)

Fig. 5-6 Thilawa Port

Thilawa Port has the following specification:

- Depth of water: 8 to 9 m
- Maximum ship to dock: 25,000 to 30,000 DWT (waiting for a favorable tide is necessary)
- Access on road: Dagon Bridge (75-ton truck permitted to pass) and Thanlyin Bridge (36-ton truck permitted) are linked to the Yangon district.

Survey Point

Besides the 37 lots mentioned above, a feasibility study has been conducted by Pusan Korea Biochemical Corporation, a Korean company, to build a 500 MW gas-fired (CCGT) power plant in the area between lot Nos. 21 and 22 (numbered from the upper stream). If a coal-fired power plant is planed, one berth (200 m) will be enough for the wharf length when a ship that can dock the wharf (25,000 DWT or lower) is taken into account.

The necessary land space will be some 50 ha space, in addition to the 15 ha backland space behind the wharf. Such land seems to be well available in the neighboring SEZ. (Refer to Fig. 5-7.)

Concerning drawing water to cool power generation facilities, a warm waste water discharge system cannot be adopted because seawater runs back into the neighboring Yangon River during high tide, which will reverse discharging warm waste water to the intake. Underground water also cannot be used because the concentration of salt content is high.

Because of these reasons, the planned power plant must adopt a cooling tower system that uses industrial water. To reserve a necessary quantity of industrial water is essential that can meet the methodological conditions, water quality, and the steam turbine output.

Source: Photographed by a member of the survey team

Fig. 5-7 Survey Point

5.2.2 Dawei Area

We surveyed two places in the Dawei area, namely the special economic zone and a place in the south-west Dawei area.

(a) Special economic zone (SEZ)

The construction of Port Dawei, which will face the Andaman Sea and the Indian Ocean, is under planning in the Nebule district of the north-west Dawei area. Some 250 km^2 of backland behind the port is specified as an industrial belt and special economic zone, where projects are underway to build a thermal power plant, oil refinery, steel mill, and petrochemical plant, etc. by 2015. The planned port will be a deeper-water port and have 22 berths and freight yards where 25 large ships, ranging from 20,000 to 50,000 ton, can dock at the same time.

The construction of a coal-fired power plant in the area is one of the construction projects that are planned in the special economic zone. The power to be generated by 400 MW × 10 units will be supplied to Thailand. This power plant construction project is being promoted mainly by Italian-Thai Development (ITB) Public Company Limited in Thailand in cooperation with Dawei Development Company (DDC). Italian-Thai (ITB) is the leading general construction contractor in Thailand. The general contractor was originally a joint venture of Italian and Thai companies. At present, however, the joint venture is managed by the Thai company alone. This Thai company engages in many large-scale projects in Thailand and overseas as well. For example, the company constructed the Mandalay Airport in Myanmar. It owns the Mae Moh Lignite coal mine (large-scale lignite coal mine in open-pit mining) in Thailand and strongly interested in overseas coal development.

(Dawei Special Economic Zone Project)

The project is a bilateral project agreed by Myanmar and Thailand. The project includes the construction of a port and a ship yard and their maintenance service; the construction of a petrochemical plants, oil refinery, iron mill, steel mill and power plant; and the construction of a highway between Dawei and Bangkok, and a railway, etc. By the construction projects, the construction of new plants and factories and Dawei Port is expected to continue improvement in traffic in the Strait of Malacca. The Government of Myanmar concluded an MOU on development with ITB in October 2011. President Thein Sein of Myanmar concluded an MOU on development with Prime Minister Yingluck Shinawatra of Thailand when the president visited Thailand in July 2012. Leading six companies in Myanmar have participated in the development plan. However, Max Myanmar, one of the six companies, announced a withdrawal from the plan. Figure 6-   and Figure 6-9 show the present states of the places designated for construction and of the coastline.

Fig. 5-8   Present State of Place Designated for Construction of a Special Economic Zone

Fig. 5-9 State of the Coastline

(b) South-western district

We heard that a plan is underway to build a coal-fired power plant in south-western Dawei. We surveyed the Lanunglon district, where a construction plan is underway to extract oil from palms. People said that Chinese companies have been hunting for purchases of neighboring land lots in this area. In reality, they have already purchased land lots in Sanhlan district near the coastline, in addition to land lots in the Lanunglon district. Sanhlan has a port, behind which a good space of flat land stretches. On the day when we visited the Lanunglon district, we also surveyed the place designated to build a coal-fired power plant in Sanhlan. The seaside area, flat land surrounded by mountains, has a shallow shore. Thus, the area is apparently unsuitable for the construction of a coal-fired power plant.

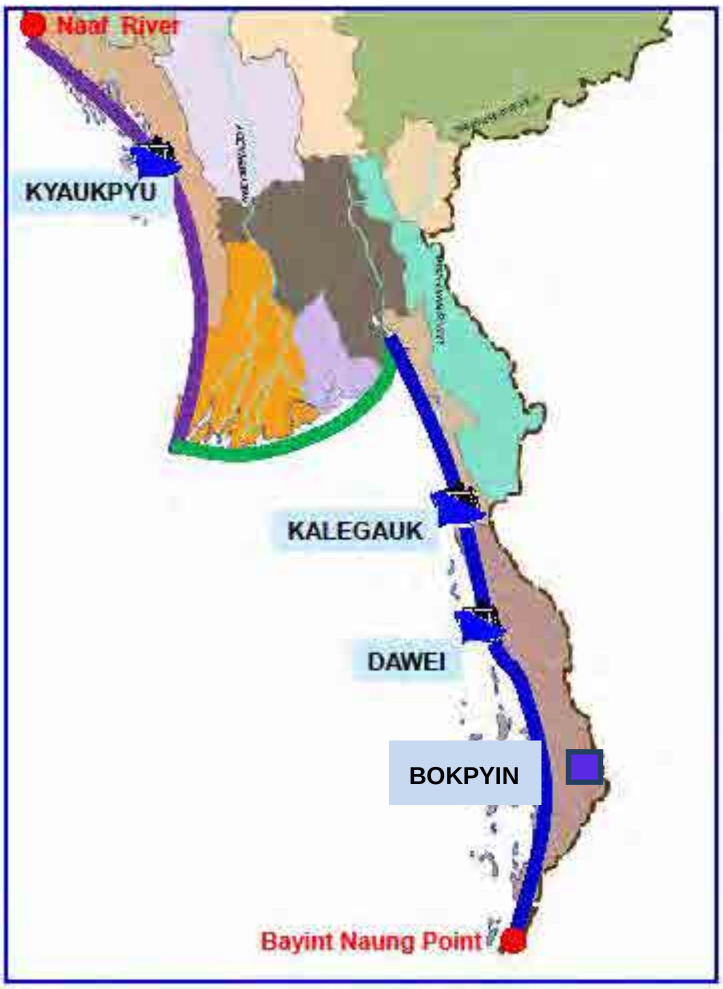
Fig. 5-10 Surroundings of Sanhlan Port

5.2.3 Other Deeper-Water Port Projects

The coastline between the Naaf River in western Myanmar, which is bound on the national border with

Bangladesh, and the place of Bayint Naung in southernmost Myanmar, which is bound on the national border with Thailand, is subdivided into the following three areas. (See Fig. 5-11.)

- Rakhin Coast: 713 km
- Delta Coast: 437 km
- Tanintharyi Coast: 1,078 km (total: 2,228 km)



Source: "Current Situation and Future Plans for Development on Ports in Myanmar" (MPA)

Fig. 5-11 State of the Coastline

As mentioned earlier, all the existing ports in Myanmar including the Yangon City Terminal are river ports. The depth of water of these ports is not enough for large ordinary cargo ships and container ships to anchor. Because of this reason, the Myanmar Port Authority studied on the development of new ports for a long time and conducted a preliminary survey to select suitable places after considering that deeper-water ports are necessary to meet future demand for international trade and demand by local people. The preliminary survey selected the places mentioned below to develop deeper-water ports along the coastline of Myanmar after natural conditions and technical conditions are taken into consideration.

Rakhin Coast (west coast): Kyaukpyu [one place]

Tanintharyi Coast (east coast): Kalegauk, Dawei, Bokpyin [three places]

(a) Kyaukpyu Deeper-Water Port Project

This project is located in the Kyaukpyu area of the Rakhine State. The project has been authorized as a deeper-water port development project for the future of the country. According to a hydrographic chart and the preliminary survey, the approach waterway has a 24-m least allowable depth (LAD), while the port area has a 20-m LAD and a 1,000- to 1,600-m sea room. The difference between high tide and low tide is 2 to 2.7 m. The port is protected against waves. The place is also off the course of ordinary tropical cyclones. The project anticipates cooperation with the neighboring ports, Sittwe-K.aladan Project, Thandwe sightseeing, and fishery. The port is also planned to moor 40,000 DWT GC ships and handles 5,000 TEU containers. (Note: TEU = Twenty feet Container Equivalent).

(b) Kalegauk Deeper-Water Port Project

Kalegauk is located between Mawlamyine and the Ye town in the Mon State. The approach waterway has a 15-m LAD, while the port area has an 18-m LAD and a 4.8 km sea room. The difference between high tide and low tide is 3 to 5 m. The site is protected against waves with Kalegauk Island and the coastline. The port will be able to moor 40,000 to 50,000 DWT ships and used for industry, fishery, and domestic and international use.

(c) Bokpyin Deeper-Water Port Project

The port is located between Myeik and Kawthoung of the Tanintharyi Region. The difference between high tide and low tide is 3 m, while the approach waterway has a 30 m LAD. The port area has a 20 m LAD and a 3.2km sea room. This project covers two ports, namely Bokpyin Port and Bang Saphan Port of Thailand, an international highway, railway, a number of natural gas pipelines, and two industrial cities specialized in heavy industries including iron manufacturing, petrochemicals, and power generation, etc. The port will have a commercial wharf for 65,000 DWT and 200,000 DWT class berths with alongside delivery of crude oil. Implementation of these projects is determined depending on the result of individual feasibility studies and negotiations between investors and the Myanmar authorities concerned.

5.3 Results of Our Surveys in Mandalay and Bagan Districts

5.3.1 Irrawaddy River Water Transportation

(a) Conditions of Jetties

(1) Mandalay District

There are no jetties, such as concrete wharfs and cranes for public use. No cement factories are built along the Irrawaddy River sides in the suburbs of Mandalay that we surveyed.

The jetties we surveyed are under the control of the Ministry of Industry. Gogan stone (apparently limestone) was being loaded onto a barge for a cement factory in Kyankin, which is located 250 miles downstream (150 miles distant in the northwestern direction to Yangon). Dump trucks, owned by the Ministry of Industry, transport Gogan stone onto the riverside where workers shoulder Gogan stone onto barges, like workers shoulder coal in Kalewa (see Fig. 5-12).

Fig. 5-12 Workers Loading Gogan Stone onto a Barge on the Irrawaddy River near Mandalay

We conducted the survey more than one month after entering a dry season (November through April). Since the level of the Irrawaddy River water was low, no barges arrived at the riverside. A small volume of coal remained seemingly disembarked on the riverside.

(2) Bagan District

Suburbs of Bagan have neither jetties, including concrete wharfs and cranes, nor cement factories. (It is said that a cement factory is in the town of Thayet located 200 miles downstream (south) to Bagan.)

There is the Iarrawaddy Bridge (Pakuakku Bridge) over the Iarrawaddy River at a point upstream to the town of Bagan. The construction of the bridge was completed in January 2012. The river bank (right: western side) opposite to Bagan near the bridge had a barge from which workers were unloading rice bags and cement bags (See Fig. 5-13).

Fig. 5-13 Workers Unloading Rice Bags from a Barge on the Irrawaddy River near Bagan

The suburbs of Bagan had no coal barges arrived nowadays. However, there was a trace of coal (seemingly to be Kalewa coal) on a riverside of the village of Nyaunghla located 18 miles upstream (north) to Bagan (see Fig. 5-14). In our visual inspection, the level of the Irrawaddy River water in the dry season was about 10 meters lower than that in the rainy season.

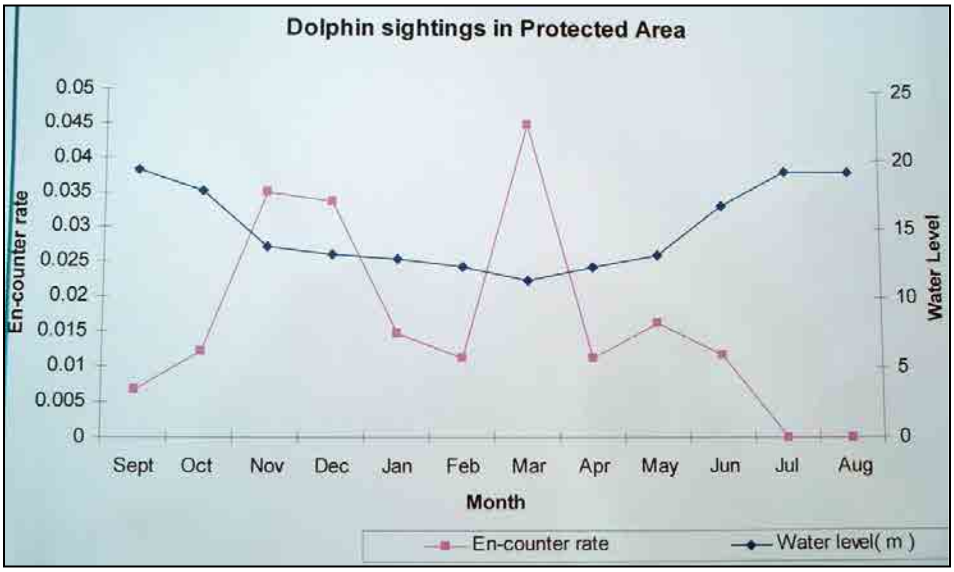
Fig. 5-14 Trace of Coal Unloaded on a Side of the Irrawaddy River in Nyaunghla Village near Bagan

(b) Water Volume and Meteorology of the Irrawaddy River

According to the Mandalay Fishing Bureau, the Irrawaddy River becomes narrow and low in water level during dry season of November through April. The level of the river water becomes lowest in January and February, while it rises somewhat in March due to increasing water from snow melted. Meanwhile, the level of the river water becomes highest in August of rainy season (see Fig. 5-15).

It seems that seasonal fluctuations in the river water level depend on the width of the river. According to a material of the Mandalay Fishing Bureau, the water level of the Irrawaddy River Dolphin Protection Area in a suburb of Mandalay becomes 11 meters in dry season and 19 meters in rainy season. The annual difference of water levels is 8 meters. The suburb of Mandalay has neither heavy rain nor flood because the area has small rainfall in dry season. The river water temperature ranges from 20°C to 27°C throughout the year and does not go beyond 30°C.

Winds may blow at a speed of 40 to 60 mile/hr (18 to 27 meter/sec) for a short period of some 15 to 30 minutes in April to June due to development of (tropical) cumulonimbi. However, the area has no typhoons (cyclones) through and it has infrequent earthquakes.



Source: Fishing Bureau

Fig. 5-15 Records of Water Levels in the Irrawaddy River Dolphin Protection Area near Mandalay

5.3.2 Fishing and Protected Animals including Dolphins in the Irrawaddy River

(a) Fishing

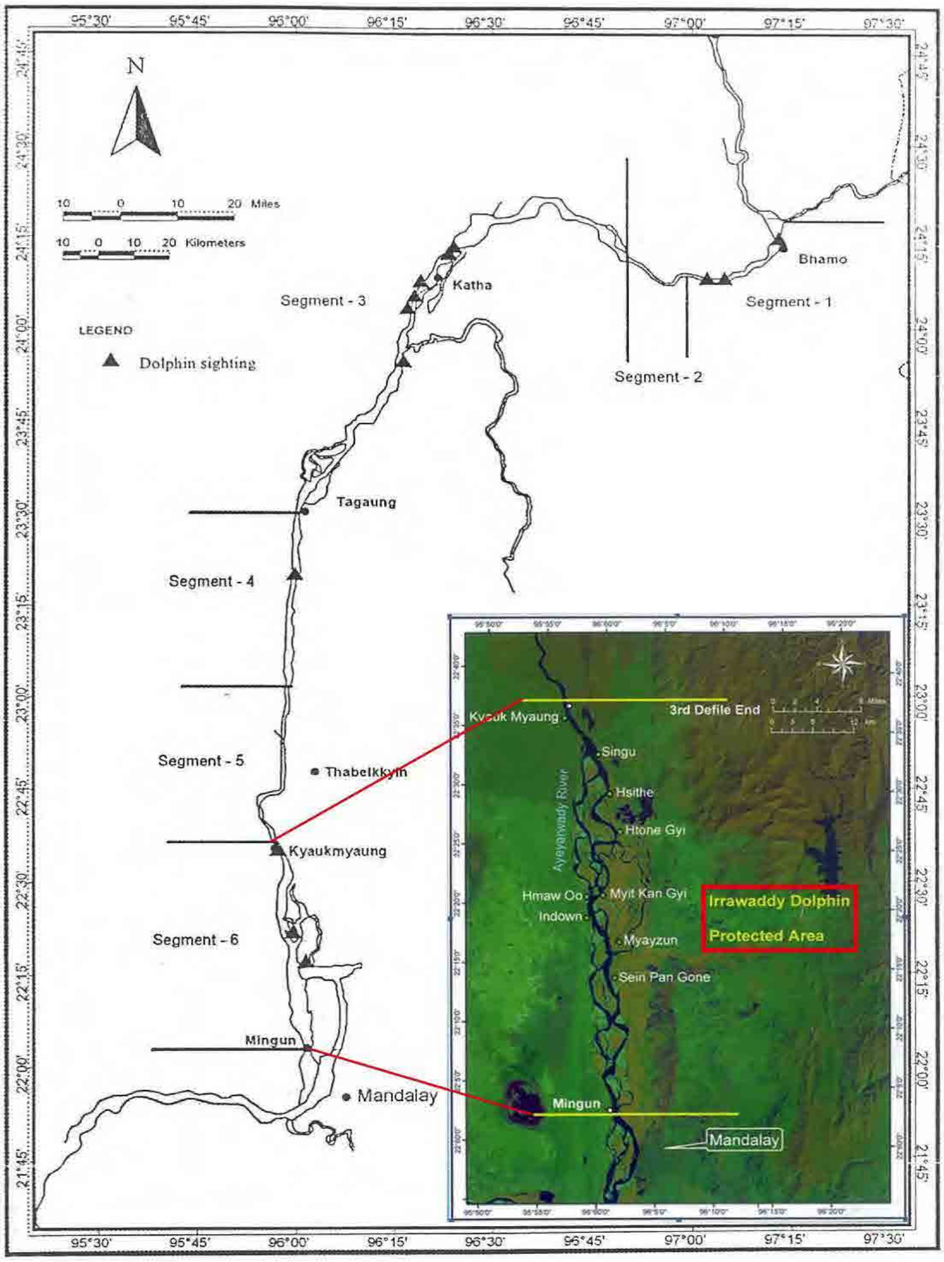
Fish in the Irrawaddy River basins in the suburb of Mandalay have become less. Although fry have been discharged, fish have not been cultivated.

Poaching, such as electrofishing, is subject to a fine of 200,000 kyats or a sentence of three-year prison. Thus poaching has become less in recent years.

(b) Irrawaddy River dolphins

River dolphins habit in the approximately 400 km long basin that ranges from Mingun in northern Mandalay to the northern upstream point 10 km distant to Bhamo. The width of the river in the further northern basin from Bhamo is too narrow for dolphins to habit. In cooperation with Wild Conservation Society (WCS), the Fishing Bureau monitors and protects river dolphins in the 70 km long basin from Mingun to upstream Kyaukmyaung. The protection area has (traditional) fishing in cooperation with dolphins (see Fig. 5-16).

A total of 70 dolphins habit in the river, namely about 20 dolphins in the protected area and about 50 dolphins in the basin north to the protected area. Dolphins go downstream (south) up to the point 10 km to the suburb of Mandalay in rainy season of July to August.



Source: Prepared by the survey team based on a material of the Fishing Bureau

Fig. 5-16 Irrawaddy River Dolphin Protected Area in the Suburb of Mandalay

River dolphins used to habit in the Bagan basin in the past. Nowadays, however, they habit up to the downstream of Mandalay. River dolphins up to present have not habited in the Chindwin River, which flows through the Kalewa District and meets the Irrawaddy River in northern Bagan.

The number of river dolphins totaled about 60 in 2002 when protection started. Since then, however, the number has increased slightly and totaled about 70 since 2007. It seems that, every year, four to five dolphins are born and almost the same number of dolphins die.

River dolphins breed (delivery) in the period of July to August and the period of December. The gestation period is 14 months. Adult dolphins grow about eight feet. NHK, a leading TV broadcast station in Japan, made a TV program in 2007 with help of the Fishing Bureau, where fishermen engaged in fishing in cooperation with river dolphins.

(c) Other protected animals

Protected animals other than river dolphins do not habit in the Irrawaddy River downstream to Mandalay. However, Star Turtles, an endangered animal, habit in the river. *Mauremys*, a protected animal, habit in the Chindwin River. In cooperation with the Ministry of Forestry and Environmental Conservation and WCS, a body in Bagan has engaged in *Mauremys* protection activities.

5.3.3 Examination on Thermal Power Plants in Mandalay and Bagan Districts

(a) Coal Transportation

If Myanmar plans to use Kalewa coal for power plants, barges will be used for coal transportation. However, the annual difference of river water levels is approximately 10 meters, indicating the need for a structural adjustment of the wharf to unload coal. Such adjustment is unfavorable because it will make the load-lifting height too high. In addition, operation of barges will be restricted in dry season, which is likely to result in an unstable supply of coal.

On the other hand, coal transportation on railways has more stable supply of coal, compared with coal transportation on barges. This is because there is no seasonal restriction of coal transportation. Besides, a coal reception facility in railway stations is easier to build, compared with an unloading facility at the wharf.

Accordingly, it is desirable that Myanmar develops railways to transport coal from the Kalewa District.

(b) Drawing water for cooling

Water quality must be analyzed in the feasibility study stage. Since river water has large volumes in dry seasons, drawing water from the Irrawaddy River is feasible throughout the year.

The annual difference of water levels, however, could reach 10 meters, depending on the width of the river spot. Thus, certain devices are needed to design a water intake pump and intake and discharge conduits. If Myanmar plans to discharge warm waste water into the river directly, the country needs to simulate possible rises in the river water temperature stemming from warm waste water to be dispersed and conduct environmental assessments of water creatures and surrounding environments.

(c) Candidate site

Thermal power plant should not be built on the sides of the Irrawaddy River surrounding Mandalay, where dolphins habit in.

When coal transportation and drawing water for cooling are considered, Myanmar should reserve a site on a side of the Irrawaddy River in surroundings of Bagan. This is because the country is going to develop the railway from Kalewa in Bagan.

Since the town of Bagan has pagodas being applied for the World Heritage, preservation of the scenery must be considered. The Irrawaddy River side opposite to the town of Bagan has a small number of houses and other buildings, so reserving a site could be relatively easier.

Chapter 6 Scale of Coal-Fired Power Stations Corresponding to Potentials of Supplying Import Coal and Domestic Coal for Fuel and Consideration of Construction Area

Based on the results of our surveys detailed in Chapter 2 through Chapter 6, we have drawn a conclusion on the development of coal-fired power plants in Myanmar as follows.

(a) Evaluation of domestic coals

We surveyed and assessed coals produced in the Kalewa district and Lasio district that are designated as domestic coal, which will be used by coal-fired power plants in future.

Concerning properties of coal produced in the Kalewa district, the value of grindability (HGI) indicated a nearly lower limit of ordinary boiler design values. However, other properties indicated those of high grade coal among sub-bituminous coal types. So we assessed that the coal has suitable properties that are enough for fuel for power generation. We also decided that the coal can be co-fired with overseas coal (premixed combustion). Although further detailed examination of the coal resource quantities is necessary, we assess that this kind of coal can maintain the operation of a certain-scale coal-fired power plant.

Coal distributed in the Lashio district ranges from lignite and sub-bituminous coal. Properties of the coal generally indicated a low calorific value, high moisture, high sulfur content and low grindability. These properties are unfavorable for the use of fuel for power generation. If a coal-fired power plant is designed on the assumption of using this coal, facility expenses will increase and may invite deterioration in the environmental performance. Thus, we decided that this coal is unsuitable for the use of fuel for power generation. In particular, the grindability (HGI) index of this coal indicated an extremely low value ranging from 20 to 27. Considering that steam coal normally used for power generation has a grindability value (HGI) of 40 or above, we must say that this coal is unfit for use of power generation. If a power plant is designed that uses this coal, the grinding facility will require excessive expenses and additional in-station power. In addition, resource quantities that are assessed at present are not enough for such a power plant to operate for more than 40 years.

(b) Domestic transportation infrastructure

Coalfields in the Kalewa district and the Lashio district are found in the northern Sagaing district and the Shan State. In case that coal produced in these coalfields is to be transported to a power plant in a coastal area near a Yangon suburb, etc., the inland transportation distance amounts to over 1,000 km. Coal transportation is supposed by means of barges, trucks, railways, etc. However, coal supply by means of barge will not be stable. This is because barge traffic is restricted during dry season at the channel between the Irrawaddy River and the Yangon River. This results in a longer transportation period. Coal transportation by truck also is not practical because the transportation distance is far long and the volume of transportation unit per truck is small.

It seems that coal transportation by railway is advantageous, compared with coal transportation by truck, because a railway can transport a large volume of coal on a stable supply basis. However, the transportation distance is far longer and takes more than a day each way to deliver coal. After considering these factors, we must say that coal transportation by railway is not practical.

Therefore, it seems that the plan in which a coal-fired power plant built in a coastal area near a Yangon suburb, etc. will be operated on domestic coal is not practical.

However, we assessed that properties of Kalewa coal allows co-firing (premixed combustion) with overseas coal. When the railway network is expanded in the future, a coal-fired power plant to be built near a Yangon suburb could use coal from the coalfields mentioned earlier as part of its fuel. Thus, it is desirable to make detailed examination on the use of coal as fuel when a specific feasibility study is held on the development of a power plant.

(c) Overseas coal procurement

Concerning the development of a power plant near a suburb of Yangon, an area of large consumption of electric power, we have decided to study on the development of an overseas coal-fired power plant because of the domestic transportation problems mentioned early.

What is important in procuring overseas coal lies in stable supply. In other words, necessary coal must be supplied on a stable basis (coal quality must be within design coal). In addition, overseas coal needs procuring at a price as low as possible. To these ends, overseas coal need procuring coal from more than one coal producer (or trader) in more than one country. This way of coal procurement will withstand a temporary interruption of supply due to heavy rain or other natural disasters and accidents in coal mines or transportation infrastructure.

Indonesia, Australia, South Africa, Russia, United States, Canada, Columbia, etc are exporters of steam coal for power generation. Considering geographical locations of Myanmar and exporters, procuring coal from Indonesia is most desirable because the country is the closest to Myanmar (the freight rate is lower) among the exporters mentioned above. As described in Chapter 2, however, coal export by Indonesia may not increase due to increasing demand in the country. In addition, depending on one supply country alone may face a risk of temporary supply interruption, etc. Thus, an institutional system should be considered to import coal from Australia and South Africa. This is because these countries are the second closest country to Myanmar, following Indonesia among the coal exporters mentioned above. Reserving more than one closer source of coal exporters will contribute to stable supply. In practice, when purchasing overseas coal, Myanmar also needs to examine other exporters of steam coal. Note, however, that the freight rate will naturally cost more when Myanmar is going to import coal from an exporter in a longer distance from Myanmar. Therefore, it is desirable that Myanmar imports coal from these three countries.

Purchasing overseas coal mostly on a long-term agreement basis is desirable to ensure stable supply. For example, as mentioned in Chapter 2, electric power companies in Japan, Korea and Taiwan have procured at least 70% of its annual consumption of coal on a long-term agreement basis.

The remaining volumes of coal are purchased on a flexible spot agreement basis. Procuring coal in the coal market when the price is inexpensive could be a means of coal procurement.

(d) Construction period of a coal-fired power generation facilities

The development of a coal-fired power plant is promoted roughly in the following procedures.

- Determining the output of a power plant based on the master plan of electric power development;
- Selecting the designated place (implementing a feasibility study);
- Implementing a geological survey of the designated place and implementing environmental surveys on the present conditions of the land and sea (river) areas surrounding the designated place (normally taking more than one year);
- Implementing an EIA survey of the construction work of a power plant and subsequent operation of the power plant (including a simulation of the atmosphere, water, noise, etc.);
- Holding meetings to explain an EIA report to local people and autonomies concerned and obtaining agreement of the local people and autonomies to build a power plant;
- Obtaining prescribed permits and approval and concluding purchase and sales agreements on electric power and fuel, etc.;
- Tender notice on the master design of equipment and power generation facilities;
- Concluding an agreement on construction works and equipment delivery;
- Designing equipment and facilities, ordering materials, and manufacturing and delivering:
- Land formation, civil engineering and foundation work (normally taking some 18 months, depending on the current conditions of the land and development scale);
- Installation of equipment and trial operation (normally taking some 24 months in case of a 300 MW unit, and additional six months or so when installing two units of a 300 MW unit); and
- Starting commercial operation.

For example, if Myanmar is going to develop a coal-fired power plant consisting of two 300 MW units, it will normally take two to three years in surveying present conditions of the environment and starting construction works on the location, and another four years or so until starting commercial operation since starting construction works on the location; Thus, a total of six to seven years will be needed at earliest.

(e) Improvement in transmission lines, power development plan, and installed capacity of power

generation

As described in Section 4.1.3, Electric Power Supply and Demand and Generated Power, of Chapter 4 in this report, Myanmar is expected to have the maximum demand power of 1,850 MW in 2012, an increase of 16.49% over the maximum demand power of 1,588 MW of 2011 according to the Ministry of Electric Power. The country is also forecasting an annual increase of 15% in the subsequent years.

As described in Section 4.3.2, Transmission System Enhancement Plan, of this report, the Ministry of Electric Power has been promoting the five-year expansion plan starting in 2011 to reinforce transmission systems. However, no details are indicated on the breakdown of increases in demand by area and a plan to reinforce supply capacity (construction of power plants), which underlie the above-mentioned increases.

To boost electric power supply, Myanmar needs to simulate the stability of the transmission and distribution systems and formulate a master plan of balanced electric power development for the entire country based on demand forecasts by area and place, power source development plan by power generation system, and a plan to reinforce transmission and distribution lines and substations, etc.

In addition, in terms of protecting electric systems, Myanmar needs to simulate the stability of transmission systems to determine the maximum single unit capacity (maximum unit output) of a power plant being connected to a transmission line so that the capacity will remain within rated values of the voltage and frequency of the electric system even if the unit trips. The impact of a drop in supply capacity is more severe at night because electric systems have smaller load on the whole. It is said that the maximum single unit capacity should be controlled at 10% or lower of the system load during low load.

In general, when the capacity of a thermal power plant is larger, the power generation efficiency will rise, bringing more advantages in terms of construction cost per unit power and maintenance cost after operation. Therefore, the construction of power generation facilities with a capacity as large as possible is desirable.

As described in the preceding section, the development of a core-fired power plant needs six years at earliest. The maximum single unit capacity (maximum unit output) of a coal-fired power generation facility being connected to an electric system in Myanmar will reach approximately 300 MW when the power plant is supposed to start operation in six years later from now. We forecast this capacity after considering increases in the maximum power demand in the future and construction of new gas-fired power and hydro-powered generation sources corresponding to the increase.

Based on the above-mentioned information and findings gathered during our survey, we studied the following items relating to the development of a coal-fired power plant.

- Assessing the development of a coal-fired power plant in terms of domestic coal properties;
- Assessing the coal supply capacity on the assumption that a coal-fired power plant is operated for 40 years or more that is defined in a policy of the Ministry of Electric Power of Myanmar;
- Selecting a designated place after considering the surrounding environments, acquisition of land, fuel transportation, taking cooling water and access to a transmission line;

- Developable output of the power plant and rough estimation of construction cost;
- Possibility to acquire a power plant location in a suburb of Yangon, the largest power consumption area in Myanmar (overseas coal used);
- Extracting development conditions and issues; and
- Measures to control the environment that accompany the development and other remarks.

6.1 Development of a domestic coal-fired power plant

In our survey, we examined the following three places relating to the construction of a domestic coal-fired power plant.

6.1.1 Kalewa District

(a) Properties of coal

According to results of analyzing coal samples gathered during the local survey, the coal produced in the Kalewa area seems to have the following major properties.

Although the grindability (HGI) value of the coal indicates a bare lower limit, other properties are classified into those of a high-grade coal type among sub-bituminous coal types. Thus, we judge that this coal has good properties as fuel for power generation

- Calorific value (kcal/kg AD/Btu/lb AD): 6,530 to 6,620/11,750 to 11,920
- Moisture (%AR): 6.1 to 8.2
- Ash (%AD): 4.4 to 5.8
- Sulfur content (%AD): 0.52 to 0.78
- Grindability (HGI): 34 to 42

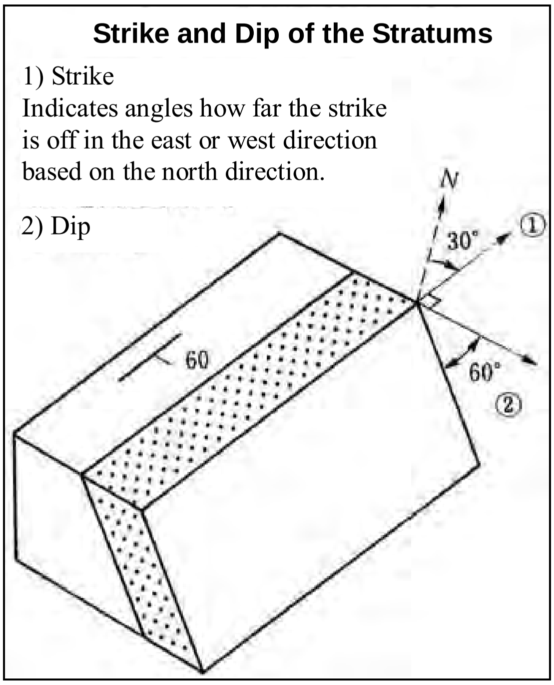
(b) Coal supply capacity

The coal beds in the Kalewa area are 5 m thick in total and the dip ranges steep 40 to 45 degrees.

Under the geological conditions, deepening mining sites and increasing rate in the soil stripping ratio will be faster, resulting in a shorter time in reaching the economical mining limit in open pit mining. In addition, to output large volumes of coal in open pit mining, inside the mining area must be developed in the strike direction. Although almost all of the coal mines in the Kalewa area had no detailed geological surveys, in the case of the Kyauk On Chaung coal mine, the recoverable reserve accounted for approximately 20% of the possible reserve at P3. In addition, according to hearings from engineers of Htoo International, total possible reserve at P3, which was proved in the survey in the Kalewa area as indicated in Fig. 5-1, is approximately 266 million ton[22]. If reserves are supposed to reach approximately 266 million ton, recoverable reserve will be multiplied by 20%, which will amount to approximately 5,300 million ton + (unproved recoverable reserve alongside the Mawleik Kyi River). However, improvement in infrastructure is essential to increase production and transport coal.

Since mining companies in Japan, China and Canada, etc. have experience in high-efficient mining in steep coal beds, they will be able to carry out underground mining in the Kalewa area. Despite this, advanced techniques will be still required. Therefore, such mining companies may face difficulty in mining according to the present situation of Myanmar.

Mining under the engineering of a Japanese company, etc. is possible if the mining system needs not so high productivity. However, when one coal mine has a production volume of tens of thousands ton only in underground mining, the production cost will rise, compared with open pit mining. In addition, an underground water layer is present in a shallow zone, a measure to discharge underground water is necessary. Fig. 6-1 shows a schematic diagram of strikes and dips of the stratums. The coal beds in the Kalewa area have a dip of nearly 60 degrees.



Source: Prepared by the survey team

Fig. 6-1 Dip and Strike of Coal Bed

22 According to data prepared by the Department of Geological Survey and Mineral Exploration (DGSE) of the Ministry of Mineral Resources shown in Fig. 3-3, mineral deposits in the Kalewa district are four, namely the Kalewa, Darthwekyauk, Paluzawa, and Mawlikegyi mineral deposits. Their coal reserves amount to 215 million ton.

(c) Reserving cooling water

In the vicinities there is the Chindwin River from which cooling water can be drawn even during dry season. The river is large and seems to have a good quantity of water in dry season. Thus, there are apparently no problems in taking water. The quality of the river water seems to have no problems because the water is regarded as ordinary river water. Thus, the river water seems available only when an ordinary dust remover is fixed to prevent floating matter from flowing in. At the stage of conducting a feasibility study, discharging warm waste water must be simulated to assess a rise in the river water temperature and the impact. After the simulation, whether to adopt a water intake and discharge system or a cooling tower system must be determined.

(d) Access to transmission line

In vicinities of the Kalewa district, there is a 230 kV transmission line stretching to the Nyaungpingyi substation that is located in the south-southeastern direction some 150 km distant to Kalewa. A plan is underway to build a 230 kV transmission line from the Nyaungpingyi substation to the already planned Kalewa coal-fired power plant, Mawlight hydropower plant and Htamanthi hydropower plant. In addition, a plan is also underway to build a 230 kV substation near the Kalewa district. Thus, connection to the substation will be easy. If transmission towers need to be built in the city to connect to the substation, the construction works would take time.

(e) Site and surrounding environments

Since some riverbanks of the Chindwin River are used as rice field, etc., there seem a plenty land lots to acquire for a power plant. At the stage of carrying out a feasibility study, a designed site must be selected to carry out a geological survey, studies on rare species of plants and animals in the surrounding areas and creatures in the Chindwin River, and assess impact on them carefully.

(f) Developable output of the power plant and rough estimation of construction cost

When we make a trial calculation of construction cost under the following conditions based on the results of our survey, the following power plant of 225 MW × 1 unit can be built.

- Recoverable reserve (ton): 53 million ton
- Rate of coal to be used for power generation (%): 50 (assuming the rest is for cement industry)
- Coal calorific value (kcal/kg AD/Btu/lb AD): 6,500 / 11,700
- Coal moisture (%AR): 10
- Operation period (years): 40
- Utilization of power plant (%): 80

・ Annual average of power generation efficiency (%): 35

When we make a trial calculation of rough construction cost that does not include ground-making expenses for 225 MW × 1 unit, it will reach US$540 to 580 million.

(g) Development conditions and issues

In studying on the development of a coal-fired power plant in this area, the following matters must be cleared.

① Careful examination of recoverable reserve and the ratio of coal to be used in the cement industry in future;

② Obtaining confirmations of cooperation from coal mine owners (companies) that they sell coal to the power plant and plans to increase coal production;

③ Improvement in mining and transportation infrastructure that correspond to the increase in coal production mentioned above;

④ That the power plant has a feasible plan so that cement manufactures, etc. will undertake or purchase or utilize coal ash and gypsum, a by-product resulting from desulfurization;

⑤ Selecting a suitable place and conducting a geological survey;

⑥ Surveying creatures in the Chindwin River and conducting EIA including a survey on rare species of plants and animals in the surroundings;

⑦ Assessing impact on a rise in the water temperature of the Chindwin River by simulating warm waste water diffusion into the river; and

⑧ Consistency in the transmission line construction (expansion) plan

6.1.2 Lasio District

(a) Properties of coal

According to information gathered during the local survey and the result of analyzing coal samples gathered, coal produced in this area has the major properties mentioned below. A distribution ranging from lignite to sub-bituminous coal is observed.

A full attention must be paid to coal of a low calorific value, high moisture, high ash, high sulfur content, and low grindability in planning a power plant if coal of these properties is used as fuel for power generation. This is because coal of these properties will lead to an increase in facility costs and deterioration in environmental performance. Like properties of coal in the Tigyit coal mine, some coal produced in this area has an extremely low grindability (HGI) index of 20s. Considering that Japan usually imports coal for power generation whose grindability is 40 or over, we must say that coal whose grindability (HGI) is up to just 27 is unfit for power generation. If a power generation facility is designed to use this kind of coal, excessive cost will be needed for grinding equipment.

- Calorific value (kcal/kg AD/Btu/lb AD): 4,740 - 5,800 / 8,530 - 10,440
- Moisture (%AR): 13.1 - 15.6
- Ash (%AD): 2.3 - 8.1
- Sulphur (%AD): 0.39 - 1.04
- Grindability (HGI): 20 - 27

(b) Coal supply capacity

According to data gathered during our local survey in the Lasio district, possible reserve at P3 in the north Shan State including the Lasio district is 30 million ton[23]. If we adopt data gathered during our local survey in the Rasio district, recoverable reserve in north Shan State will be 30 million ton × 20% = 6 million ton. Adopting 20% means that the mining is assumed to have a similar mining dip condition of 40-degrees like the mining in the Kalewa district.

- Recoverable reserve in the north Shan district: approximately 6 million ton

(c) Reserving cooling water

In the vicinity there is a river from which cooling water can be drawn even during dry season. Because the river is small, a cooling tower system must be adopted that discharge no warm waste water into the river. The quality of the river water seems to have no problems because the water is regarded as ordinary river water. For a cooling tower system where water is circulated, grit processing is necessary when taking river water, in addition to an ordinary dust remover to prevent floating matter from flowing in.

(d) Access to transmission line

In a vicinity of the Lasio district, there is a 230 kV transmission line stretching to the Man san substation that is located in the west direction some 35 km distant to Lasio. A plan is underway to build a 66 kV transmission line from Lasio to the Man san substation. Furthermore, a plan is underway to build a 66 kV substation in Lasio. Therefore, connecting to a substation seems to be easy. If transmission towers need to be built in the city to connect to the substation, the construction works would take time.

(e) Site and surrounding environments

Since the Lasio district has some land lots in vicinities of the river are used for rice fields, etc., there seem a plenty land lots to acquire for a power plant. At the stage of carrying out a feasibility study, a designed site must be selected to carry out a geological survey and an EIA including a study on rare

[23] According to material prepared by the Department of Geological Survey and Mineral Exploration (DGSE) that is shown in Fig. 3-3, mineral deposits in the Lasio district amount to 12, including the Harput and Sale mineral deposits. Their reserves total 55 million ton.

species of plants and animals in the surroundings, and assess impact on the environment.

(f) Developable output of the power plant

Under the conditions mentioned below and based on the results of our survey, when we make a trial calculation of costs to build a power plant that uses coal in north Shah State, only an 18 MW power plant can be built. Thus, contracting a power plant is not practical.

・ Recoverable reserve (ton):	6 million ton
・ Rate of coal to be used for power generation (%):	50 (assuming the rest is for cement industry)
・ Coal calorific value (kcal/kg AD/Btu/lb AD):	5,000 / 9,000
・ Coal moisture (%AR):	15
・ Operation period (years):	40
・ Utilization of power plant (%):	80
・ Annual average of power generation efficiency (%):	33

(g) Development conditions and issues

In studying on the development of a coal-fired power plant in this area, the following matters must be cleared.

① Studying on an optimal power generation facility that uses extremely low grindable coal;
② Careful examination of recoverable reserve and the ratio of coal to be used in the cement industry in future;
③ Confirming cooperation with coal mine owners (companies) that they sell coal to the power plant and plans to increase coal production;
④ Improvement in mining and transportation infrastructure that correspond to the increase in coal production mentioned above;
⑤ That the power station has a feasible plan so that cement manufactures, etc. will undertake or purchase or utilize coal ash and gypsum, a by-product resulting from desulfurization;
⑥ Selecting a suitable place and conducting a geological survey;
⑦ Conducting an environmental survey including a survey on rare species of plants and animals in the surroundings and assessing impact on the environment; and
⑧ Consistency in the transmission line construction (expansion) plan

6.1.3 Mandalay and Bagan Districts

Nowadays, coal produced in the Kalewa and Lasio districts is collected after coal is unloaded from barges or transported by truck in the Mandalay and Bagan districts before it is transported to a cement factory. If a coal-fired power plant is planned in the Mandalay and Bagan districts, the power plant will have the following advantages and disadvantages.

(Advantages)

- Coal from broader areas is available;
- Since the site is close to the backbone (high voltage) transmission line, it is advantageous to transmit power to a large consumption area (cost to build a transmission line is relatively low);
- Since the site is close to a cement factory, utilization of coal ash and gypsum, a by-product from desulfurization, will be made;
- It is easier to build a power plant and transport construction materials, compared with building in the coal mine;
- It is advantageous to recruit workers for building, maintaining and operating the power plant and easier for workers to commute.

(Disadvantages)

- Coal transportation will cost more (especially, in dry season in which the barge freight is higher).

(a) Properties of coal

Coal properties are supposed to be similar to coal produced in the Kalewa district.

(b) Coal supply capacity

Recoverable reserve: 53 million ton or more; assuming 50% of them are used for power generation

(c) Reserving cooling water

Water quality must be analyzed in the feasibility study stage. Since river water has large volumes in dry seasons, drawing water from the Irrawaddy River is feasible throughout the year.

The annual difference of water levels, however, could reach 10 meters, depending on the width of the river spot, certain devices are needed to design a water intake pump and intake and discharge conduits. If Myanmar plans to discharge warm waste water into the river directly, the country needs to simulate possible rises in the river water temperature stemming from warm waste water to be dispersed and conduct environmental assessments of water creatures and surrounding environments.

(d) Access to transmission line

In a vicinity of the Mandalay district, there are a 132 kV transmission line and substations. Thus, the power plant can connect to an optimal substation. If transmission towers need to be built in the city to connect to the substation, the construction works would take time. There is a 66 kV transmission line near the Bagan district that is connected to Nagthayauk Substation in the west some 30 km distant to Bagan. In addition, a plan is underway to build a 66 kV substation in the Bagan district. Thus, connecting to a substation seems easy.

(e) Site and surrounding environments (under checking)

Thermal power plant should not be built on the sides of the Irrawaddy River surrounding Mandalay, where dolphins habit in.

When coal transportation and drawing water for cooling are considered, Myanmar should reserve a site on a side of the Irrawaddy River in surroundings of Bagan. This is because the country is going to develop the railway from Kalewa in Bagan.

Since the town of Bagan has pagodas being applied for the World Heritage, preservation of the scenery must be considered. The Irrawaddy River side opposite to the town of Bagan has a small number of houses and other buildings, so reserving a site could be relatively easier.

(f) Developable output of the power plant and rough estimation of construction cost

225 MW or over (depending on the careful examination of an available coal volume)

When we make a trial calculation of rough construction cost that does not include ground-making expenses for 225 MW × 1 unit, it will reach US$540 to 580 million.

(g) Development conditions and issues

In studding on the development of a coal-fired power plant in this area, the following matters must be cleared.

① Careful examination of recoverable reserves of coal in the supply designated districts and the ratio of coal to be used in the cement industry in future;

② Obtaining confirmations of cooperation from coal mine owners (companies) that they sell coal to the power plant and plans to increase coal production;

③ Improvement in mining and transportation infrastructure that correspond to the increase in coal production mentioned above;

④ That the power plant has a feasible plan so that cement manufactures, etc. will undertake or purchase or utilize coal ash and gypsum, a by-product resulting from desulfurization;

⑤ Selecting a suitable place and conducting a geological survey;

⑥ Carrying out a geological survey and studies on rare species of plants and animals in the surrounding areas and on creatures in the Irrawaddy River, and assessing impact on them;

⑦ Conducting an environmental survey of impact on a rise of the river water temperature by simulating warm waste water diffusion into the Irrawaddy River; and

⑧ Consistency in the transmission line construction (expansion) plan

6.2 Development of an Overseas Coal-Fired Power Plant

In our survey, we examined the following three places relating to the development of an overseas coal-fired power plant.

6.2.1 Surroundings of Yangon City Terminal

(a) Site and surroundings

This survey covered only limited areas in a limited time (surroundings of the Yangon City Terminal). However, we confirmed one designated place on the riverbank of the Yangon City Terminal. It is desirable to have additional surveys in future to look for suitable places in the surrounding areas. The place we surveyed is located on the riverbank opposite to the Ahlone district in the Yangon City Terminal. The place in rice fields has 100 m or taller high-voltage transmission towers and no other buildings. A space of 50 ha (1 km × 500 m) or wider can be reserved.

Access to this place from Yangon City located on the opposite riverbank must go around Bayint Naung Bridge located 10 km to the upper stream, or by ferry crossing the Yangon River. A geological survey of this place (whether there is a supporting bedrock and thickness, etc.) is necessary. However, judging from the facts that the transmission towers have been built and that rocks are exposed on the riverside, the bedrock of this place could withstand to support the planned power plant.

(b) Coal reception capacity

Considering the depth of the Yangon River, a ship size to moor will be limited to a 15,000 DWT or lower ships. Even in such a case, depending on changes in the river depth due to high and low tides, the ship must wait for up to six hours before docking. After these facts are considered, one berth could receive approximately 1.8 million ton of cargo in a year.

(Conditions to examine)

- Coal loading capacity per ship: 15,000 ton
- Time needed for unloading per ship: 2.5 days
- Number of unloading days per year: 300 days (60 days for periodical checks of unloaders, etc.)

(c) Reserving cooling water

The Yangon River, which is in front of the designated place, has a good volume of river water even during dry season. Taking river water to cool a power generation facility would cause no problems. However, the river water runs back during high tide. What is needed to examine is which system to adopt, a system that takes water from the Yangon River in front of the designated place (Yangon City) and discharges into a branch river behind, or a cooling tower system that uses underground water depending on the result of simulating warm waste water diffusion into the river. Concerning quality, river water seems available when an ordinary dust remover is fixed to prevent floating matter from flowing in. However, since seawater may mix into river water, a water quality survey must be conducted to study on a suitable system and piping material, etc.

(d) Access to transmission lines

The Yangon district has 230 kV transmission lines and substations. The designated place can connect to an optimal substation. If transmission towers need to be built in the city to connect to a substation, the construction works would take time.

(e) Developable output

When we make a trial calculation of construction cost under the following conditions, a power plant of 300 MW × 2 units can be built.

・ Annual coal reception volume (ton):	1,800,000
・ Coal calorific value (kcal/kg AD/Btu/lb AD):	6,500 / 11,700
・ Coal moisture (%AR):	10
・ Operation period (years):	40
・ Power station utilization rate (%):	80
・ Annual average power generation efficiency (%):	35
・ Maximum output per unit (MW):	300

When we make a trial calculation of rough construction cost that does not include ground-making expenses for 300 MW × 2 units, it will reach US$1,200 to 1,300 million.

(f) Development conditions and issues

In studying the development of a coal-fired power plant, the following matters must be cleared.

① To import overseas coal, a coal center (coal transship yard) where large ocean-going vessels can approach to dock is necessary, or the development of another coal-fired power plant that furnishes a coal shipment facility is necessary to uses other overseas coal;

② That the power plant has a feasible plan so that cement manufactures, etc. will undertake or purchase or utilize coal ash and gypsum, a by-product resulting from desulfurization;

③ Confirming the ownerships of the land lots, obtaining cooperation from the land owners and conducting a geological survey;

④ Conducting an environmental survey including rare species of plants and animals in the surroundings, surveying creatures in the Yangon River and assessing impact on them;

⑤ Assessing impact on a rise in the water temperature of the Yangon River by simulating warm waste water diffusion into the river; and

⑥ Consistency in the transmission line construction (expansion) plan

6.2.2 Thilawa SEZ

(a) Site and surrounding environments

When a ship (25,000 DWT or lower) that can dock is considered, a wharf that has one berth (200 m) would be enough. Some 50 ha space of land will be necessary in addition to 15 ha backland behind the wharf. Such a land space can be reserved well within the neighboring SEZ.

(b) Coal reception capacity

Considering the water depth around the Thilawa district, a ship size to moor will be limited to a 25,000 DWT or lower ships. Even in such a case, depending on changes in the river depth due to high and low tides, the ship must wait for up to six hours before docking. After these facts are considered, one berth could receive approximately 2.50 million ton of cargo in a year.

(Conditions to examine)

- Coal loading capacity per ship: 25,000 ton
- Time needed for unloading per ship: 3 days
- Number of unloading days per year: 300 days (60 days for periodical checks of unloaders, etc.)

(c) Reserving cooling water

Concerning the intake of river water to cool a power generation facility, the front Yangon River runs back during high tide. Therefore, river water cannot be used to cool the power generation facility. This is because discharged warm waste water will be reversed into the intake. Groundwater also cannot be used because it has a high concentration of salt. As a result, a cooling tower system for the power plant must be adopted that uses industrial water. It is essential to reserve a volume of water that meets methodological conditions, water quality, and steam turbine output. There are no problems on water quality because industrial water is used.

(d) Access to transmission lines

In vicinities of the Thilawa SEZ, there is a 230 kV transmission line stretching to the Thanlyin substation that is located in the north direction some 10 km distant to the Thilawa SEZ. If transmission towers need to be built in the city to connect to the Thanlyin substation, the construction works would take time.

(e) Developable output

When we make a trial calculation of construction cost under the following conditions, a power plant of 300 MW × 3 units can be built.

・ Annual coal reception volume (ton):	2,500,000
・ Coal calorific value (kcal/kg AD/Btu/lb AD):	6,500 / 11,700
・ Coal moisture (%AR):	10
・ Operation period (years):	40
・ Power station utilization rate (%):	80
・ Annual average power generation efficiency (%):	35
・ Maximum output per unit (MW):	300

(f) Development conditions and issues

In studying on the development of a coal-fired power plant in this area, the following matters must be cleared.

① To import overseas coal, a coal center (coal transship yard) where large ocean-going vessels can approach to dock is necessary, or the development of another coal-fired power plant that furnishes a coal shipment facility is necessary to uses other overseas coal;

② That the power plant has a feasible plan so that cement manufactures, etc. will undertake or purchase or utilize coal ash and gypsum, a by-product resulting from desulfurization;

③ Conducting a geological survey of the designated site;

④ Conducting an environmental survey including rare species of plants and animals in the surroundings, surveying creatures in the Yangon River and assessing impact on them;

⑤ Reserving and making stable supply of industrial water; and

⑥ Consistency in the transmission line construction (expansion) plan

6.2.3 Dawei Area

(a) Site and surrounding environments

The Dawei SEZ has a total development space of 250 km^2 (25,000 ha) where the site of 5.6 km^2 for coal-fired power plant (400 MW × 10 units) for Thailand is reserved. Together with this reservation, the construction of a bulk yard of 4.6 km^2 (460 ha) is planned for coal and iron ore.

(b) Coal reception capacity

The central waterway of Dawei Port is 16 m deep, which will allow a coal ship up to 100,000 DWT to sail into the port. Depending on the number of berths in use, the reception capacity will increase. When one berth alone is used, however, the annual reception capacity will be approximately 3.80 million ton.

(Conditions to examine)

- Coal loading capacity per ship: 85,000 ton
- Time needed for unloading per ship: 3 days
- Number of unloading days per year: 270 days (90 days for stormy weather and unloader periodical checks, etc.)
- Berth occupation rate: 50% (Sail by ocean-going vessels from loading port is considered)

(c) Reserving cooling water

The designated place faces an ocean area. A seawater cooling system can be adopted if the locations for a water intake and an outlet are selected properly. The water quality seems to have no problems since the location faces outer sea. Thus, water seems available only when an ordinary dust remover is fixed to prevent floating matter from flowing in.

(d) Access to transmission lines

The Dawei area has no transmission lines of Myanmar. According to new transmission line construction (expansion) plan formulated by the Ministry of Electric Power, a 230 kV transmission line will be built. The distance from a substation planned in Dawei to the Dawei SEZ is approximately 10 km.

(e) Developable output

When we make a trial calculation of construction cost under the following conditions, the following power plant of 300 MW × 4 units can be built.

- Annual coal reception volume (ton): 3,800,000

- Coal calorific value (kcal/kg AD/Btu/lb AD): 6,500 / 11,700
- Coal moisture (%AR): 10
- Operation period (years): 40
- Power station utilization rate (%): 80
- Annual average power generation efficiency (%): 35
- Maximum output per unit (MW): 300 (case when connecting to domestic transmission lines only)

When we make a trial calculation of rough construction cost that does not include ground-making expenses for 300 MW × 4 units, it will reach US$2,400 to 2,600 million.

(f) Development conditions and issues

In studying on the development of a coal-fired power plant in this area, the following matters must be cleared.

① That the power plant has a feasible plan so that cement manufactures, etc. will undertake or purchase or utilize coal ash and gypsum, a by-product resulting from desulfurization;
② Obtaining geological data on the designated place
③ Conducting an environmental survey including rare species of plants and animals in the surroundings, surveying marine organisms in the ocean area and assessing impact on them;
④ Assessing impact on a rise in the seawater temperature in the neighboring ocean area by simulating warm waste water diffusion into the sea; and
⑤ Reserving and making stable supply of industrial water; and
⑥ Consistency in the transmission line construction (expansion) plan

6.2.4 Other

As designated places for deeper-water commercial ports, the places listed below are selected by the Myanmar Port Authority. Conditions of these places seem to be roughly similar to those in the Dawei area.

To improve the precision of the examination, however, further information must be gathered in future about conditions of the following ports and surrounding areas.

- Kyaukpyu on Rakhin Coast
- Kalegauk and Bokpyin on Tanintharyi Coast

6.3 Remarks relating to the Plan to Develop a Coal-Fired Power Plant

(a) Environmental control measures

Existing coal mines need to undertake large-scale reinforcement of their coal production capacity in order to supply domestic coal to coal-fired power plants. To this end, existing coal mines need soil stripping and treatment and control of coal mine drainage, which are not conducted at present. In addition, coal mines need making efforts to reduce dust emission, noise, and vibration, which result from the improvement in transportation roads from the coal mine.

Concerning power generation facilities, coal mines need to adopt a coal handling facility where a control measure is taken to prevent dust emission from coal. Furthermore, coal mines need to adopt a dust chamber, exhaust gas desulfurizer, NOx removal system, etc. to treat flue gas. It is also desirable that coal mines work on cutting global warming gas and implement high-efficiency power generation facility that is also useful for cutting fuel consumption. Compared with a 600 to 1,000 MW class power generation facility a power generation facility having some 300 MW output will have a greater ratio of cost for additional facilities in achieving a higher fuel cost cutting effect.

Thus, it is derivable that coal mines study on the introduction of a facility that enables to improve steam conditions from 16.6 MPa/538°C/538°C, which are steam conditions achieved by an ordinary facility of this class, to approximately 18.6 MPa/600°C/600°C to improve in efficiency although it is difficult to improve steam conditions for boilers and turbines to a world highest 25 MPa/600°C/620°C level, which is the ultra super critical (USC) steam condition. Such a higher efficiency facility will cut fuel cost and global warming gas.

(b) Other remarks relating to the plan to develop a coal-fired power plant

In developing a coal-fired power plant, the following matters must be noted.

- Formulating a master plan of electric power for the entire Myanmar;
- Conducting surveys to know precise coal resource quantities in the country (geological structure surveys);
- Improving related infrastructure (road, bridge, railway, port (including ports to transship coal), coal bulk terminal, and dam and other facilities to supply industrial water);
- Studying on possible application for Official Development Assistance (ODA) provided by the Government of Japan;
- Enforcing laws and introducing systems to promote foreign capital investment (such as IPP);
- Acquiring technology and techniques by learning power plant planning, designing and building, and developing human resources;
- Educating and training personnel to operate and maintain power plants; and

- Promoting international cooperation and support including introduction of technology and technique into the country.

Chapter 7 Suggestions to Develop Coal-Fired Power Plants

7.1 Evaluation of Domestic Coals and Coal Mine Surveys and Development in Future

7.1.1 Evaluation of Domestic Coals

(a) Coal in the Kalewa district

Properties of coal in the Kalewa District are decided to be appropriate for thermal power generation.

Our analysis of the coal samples picked during the survey indicated that some of the coal samples have low grindability (meaning hard). Thus, it is desirable that Myanmar should conduct a broad range of coal property surveys in a feasibility study stage prior to proceeding to specific development and that the country should select coals in mining areas that have no problems in consuming at coal-fired power plants.

According to the recoverable reserve of coal in the entire Kalewa District that we surveyed, a coal-fired power plant up to 450 MW can be planned if the coal is not used at cement factories but used only at the power plant.

If the country is going to increase the production of coal for power generation in future, coal mining companies that have small mining areas must be consolidated so that they can supply a volume of coal on a stable basis.

(b) Coal in the Lasio district

As a result of our analysis of coal samples picked in the survey, we decide that coal in the Lasio district is unfit for power generation because it has an extremely low grindability.

According to the recoverable reserve of coal in the entire Lasio District that we surveyed, a coal-fired power plant up to 40 MW or so can be planned only if coal is not used at cement factories but all the coal is used for power generation.

(c) Coal in other district

Mining areas in the Taninthayi Division that we were unable to survey may have coal of relatively high grade. We hope that Myanmar conducts surveys to check on coal in future.

7.1.2 Coal Mine Surveys and Development in Future

(a) Surveying reserves of coal

Myanmar should conduct geological structural surveys to grasp precise coal resource quantities in the entire country.

(b) Coal mine development to plan coal-fired power plants

The primary condition to plan a coal-fired power plant lies in stable supply of coal whose properties are suitable for power generation. For example, in case of Kalewa coal properties, operating a 300 MW coal-fired power plant needs approximately 800,000 ton of coal per year.

Increasing coal production needs to engage in concurrent developments of infrastructure (production facilities, transportation road, bridge, and railway) and environmental control measures (soil stripping, waste water treatment).

7.2 Importing Overseas Coal

It is desirable that Myanmar has more than one overseas coal supplier county, for example, Indonesia, Australia and South Africa that have a relatively short transportation distance to Myanmar.

For stable operation of power plants, electric power companies often conclude a long-term coal procurement contract with coal mining companies and/or trading firms.

To reduce transportation cost, approximately 80,000 DWT class large ocean-going vessels are generally used for coal transportation. A port where such vessels can dock needs a 16-meter deep seawater or more. If Myanmar is going to import coal from Indonesia or other neighboring countries in a short distance to Myanmar, 25,000 to 30,000 DWT class colliers could be used to transport coal.

7.3 Development of Coal-Fired Power Plants

7.3.1 Domestic Coal-Fired Power Plant

We think that surroundings of Kalewa or suburbs of Bagan have a site that can be designated for a power plant. Depending on the plan to increase coal production in coal mines and consumption of coal at cement factories, a 200 to 450 MW coal-fired power plant could be developed where coal in the Kalewa district is used.

To utilize domestic coal for coal-fired power generation in a surrounding site of Yangon has no advantages for stable supply and economy. This is because such a power plant will need a long distance (1,000 km or over) transportation of domestic coal.

7.3.2 Overseas Coal Fired-Power Plants

A candidate site for a power plant that will supply electric power for the Yangon district, which consumes largest electric power, could be found in a surrounding site of City Terminal and the Thilawa special economic zone (SEZ).

An overseas coal-fired power plant of 2 × 300 MW can be developed in a surrounding site of City Terminal.

An overseas coal-fired power plant of 3 × 300 MW can be developed in a site neighboring on a berth in the SEZ zone of Thilawa Port.

An overseas coal-fired power plant with larger output could be developed in the Dawei SEZ and other area near the 16-meter or deeper water port.

7.4 Matters Confirmed and Challenging Issues in Future to Develop Coal-Fired Power Plants

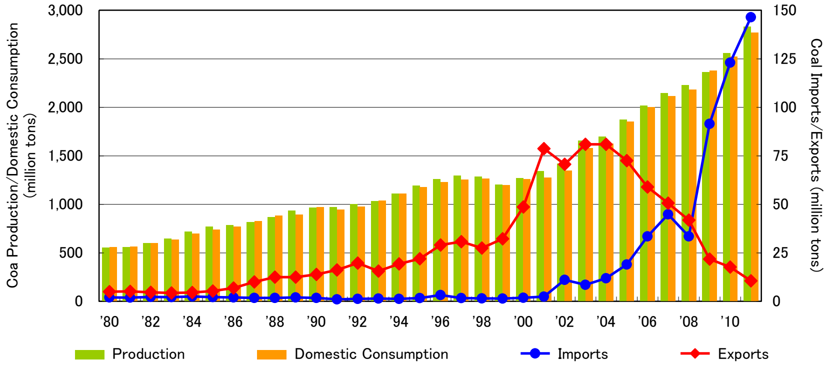
We conducted local surveys in Myanmar to collect information on construction of coal-fired power plants in the country. We consider, as results of our surveys, that Myanmar has the following challenging issues:

1) Myanmar needs to formulate an electric power development master plan to build power generation facilities, transmission and distribution lines based on the forecast of demand for electric power in the entire country. Myanmar is urged to develop an institutional IPP system and related laws and regulations so that foreign companies, including Japanese companies with Clean Coal Technology, could invest in the country.
2) It takes more than six years to develop a coal-fired power plant from conduct environmental impact assessments to starting commercial operation of the power plant. Myanmar needs to carry out a detailed feasibility study to develop a power plant at a specific location.
3) The country needs to simulate the stability of transmission systems based on the master plan to determine the generation capacity per unit of coal fired-power plant. Assuming such a power plant is connected to grid after the latter of 2010s, the generation capacity is supposed to reach 300 MW or so.
4) The development of a coal fired-power plant is based on the pre-condition that the power plant can obtain coal whose properties are suitable for power generation for a long time on a stable basis. Based on the properties of such coal, Myanmar can plan power generation facilities.
5) To this end, Myanmar needs to promote nationwide surveys on coal resource quantities.
6) Prior to the development of a coal-fired power plant, Myanmar needs to conduct a careful survey of the current environmental conditions surrounding the location designated for the construction of a power plant, conduct assessments on impacts of construction works and after-operation. Based on the results of the survey and the environmental assessments, Myanmar needs to design facilities and engage in construction works to minimize such impacts on the environment.
7) To develop a coal-fired power plant, Myanmar also needs to develop infrastructure related to coal transportation facilities (including railway and ports), transmission lines, water supply, and construction roads and bridges.
8) In particular, Myanmar is urged to build a coal transportation railway between Kalewa and Bagan.
9) Along with the development of a coal-fired power plant, the country needs to develop and train human resources so that such personnel will engage in the design and construction of the power plant, operation and maintenance of the power plant, and control of the entire power plant.
10) If Myanmar plans to develop an overseas coal-fired power plant in a location around City Terminal in Yangon, the country needs to construct a new terminal to unload overseas coal in the deeper-water port, transship coal on 15,000 DWT shuttle boats to transport to the power plant around the City Terminal whose depth of water is shallow.

11)Since 25,000 DWT class colliers can dock at the wharf of the Thilawa SEZ, Myanmar needs to study on direct transport of coal from Indonesia and construction of a terminal to unload such coal.

Reference 1: Balance of supply and demand of steam coal in each country surveyed

1) China



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	552	769	965	1,195	1,271	1,874	2,018	2,147	2,229	2,360	2,560	2,831
Imports	2	2	2	2	2	19	33	45	33	91	123	146
Exports	-5	-5	-14	-22	-49	-72	-59	-51	-42	-22	-18	-11
Stock Changes	10	-25	18	1	34	33	8	-27	-37	-51	-145	-195
Domestic Consumption	559	741	971	1,176	1,259	1,854	2,001	2,114	2,184	2,379	2,520	2,772
for Power Generation	*126*	*179*	*302*	*500*	*645*	*1,167*	*1,332*	*1,459*	*1,503*	*1,593*	*1,698*	–
	23%	*24%*	*31%*	*43%*	*51%*	*63%*	*67%*	*69%*	*69%*	*67%*	*67%*	–

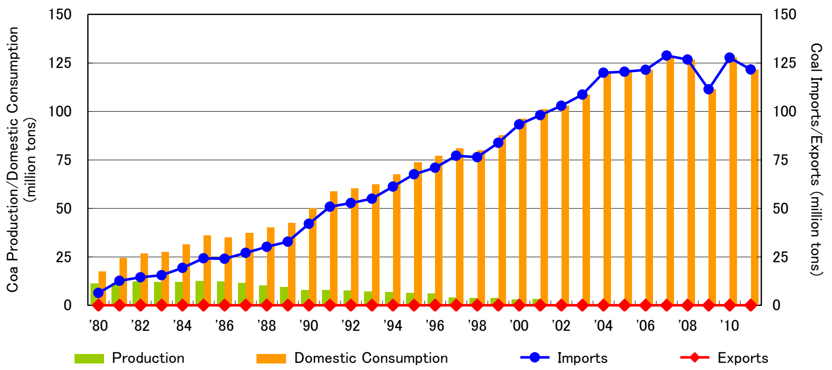
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-1 Balance of Supply and Demand of Steam Coal in China

2) Japan



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	11.1	12.5	8.0	6.3	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imports	6.3	24.2	42.0	67.6	93.3	120.4	121.4	128.8	126.7	111.4	127.7	121.5
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Changes	0.1	-0.7	0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Domestic Consumption	17.5	35.9	50.0	73.8	96.1	120.4	121.4	128.8	126.7	111.4	127.7	121.5
for Power Generation	*9.6*	*23.8*	*31.1*	*47.6*	*64.9*	*92.3*	*89.5*	*94.3*	*90.2*	*86.4*	*90.0*	–
	55%	*66%*	*62%*	*64%*	*68%*	*77%*	*74%*	*73%*	*71%*	*78%*	*71%*	–

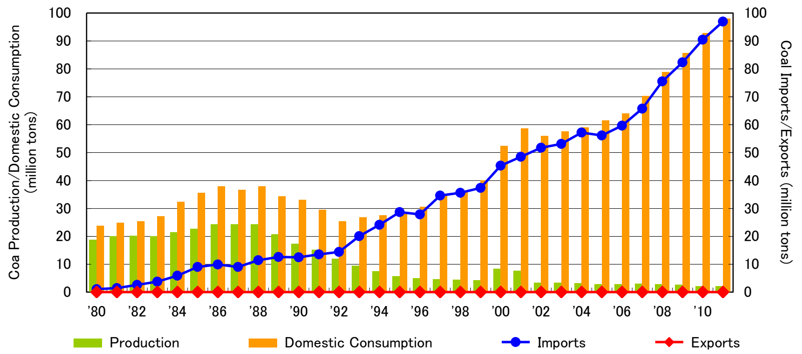
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal. It should be noted that, according to the statistics of IEA no production has been recorded in Japan since 2002, but around a million tons of steam coal is continuously produced every year in Hokkaido.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-2 Balance of Supply and Demand of Steam Coal in China

3) Korea



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	18.6	22.5	17.2	5.7	8.3	2.8	2.8	2.9	2.8	2.5	2.1	2.1
Imports	1.0	9.0	12.4	28.7	45.3	56.1	59.6	65.8	75.5	82.3	90.4	96.9
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Changes	4.1	4.0	3.4	-6.1	-1.2	2.4	1.5	1.7	0.6	0.8	0.3	-1.0
Domestic Consumption	23.8	35.5	33.0	28.3	52.4	61.4	64.0	70.3	78.9	85.7	92.8	98.1
for Power Generation	*1.9*	*6.9*	*7.7*	*16.7*	*39.0*	*52.7*	*55.1*	*60.9*	*68.7*	*77.7*	*83.2*	–
	8%	*19%*	*23%*	*59%*	*74%*	*86%*	*86%*	*87%*	*87%*	*91%*	*90%*	–

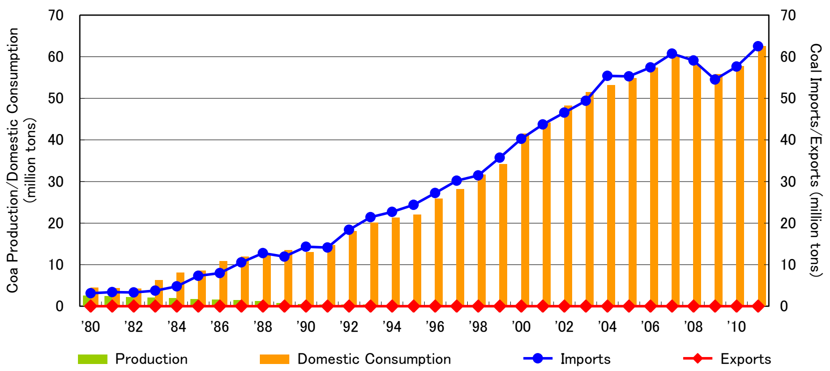
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-3 Balance of Supply and Demand of Steam Coal in Korea

4) Taiwan



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	2.6	1.8	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imports	3.1	7.3	14.3	24.4	40.3	55.3	57.4	60.7	59.1	54.5	57.6	62.5
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Changes	-1.3	-0.5	-1.7	-2.6	1.2	-0.5	-0.1	-0.3	-1.1	1.3	0.1	0.0
Domestic Consumption	4.4	8.5	13.1	22.0	41.5	54.8	57.4	60.5	58.0	55.8	57.8	62.5
for Power Generation	*2.4*	*5.2*	*8.6*	*16.4*	*33.3*	*46.0*	*47.9*	*49.5*	*47.9*	*46.9*	*46.2*	–
	55%	*61%*	*66%*	*75%*	*80%*	*84%*	*83%*	*82%*	*83%*	*84%*	*80%*	–

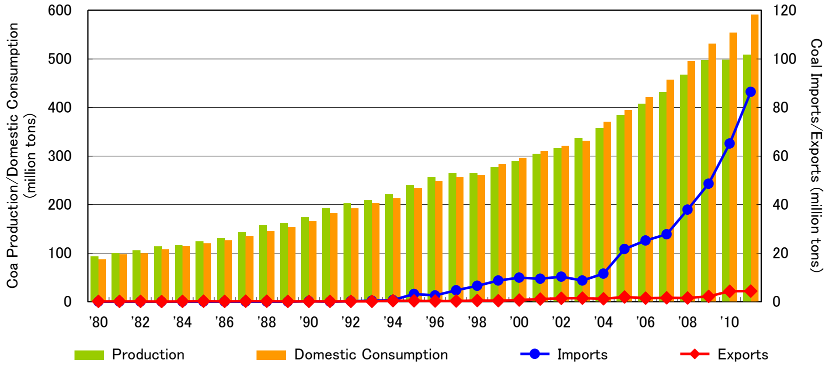
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-4 Balance of Supply and Demand of Steam Coal in Taiwan

5) India



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	92.9	124.6	175.1	239.5	289.3	383.5	407.1	431.5	467.4	497.3	498.6	509.1
Imports	0.0	0.0	0.2	3.1	9.9	21.7	25.2	27.8	37.9	48.6	65.1	86.4
Exports	-0.1	-0.2	-0.1	-0.3	-0.7	-1.9	-1.4	-1.6	-1.5	-2.2	-4.3	-4.4
Stock Changes	-5.5	-4.2	-9.0	-9.1	-2.2	-9.0	-9.6	-0.9	-8.3	-12.9	-5.8	0.0
Domestic Consumption	87.3	120.2	166.2	233.2	296.3	394.2	421.3	456.8	495.5	530.7	553.6	591.1
for Power Generation	*38.2*	*66.3*	*109.9*	*178.3*	*244.3*	*316.4*	*339.5*	*367.8*	*385.3*	*397.1*	*406.0*	–
	44%	*55%*	*66%*	*76%*	*82%*	*80%*	*81%*	*81%*	*78%*	*75%*	*73%*	–

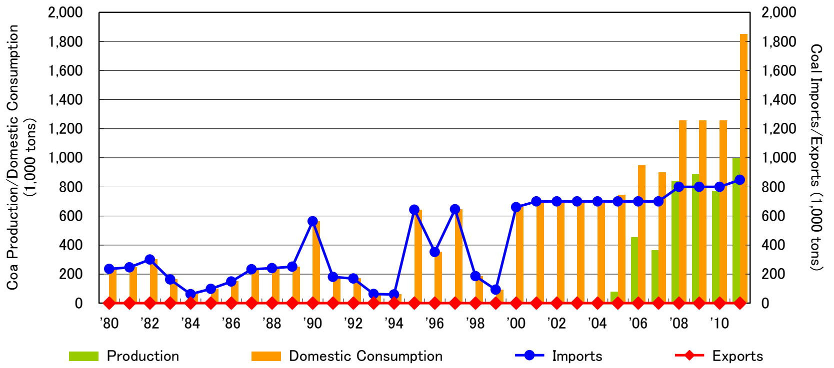
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-5 Balance of Supply and Demand of Steam Coal in India

6) Bangladesh



(1,000 tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	0	0	0	0	0	77	451	361	840	888	770	1,000
Imports	235	98	563	642	660	700	700	700	800	800	800	848
Exports	0	0	0	0	0	0	0	0	0	0	0	0
Stock Changes	0	0	0	0	0	-35	-205	-164	-383	-431	-313	0
Domestic Consumption	235	98	563	642	660	742	946	897	1,257	1,257	1,257	1,848
for Power Generation	*0*	*0*	*0*	*0*	*0*	*40*	*236*	*189*	*439*	*439*	*439*	–
	0%	*0%*	*0%*	*0%*	*0%*	*5%*	*25%*	*21%*	*35%*	*35%*	*35%*	–

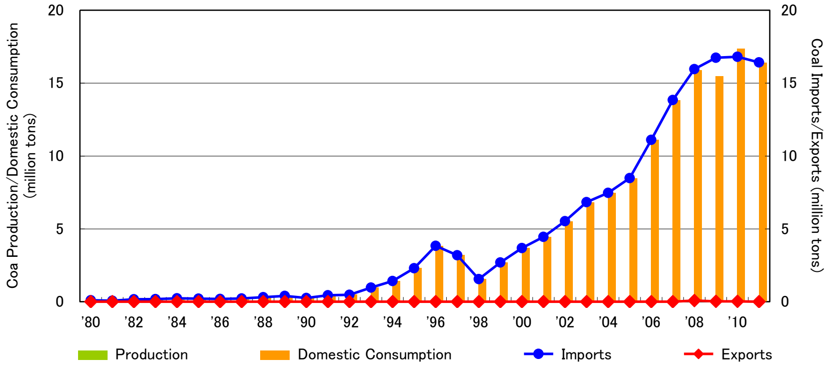
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-6 Balance of Supply and Demand of Steam Coal in Bangladesh

7) Thailand



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.10	0.21	0.25	2.30	3.68	8.48	11.10	13.84	15.96	16.74	16.80	16.43
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.08	-0.03	-0.02	0.00
Stock Changes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.24	0.60	0.00
Domestic Consumption	0.09	0.21	0.25	2.31	3.68	8.48	11.10	13.84	15.89	15.48	17.38	16.43
for Power Generation	*0.00*	*0.00*	*0.00*	*0.00*	*0.47*	*0.88*	*1.34*	*5.21*	*5.01*	*4.37*	*4.43*	–
	0%	*0%*	*0%*	*0%*	*13%*	*10%*	*12%*	*38%*	*32%*	*28%*	*26%*	–

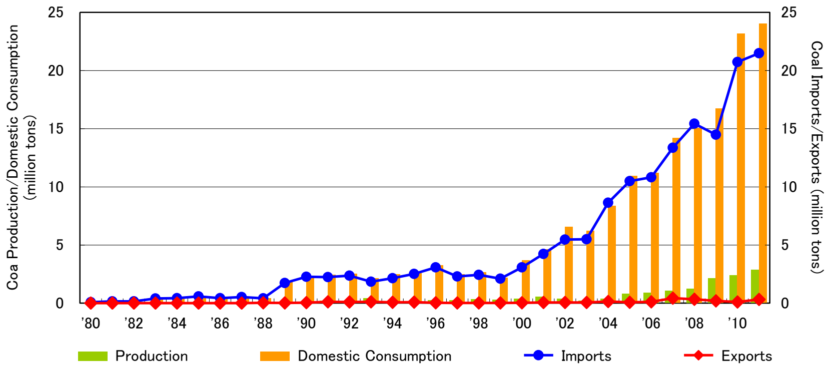
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-7 Balance of Supply and Demand of Steam Coal in Thailand

8) Malaysia



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	0.00	0.00	0.11	0.14	0.38	0.79	0.90	1.08	1.25	2.14	2.40	2.84
Imports	0.08	0.57	2.26	2.52	3.08	10.49	10.82	13.36	15.43	14.48	20.74	21.49
Exports	0.00	0.00	-0.04	-0.08	-0.03	-0.07	-0.11	-0.43	-0.33	-0.19	-0.10	-0.31
Stock Changes	0.00	0.00	-0.18	-0.02	0.23	-0.28	-0.43	0.20	-1.29	0.30	0.13	0.00
Domestic Consumption	0.08	0.57	2.15	2.56	3.66	10.93	11.18	14.21	15.06	16.73	23.16	24.02
for Power Generation	*0.00*	*0.00*	*1.29*	*1.52*	*2.37*	*8.79*	*9.11*	*11.88*	*12.80*	*14.56*	*20.54*	–
	0%	*0%*	*60%*	*59%*	*65%*	*80%*	*82%*	*84%*	*85%*	*87%*	*89%*	–

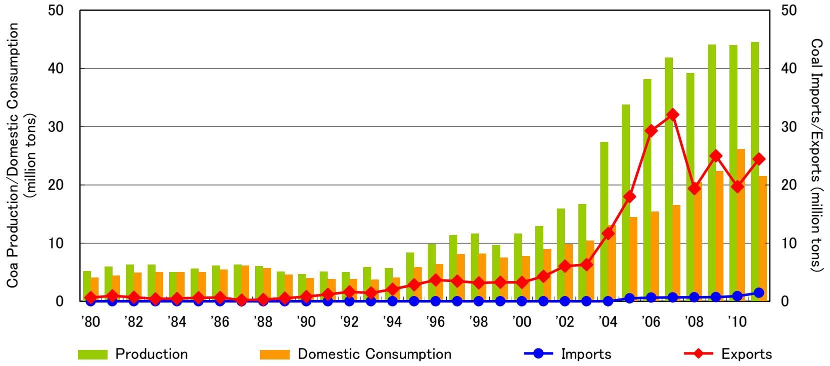
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-8 Balance of Supply and Demand of Steam Coal in Malaysia

9) Vietnam



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	5.20	5.59	4.64	8.35	11.61	33.77	38.20	41.85	39.18	44.08	44.01	44.52
Imports	0.01	0.00	0.00	0.00	0.00	0.51	0.64	0.67	0.68	0.72	0.88	1.47
Exports	-0.64	-0.60	-0.79	-2.82	-3.25	-17.97	-29.31	-32.07	-19.36	-24.99	-19.70	-24.43
Stock Changes	-0.51	0.00	0.10	0.39	-0.55	-1.81	5.89	6.09	0.00	2.59	0.95	0.00
Domestic Consumption	4.05	4.99	3.95	5.92	7.81	14.49	15.42	16.54	20.51	22.40	26.15	21.57
for Power Generation	*1.36*	*1.78*	*1.59*	*1.27*	*2.05*	*5.34*	*6.19*	*6.41*	*6.46*	*6.57*	*8.64*	—
	33%	*36%*	*40%*	*21%*	*26%*	*37%*	*40%*	*39%*	*31%*	*29%*	*33%*	—

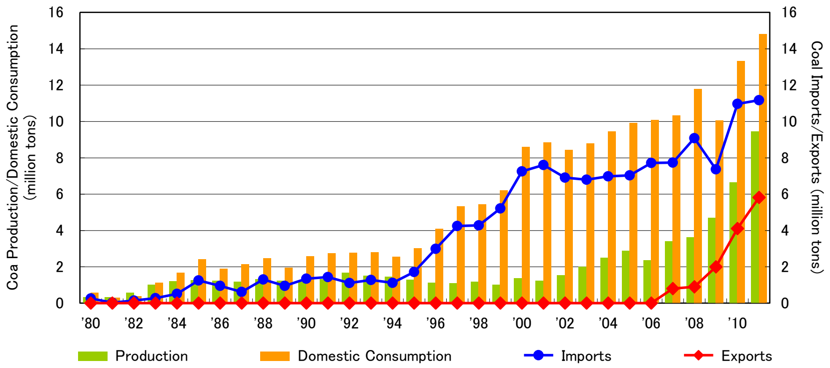
Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-9 Balance of Supply and Demand of Steam Coal in Vietnam

10) The Philippines



(million tons)

	'80	'85	'90	'95	'00	'05	'06	'07	'08	'09	'10	'11*
Production	0.33	1.25	1.23	1.29	1.35	2.88	2.36	3.39	3.61	4.69	6.65	9.44
Imports	0.25	1.25	1.34	1.71	7.25	7.03	7.72	7.73	9.08	7.37	10.97	11.17
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.80	-0.89	-1.99	-4.10	-5.82
Stock Changes	-0.02	-0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.20	0.00
Domestic Consumption	0.56	2.42	2.57	3.00	8.60	9.91	10.07	10.32	11.79	10.06	13.32	14.79
for Power Generation	*0.10*	*1.73*	*1.06*	*1.42*	*7.17*	*7.83*	*7.04*	*7.53*	*8.64*	*8.42*	*9.64*	—
	18%	*72%*	*41%*	*47%*	*83%*	*79%*	*70%*	*73%*	*73%*	*84%*	*72%*	—

Note: The volume of domestic consumption = the volume of domestic production + the volume of import + the volume of export + the change in stock

Steam coal includes anthracite. The graph shows the volume of export in positive numbers. The oblique characters in the domestic consumption show the volume of steam coal for power generation (including in-house power generation and heat supply) and the percentage relative to the domestic consumption of steam coal.

Source: IEA, "Coal Information 2012" and "Energy Statistics OECD/non-OECD 2012

Fig. R-10 Balance of Supply and Demand of Steam Coal in The Philippines