Chapter 1

Financial Aid for Coal-fired Power Plants

December 2015

This chapter should be cited as

Kutani, I. and V. Anbumozhi (2015), 'Financial Aid for Coal-fired Power Plants', in *The Macroeconomic Impact of Coal-Fired Power Plants*. ERIA Research Project Report 2014-43, Jakarta: ERIA, pp.1-13.

CHAPTER 1

Financial Aid for Coal-fired Power Plants

In this chapter, we establish the present status of coal-fired power plants (CPPs) in ASEAN countries and India, and study cases of support by public financial institutions for construction of CPPs.

1.1. Importance of Coal-fired Power Generation

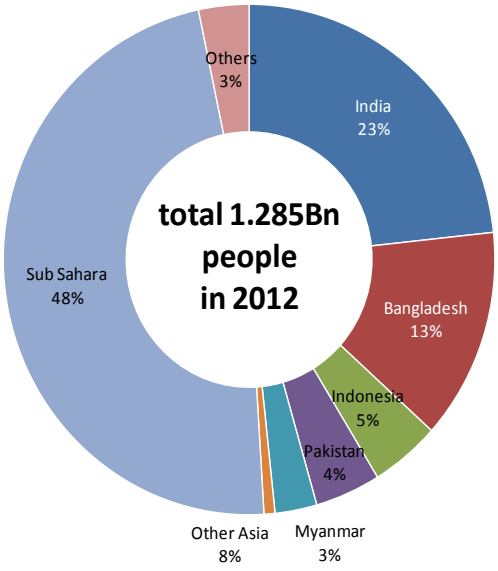
A. Importance of Coal in Economic Development

Improving access to electricity, supplying low-cost electricity, and lowering pollution are the important issues facing the electric power sector in the developing countries.

As many as 1.285 billion people in the world have had no access to electricity as of 2012[1] and supplying them with electric power remains a serious challenge (Figure 1.1). The global demand for electric power is expected to reach 40,104 TWh in 2040, approximately 1.8 times higher than in 2012. This issue is particularly serious among the developing countries in Asia where the average income and purchasing levels are low, and where there is a demand for supply of electric power at the lowest price possible. This demand is a significant issue that concerns industrial competitiveness, as well as the concomitant air and water pollution and climate change problems it poses to human beings. Under these circumstances, electric power supply with low environmental load becomes more necessary.

[1] International Energy Agency, *World Energy Outlook 2014*.

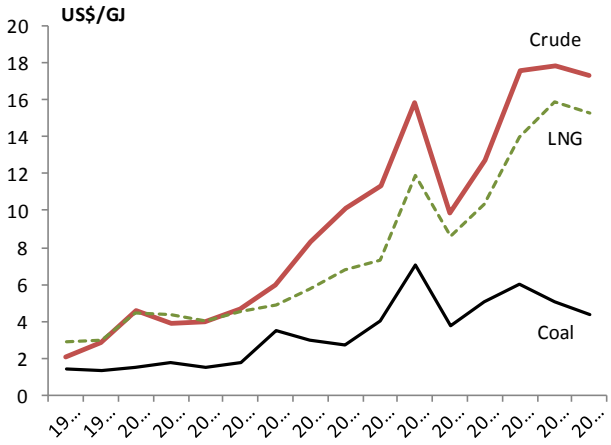
Figure 1.1: Populations Without Access to Electricity



Source: International Energy Agency, *World Energy Outlook 2014.*

There is, therefore, a demand to develop on a large scale low-cost and clean power source in developing countries. One answer is high-efficiency coal-fired power generation, considered superior to other power generation methods in terms of economic efficiency. Coal exists abundantly as fuel, but its high environmental load strips itself of merits although this can be offset by high-efficiency power generation technology.

Figure 1.2: Fossil Fuel Price



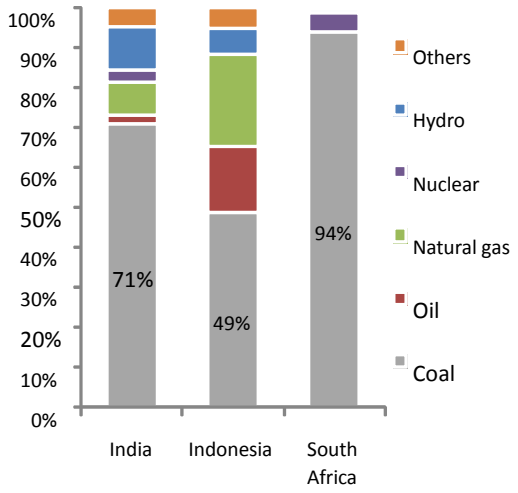
Crude oil: OECD cif. LNG: Japan cif. Coal: Asian market price
Cif = cost, insurance and freight, GJ = gigajoule, LNG = liquefied natural gas.
Source: BP, *Statistical Review of World Energy,* June 2014.

B. Current Use of Coal in Power Generation

Coal-fired power generation has been increasing in several developing countries such as India, Indonesia, and South Africa, where it provides stable supply of electric power.

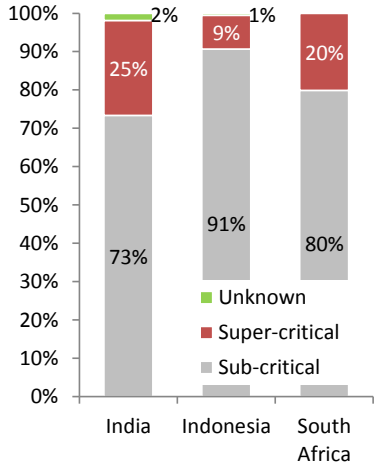
If we take a look at the power-generation technology utilised for coal-fired power generation, we find an overwhelming ratio of subcritical pressure-power generation, followed by supercritical pressure-power generation at 10–25 percent. On the other hand, ultra supercritical pressure-power generation, the technology with the highest efficiency currently available, is not being utilised in any country. This indicates that power-generation efficiency still has room for improvement. To lower its environmental load, it is necessary to combust coal as efficiently as possible, but the methods used by developing countries leave a lot to be desired.

Figure 1.3: Power Generation Mix



kWh base, 2012

Figure 1.4: Share of Technology in Coal-fired Power Plants



existing + under construction

CPP = coal-fired power plant, kWh = kilowatt-hour.
Source: (Fig 1-3) International Energy Agency, *Energy Balance 2014*;
(Fig 1-4:) Platts, 'UDI World Electric Power Plants Database September 2012'.

1.2. Overview of Coal-fired Power Plants in Study Target Countries

This section provides overviews of the circumstances of coal-fired power generation in the ASEAN countries and India. We chose the CPPs from the Platts 'UDI World Electric Power Plants Database June 2014' and used these as database after excluding private power-generation plants. Included in this database are the CPPs in Cambodia, India,

Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

A. Coal-fired Power-generating Capacity by Operational Status

Table 1.1 shows the coal-fired power-generating capacity by operational status based on the database. The total power-generating capacity is 751 GW. India accounts for 76 percent of the total at 567 GW, followed by Viet Nam at 63 GW (eight percent), and Indonesia at 62 GW (eight percent). The power plants in the planning stage account for 51 percent of the total at 387 GW, followed by those in operation at 194 GW (26 percent), and those under construction at 114 GW (15 percent).

The database covers 762 power plants and 2,232 power-generation units.

Table 1.1. Capacity of Coal-fired Power Plants, by Operational Status

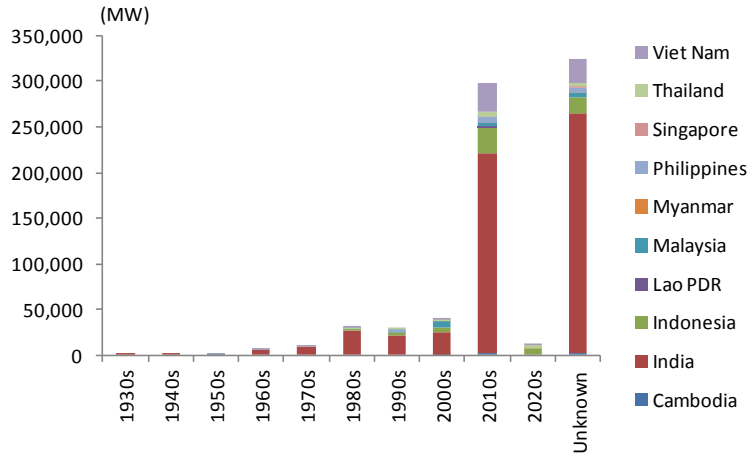
Unit: MW

Country	Operational Status										Total
	OPR	CON	PLN	DEL	CAN	DEF	DAC	STN	RET	UNK	
Cambodia	130	405	3,570		350						4,455
India	147,713	90,192	290,803	6,872	9,080	17,830	600	50	3,922	59	567,120
Indonesia	21,652	4,624	34,153	670	930	270					62,299
Lao PDR		1,878									1,878
Malaysia	7,929	2,080	4,800		1,300	1,400					17,509
Myanmar	128		1,480	12							1,620
Philippines	5,498	1,597	6,936		587	1,250			10		15,878
Singapore	102	60				1,200					1,362
Thailand	5,265		5,740		4,550				285		15,840
Viet Nam	5,860	13,313	39,027	30		4,520			195		62,945
Total	194,277	114,149	386,509	7,584	16,797	26,470	600	50	4,411	59	750,905

Note: CAN = Cancelled, CON = Under construction, DAC = Deactivated/mothballed, DEF = Deferred without construction start, DEL = Delayed after construction start, MW = megawatt, OPR = In commercial operation, PLN = Planned and still in design, RET = Retired, STN = Shutdown or standby, UNK = Unknown operational status (typically assigned to old plants).
Source: Platts, September 2012.

Figure 1.5 shows the coal-fired power-generating capacities of the ASEAN countries and India, in increments of 10 years. The figures for 2010s include the power plants in operation, under construction, and in the planning stage. Many power plants with unknown start period of operation are in the planning stage and their start year is not mentioned in the database.

Figure 1.5: Capacity of Coal-fired Power Plants, by Age



MW = megawatt.
Source: Platts, September 2012.

B. Supplier Countries of Major Power-generation Facilities

We now look at the countries which supply major power-generation facilities such as boilers, turbines, and generators. The names of the manufacturers in the database were used to determine the supplier countries, whereas the places of origin were used in the case of multinational corporations. In cases of joint ventures between a particular country and an overseas manufacturer, the country of the manufacturer providing technology was regarded as the supplier country.

It is necessary to understand that a country supplying facilities is not always a facility-exporting country or a funding country.

a. Boilers

Table 1.2 shows the power-generating capacity of boilers from countries with known suppliers. In the database, the total coal-fired power generating capacity of the study target countries is 751 GW, but the power-generating capacity of boilers from known supplier countries is 365 GW. The difference (386 GW) stems from the fact that supplier countries of these boilers are unknown and that many of the power plants are in the planning stage.

In the case of India, domestic manufacturers supply 45 percent of boilers. In all the target countries of the study, Chinese manufacturers supply 31 percent of the total number

of boilers, followed by Japanese manufacturers at eight percent, and Korean manufacturers at five percent. The rest are domestically manufactured boilers.

Table 1.2: Countries Supplying Boilers to ASEAN Countries and India

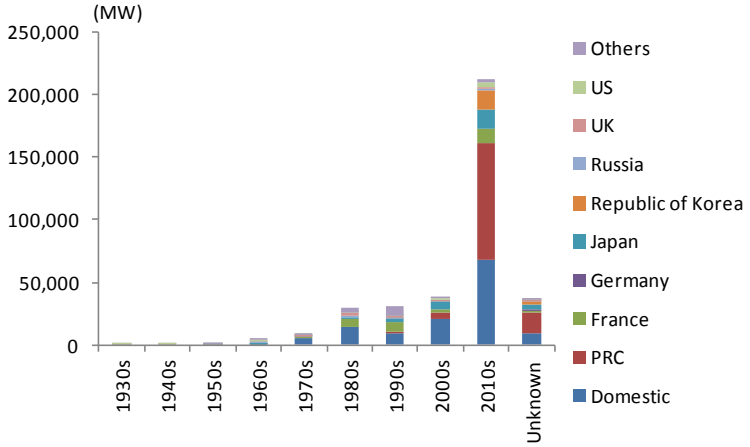
Unit: MW

Country	Domestic	China	France	Germany	Japan	Korea	Russia	UK	US	Others	Total
Cambodia		120								10	130
India	128,728	83,733	26,133	743	16,167	13,900	6,148	5,438	2,526	5,036	288,550
Indonesia	78	12,085	660		2,409	700			1,320	7,170	24,422
Lao PDR		1,878									1,878
Malaysia		480	4,180		7,349						12,009
Myanmar		132									132
Philippines		1,470	1,344		2,512	206			1,344	2,197	9,073
Singapore					102						102
Thailand		540			1,434	700			731	2,685	6,090
Viet Nam		13,313	100			2,400	1,002	1,840	3,480		22,135
Total	128,806	113,751	32,417	743	29,973	17,906	7,150	7,278	9,401	17,098	364,521

MW = megawatt, PRC = People's Republic of China, UK = United Kingdom, US = United States.
Source: Platts, September 2012.

Figure 1.6 shows the supplier countries of boilers from the 1930s to the present. The supply volume from Chinese manufacturers has been increasing in the 2010s. Many power plants with unknown operation start periods are in the planning stage and their operation start periods are not mentioned in the database.

Figure 1.6: Countries Supplying Boilers, by Age



MW = megawatt, PRC = People's Republic of China, UK = United Kingdom, US = United States.
Source: Platts, September 2012.

b. Turbines

Table 1.3 shows the power-generating capacity of turbines supplied by countries with known suppliers. In the database, the total coal-fired power-generating capacity of the target countries of the study is 751 GW, but the power-generating capacity of turbines

from known supplier countries is 367 GW. The difference (384 GW) stems from the fact that the other supplier countries are unknown and that many power plants are in the planning stage.

In the case of India, domestic manufacturers supply 44 percent of turbines. In all the target countries, Chinese manufacturers supply 31 percent of the total number of turbines, followed by Japanese manufacturers at 15 percent, and French manufacturers at four percent. The rest are domestically manufactured turbines.

Table 1.3: Countries Supplying Turbines to the ASEAN Countries and India

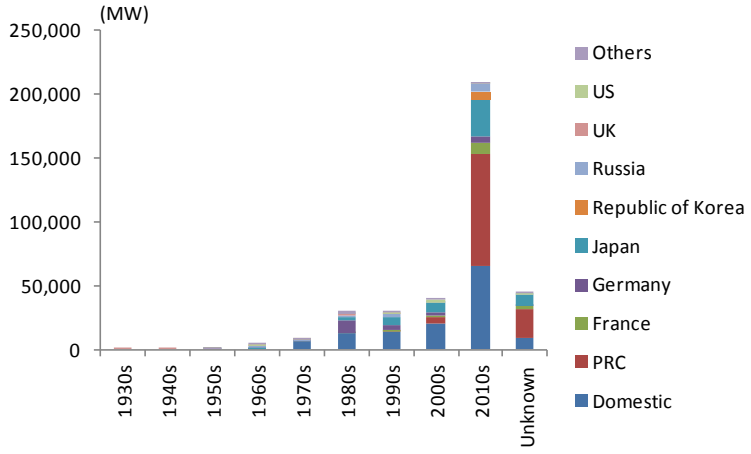
Unit: MW

Country	Domestic	PRC	France	Germany	Japan	Korea	Russia	UK	US	Others	Total
Cambodia		525			10						535
India	127,427	87,645	8,840	17,620	28,076	1,370	9,676	2,715	3,517	5,031	291,917
Indonesia		12,666	504	1,360	8,085	700			1,340		24,655
Lao PDR		1,878									1,878
Malaysia		480	4,180		6,349				1,000		12,009
Myanmar		132									132
Philippines		1,200	1,999		3,912	206			902	655	8,874
Singapore					102						102
Thailand		540	300	127	5,234	700			304	285	7,490
Viet Nam		10,223			4,360	3,480	1,002		600	8	19,673
Total	127,427	115,289	15,823	19,107	56,128	6,456	10,678	2,715	7,663	5,979	367,264

MW = megawatt, PRC = People's Republic of China, UK = United Kingdom, US = United States.
Source: Platts, September 2012.

Figure 1.7 shows the power generated by turbines from supplier countries over the years. The supply volume of Chinese manufacturers has been increasing in the 2010s. Many power plants with unknown start period of operation are in the planning stage and their start year of operation is not mentioned in the database.

Figure 1.7: Capacity of Turbines from Supplier Countries over the Years (Country Total)



MW = megawatt, PRC = People's Republic of China, UK = United Kingdom, US = United States.
Source: Platts, September 2012.

c. Generators

Table 1.4 shows the power-generating capacity of generators from known supplier countries. In the database, the total coal-fired power-generating capacity of the target countries of the study is 751 GW, but the power-generating capacity of generators from known supplier countries is 366 GW. The difference (385 GW) stems from the fact that the rest of supplier countries are unknown and that many power plants are in the planning stage.

In the case of India, domestic manufacturers supply 47 percent of generators. In all the target countries, Chinese manufacturers supply 31 percent of the total power capacity, followed by Japanese manufacturers at 15 percent, and French manufacturers at four percent. The rest is from domestically manufactured generators

Table 1.4: Countries Supplying Generators to ASEAN Countries and India

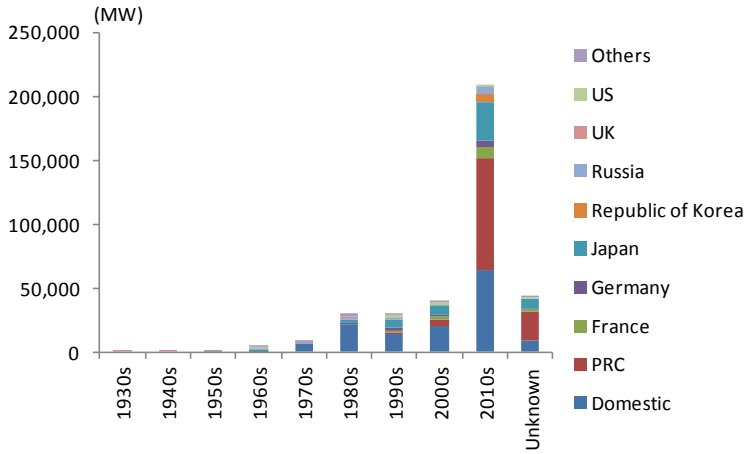
Unit: MW

Country	Domestic	China	France	Germany	Japan	Korea	Russia	UK	US	Others	Total
Cambodia		120								10	130
India	128,728	83,733	26,133	743	16,167	13,900	6,148	5,438	2,526	5,036	288,550
Indonesia	78	12,085	660		2,409	700			1,320	7,170	24,422
Lao PDR		1,878									1,878
Malaysia		480	4,180		7,349						12,009
Myanmar		132									132
Philippines		1,470	1,344		2,512	206			1,344	2,197	9,073
Singapore					102						102
Thailand		540			1,434	700			731	2,685	6,090
Viet Nam		13,313	100			2,400	1,002	1,840	3,480		22,135
Total	128,806	113,751	32,417	743	29,973	17,906	7,150	7,278	9,401	17,098	364,521

MW = megawatt, UK = United Kingdom, US = United States.
Source: Platts, September 2012.

Figure 1.8 shows the power capacity of generators from supplier countries over the years. The supply volume of Chinese manufacturers has been increasing quickly. Many power plants with unknown start period of operation are in the planning stage and, thus, their start years are not mentioned in the database.

Figure 1.8: Capacity of Generators from Supplier Countries over the Years (Country Total)



MW = megawatt, PRC = People's Republic of China, UK = United Kingdom, US = United States.
Source: Platts, September 2012.

1.3. Support to Coal-fired Power Generation by Public Financial Institutions

This section summarises the study results on the financial support by public financial institutions for construction of CPPs and others in the target countries. The study was done through the project databases or press releases of public financial institutions. It does not cover all CPPs.

The amount of support funds is not included because the study focuses mainly on examining the power-generating capacity of the CPPs supported by public financial institution and also because the years of support and currency used differ, the scopes of supported projects differ from one public financial institution to another, and the forms of financing differ from one project to another.

A. Examined Public Financial Institutions

Table 1.5 lists the examined public financial institutions and the dates of availability of information about them. The information on the financial support of the World Bank Group and the Asian Development Bank (ADB) for the construction of CPPs in the target countries of the study was extracted from the project database. The information on financial support by the other public financial institutions for the construction of CPPs in the target countries of the study were collected from mid-August to the end of September 2014 from press releases at their websites. Updated information after October 2014 is not included.

Since the purpose of the study is to examine the coal-fired power-generating capacity of the power plants financially supported by public financial institutions, information from specified CPPs was collected. The types of target financial support were project finance, export finance, and loan guarantee. Once confirmed, any case of financial support by public financial institutions was examined regardless of the amount. Financial support for private power generation was excluded from the study.

As shown in Table 1.5, information is available from the World Bank Group and ADB. For the other public financial institutions, however, old information is not always available. In the case of Chinese public financial institutions, specific financial support information has not been published.

It is necessary to note that this study does not cover all financial support.

Table 1.5: List of Examined Public Financial Institutions

Public Financial Institution	Country	Available Information
Asian Development Bank (ADB)	Multilateral	All
European Investment Bank (EIB)	Multilateral	1980-
European Bank for Reconstruction and Development (EBRD)	Multilateral	1991-
World Bank Group (IBRD/IDA/IFC/MIGA)	Multilateral	All
Export Development Canada (EDC)	Canada	2011-
Bank of China	China	NA
China Development Bank	China	NA
China Exim Bank	China	NA
Sinosure	China	NA
Compagnie Francaise d'Assurance pour le Commerce Exterieur (COFACE)	France	2011-
Deutsche Investitions- und Entwicklungsgesellschaft (DEG)	Germany	2009-
Euler Hermes	Germany	2010-
Kreditanstalt für Wiederaufbau (KfW)	Germany	2007-
Servizi Assicurativi del Commercio Estero (SACE)	Italy	2006-
Japan Bank for International Cooperation (JBIC)	Japan	FY2004-
Nippon Export and Investment Insurance (NEXI)	Japan	1998-
Export-Import Bank of Korea (Kexim)	Korea	1995-
Korea Export Insurance Corporation (KEIC)	Korea	NA
Netherlands Development Finance Company (FMO)	Netherlands	2008-
Garanti-instituttet for eksportkreditt (GIEK)	Norway	2010-
CESCE	Spain	2009-
Geschäftsstelle für die Exportrisikogarantie (ERG)	Switzerland	2010-
Commonwealth Development Corporation (CDC)	United Kingdom	2005-
Export Credits Guarantee Department (ECGD)	United Kingdom	2010-
Overseas Private Investment Corporation (OPIC)	United States	2009-
US Export-Import Bank	United States	1996-

Note: The World Bank Group consists of the International Bank for Reconstruction and Development, the International Development Association, the International Finance Corporation, and the Multilateral Investment Guarantee Agency.

B. Financially Supported Coal-fired Power-generating Capacity

Cases of financial support by public financial institutions for coal-fired power generation were confirmed in India, Indonesia, Philippines, and Viet Nam. Table 1.6 shows

the coal-fired power-generating capacity by operational status for which financial support was confirmed, and a ratio of financially supported power-generating capacity to total power-generating capacity. The ratio is calculated by dividing the 'financially supported power-generating capacity in the total power-generating capacity' by the 'total power-generating capacity.'

The coal-fired power-generating capacity supported by public financial institutions totalled 56,859 MW in the target countries, or 7.6 percent of the total power-generating capacity. Since the database includes closed power plants and cancelled construction of power plants, the total power-generating capacity of 750,905 MW is considered a maximum denominator value for calculating financial support ratio. Also, since the financially supported coal-fired power-generating capacity of 56,859 MW does not cover all cases, it is considered a minimum numerator value for calculating a ratio. Accordingly, though the 7.6 percent ratio of the supported power-generating capacity to the total power-generating capacity is considered a minimum value, it is actually assumed to be higher than this.

Of the countries receiving support, the scale of power-generating capacity is overwhelmingly higher in India. In terms of the ratio to the total power-generating capacity, however, Indonesia and the Philippines have a higher financial support reception rate.

The number of power plants confirmed to be financially supported was 45 whereas that of power-generation units was 130.

Table 1.6: CPP Capacity Financially Supported by Public Financial Institutions

Unit: MW

Country	Coal-fired power plant generation capacity with financial aid											Total	Share
	Operational Status										Sub-Total		
	OPR	CON	PLN	DEL	CAN	DEF	DAC	STN	RET	UNK			
Cambodia												4,455	
India	24,140	7,300		2,400					507		34,347	567,120	6.1%
Indonesia	11,220										11,220	62,299	18.0%
Lao PDR												1,878	
Malaysia												17,509	
Myanmar												1,620	
Philippines	2,738										2,738	15,878	17.2%
Singapore												1,362	
Thailand	1,434										1,434	15,840	9.1%
Viet Nam	1,200	5,920									7,120	62,945	11.3%
Total	40,732	13,220		2,400					507		56,859	750,905	7.6%

Note: CAN = Cancelled, CON = Under construction, DAC = Deactivated/mothballed, DEF = Deferred without construction start, DEL = Delayed after construction start, MW = megawatt, OPR = In commercial operation, PLN = Planned and still in design, RET = Retired, STN = Shutdown or standby, UNK = Unknown operational status (typically assigned to old plants).
Source: Platts, September 2012.

Constructing a CPP requires a huge amount of money and the initial investment increases for technology with higher power-generation efficiency. For this reason, construction of CPPs in developing countries may be financed by multilateral development banks (MDBs) and economic credit agencies (ECAs). In financing coal-fired power generation, MDBs and ECAs of advanced countries have set strict criteria for improving power-generation efficiency and reducing environmental load, a measure taken to strike a balance of stability, economic efficiency, and environmental friendliness in an electric power source.

Table 1.7 shows the financially supported coal-fired power generating capacity by confirmed public financial institutions. Looking at MDBs, the coal-fired power-generating capacity where the World Bank Group is involved was a total of 22,277 MW (ADB/IFC/Kexim joint financing included), while that of the CPPs was 12,479MW (same as above).

Table 1.7: CPP Capacity Financially Supported by Public Financial Institutions (Total of Study Target Countries)

Institution	MW
IBRD/IDA	16,807
IFC	1,320
ADB	4,534
ADB/IFC/Kexim	4,150
ADB/Kexim	3,060
ADB/JBIC	735
JBIC	5,350
JBIC/NEXI	12,892
JBIC/NEXI/Kexim	700
JBIC/NEXI/US Exlm/OPIC	1,340
Kexim	1,240
US Exlm	4,731
Total	56,859

Note: ADB = Asian Development Bank, IBRD = International Bank for Reconstruction and Development, IDA = International Development Association, IFC = International Finance Corporation, JBIC = Japan Bank for International Cooperation, Kexim = Export–Import Bank of Korea, MW = megawatt, NEXI = Nippon Export and Investment Insurance, OPIC = Overseas Private Investment Corporation, US Eximbank = Export-Import Bank of the United States.
Sources: Websites of institutions.

1.4. Conclusion

Based on the above summary, the following can be pointed out regarding financing by public financial institutions of coal-fired power generation in the ASEAN countries and India.

- Except from those of the World Bank Group and ADB, the availability of financing information before the 1990s was extremely limited.
- In the database, India's coal-fired power-generating capacity is considerably higher than tha of ASEAN member countries.
- Share of Chinese manufacturers' supply has been increasing with the upsurge of coal-fired power-generating capacity from the 2010s, including the CPPs under construction and in the planning stage.
- Comprehensive financing, which does not identify a power plant, was also confirmed. In such a case, it is tough to identify the target power plant for financing.

In this study, the coal-fired power-generating capacity supported by public financial institutions was confirmed to be 7.6 percent of the total power-generating capacity of the target countries under study. Given the limitations of this study, however, the numerical values obtained through this study do not seem to have fully reflected the reality: the ratio of coal-fired power-generating capacity funded by public financial institutions is estimated to be higher.