APPENDIX B STEEL INDUSTRY IN THAILAND

B.1 Present Status of Steel Industry in Thailand

The Thai steel industry has experienced constant growth in terms of both consumption and production, underpinned by steady economic growth (see Table B.1.1). This is in accordance with the general trend in Asia, where most countries have enjoyed constant growth in finished steel consumption, as shown below.

Apparent consumption of finished steel in Asia (1990-1994)

(1000 tonnes)

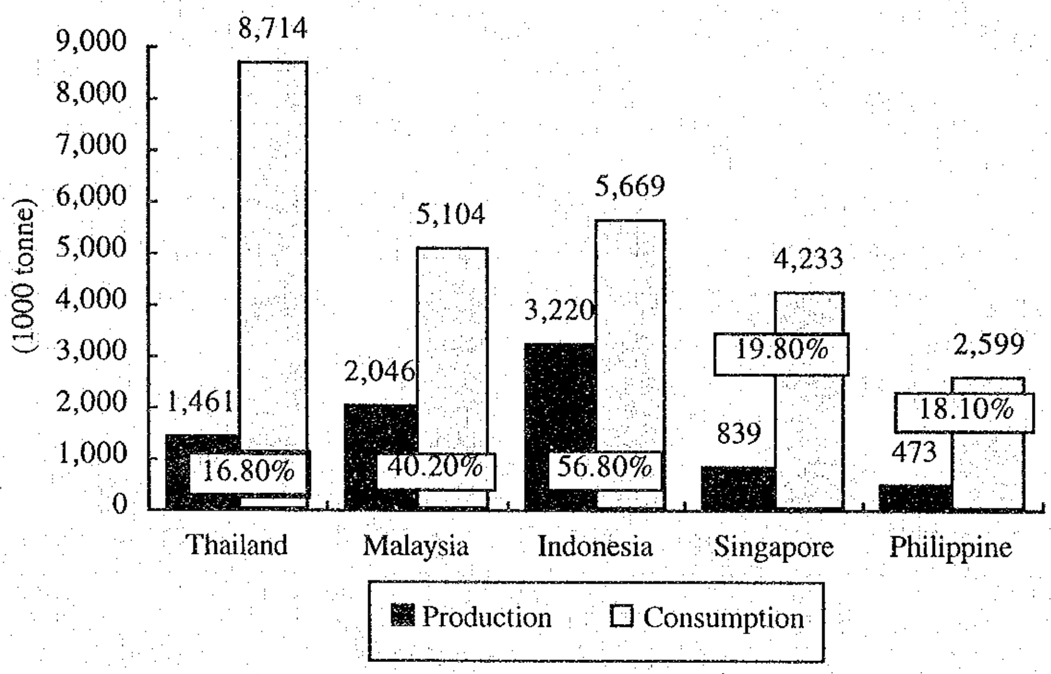
		1990	1991	1992	1993	1994	94/90*
ASEAN 5		17,700	17,984	20,408	22,473	23,694	7.6
	Thailand	6,434	6,081	7,456	7,619	7,849	5.1
	Malaysia	3,159	3,521	3,876	4,809	4,594	9.8
	Indonesia	3,944	4,076	4,581	4,484	5,102	6.6
	Singapore	2,471	2,513	2,575	3,185	3,810	11.4
	Philippine	1,692	1,793	1,920	2,376	2,339	8.4
Korea, R.O.		19,960	24,470	21,090	24,760	30,020	10.7
Taiwan		12,713	15,567	17,640	20,830	18,692	10.1
China, P.R.		49,216	52,410	66,311	99,095	90,000	17.9
Total listed		99,589	110,431	125,449	167,158	162,406	13.0

Source: South-East Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994" and other national statistics.

*: Annual percentage change from 1990 to 1994.

However, one of the characteristics of the Thai steel industry is that along with Singapore, it is one of the two countries among the five ASEAN countries, with the lowest self sufficiency rate in steel products (see Figure B.1.1). Particularly, it is notable that Thailand has the lowest self-sufficiency rate in terms of crude steel, as shown below, while it has a relatively large economy and is in an advanced stage of economic development among the ASEAN countries. This is a result of the underdevelopment of the upstream steel industry; namely iron and steel making. Establishment of iron and steel making facilities requires a large amount of capital, and the fact that Thailand has no state-owned integrated steel mills is largely responsible for this low rate of self-sufficiency in crude steel, while other ASEAN countries such as Indonesia and Malaysia have .

Production and consumption of crude steel in ASEAN 5 (1994)



*: Percentage is a self-sufficiency rate (Production/Consumption).

Source: South-East Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994" and estimation by JICA study team.

In Thailand, almost all steel producers are medium and small scale companies with less than 500,000 tonnes capacity, while some adopt the electric arc furnace steelmaking process (see Table B.1.2). All producers are located in the southeastern part of the country except for one new steel complex in Bang Saphan. In 1993 almost 70% of finished steel production was of long products which are mainly used by the construction sector. This has resulted in a much lower self-sufficiency rate of flat products at 13% in 1993, while the rate of long products was 60%. Due to the start-up of the first hot strip mill in the country in Bang Saphan, production of flat products jumped from 576,000 tonnes in 1993 to 1.27 million tonnes in 1994, but the self-sufficiency rate stayed at around 25%. Because flat products are mainly used for higher-value-added manufacturing such as automobiles and electrical appliances as well as for construction, an increase in self-sufficiency of flat products through the establishment of production facilities is a central issue for Thailand from the viewpoint of balanced industrial development. At the same time, an increase in self-sufficiency in crude steel through the development of the upstream steel industry is another important issue for the future of the Thai steel industry. For improving the trade imbalance and ensuring a stable supply of steel products as a basic material, these factors will be central for consideration.

B.2 Comparison Study of Promoting Measures for Steel Industries in Asia

In many cases governments have played an important role in promoting the growth of the steel industry of their country by establishing a state-owned company or giving many incentives and protection. Government ownership of the steel industry in Asia is found in Korea, Taiwan, Malaysia and Indonesia, and also at the early stage of the industry's formation in Japan. Private investment in the steel industry has often been discouraged by a lower rate of return and large capital requirements, and governments have often provided assistance instead. For example, when a World Bank study did not propose to construct an integrated steel mill in Korea, the government funded the development program itself.

The recovery of the Japanese steel industry after serious damage during the World War II was remarkable. The steel industry became one of the main targets of industrial policy, and various forms of policy-based assistance were given to it between the end of the war and the mid-1960s. One measure was so-called "policy based finance", in which government funds, including loans from international financial institutions such as the World Bank, were preferentially allocated to specific industries, including steel. Finance was usually supplied through the government-owned Japan Development Bank (JDB). JDB financing and favorable tax-treatment measures such as special depreciation and deductions on export-earned income, made it easier to procure funds for capital investment. An approval system for introducing technology based on a foreign exchange allocation, and an import quota scheme were also established. These policies had four primary objectives: (1) to promote capital investment through the strategic supply of financing and tax reductions and exemptions, (2) to promote exports through tax exemption measures, (3) to introduce technology strategically, and (4) to protect the industry from international competition. However, even with these supporting measures, an internal competitive environment emerged within the industry and steel producers carried out positive capital investment to lower costs and to enhance quality, which resulted in a remarkable increase in productivity and market competitiveness.[1]

In Korea, the first-ever integrated blast furnace mill in the country, Pohang Iron and Steel Corporation (POSCO), was established in 1968 as a state-owned company. Along with the government's import substitution policy during its industrialization drive, strong government support came especially in its early stage. POSCO has become the world's second largest steel producer by 1995, having two integrated mills in Pohang and Kwangyang, through a succession of huge investments. One World Bank report[2] summarizes the following three

1 "Policy-Based Finance : The Experience of Postwar Japan", World Bank Discussion Papers No. 221, 1994.

2 "Credit Policies and the Industrialization of Korea", World Bank Discussion Papers, No. 286, 1995.

as key measures for promoting its success. First, POSCO mobilized foreign funds necessary to construct steel mills at low cost under the government's loan repayment guarantee. In addition, one study[3] notes that government funds were directly allocated to cover basic infrastructure development such as roads, new railroad lines, loading and unloading port facilities, and electric and communication facilities. Second, banks which were the major shareholders of POSCO complied with the government's "no-dividend" policy until the early 1980s. This cooperation led to the expansion of POSCO's retained earnings and in turn allowed it to maintain a sound financial structure, eliminating bankruptcy risks. Third, as a fiscal policy instrument, the government promulgated the Steel Industry Promotion Law which supported the reduction of taxes and provided discounted fees for public services. The report concluded that financing was the most critical factor, considering that the construction of a steel-making facility required an enormous amount of capital and the fact that POSCO began to earn profits 6 years after its inauguration. Moreover, POSCO and other steel producers enjoyed general incentives for export-oriented industry such as "policy loans", low interest rate for the acquisition of equipment and to finance production for export, tax holidays, accelerated depreciation and investment tax credits. At the same time, steel products manufactured by Korean firms were placed on the list of "restricted import items", which meant that the product could only be imported if approved by the government and the steel industry. However, in the late 1970s the Korean government began removing many of Korea's formal barriers to imported steel products and between 1984 and 1988 all steel products were removed from the "restricted list".

In Taiwan, the establishment of the China Steel Corporation (CSC) in 1971 marked the government's first effort to promote the growth of the steel industry. Prior to 1970 all of Taiwan's steel was imported or produced by one of the many small family-run mills, which were heavily dependent on imported billets and scrap. The government established CSC to provide a large-scale integrated steel making capability required to support Taiwanese industrialization. After failures to establish a joint venture with private investors, particularly from abroad, CSC became a wholly "state-owned enterprise" in 1977. One study[4] notes that the greater portion of $970 million construction cost for its first phase came from the government. The government also contributed to the establishment of a supporting infrastructure and the securing of raw materials to produce steel. The Kaoshiung harbor, the site of the mill, was expanded and deepened. The government oversaw the construction of a network of railroads and highways to support the Kaoshiung industrial zone, financed by the Taiwan Provincial Government. Not only CSC, but also

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3 "Steel and The State", T.Howell, W. Noellert, J. Kreier and A. Wolf, Westview Press, 1988.

4 "Steel and The State", ibid.

many other steel producers, were exempt from import duties, harbor fees and a surtax on raw materials used to produce steel for export, and were exempt from various taxes on revenue generated by export sales, while the government attempted to put the nation's numerous small and medium-sized mills on a sounder economic footing. The government's policy has been to encourage import substitution, and import restrictions were imposed on products produced in Taiwan in the form of licensing requirements. However, the self sufficiency rate of steel products has stayed at less than 50% with a much higher increase in steel consumption, and many investors now have an interest in establishing production facilities.

The majority of Indonesian steel production comes from a 100% state-owned company, Krakatau Steel, which is at the moment one of the two integrated steel mills equipped with a direct reduced iron (DRI) plant in ASEAN. Established in 1962 after having experienced a complicated struggle to form a steel venture, Krakatau finally succeeded in starting operation of its first phase facilities in the early 1980s. Major products are direct reduced iron from DRI plant, billets and slabs, long products and hot strip and sheet steel. Krakatau has long been faced with financial problems and has reportedly been supported in financing by the government. The basic policy of the government is to concentrate production of flat products on Krakatau, which requires a larger investment and higher technical base, and to let the private sector equipped with electric arc steelmaking to produce long products. Even though strong government involvement still exists, it is reported that the government is considering selling some portion of its shares in Krakatau or establishing a joint venture in order to finance the expansion plan of the mill. Since 1981 Krakatau had worked as a sole authorized importer of a wide range of steel products, being a "Center of procurement for iron and steel" under the "Cooperative buying system" which enabled it to control access by its foreign competitors to its home market. This regulation had gradually been transferred to an "Import license" system and finally was liberalized in principle.

In Malaysia, the government has always been involved with the steel industry, holding shares of several major steel mills. Malayawata Steel, the only integrated mill with a blast furnace in ASEAN, though it is very small, and Perwaja Steel which is an integrated mill with DRI, are the two major state-affiliated producers. There have been general measures for export promotion and also to protect the market for steel products which can be produced by domestic mills. The government's policy is to play a big supporting role in big steel mill projects such as for flat products and let the private sector focus on long products and downstream steel production with only limited government control. Perwaja has long been faced with financial problems and it was recently reported that the government provide financial assistance for its payment of international loan.

As seen above, in many Asian countries there have been various promoting and protecting measures for the steel industry, especially at the early stage of its development (see Table B.2.1). In all cases, there were direct or indirect financial supports by the government, because the steel industry requires a huge amount of capital. There have also been various tax benefits, support for infrastructure and protection from imports. In Thailand the scale of measures taken was relatively small especially with no direct injection of capital to core steel producers. However, on a worldwide basis, government control and promoting measures have been gradually diminishing under a general trend of deregulation and trade liberalization. There is also a global trend of privatization of state-owned steel firms on a worldwide basis to promote efficiency and to reduce government obligations. POSCO's stock has been sold to the general public since 1988 and now it is listed on the New York Stock Exchange, while CSC was privatized in 1995. However, it should be noted that privatization of these core steel companies in Asia was realized only after establishment of solid business foundations. On the contrary, the Taiwanese government announced that it would participate in financing a joint venture to construct an integrated steel mill led by Kuei Yi and CSC, showing an unchanged interest in supporting the steel industry. Tariff rates for steel products have been declining and will be reduced in Asia (see Table B.2.2) along with the efforts to conclude "Multilateral Steel Agreement (MSA)" under the WTO scheme and also efforts for AFTA. In conclusion, while there is no rationale for introducing subsidies and direct promoting measures under this global environment, introduction of indirect measures such as preparing basic infrastructures, such as port facilities, roads, railways, electricity and water supply, should be considered to nurture the steel industry and to establish a steel-based industrial complex in Thailand, particularly in Bang Saphan. This area is far away from the Bangkok Metropolitan area and has to bear a lot of inconveniences due to such isolation, while having a perfect conformity to the government policy of "Decentralization". Therefore, those projects which could lead the way to local development should be given special government support.

B.3 Future Steel Industry in Thailand

It is generally recognized that Asia will lead world economic growth toward 2011, and Thailand will be one of the chief engines of this growth. Based on the macro economic scenario which assumes an annual 12.6% growth between 1995 and 2001, and an annual 7.9% growth between 2001 and 2011 in terms of nominal GDP, it is forecast that finished steel consumption in Thailand would reach 11.5 million tonnes in 2001 and 17 million tonnes in 2011. Because infrastructure development needs will be high in Thailand, demand of steel from the construction sector will remain strong. Higher integration of the manufacturing sector whose share to GDP is expected to increase toward 2011 would bring about increased consumption of various flat products. For instance, it is assumed that production of passenger cars in Thailand could increase to more than 1.5 million units against 540,000 in 1995, therefore, demand for cold rolled and coated sheet would increase. The Study Team forecasts that steady growth in major steel using industries will bring about an annual 5.6% growth in finished steel consumption between 1994 and 2001, and an annual 4.0% growth between 2001 and 2011 (see Table B.3.1). Consumption of 17 million tonnes of finished steel means that every individual in Thailand consumes a 237 kilograms of steel every year, or in other words Thailand consumes a 26 grams of steel to produce one US dollar of GDP, which is a world standard level compared to its assumed per capita GDP of US$9,000.

Taking into account the fact that Thailand has a low self-sufficiency rate of steel products and steel consumption is expected to grow at a steady rate, many are planning to construct steel mills in Thailand (see Table B.3.2). Simple accumulation of reported capacities of these projects suggest that production capacity increases of 12 to 13 million tonnes of iron and steel including 3.7 million tonnes of long products, 6.2 million tonnes of hot strip, 4 million tonnes of cold strip, and 840,000 tonnes of coated steel sheet, are in consideration. While there is much uncertainty about realization of these projects, some other projects could be realized. It is assumed that production capacities would be improved in a direction to increase the country's self-sufficiency in steel products. The Study Team sees much possibility for Thailand to increase its self-sufficiency rate of finished steel to around 90% by the year 2011 (see Table B.3.3). However, it should be noted that most of expanded facilities would concentrate on commodity grade products, and therefore, there would still be a large amount of exchange of products across the border; namely exports and imports. At the same time, it is a fact that many steel mill projects are planned everywhere in Asia (see Table B.3.4). Particularly, the Republic of Korea and Taiwan could dramatically increase their export capabilities in terms of volume, and if China, which could absorb much of the steel produced by new facilities in Asia, fails to follow its anticipated economic growth track, there is a real risk of over-supply of steel products. In that respect, construction of new facilities in Thailand needs a step-by-step approach with a careful assessment of demand-supply balance of steel products in Asia.

Among planned steel mill projects in Thailand, several include iron and steel making processes as well as rolling of the flat products which Thailand is most lacking at the moment (see Table B.3.5). The project Sahaviriya and its group in Bang Saphan is positioned as one of the three integrated steel mill projects which include iron making processes. The other two are the Nakorn Thai Steel group (Nakorn Thai Strip Mill) and Thai Special Steel Industry, both of which are being pursued or planned along the Eastern Seaboard. While Sahaviriya and Nakorn Thai Strip Mill focus on the flat product market, Thai Special Steel Industry is planning to produce semi-finished and finished long products. Some other projects are planned to produce direct reduced iron (DRI) to feed electric arc furnace (EAF), because steel scrap, the main raw material for EAF, is anticipated to be in shortage in the future both in Thailand and overall Asia. However, it is notable that the feasibility of investment for upstream products is still fragile and for all the planned projects it has still not been determined which technology they should adopt. The only project planned by United Iron and Steel would proceed with natural gas based iron making technology (HYL III or Midrex), given the relatively cheap energy price agreed by PTT, EGAT and MOI, because this is positioned as a kind of national project. Other projects for iron making would take either a coal based technology such as Fastmet, Corex and DIOS or the traditional blast furnace method, while many experts are pessimistic about the gas-based iron making technology because of its availability and high price in Thailand. Thai Special Steel Industry has recently announced that it will apply the conventional blast furnace method, constructing a coke oven battery, a 2,800 m^3 blast furnace and basic oxygen converters, although it is seen as a little unusual due to its huge investment cost to produce relatively low added value products, billets and long products. A part of pig iron is scheduled to be sold to Siam Strip Mill which is the subsidiary of one of the shareholders of TSSI.

It is clear that Thailand would benefit from establishing iron making facilities in the future, taking into account the fact that many steel making projects are planned everywhere in Asia, and that there is much concern about a possible shortage of DRI and steel scrap. Under this assumption, it is rational to establish both iron and steel making facilities in the Bang Saphan area, because it has one of the best deep sea ports in Thailand, which is the critical cost factor for transportation of raw materials such as iron ore and coal, and this area will require much more semi-products by having a hot rolling capacity of more than 3 million tonnes by 1996.

B.4 Prospective Development of Steel Industry in the Bang Saphan Area

B.4.1 Basic Concept of Development

Considering that Thailand could expect a constant increase in steel consumption and that the Bang Saphan area has an established base for the steel complex with a deep sea port, it would be quite reasonable to expand its capacity including iron and steel making up to 6 million tonnes by 2011, which is almost one third of the estimated crude steel consumption in Thailand. However, the steel complex in Bang Saphan has been and will be developed by the private sector, therefore it is recommended to take very prudent steps. The reasons for this are as follows:

a) A private entrepreneur cannot make a huge investment at one time betting on a continual growth scenario into the future, even if it is assumed to have excellent potential. Even in the case that a high return on investment over the long term is expected, a huge investment at one time largely affects the project's cash flow in its early stage and makes it difficult from a financial point of view.

b) It will be appropriate to increase production capacity step by step in accordance with market growth and a consideration of the producer's competitiveness from time to time. Furthermore, production flexibility will be desirous to cope with fluctuations of the economy.

c) The expansion plan must match the availability of utility supply and necessary infrastructure. The current supply of water and electricity does not allow the installation of iron and steel making facilities on an economical scale before the completion of new sources.

B.4.2 Current Situation of the Steel Complex

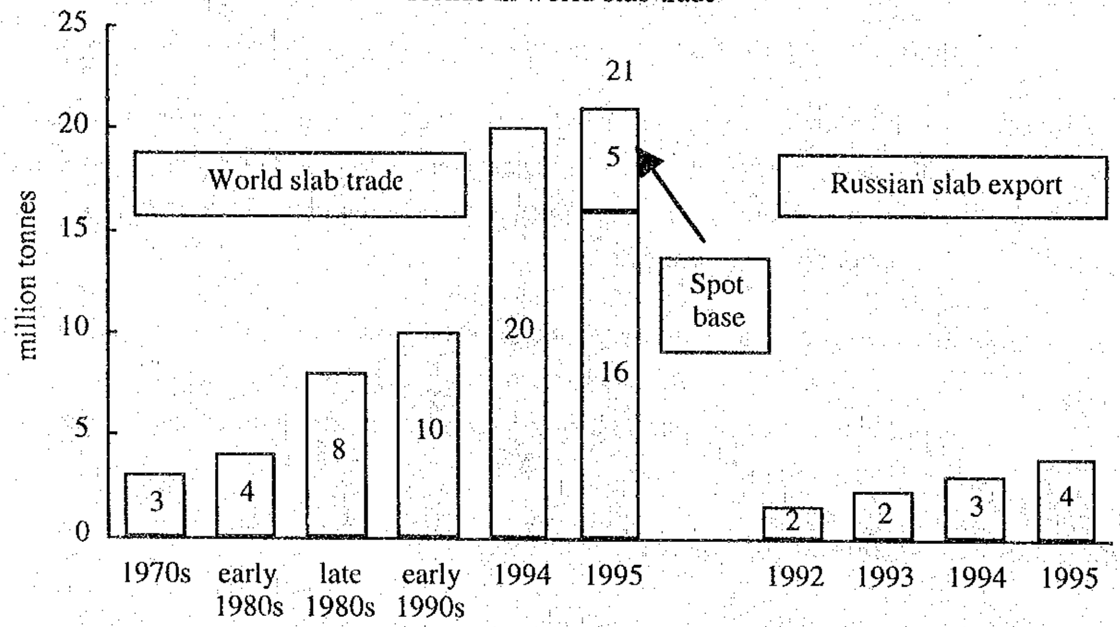
The following facilities have been installed or are under construction in Bang Saphan.

Hot Strip Mill	2.4 million tonnes/y(Mt/y)	in operation
Electrogalvanizing	0.135 Mt/y	in operation
Bar Mill	0.72 Mt/y	in operation
Cold Strip Mill	1.0 Mt/y	under construction

In 1995 actual production of the hot strip mill and the electrogalvanizing line was about 1,130,000 tonnes and 80,000 tonnes, respectively. With those production volumes, water consumption and electricity demand were reported to be 1.83 MCM/y and 80 MW at maximum, respectively.

At the moment, the complex does not have upstream production facilities which provide semi-products such as slabs for hot strip mill and billets for bar mill. Therefore, these feedstocks have been imported. However, procurement of a big amount of slabs (2.5 million tonnes per annum) is not always easy and will be more difficult, because the international trade volume of slabs has been typically between 8 and 15 million tonnes per annum and supply source is limited. Even though the world trade volume of slabs has recently increased, the chaotic state of the Russian steel market is a major factor for this temporary increase of supply and most of the slab trade is long-term based, as seen below. Therefore, there is no guarantee that slabs will be adequately available in the future.

Trends in world slab trade

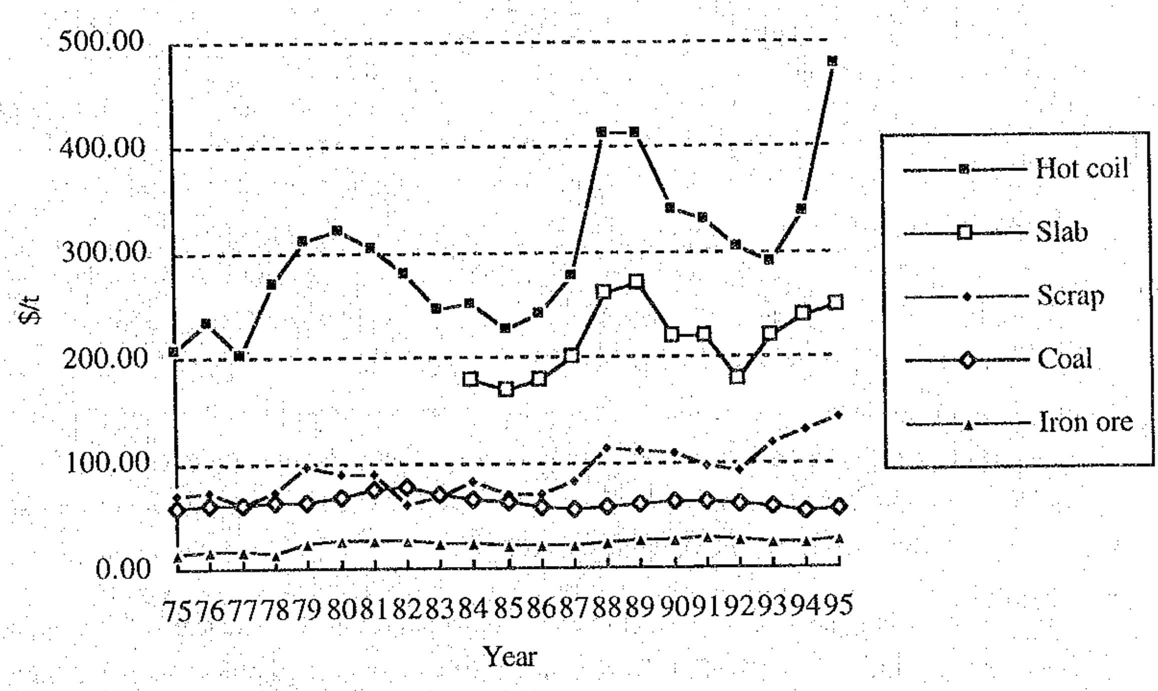


Sources: *"World Steel Dynamics"*, Painne Webber, and estimation by JICA team.

Notes:
(1) World slab trade has increased under globalization and restructuring of the steel industry worldwide.
(2) Most of the trade is under long term contract.
(3) Recent increase in slab export by Russia seems to be only temporary one under its painful restructuring efforts.
(4) In conclusion, an increase in slab trade, particularly on a spot basis, is not expected in the future.

At the same time, slab prices have fluctuated in the past depending upon the situation of international economy, while iron ore and coal prices are rather stable compared with semi or finished products, as shown below. This trend will continue into the future. Furthermore in the process of steel strip production, the quality and width of final products are basically decided by slabs fed to a hot strip mill, and therefore, too much dependence on purchased slabs from outside will make it difficult to meet these customers' requirements. Therefore, the steel complex will require to have its own capability to produce slabs in order to provide quick and better response to customers' demands. However, it should be again noted that iron and steel making processes require huge capital investment and infrastructure, including water and electricity supply. Because water and electricity are not abundant in Bang Saphan area, the availability of those utilities are critical factors to decide the process, capacity, and time schedule.

Trends in international market prices of steel products and raw materials



B.4.3 Available Technologies for Iron Making

In Thailand the availability of natural gas is limited and the priority of its usage is given to petrochemical industry and electric power generation. Also the price of natural gas is assumed to be US$ 2.70 per mm Btu (million British Thermal Unit). Those situations generally prohibit the steel industry from depending on natural gas except in one special case of a national project, as shown below. The following evaluation of possible processes is focused on coal-based ones.

Current status of alternative iron making processes (Coal-based technology)

Process	Current Status	Proved Capacity per unit	Improvement Plan
Blast Furnace	Industrialized Most-established	4,000,000 t/y	Nitrogen free furnace Coal powder injection Plastic scrap injection
SL-RN	Industrialized	300,000 t/y	Difficult to increase capacity
Corex	Industrialized	340,000 t/y	Scale up to 600,000 t/y Corex/Midrex combined
DIOS	Pilot plant	500 t/d completed	Next step up to 3,000t/D
Fastmet	Pilot plant	50 t/d underway	Industrial plan 450,000t/y
Hismelt	Pilot plant	350 t/d underway	
Romelt	Pilot plant	670 t/d underway	

Notes: Other processes under development are AISI Direct Steelmaking, CCF, Circofer, etc., but in a bench scale. Schematic pictures with brief explanation on these processes are given in Figures B.4.4-B.4.7.

Among those processes, the blast furnace coupled with basic oxygen furnace (BF/BOF process) is the most established and reliable in terms of quality and quantity. The critical shortcomings of the BF/BOF process are the larger facility costs including BF, coke battery and BOF as well as the lack of flexibility of operation with regard to stop and go. Two other industrialized processes, SL-RN and Corex are presently in much smaller unit capacity like 0.3 million tonnes per annum. Four other processes are still in the pilot plant stage which include DIOS, Fastmet, Hismelt and Romelt. There are some other processes under development, but they are in the bench scale stage. At this moment Corex (or coupled with Midrex), Fastmet and DIOS are possible candidates.

Corex process has been operated at ISCOR, South Africa, in the capacity of 0.3 million tonnes per annum. But POSCO, Korea, has started to operate the new model of Corex with an annual capacity of 0.6 million tonnes in November 1995. Fastmet process development will be completed in the fall this year. The first commercial plant will start its operation in the latter half of 1998 in the U.S. Also some further improvement is going to be studied parallelly.

Note: Environmental problems of every iron making technology can be technically fixed by many pollution control measures such as NOx and SOx removal from off gases, emission control devices and advanced waste-water treatment.

Another strong candidate will be DIOS, whose pilot plant test was completed successfully in February 1996 as a national project in Japan. This process has a flexibility in utilizing by-product gas either internally in the process or externally as fuel gas, for example, at an on-site power station. Another big advantage of this process is flexibility in raw material sourcing (ore, coal). Many of the new iron-making processes have strong preference to specific raw materials and their sourcing, while DIOS has broader freedom in its raw material sourcing which will give an advantageous position in procurement. Based on the test results, conceptual designing for the commercial plant (1 million tonnes annual capacity per unit) was completed in July 1996 which showed manufacturing cost reduction by 19% and facility cost reduction by 35% compared with BF/BOF process with coke oven and sinter. The operability and reliability of those three new processes still remain to be seen.

One study shows a calculation for economic evaluation among these processes as follows:

Process	BF/BOF	Corex/BOF	Fastmet/EAF [1/]	Fastmet/EAF [2/]
Variable Cost (liquid steel ton)	188.48 $/t	165.12 $/t	210.00 $/t	177 $/t
Include. Capital Charges (Depreciation, Interest)	242.41 $/t	213.14 $/t	227.70 $/t	217 $/t

Source: "Steel Survival Strategies X", D.F. Barnett, June 1995

Note: 1/ Fastmet provides 20% of EAF raw material and the balance is scrap
2/ 75% Fastmet and 25% scrap of EAF raw material, adjusted by the Study Team.

Base data of calculation vary depending on the situation, therefore those data should be taken only as a reference.

In this report, the direct reduced iron and electric arc furnace process (DRI/EAF) is assumed as an example case of an iron and steel making. As explained above, technical development in the next several years would enable us to make a decision in selecting the most favorable process. If process selection is made by 1999, the first iron making facilities will be able to start by 2003 in Bang Saphan when necessary electricity could be supplied by a new 500 kV transmission line and water could be supplied by the enhancement of the Bang Saphan River pumping station. If everything is successful, facilities could be gradually added up to reach 6 million tonnes annual capacity or more in concert with the enhancement of infrastructure including EGAT power stations, IPP power stations, Tha Sae Dam and other water resources.

B.4.4 Recommended Facility Plan

As shown in Table B.4.1, it is recommended to take four steps to expand the Bang Saphan Steel Complex both upstream and downstream, in consideration of factors stated in Section B.4.1. The recommended facilities for the complex are shown in double framed boxes along with other typical production processes in Figure B.4.1. Although an early installation of a 2 million tonnes iron and steel making capacity is preferable, utility supply does not allow it until 2002. Therefore, in the meantime it is recommended to install electric arc furnace(s) and a continuous caster to produce 1 million tonnes of slabs annually as the first step. A 500 kV EGAT transmission line from the BMA grid is scheduled to be laid by the end of 2001, which will be able to support this EAF installation. The proposed amount is only a half of slab consumption, but will strengthen the bargaining power in the procurement of slabs. As for billets it is generally understood that procurement of ordinary quality billets is much easier in both domestic and international markets, and therefore, production facilities for billets could be left until the third step. Production of one million tonnes of crude steel through EAF will require an enhancement of the existing water pumping station and water reservoir in the steel complex as well as some modification of the power transmission lines and installation of a voltage stabilizer to reduce the voltage fluctuation induced by EAFs.

In the second step in 2002, a iron and steel making capacity of 2.5 million tonnes would be recommended, adding 1.5 million tonnes EAF capacity and 1.8 million tonnes DRI capacity. Considering that candidate iron making processes are in the development stage, earlier start up of half volume DRI (1 unit) could be a deliberate alternative step. Then in 2004 when water supply from the Tha Sae Dam is secured and electricity supply is enhanced through EGAT new power stations and IPP plants, a complex capable of producing 2 million tonnes of long products could be completed, and in 2006 the production capacity of flat rolled products could be expanded through the construction of a 2-million tonnes iron making plant followed by a thin slab caster and hot strip mill. The full capacity at each step could be reached 2 years after the construction of the equipment. A material flow chart in the steel complex is shown in Figure B.4.8. The installation and expansion of iron and steel making facilities will call for an increase in finishing capabilities. The recommended facilities for hot rolling and finishing processes are figured out in relation to the steel market analysis by product category (see Table B.4.8). But those finishing facilities plans may be modified from time to time depending on the market situation and the entrepreneur's strategy. Figures B.4.2 and B.4.3 show respectively the water and electricity demand in relation to production capacity. Tentatively calculated necessary transformer capacities and water supply demand are shown in Tables B.4.2 and B.4.3 respectively.

B.4.5 Other Possibilities for Iron Making

In this study the construction of iron-making plants in Bang Saphan is recommended. But there are two other possibilities for procuring iron to feed electric arc furnaces, and these options should be carefully considered in the selection of an iron making technology.

a) Re-utilization of unused capacity of iron and steel making in Japan

Due to restructuring moves in Japan, there is a significant volume* of unused iron and steel making facilities which were substantially modernized in terms of production efficiency and environmental protection. Some of those facilities could be economically reutilized through a joint venture or a long-term contract of purchasing or tolling. This would be worth considering from the viewpoints of economy and environment.

b) Construction of DRI plants in foreign countries

Among DRI processes, the Midrex process is the most established and reliable, if natural gas is available and cheap. Investment in the Midrex process like in such country as Venezuela where natural gas costs only a fifth of the cost in Thailand and iron ore is abundant would be another possibility.

* Note: As of December 1995, it was reported that 13 blast furnaces were not in operation in Japan, whose total volume was 32,602 m3, equivalent to about 20 million tonnes annual iron making capacity.

Table B.1.1 Basic Statistics of the Thai Steel Industry (1990-1994)

(1000 tonnes)

	1990	1991	1992	1993	1994	94/90** (%)
Crude steel						
Apparent consumption	7,149	6,757	8,284	8,466	8,721	5.1
Production	789	711	929	954	1,461	16.7
Self sufficiency rate (%)	11.0	10.5	11.2	11.3	16.8	5.7
Finished steel						
Apparent consumption*	7,133	6,964	8,366	8,635	9,197	6.6
Production	2,799	2,177	2,710	3,282	3,328	4.4
Self sufficiency rate (%)	39.2	31.3	32.4	38.0	36.2	-3.1
Net exports	-4,334	-4,787	-5,656	-5,353	-5,869	7.9
Exports	175	185	175	270	301	14.5
Imports	4,509	4,972	5,831	5,623	6,170	8.2
Long products						
Apparent consumption	3,811	2,824	3,836	3,965	3,603	-1.4
Production	2,170	1,412	1,921	2,386	1,604	-7.3
Self sufficiency rate (%)	56.9	50.0	50.1	60.2	44.5	-12.4
Net exports	-1,641	-1,412	-1,915	-1,579	-1,999	5.1
Exports	10	5	9	7	14	8.8
Imports	1,651	1,417	1,924	1,586	2,013	5.1
Flat products						
Apparent consumption*	3,193	4,015	4,364	4,448	5,213	13.0
Production	449	565	589	576	1,272	29.7
Self sufficiency rate (%)	14.1	14.1	13.5	12.9	24.4	10.3
Net exports	-2,744	-3,450	-3,775	-3,872	-3,941	9.5
Exports	31	19	27	33	56	15.9
Imports	2,775	3,469	3,802	3,905	3,997	9.6
Pipe and tube						
Apparent consumption	129	125	166	222	381	31.1
Production	180	200	200	320	452	25.9
Self sufficiency rate (%)	139.5	160.0	120.5	144.1	118.6	-20.9
Net exports	51	75	34	98	71	8.6
Exports	134	161	139	230	232	14.7
Imports	83	86	105	132	161	18.0

Source: South East Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994"

Notes: Flat products include plate, hot strip, cold rolled sheet, coated steel sheet and tinplate.

*: Apparent consumption includes amount used for next process.

**: Annual percentage change from 1990 to 1994. For self sufficiency rate it is a simple change from 1990 to 1994.

Table B.1.2 Current Steel Production Capacities in Thailand

(1000 tonnes)

Process	Company	Place	Capacity
Steelmaking	The Bangkok Iron and Steel Works	Samutprakarn	150
	Bangkok Steel Industry	Samutprakarn	300
	Namheng Steel	Lopburi	150
	Nicco Industries	Rayong	120
	Nakorn Thai Steel	Chonburi	445
	Sahamiter	Rayong	150
	The Siam Construction Steel	Map Ta Phut	500
	The Siam Iron & Steel	Ta Luang	400
	Siam Steel Syndicate	Samut Prakarn	50
	Siam Yamato Steel	Map Ta Phut	600
	Thai Steel Bar	Samutprakarn	135
	Thai-India Steel	Samutprakarn	40
	Thai Pathana Steel Industry	Samutprakarn	240
	BNS Steel	Chonburi	250
	UMC Metal	Chonburi	200
	Triumph Steel		120
	TOTAL		3,850
Rolling of long products	The Bangkok Iron & Steel Works	Samutprakarn	250
	Bangkok Steel Industry	Samutprakarn	430
	Bagna Steel		200
	Chonviriya Iron Products		48
	Chonviriya Steel		20
	Namheng Steel	Lopburi	150
	Nicco Industries	Rayong	120
	Nakorn Thai Steel	Chonburi	550
	Sahaviriya Steel Works	Bang Pakorn	48
	Sahamiter	Rayong	140
	The Siam Construction Steel	Map Ta Phut	400
	The Siam Iron & Steel	Ta Luang	400
	Siam Steel Syndicate	Samutprakarn	60
	Siam Yamato Steel	Map Ta Phut	600
	Thai Steel Bar	Samutprakarn	150
	Thai-India Steel	Samutprakarn	40
	Thailand Steel Works		36
	Thai Pathana Steel Industry	Samutprakarn	240
	Triumph Steel		144
	Union Metal		30
	TOTAL		4,056
Rolling of plate	LPN Plate Mill		300
	Sahaviriya Plate Mill	Bang Pakong	200
	TOTAL		500
Rolling of hot strip	Sahaviriya Steel Industries	Bang Saphan	2,400
	TOTAL		2,400
Cold Strip Mill	Thainox Steel (stainless steel)	Rayong	60
	TOTAL		60
Tinplate	Siam Tinplate	Map Ta Phut	120
	Thai Tinplate	Samutprakarn	350
	TOTAL		470
Coating (CGL,EGL,etc.)	Bangkok Steel Industries	Samutprakarn	130
	Far East Iron Works		66
	The Sangkasi Thai	Samutprakarn	120
	Thai Coated Steel Sheet	Bang Saphan	135
	Thailand Iron Works Public		60
	TOTAL		511
Pipe and Tubes	Siam Matsushita Steel		50
	Thai Steel Pipe Industry		60
	Thai-Asia Steel Pipe	Samutprakarn	40
	Thailand Steel Works		36
	TOTAL		186

Sources: BOI and various articles and hearings

Table B.2.1 Promoting Measures for the Steel Industry in Asia

Country	Basic policy and scheme	Detailed measures
Japan	- To position the steel industry as targeted and important - To promote capital investment through strategic supply of financing and tax reductions/exemptions - To promote exports through tax benefits - To introduce technology strategically - To protect the industry from international competition (1945 - the mid 1960s)	(1) Preferential allocation of government funds - JDB low interest finance (2) Tax benefits - Special depreciation and deductions on export-earned income (3) Preferential allocation of foreign exchange to introduce technology (4) Import quota
Korea, R.O.	- To grow "HCI" (heavy and chemical industry) - To grow steel industry as an export industry - "Steel Industry Promotion Law" (1968) as a legal base	(1) $77.2 million government loan to POSCO (1969) - $30.8 million with 0 interest - $46.4 million with 3.5% interest for 20 years with a grace period of 7 years (2) Share holding by government and major banks and no dividend policy at POSCO - Ministry of Finance owned 56.2% and the rest was held by a single public company (1968) - Share gradually transferred to Korean Development Bank and other commercial banks, and no general public held shares until 1987 - No dividend was paid until 1982 (3) Benefits to infrastructure cost to POSCO - Financing to the building project for roads, railroad, harbors, industrial water supply, and electricity - Discounted user fee for railroad rate of 40%, a port rate of 50%, a water supply rate of 30%, and a gas rate of 20% (4) Tax benefits to export industry - Low interest rate of financing to production of export item and to purchase of raw materials (1972-1982) - Special accelerated depreciation (30% increase) - Reduction of import duties for production equipment - Exemption of income tax, etc. (POSCO until 1982)

(To be continued)

Table B.2.1 Promoting Measures for the Steel Industry in Asia (continued)

Taiwan	- To give special financial and tax benefits under "The Statute for the Encouragement of Investment"	
	(1) Preferential income tax ceilings	- Special 22% ceiling on annual income tax
	(2) Accelerated depreciation	- If depreciable life of assets is 10 years or more, may accelerate 5 years. If less than 10 years, may accelerate by half. Applies to producers of sheet, plate, seamless pipes.
	(4) Tax holidays	- One to four year deferral of taxes after an enterprises begins to market its products
	(5) Tax credits for investment	- 5 to 20 % tax credit for investment in machinery and equipment
	(5) Exemption from tariff on imported equipment	- Applies to equipment purchased to establish or expand production capacity
	(6) Preferential long term loans	- Long term loans from government Bank of Communications to important productive enterprises (includes steel industry)
Indonesia	- To grow steel industry by maximizing utilization of the country's natural resources - To position Krakatau as a center to increase self-sufficiency of steel production, especially for flat products	(1) Capital injection to Krakatau by the government (2) Export incentives (3) Regulation for import access (until 1993) - Krakatau worked as a sole authorized importer of major steel products under the "Cooperative Buying System" - Quota and license system for other products
Malaysia	- To increase self sufficiency of steel products - Governmnet's initiatives for big projects by holding majority shares of key companies	(1) Equity holding of Malayawata Steel, Perwaja Steel, etc. and government guarantee for finance (2) Export incentives (3) Regulation for import access - Prohibition of round bar import - Import licence program for long products and billets - Barter/counter purchase program
Thailand	- To promote steel industry along with general incentives for business in industrial zone	(1) Tax incentives for industrial estate in zone 3 - Exemption from import tariff on machinery and equipments - Exemption from corporate income tax for 8 years and 50% reduction thereafter - Exemption from import duty for 5 years on raw or essential materials used in export products for projects exporting at least 30% of total sales - 75% reduction of import duty on raw and essential materials used in production for domestic sales for 5 years - Double deduction for taxable income of water, electricity and transport costs for 10 years after recording a profit - Deduction from net profit of 25% of the costs of installation or construction of the project's infrastructure facilities for 10 years

Table B.2.2 Tariff Rate for Steel Products in Major Asian Countries

Country	Tariff rate	Remarks
Thailand	5-17% or up to BA 1.5/kg	- Scheduled to reduce up to 10% or BA 1.1/kg from January, 1997
Malaysia	0-25% or up to M$ 350/MT	- 0 tariff for most flat products - Higher tariff for bars and wire rods(M$ 180-350/MT) - 5% or M$ 49.21/MT for semi-products
Indonesia	5-40% (majority : 7-12.5%)	- Lower tariff for most flat products (10-15%) - Higher tariff for long products (30-40%) and coated sheet (20%) - Requires additional 10% VAT
Philippine	10-30% (majority : 10-20%)	- Lower tariff for most flat products (10-15%) - Higher tariff for wire rods (30%) and coated sheet (25%)
Korea, R.O.	7%	- 5% for semi-products - Reduced from 8% at January, 1995
Taiwan	0-20% (majority : 7-12.5%)	- Lower tariff for most flat products - Higher tariff for long products and coated sheet - 0% for semi-products

Table B.3.1 Forecast of Consumption, Consumption per Capita and Steel Intensity in Asia

(1000 tonnes, %)

Consumption	1990	1994	2001	2011	94/90	2001/94	2011/2001
ASEAN5	17,700	23,694	36,100	68,400	7.6	6.2	6.6
Thailand	6,434	7,849	11,500	17,000	5.1	5.6	4.0
Malaysia	3,159	4,594	7,100	10,500	9.8	6.4	4.0
Indonesia	3,944	5,102	8,800	22,900	6.6	8.1	10.0
Singapore	2,471	3,810	4,100	4,300	11.4	1.1	0.5
Philippine	1,692	2,339	4,600	13,700	8.4	10.1	11.5
Korea,R.O.	19,960	30,020	39,600	43,800	10.7	4.0	1.0
Taiwan	12,713	18,692	21,500	23,700	10.1	2.0	1.0
China, P.R.	49,216	90,000	117,000	209,600	16.3	3.8	6.0
Total listed	99,589	162,406	214,200	345,500	13.0	4.0	4.9

(kg/capita)

Consumption per capita	1990	1994	2001	2011	94/90	2001/94	2011/2001
ASEAN5	56	69	96	157	5.7	4.7	5.1
Thailand	115	132	177	237	3.6	4.3	3.0
Malaysia	178	233	300	343	6.9	3.7	1.4
Indonesia	22	27	42	97	4.9	6.9	8.7
Singapore	912	1,300	1,262	1,143	9.3	-0.4	-1.0
Philippine	28	35	60	146	6.1	7.9	9.4
Korea,R.O.	466	675	849	875	9.7	3.3	0.3
Taiwan	632	898	975	995	9.2	1.2	0.2
China, P.R.	43	75	90	146	14.9	2.8	5.0
Total listed	65	101	123	178	11.6	2.9	3.8

(grams per 1 US$ GDP)

Steel intensity	1990	1994	2001	2011	94/90	2001/94	2011/2001
ASEAN5	54.7	46.7	34.7	23.3	-3.9	-4.2	-3.9
Thailand	75.1	54.8	37.6	26.1	-7.6	-5.2	-3.6
Malaysia	73.8	65.0	50.6	21.0	-3.1	-3.5	-8.4
Indonesia	37.2	29.2	24.6	19.6	-5.9	-2.4	-2.2
Singapore	55.8	69.2	37.6	18.3	5.5	-8.3	-6.9
Philippine	38.2	36.6	36.3	35.8	-1.1	-0.1	-0.1
Korea,R.O.	78.8	79.1	57.2	25.8	0.1	-4.5	-7.7
Taiwan	79.4	77.2	45.7	23.4	-0.7	-7.2	-6.5
China, P.R.	133.2	177.1	96.7	56.8	7.4	-8.3	-5.2
Total listed	90.0	99.2	61.7	36.4	2.5	-6.6	-5.1

Table B.3.2 Planned Steel Mill Projects in Thailand

(1000 tonnes)

Process	Company	Place	Capacity	Start-up	Status **
Ironmaking*	Nakorn Thai Strip Mill	Chonburi	1,500	1998	BOI
	Thai Special Steel Industries (BF)	Rayong	2,750	1998	BOI*
	United Iron and Steel		750		BOI
	Sahaviriya Steel Industries	Bang Saphan	1,800	2004	BOI
	Sahaviriya Steel Industries	Bang Saphan	3,600	2010	R
	Thai Union Steel, Nippon Denro Ispat	Rayong	1,200		BOI
	Kobe Steel, Italian Thai Development	Rayong	900		BOI
	TOTAL		12,500		
Steelmaking	Namheng Steel	Lopburi	250	1996	
	Saereephan	Nakorn Rachasima	300		
	Sahamiter	Rayong	500		
	Nicco Industries	Rayong	500		
	Nakorn Thai Strip Mill	Chonburi	1,500		BOI
	Thai Special Steel Industries	Map Ta Phut	2,150	1998	BOI
	Siam Strip Mill	Rayong	1,800	1999	BOI
	Sahaviriya Steel Industries	Bang Saphan	1,000	2000	R
	Sahaviriya Steel Industries	Bang Saphan	1,000	2004	R
	Sahaviriya Steel Industries	Bang Saphan	4,000	2010	R
	TOTAL		13,000		
Rolling of long products	Bangkok Steel Industry	Nakorn Rachasima	300		BOI
	Bang Saphan Bar Mill (Sahaviriya)	Bang Saphan	720	1996	BOI
	Namheng Steel	Lopburi	250	1996	
	Nicco Industries	Rayong	500	1997	
	Nakorn Thai Steel	Chonburi	450	1996	
	Saereephan	Nakorn Rachasima	200	1997	BOI
	Sahamiter	Rayong	140	1998	BOI
	Sahaviriya Steel Industries	Bang Saphan	1,000	2010	R
	The Siam Construction Steel	Map Ta Phut	100		
	Siam Steel Syndicate	Samutprakarn	100		
	TOTAL		3,760		
Rolling of plate	-	-	-		
	TOTAL		0		
Rolling of hot strip	Sahaviriya Steel Industries	Bang Saphan	2,000	2010	R
	Nakorn Thai Strip Mill	Chonburi	2,400		BOI
	Siam Strip Mill	Rayong	1,800		BOI
	TOTAL		6,200		
Cold Strip Mill	Thai Cold Rolled Steel Sheet	Bang Saphan	1,000	1997	BOI
	BHP Steel Southeast Asia	Rayong	390		BOI
	Thainox Steel (Stainless steel)	Rayong	100	1998	
	Nakorn Thai Strip Mill	Chonburi	1,000		
	Siam Strip Mill	Rayong	500		
	Siam United Steel	Map Ta Phut	1,000	1998	BOI
	TOTAL		3,990		
Tinplate	-	-	-		
	TOTAL		0		
Coating (CGL,EGL,etc.)	Bangkok Steel Industries	Samutprakarn	150		
	BHP Steel Southeast Asia	Rayong	230		BOI
	Sahaviriya Steel Industries	Bang Saphan	350	2010	R
	Sangkasi Far East		60		BOI
	Thai Coated Steel Sheet	Bang Saphan	50		
	TOTAL		840		
Pipe and Tubes	Siam Nippon Steel Pipe		20		
	Thai Steel Pipe Industry		25		
	TOTAL		45		

* If not specified, projects are construction of direct reduced iron (DRI) plant.
Plan by Thai Special Steel Industries was originally approved by DRI (with Corex) basis.

** "BOI" means projects approved by BOI. "R" means capacities recommended in a design of the Bang Saphan Steel Complex. Otherwise, based on various available information.

Table B.3.3 Consumption and Production of Steel Products in Thailand toward 2011

(1000 tonnes)

	1990	1994	2001(F)	2011(F)	94/90 (%)	01/94 (%)	11/01 (%)
Long products							
Consumption	3,811	3,603	4,408	5,866	-1.4	2.9	2.9
Production	2,170	1,604	3,600	5,080	-7.3	12.2	3.5
Self sufficiency rate	56.9%	44.5%	81.7%	86.6%	-12.4%	37.2%	4.9%
Plate							
Consumption	269	492	624	880	16.3	3.5	3.5
Production	0	0	400	800	-	-	7.2
Self sufficiency rate	0.0%	0.0%	64.1%	90.9%	0.0%	64.1%	26.8%
Hot strip							
Consumption*	1,209	2,104	5,100	8,731	14.9	13.5	5.5
Production	0	510	5,300	9,490	0.0	39.7	6.0
Self sufficiency rate	0.0%	24.2%	103.9%	108.7%	24.2%	79.7%	4.8%
Cold rolled sheet							
Consumption*	1,016	1,479	2,520	4,431	9.8	7.9	5.8
Production	0	0	2,000	4,000	-	-	7.2
Self sufficiency rate	0.0%	0.0%	79.4%	90.3%	0.0%	79.4%	10.9%
Coated steel sheet							
Consumption	484	881	2,100	3,423	16.2	13.2	5.0
Production	276	525	900	1,770	17.4	8.0	7.0
Self sufficiency rate	57.0%	59.6%	42.9%	51.7%	2.6%	-16.7%	8.9%
Tinplate							
Consumption	215	258	508	906	4.7	10.2	6.0
Production	173	237	400	620	8.2	7.8	4.5
Self sufficiency rate	80.5%	91.9%	78.7%	68.4%	11.4%	-13.1%	-10.3%
Tubes and pipes							
Consumption	129	381	463	607	31.1	2.8	2.8
Production	180	452	500	670	25.9	1.5	3.0
Self sufficiency rate	139.5%	118.6%	108.1%	110.4%	-20.9%	-10.6%	2.3%
TOTAL							
Consumption*	7,133	9,198	15,722	24,845	6.6	8.0	4.7
Production	2,799	3,328	13,100	22,430	4.4	21.6	5.5
Self sufficiency rate	39.2%	36.2%	83.3%	90.3%	-3.1%	47.1%	7.0%
Net exports	-4,334	-5,869	-2,622	-2,415	7.9	-	-
Exports	175	301	1,750	3,300	14.5	28.6	6.5
Imports	4,509	6,170	4,372	5,715	8.2	-4.8	2.7
Finished steel consumption**	6,434	7,849	11,500	17,000	5.1	5.6	4.0
Hot strip**	1,009	1,602	2,322	3,542	12.2	5.4	4.3
Cold rolled sheet**	517	632	1,076	1,775	5.2	7.9	5.1
Crude steel							
Consumption	7,149	8,721	12,778	18,888	5.1	5.6	4.0
Production	789	1,461	8,000	16,000	16.7	27.5	7.2
Self sufficiency rate	11.0%	16.8%	62.6%	84.7%	5.7%	45.9%	22.1%

* Consumption includes used amount for next process.
** Consumption does not include amount for next process.
Notes: Production amount is forecast as "Planned capacity x 60-100%" depending on products.
Sources: South East Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994", and forecast by JICA study team.

Table B.3.4 Major Steel Mill Projects in Korea, Taiwan and ASEAN Countries except Thailand

(1,000 tonnes)

Country	Company	Facility	Capacity	Start-up	Remarks
Korea, R. of	Pohang Iron and Steel Co. (POSCO)	Ironmaking (COREX)	600	1995	Pohang Works
		Steelmaking (EAF)	600	1995	Pohang Works
		Steelmaking (EAF)	420	1996	Pohang Works
		Steelmaking (EAF)	1,800	1996	Kwangyang Works
		Hot Strip Mill	1,800	1996	Kwangyang Works
		CGL	300	1996	Kwangyang Works No. 3
		Plate	1,100	1997	
		Hot Strip Mill	180	1997	Pohang Works
		Cold Strip Mill	1,800	1997	Kwangyang
		EGL	300	1997	Kwangyang Works No. 2
		Ironmaking (BF)	2,500	1999	Kwangyang Works No.5
		Steelmaking (BOF)	3,000	1999	Kwangyang Works
		Long product hot rolling	500	1999	Pohang Works
		Hot Strip Mill	1,800	1999	Kwangyang Works
	Hanbo Steel & General Construction	Steelmaking (EAF)	3,000	1995	
		Hot Strip Mill	2,000	1995	
		Cold Strip Mill	1,500	1996	
		Ironmaking (COREX)	1,500	1997	
		Ironmaking (DRI)	800	1997	
		Steelmaking (EAF)	2,300	1997	
		Hot Strip Mill	2,100	1997	
		CGL	350	1997	
	Dongkuk Steel Mill Co	Steelmaking (EAF)	1,000	1996	
		Long product hot rolling	600	1997	
		Plate	1,000	1999	
Taiwan	Feng Hshin Iron & Steel Co	Steelmaking (EAF)	550	1995	
		Long product hot rolling	600		
	Yieh United Steel Corp	Steelmaking (EAF)	400	1995	
		Hot Strip Mill	600	1995	
		Cold Strip Mill	75	1995	
	China Steel Corp (CSC)	Ironmaking (BF)	2,400	1997	No.4 BF
		Steelmaking (BOF)	2,400	1997	
		Hot Strip Mill	2,100	1997	
	Yieh Loong Co	Steelmaking (EAF)	600	1996	
		Hot Strip Mill	2,400	1998	
	Yieh Phui Enterprise Co	Cold Strip Mill	250	1997	
		CGL	250	1997	
	Yieh Loong Group	Ironmaking (BF)	7,500	2000-?	
		Steelmaking (BOF)	7,500	2000-?	
		Long product hot rolling	2,000	2000-?	
		Hot Strip Mill	2,300	2000-?	
		Plate	800	2000-?	
	Kuei Yi & CSC	Ironmaking (COREX+DRI)	3,250	2000-?	
		Steelmaking (EAF)	3,250	2000-?	
		TSP (CC + Hot Strip)	1,800	2000-?	
		Long product hot rolling	1,300	2000-?	
	Formosa Plastics & Yieh Loong Group	Ironmaking (BF)	7,500	2000-?	
		Steelmaking (BOF)	7,500	2000-?	
	An Feng Steel Co	Ironmaking (DRI)	2,000	2000-?	
Malaysia	Malayawata Steel	Steelmaking (EAF)	350	1995	
	Perwaja Steel	Steelmaking (EAF)	900	1996	
		Steelmaking (EAF)	2,000	1998	
		Log product hot rolling	700	1996	
		Hot Strip Mill	2,000	1998	
	Amsteel Mills	Ironmaking (DRI)	1,000	1998	
Indonesia	PT Krakatau Steel	Hot Strip Mill	2,000	1998?	J/V with POSCO, BHP, etc is considered.
	Kodeco-Posco	Steelmaking (EAF)	2,000	1998?	J/V between Korean Development Co. and POSCO
		TSP (CC-Hot Strip)	2,000	1998?	
Phillipine	National Steel	Hot Strip Mill	1,200	1998?	

Source: Data from various articles and hearings.

Table B.3.5 Steel mill projects involving iron/steel-making and flat rolled products

(1,000 tonnes)

Company	Facility	Capacity	Status	Start-up	Remarks
Nakorn Thai Steel (NTS)	Bar/Wire rod	450	Construction	1996	Current capacity for Bar/Wire rod: 550
and its group	DRI	1,500	BOI approved	1998	NTS should hold 12% equity of U.I.S.
(Nakorn Thai	Steelmaking (EF)	1,800	BOI approved	1998	Mann-Demag AC : 180t + Consteel,LF
Strip Mill Co.)	Steelmaking (II)	-	Planned?	-	
(Chonburi I.E.)	Slab CC	1,500	BOI approved	1998	SMS(CSP)
	Slab CC (II)	-	Planned?	-	SMS(CSP)
	Hot strip mill	2,400	BOI approved	1998	SMS(CSP), BOI approval: 900kt
	Cold rolling	1,000	BOI applied	-	
	CGL	-	Planning	-	
(Rayong)	Process of HRC	500	BOI applied		Rayong
Thai Special	Coke Battery	1,100	-	1998	J/V among
Steel Industry	Blast Furnace	2,750	BOI approved	1998	- Thai Petrochemical Industry (TPI)
(TSSI)	Steelmaking (BOF	2,150	BOI approved	1998	- Bangkok Fastening (User of wire rods)
(TPI I.Park, Rayong)	Billet CC	2,150	BOI approved	1998	- Siam Steel Pipe
	Wire rod	500	BOI approved	1997	
	Slab CC	-	?	-	* Original plan approved by BOI was
	Hot strip mill	2,200	BOI applied	1999	DRI-Corex-EF route (1.5 million tonne)
Siam Strip Mill	Steelmaking (EF)	1,800	BOI approved	1999	Subsidiary of Siam Steel Pipe(SSP:
(SSM)	Slab CC	1,800	BOI approved	1999	Biggest pipe producer in S.E.Asia)
(Rayong)	Hot strip mill	1,800	BOI approved	1999	Investment cost: 1.7 bill baths
	Cold strip mill	500			
United Iron & Steel (UIS)	DRI	750	BOI approved		Suspended because of high LNG price (Final target: 1.5 mill tonne)
Thai Union Steel, Nippon Denro Ispat (Rayong)	DRI	1,200	BOI approved		
Kobe Steel, Italian Thai Development (Rayong)	DRI	900	BOI approved		
Sahaviriya Steel Industry	FASTMET	1,800	BOI appoved		
(SSI) and its group	DRI	4,000	Planning		* Possibility of Fastmet or BF
(Bang Saphan,	Steelmaking (EF)	2,200	Planning		
Prachuap Khiri Khan)	Steelmaking (II)		Not confirmed		
	Slab CC	2,200	Planning		
	Slab CC (II)		Not confirmed		
	Billet CC	2,000	Planning		
	Plate	200	Construction	1995	Sahaviriya Plate Mill Co. (Bang Pakorn)
	Hot strip mill	2,400	Operated	1994	
	Hot strip mill (II)	2,000	Planning		
	Cold Rolling	1,000	Construction	1997	Thai Cold Rolled Steel Sheet Co.
	Bar	720	Construction	1996	Bang Saphan Bar Mill Co.
	Wire rod	400	Planning		
	Section/Shape	600	Planning		
	EGL	135	Operated	1994	Thai Coated Steel Sheet Co.
	CGL	150	Planning		
Siam United Steel (SUS) (Eastern I.E.,Rayong)	Cold rolling	1,000	BOI approved	1999	J/V among Siam Cement, NSC, POSCO
BHP Steel Southeast Asia	Cold rolling	390	BOI approved		
Co. (Eastern I.E.,Rayong)	Zincalume galv.	160	BOI approved		
	Color	70	BOI approved		
LPN Plate Mill	Plate	300	Construction	1995	

Source: Data from BOI, various articles and hearings from Thai steel experts.

Table B.4.1 Recommended Facilities in the Bang Saphan Steel Complex

Step	Completion year	Iron making	Steel making	Casting	Hot Rolling	Cold Rolling	Coating	Remarks
	Current				HSM : 2.4 BM : 0.7	CSM : 1.0	EGL : 0.15	No more facilities possible because of electricity limitation
1	2001		EAF : 1.0 LF : 1.0	SLCC : 1.0			CGL : 0.1	Water pump enhancement necessary. Electricity 500 KV trnasmission line
2	2002	DRI : 1.80	EAF : 1.5 LF : 1.5	SLCC : 1.5			CGL : 0.2	Iron making process decision before 1999
3	2004	DRI : 1.80	EAF : 2.0 LF : 2.0	BTCC, BLCC 2.0	SM : 0.6 WRM : 0.4			Tha Sae Dam water 15Mcm/y (1400 MW IPP)
4	2006	DRI : 1.80	EAF : 2.0 LF : 2.0	TSP : 2.0 - TSP : 2.0				Tha Sae Dam water 15Mcm/y
	Total	**DRI : 5.4**	**EAF : 6.5** **LF : 6.5**	**SLCC : 2.5** **BTCC, BLCC 2.0** **TSP 2.0**	**HSM : 2.4** **BM : 0.7** **SM : 0.6** **WRM : 0.4** **TSP : 2.0**	**CSM : 1.0**	**EGL : 0.2** **CGL : 0.3**	* Bang Saphan river basin reservoir development

Note : 1) Figures show their annual capacities in million tonnes.

DRI :	Direct Reduced Iron	HSM :	Hot Strip Mill
SLCC:	Slab Caster	WRM :	Wire Rod Mill
TSP :	Thin Slab Process	CGL :	Continuous (Hot Dip) Galvanizing
SM :	Structural Mill	LF :	Ladle Furnace
EGL :	Electrogalvanizing	BLCC :	Bloom Caster
EAF :	Electric Arc Furnace	BM :	Bar Mill
BTCC :	Billet Caster	CSM :	Cold Strip Mill

2) Alternatives: Earlier installation of one DRI unit to assure its operability and reliability.

Table B.4.2 Industrial Water Demand at the Steel Complex

Group	Facility	Year 2001			Year 2002			Year 2004			Year 2006		
		Capacity (Mt/y)	Unit (m3/t)	Total (Mm3/y)	Capacity (Mt/y)	Unit (m3/t)	Total (Mm3/y)	Capacity (Mt/y)	Unit (m3/t)	Total (Mm3/y)	Capacity (Mt/y)	Unit (m3/t)	Total (Mm3/y)
Flat Products	DRI	-	-	0	1.80	1.5	2.70	1.80	1.5	2.70	1.80	1.5	2.70
	EAF	1.00	1.0	1.00	2.50	1.0	2.50	2.50	1.0	2.50	2.50	1.0	2.50
	LF	1.00	0.2	0.20	2.50	0.2	0.50	2.50	0.2	0.50	2.50	0.2	0.50
	SLCC	1.00	0.9	0.90	2.50	0.9	2.25	2.50	0.9	2.25	2.50	0.9	2.25
	HSM	2.40	1.6	3.84	2.40	1.6	3.84	2.40	1.6	3.84	2.40	1.6	3.84
	CSM	1.00	3.6	3.60	1.00	3.6	3.60	1.00	3.6	3.60	1.00	3.6	3.60
	EGL	0.15	6.1	0.92	0.15	6.1	0.92	0.15	6.1	0.92	0.20	6.1	1.22
	CGL	0.10	3.6	0.36	0.30	3.6	1.08	0.30	3.6	1.08	0.30	3.6	1.08
Long Products	DRI							1.80	1.5	2.70	1.80	1.5	2.70
	EAF							2.00	1.0	2.00	2.00	1.0	2.00
	LF							2.00	0.2	0.40	2.00	0.2	0.40
	BT, BLCC							2.00	0.9	1.80	2.00	0.9	1.80
	Bar	0.72	1.2	0.86	0.72	1.2	0.86	0.72	1.2	0.86	0.72	1.2	0.86
	Section							0.60	1.2	0.72	0.60	1.2	0.72
	Wire Rod							0.40	1.2	0.48	0.40	1.2	0.48
Thin Slab HSM	DRI										1.80	1.5	2.70
	EAF										2.00	1.0	2.00
	LF										2.00	0.2	0.40
	TSP										2.00	2.0	4.00
Others	O2 Plant	3.1 KNm3/H		0.04	12.6 KNm3/H		0.11	22.5 KNm3/H		0.18	32.4 KNm3/H		0.27
	Power Plant							1400MW		0.48	1400MW		0.48
	Total			**11.72**			**18.36**			**27.31**			**36.50**

Note : Process is DRI-EAF-CC-Rolling, and recirculation rate is assumed as 96%.

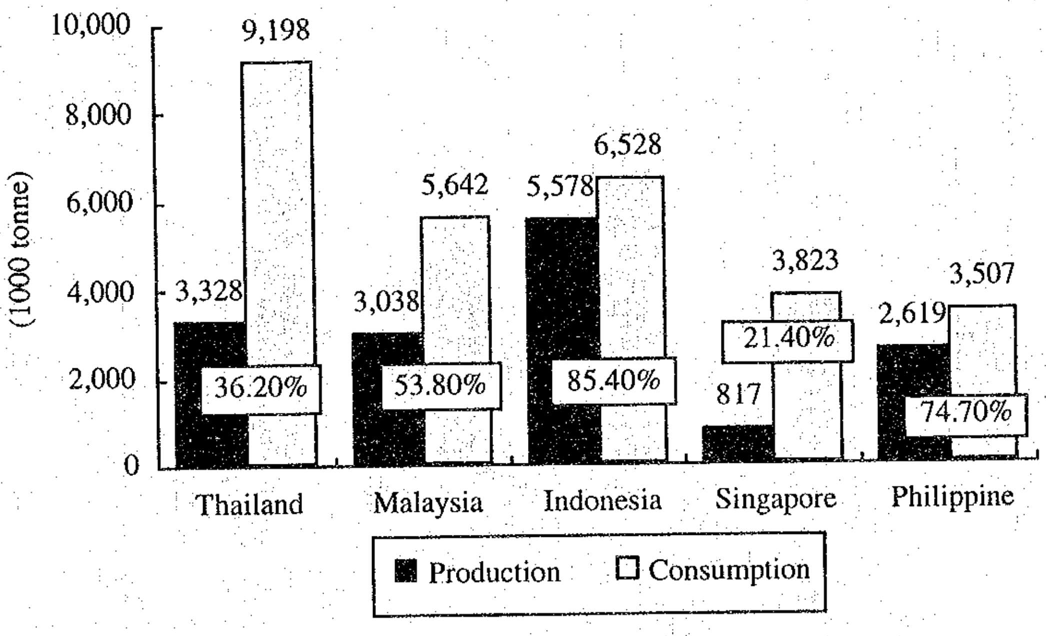
Table B.4.3 Electricity Demand and Transformer Capacity at the Steel Complex

Group	Facility	Year 2001						Year 2002					
		Capacity (Mt/y)	Average t/H	Unit (KWH/t)	Average MWH/H	MVA	MVA x 1.5	Capacity (Mt/y)	Average t/H	Unit (KWH/t)	Average MWH/H	MVA	MVA x 1.5
Flat Products	DRI	-	-	-	-	-	-	1.80	260	96	25.0	33.0	50
	EAF	1.00	170	600	102.0	-	150	2.50	420	600	252.0	-	375
	LF	1.00	170	50	8.5	-	15	2.50	420	50	21.0	-	38
	SLCC	1.00	170	15	2.5	4.4	7	2.50	420	15	6.3	11.0	17
	HSM	2.40	350	110	38.5	87.3	130	2.40	350	110	38.5	87.3	130
	CSM	1.00	160	150	24.0	44.8	67	1.00	160	150	24.0	44.8	67
	EGL	0.15	25	195	4.9	9.1	14	0.15	25	195	4.9	9.1	14
	CGL	0.10	13	90	1.2	2.2	4	0.30	39	90	3.5	2.2	10
Long Products	DRI												
	EAF												
	LF												
	BT, BLCC												
	Bar	0.72	105	105	11.0	24.9	38	0.72	105	105	11.0	24.9	38
	Section												
	Wire Rod												
Thin Slab HSM	DRI												
	EAF												
	LF												
	TSP-HSM												
Sub total					192.6		425				386.2		739
Diversity factor (1.1)							390						672
O2 Plant		<1>	<170>	<30Nm3/t>	3.3	4.3	6	<2.5>	<420>	<30Nm3/t>	8.1	10.6	16
Total							396						688

Group	Facility	Year 2004						Year 2006					
		Capacity (Mt/y)	Average t/H	Unit (KWH/t)	Average MWH/H	MVA	MVA x 1.5	Capacity (Mt/y)	Average t/H	Unit (KWH/t)	Average MWH/H	MVA	MVA x 1.5
Flat Products	DRI	1.80	260	96	25.0	33.0	50	1.80	260	96	25.0	33.0	50
	EAF	2.50	420	600	252.0	-	375	2.50	420	600	252.0	-	375
	LF	2.50	420	50	21.0	-	38	2.50	420	50	21.0	-	38
	SLCC	2.50	420	15	6.3	11.0	17	2.50	420	15	6.3	11.0	17
	HSM	2.40	350	110	38.5	87.3	130	2.40	350	110	38.5	87.3	130
	CSM	1.00	160	150	24.0	44.8	67	1.00	160	150	24.0	44.8	67
	EGL	0.15	25	195	4.9	9.1	14	0.20	30	195	5.9	11.0	17
	CGL	0.30	39	90	3.5	6.5	10	0.30	39	90	3.5	6.5	10
Long Products	DRI	1.80	260	96	25.0	33	50	1.80	260	96	25.0	33	50
	EAF	2.00	330	600	198.0	-	300	2.00	330	600	198.0	-	300
	LF	2.00	330	50	16.5	-	25	2.00	330	50	16.5	-	25
	BT, BLCC	2.00	330	15	5.0	8.8	13	2.00	330	15	5.0	8.8	13
	Bar	0.72	105	105	11.0	24.9	38	0.72	105	105	11.0	24.9	38
	Section	0.60	90	105	9.5	21.5	33	0.60	90	105	9.5	21.5	33
	Wire Rod	0.40	60	150	9.0	20.4	31	0.40	60	150	9.0	20.4	31
Thin Slab HSM	DRI							1.80	260	96	25.0	33	50
	EAF							2.00	330	600	198.0	-	300
	LF							2.00	330	50	16.5	-	25
	TSP-HSM							2.00	330	90	29.7	67.3	101
Sub total					649.2		1,191				919.4		1,670
Diversity factor (1.1)							1,083						1,518
O2 Plant		<4.5>	<750>	<30Nm3/t>	14.4	18.8	28	<6.5>	<1080>	<30Nm3/t>	20.7	27.1	41
Total							1,111						1,559

	DRI	SLCC	HSM	CSM	EGL	CGL	BTCC	Bar	Section	Wire Rod	TSP	O2
Lf	0.90	0.67	0.63	0.67	0.67	0.67	0.67	0.63	0.63	0.63	0.63	0.90
Pf	0.85	0.85	0.70	0.70	0.80	0.80	0.85	0.70	0.70	0.70	0.70	0.85

Note :
1) Process is DRI-EAF-CC-Rolling.
2) MVA = Average MWH devided by Lf x Pf. (Lf: Load factor, Pf: Power factor)
3) Safety factor: 1.5 for transformer capacity.
4) Electricity demand at O2 Plant: 0.64 KwH/Nm3 O2



*: Percentage is a self-sufficiency rate (Production/Consumption). Figure for consumption includes amount used for next process.

Source: South-East Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994" and estimate by the JICA Study Team.

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Figure B.1.1 Production and Consumption of Finished Steel in ASEAN5 (1994)

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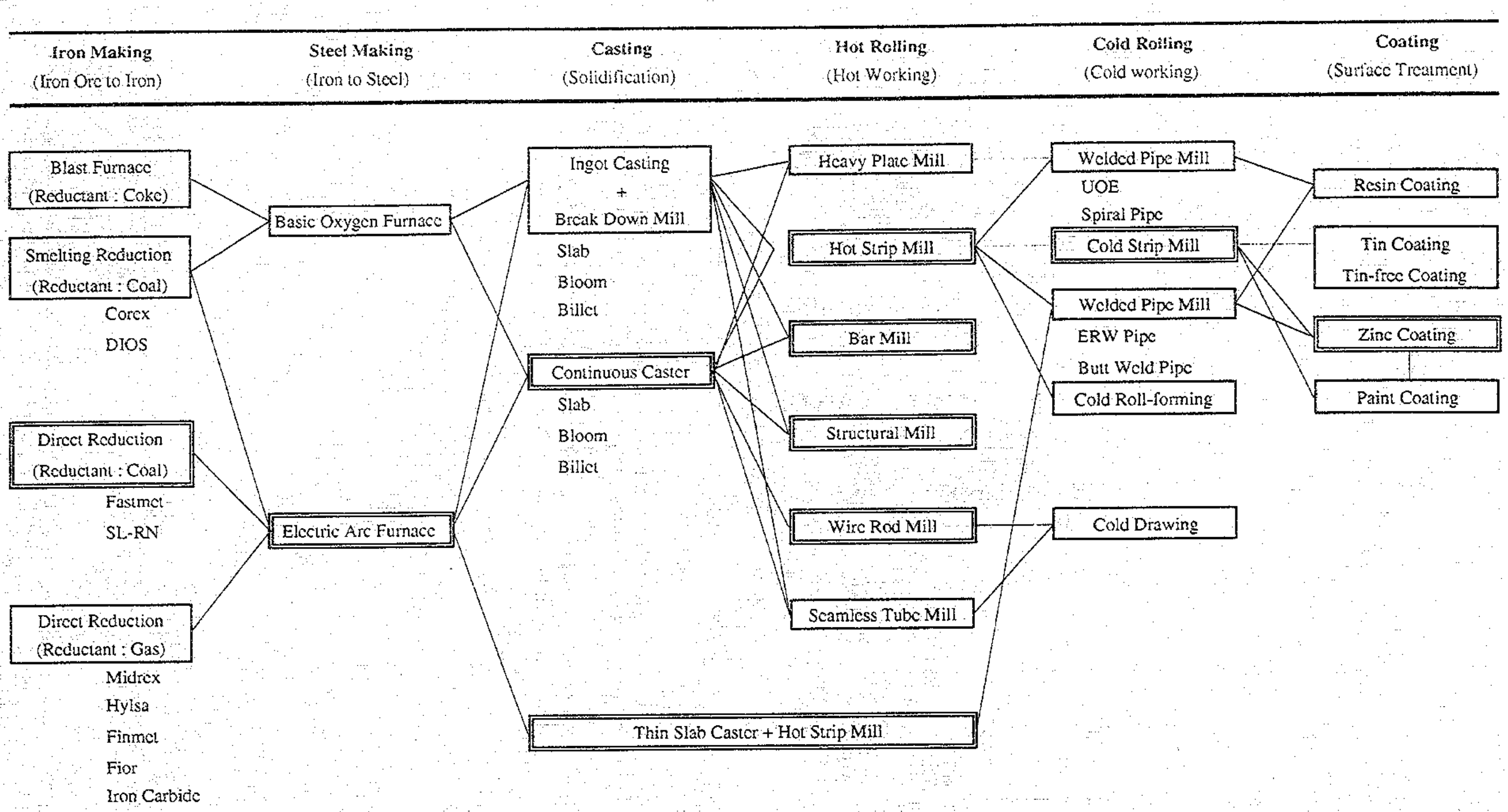

* Double-framed processes are recommended in the Bang Saphan Steel Complex.

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Figure B.4.1 Recommended Facilities in the Steel Complex along with a Typical Process in Steel Production

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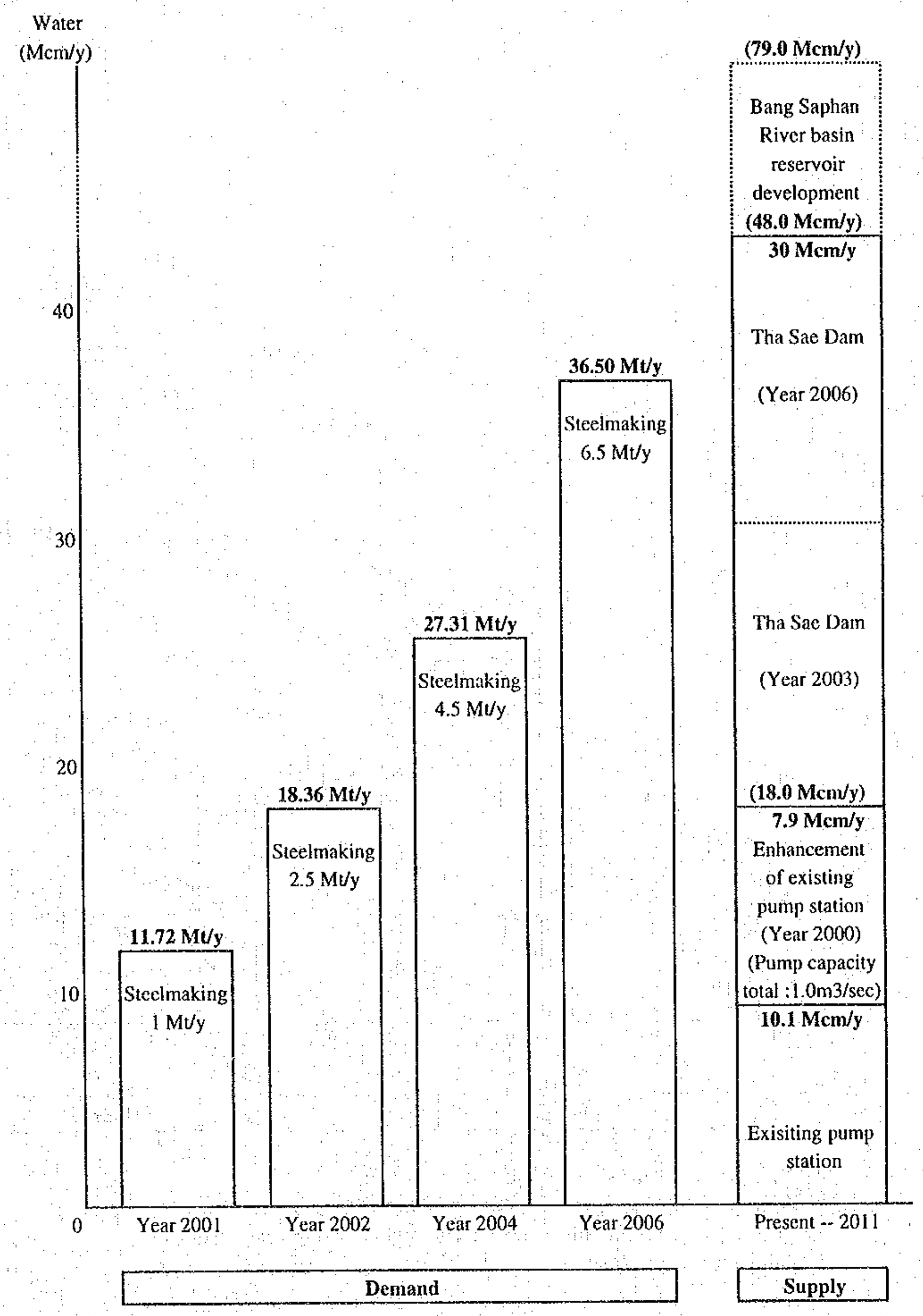

Note: Assumptions for water demand calculation
1) Mill operation at full capacity.
2) Water unit consumption is the average of the Japanese steelworks.

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Figure B.4.2 Water Demand and Supply Capacity
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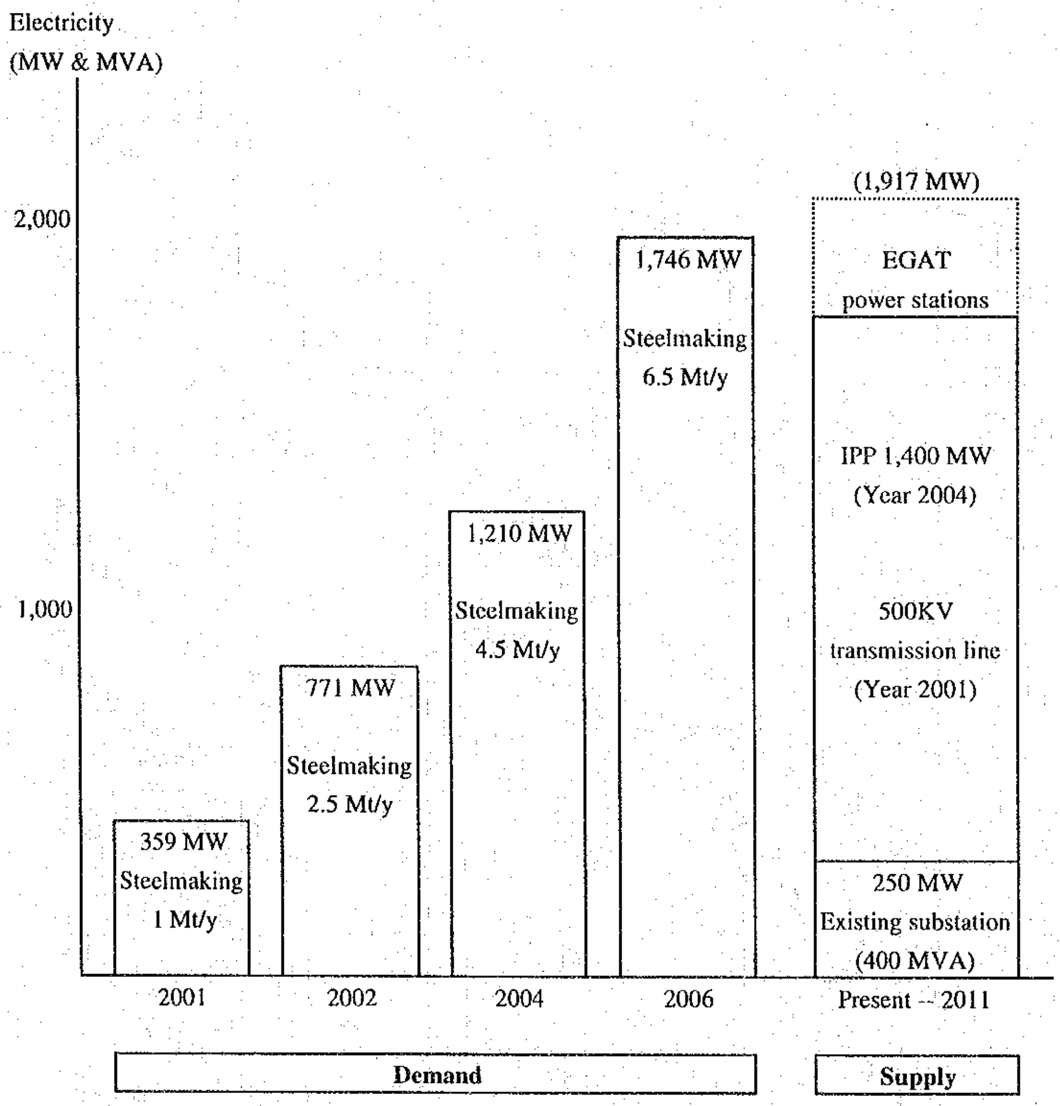

Note: Assumptions for electricity calculation
1) Mill operation at full capacity, operating 624 hours/month.
2) Electricity unit consumption is the average of the Japanese steelworks.
3) Monthly load factor: 50%.

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Figure B.4.3 Electricity Demand and Supply Capacity

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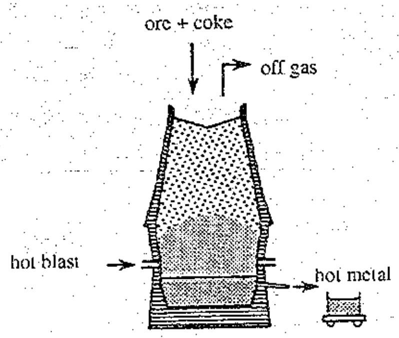
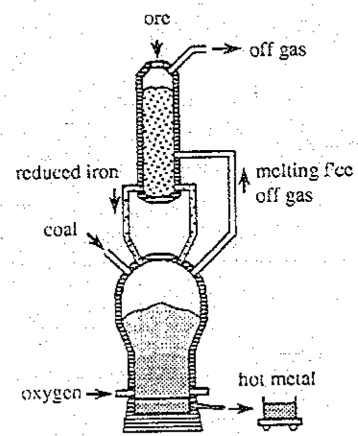
	Blast Furnace	Corex
Flow		
Characteristics	Large capacity, needs of coke battery	Reducing in shaft f'ce smelting in coal charged f'ce
Main Facilities	Blast furnace,(sinter or pellet), coke battery	Shaft furnace, smelting furnace, oxygen plant
Status in 1994	53% of total iron source in the world	One industrial unit : capacity 1000t/D/unit
Raw Material	Pellet, lump ore, coking coal,	Pellet, lump ore, steam coal
Reference	Large capital investment, including coke battery, Modern unit 5000-10000t/D unit.	Second industrial unit : 2000t/D unit in 1995 is build, and real performance to be seen. Economic feasibility rests upon the value of off-gas.

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Figure B.4.4 Possible Iron Making Processes and Their Evaluation (Coal Based Technology): Blast Furnace, Corex

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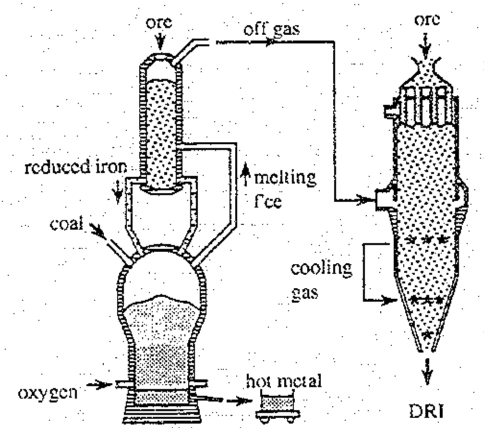
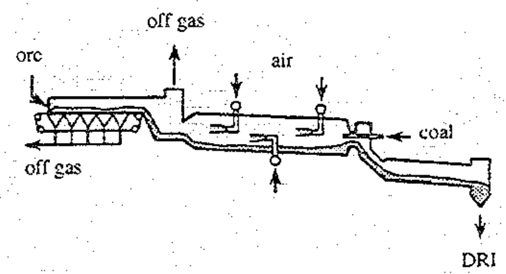
	Corex + Midrex	SL-RN
Flow		
Characteristics	Use off-gas from Corex as fuel gas in Midrex	Solid-state reduction in rotary Kiln
Main Facilities	Corex shaft furnace, meet furnace, Midrex shaft furnace, oxygen plant	Pelletizing, rotary kiln
Status in 1994	First facility plan in Korea	14 unit in operation, max 1000t/D/unit
Raw Material	Pellet, lamp ore and steaming coal	Ore fine, steaming coal
Reference	Development stage, performance to be seen in 1997	Difficulty in enlargement of unit

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Figure B.4.5 Possible Iron Making Processes and Their Evaluation (Coal-based Technology): Corex+Midrex, SL-RN

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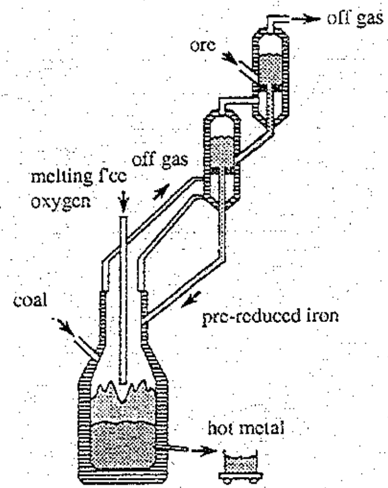
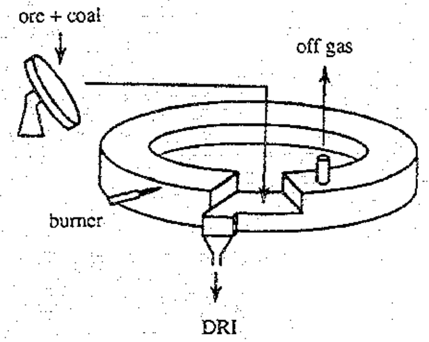
	DIOS	Fastmet
Flow		
Characteristics	Pre-reduction in fluidized bed, flexible in raw material	Solid-state reduction in rotary f'ce
Main Facilities	Two-fluidized bed furnaces, smelting furnace, oxygen plant	Pelletizer, rotary furnace, waste gas de-sulpher
Status in 1994	500t/D pilot, national project in Japan	50t/D demonstration plant
Raw Material	Ore fine, steaming coal	Ore-fine, steam coal, natural gas (heavy oil)
Reference	500t/D pilot test completed in March 1996 3000t/D plant designing and F.S by June 1996 Industrialization targeted by 2010	50t/D pilot test completed in January 1996 0.45 Mt/y industrial plant to be started in 1998 in the USA

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Figure B.4.6 Possible Iron Making Processes and Their Evaluation (Coal-based Technology): DIOS, Fastmet

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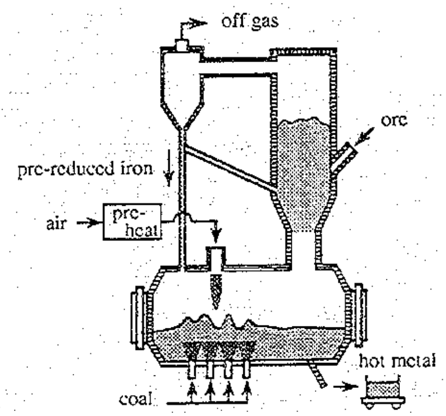
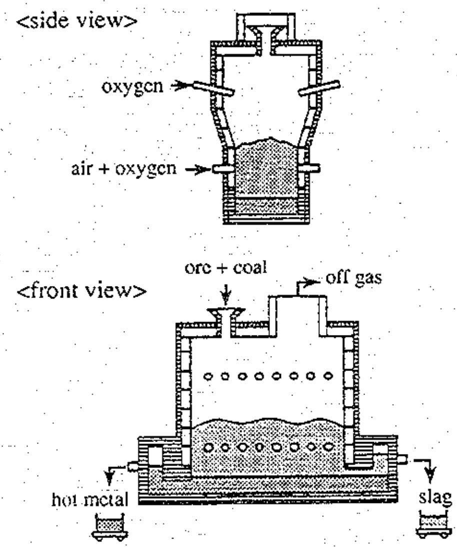
	Hismelt	Romelt
Flow	 	
Characteristics	Hot air blast, coal powder injection from the bottom	Single-stage smelting reduction, 2 layer tuyers
Main facilities	Fluidized bed furnace, smelting furnace, hot stove	Smelting furnace, oxygen plant, waste-gas desulpher
Status in 1994	350 t/day pilot plant 7-8t/H	670 t/day commercial-plant
Raw material	Ore fine and steaming coal	Ore fine, lump ore and steaming coal
Reference		

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Figure B.4.7 Possible Iron Making Processes and Their Evaluation (Coal-based Technology): Hismelt, Romelt

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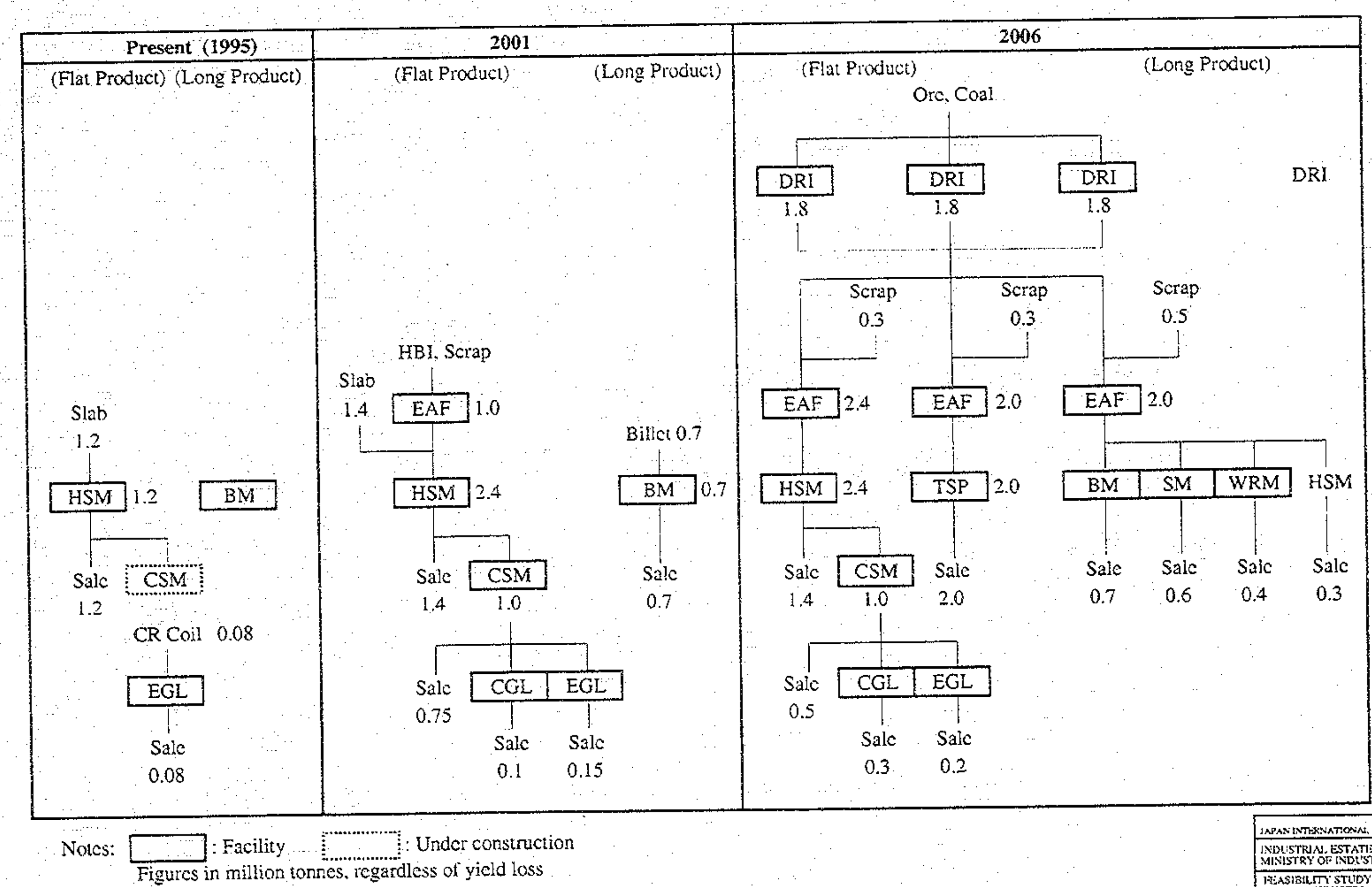

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Figure B.4.8 Recommended Process and Material Flow in the Steel Complex

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APPENDIX C DEVELOPMENT PLAN OF BANG SAPHAN INDUSTRIAL CITY AND FREE TRADE AREA

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