important items, providing general discussion along with discussion on the other countries' experience.

II. Discussion on master plan

1. Strategy for partial import substitution

1-1 Risks of overestimating demand

Viet Nam is pursuing a policy of import substitution to nurture the steel industry. It is realistic for the steel industry. After World War II, only South Korea saw a quick, rapid expansion in steel exports, and at the same time growth of the domestic market supported the steel demand.[46] Although exports from Brazil also expanded in the 1980s, it was the result of excess capacity triggered by the country's economic downturn. Namely, brisk exports from Brazil were not necessarily an indication of a success in industrialization.[47]

As growth of the steel industry depends on smooth expansion of the sales to domestic market, success in investment plans depends on accurate forecasts of domestic demand. It is particularly important to avoid overcapacity. Not a few steel projects in developed and developing countries have failed for that reason. In the most severe cases, construction of an integrated steelworks was discontinued before completion, purchased equipment was not used but stored in a warehouse, or manufacturers were forced to sell semi-finished products with low added value.

Sicartsa II, a SOE in Mexico that began operation in 1988, is an example.[48] Employing a direct reduction process, Sicartsa II had a plan to produce high-quality thick plates for large-diameter pipes. However, due to the government's financial straits and decreased demand stemming from a drop in oil prices, construction of a thick-plate plant was halted. Sicartsa II instead sold slabs while its plant operating rate in 1989 was only 24.5%. Sicartsa II was eventually privatized, becoming Ispat Mexicana.

Forecasting inherently contains uncertainty. To construct plants in the steel industry for the domestic market, it is preferable to seek partial rather than full import substitution, partly to protect the industry from fluctuations in demand. Also, it is preferable to import unprofitable low-grade products, the

[46] Toshio Watanabe, Kaihatsu Keizai Gaku: Keizai Gaku to Gendai Ajia *(Economics and Contemporary Asia)*, Nihon Hyoron-sha, 1996, p.206, (Japanese).

[47] Sin Hasegawa, Seifu Kei Tekko Kigyo no Keiei Kiki to Yusyutsu Siko (Financial Crisis and Export Incentives of the Public Steel companies in Brazil), *The Keizai Gaku (Annual Report of the Economic Society)*, Vol. 56, No. 2, The Economic Society, Tohoku University, September 1994 (Japanese).

[48] Tetsuro Nakaoka, Nihon Tekko Gyo no Tai Mexico Gijyutsu Kyoryoku to Sonogo (1) (2) (Three Big Projects in Mexico by the Japanese Steel Industry), *Keizaigaku Zasshi (Journal of Economics)*, Vol. 92, No.1, 2, The Economic Society of Osaka City University, May and July 1991 (Japanese).

reasons for which are explored later.

1-2 Scenarios for import substitution in the master plan

The inclusion of a strategy for partial import substitution in the master plan is a realistic approach. However, several problems are seen in forecasts for supply and demand.

First, the current overproduction of long products is overlooked in both of the base and low cases. The master plan calls for an increase in production capacity of long products by 550,000 tons during the period from 2001 to 2006. This would push the total production capacity of VSC and foreign-affiliated companies to 2,720,000 tons, while long-product demand in 2006 is forecast at 2,090,000 tons. With the addition of production capacity at SOEs in other industries, private companies and the home industry, it becomes clear that excessive production will continue. The government and VSC are requested to review competition policies for the long-product market, pointed out in Part 1, and to adjust planned construction of long-product rolling mills accordingly.

For products other than long products, the scale of import substitution varies widely. According to the base case, Viet Nam will produce 63.0% of cold rolled sheets, 46.0% of billets, 94.3% of hot coils and all slabs for domestic consumption in 2015. In the low case, the figures are 33.1% of cold rolled sheets, 46.0% of billets, 47.2% of hot coils and all slabs in 2010. In the base case, an economic downturn would force a severe production adjustment or exports in hot coils, while massive imports of billets would continue. No risk of overproduction of flat products is seen in the low case.

2. *Establishment of sound management entity*

2-1 Sound management required

Clearly, the construction of an integrated steelworks is the costliest project in the master plan. One of the most important issues in this project is securing funding for construction. Professor Ohno has addressed this in his scenarios for the low and base cases, which include recommendations on how much to borrow and when as well as steps to cushion the industry from external shocks. The author covers here only one topic. That is the management entity that is to raise the funds and handle investments.

Although VSC has not clearly stated the amount of funds it will be able to raise itself, VSC managers and some Vietnamese researchers stated that VSC would be unable to build an integrated steelworks alone. And they called on the government to draw up a national project to realize the construction of steelworks.

Generally speaking, it is possible to build steelworks as a national project. However, the author is concerned about the view held by some experts that the project should be implemented for the benefit of the national economy even when it is not profitable as a business.

It would be appropriate for the government to build infrastructure such as ports, roads and an industrial water supply, as far as such infrastructure is prepared not exclusively for steelworks. However, construction of steelworks is an another challenge.

To stress this point, the author cites cases in South Korea, Brazil and India. Each nation established SOEs in the steel industry, though their performance varied widely.[49]

Brazil's Acominas and India's Vizag, integrated steelworks constructed in the 1970s and 1980s, saw costs skyrocket due to construction delays and failure to obtain low-interest funding, which made the financial conditions at the SOE difficult. In Brazil, equipment was up to the world's standard but interest payments and depreciation sent production costs soaring to levels above those in Japan and West Germany. Table 11 shows cost breakdown. Brazil and India, meanwhile, kept steel prices low to nurture their domestic industries. Furthermore, these low-priced steel products helped support other state-owned sectors in India and foreign-affiliated automobile makers in Brazil. However, the steel enterprises had suffered losses. In Brazil, the ratio of net profit to net sales at the state-owned holding company Siderbras had been in the red every year from 1979 to 1985, and in 1987 the total debt exceeded USD 17 billion. The government bore the burden of funding for additional expansion or investment in renewal and replacement. In South Korea, meanwhile, the state-owned Pohang Iron and Steel Company (POSCO) maintained price competitiveness and profitability though price regulations had executed based on the anti-monopoly policies. And industries using steel were supported by the supply of low steel price.

POSCO serves as a good model for integrated steelworks in Viet Nam. Even with government support for construction, such steelworks should pursue sound independent management to compete in market economy. Otherwise, the burden on the people will become greater. Viet Nam's commitment to integration with international economy is stronger than that of South Korea and Brazil in the past, and its various industries must survive in global competition.

2-2 *Management entity in the master plan*

Who would own and manage integrated steelworks and other new facilities is not clear in the master plan. VSC assumes that either a SOE or a joint venture between VSC and foreign capital would be responsible for management. The author acknowledges the possibility of management fully by a SOE. However, he recommends participation by foreign capital to realize sound management. This would offer a source of funding as well as dispatches of engineers and managers, which would help the Vietnamese to learn technology and management know-how.

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[49] D'Costa, *op. cit.*, Chapter 5. Shin Hasegawa, *op. cit.* Hasegawa, Burajiru Tekko Gyo no Seisan Kozo (Production Structure of the Steel Industry in Brazil), *Latin America Ronshu (Review of Latin America)*, Latin America Seikei Gakkai, 1994 (Japanese).

3. *Selection of construction sites and hardware*

3-1 Principles in selecting sites and technologies

Development of the steel industry and integrated steelworks requires an organized and systematic introduction of technologies to realize mass production. Mass production does not rely only on plant capacity but on a smooth flow in massive goods and services, from mining of raw ore to transportation, procurement to pretreatment, manufacturing, distribution and consumption.

At first the author discusses the selection of hardware and construction sites. The core hardware in a steel industry is steelworks. But one cannot overlook the importance of geography, where the plants are located as well as their location relative to the sources of raw materials and consumption areas.

First, the latest proven technologies should be employed at facilities. The use of old technologies would hurt competitiveness unless there are exceptional advantages in other areas such as raw materials and labor costs. This point must become evident to VSC managers in reviewing the history of TISCO, which had closed small basic oxygen furnaces and open-hearth furnaces. On the other, it is undesirable to use technologies that are under development or those for which no standards have been established even though they are advanced technologies. In the past, transfers of proven technologies to newly industrialized areas and developing countries have been smooth and successful because of set standards and improvements achieved in industrialized countries.

One example is the transfer of technology from Kawasaki Steel Corporation to CST, a Brazilian company that started operations in 1983.[50] Kawasaki Steel transferred several proven technologies with which it was familiar such as those for blast furnaces, basic oxygen furnaces, blooming and slabbing mills. On the other, unproved technologies are not transferred usually. For example, CST did not install continuous casting machines until the 1990s. Baoshan Steelworks in China, which began operating first blast furnaces in 1985 with technologies transferred from Nippon Steel Corporation, did not adopt continuous casting machines in the first phase of construction but did in the second phase.[51] Continuous casting technology is now proven, but was not proven at the start of these two projects in the 1970s, and caused some accidents such as breakouts.

Adoption of recently developed technology would require troubleshooting and setting of standards during the operation phase, in essence turning the new steelworks in Viet Nam into a laboratory for testing. It would invite a great risk. The best approach is a fast-second approach; that is to quickly

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[50] Nihon Tekko Kyokai Shakai Tekko Kogaku Bukai (Division of Social Engineering of Iron and Steel Industry, The Iron and Steel Institute of Japan), *Tekko no Gijutsu to Syakai Dotai (Steel technology and dynamic state of society)* 1997 (Japanese).

[51] Takashi Sugimoto, *Hozan Seitetsusho no Kenkyu (A Note on the Baoshan Steel)*, Master Thesis, University of Tokyo (Japanese).

adopt recently proven technologies rather than technologies that are obsolete or under development.[52]

As for concrete recommendations, Viet Nam is urged to employ blast furnaces and basic oxygen furnaces for large-scale production of totaling 3 million tons per steelworks that center on flat products, while for production of 1 million ton or less per steelworks, EAF mill is recommended. It should be emphasized, however, currently EAF-related technologies are undergoing innovation, particularly in the areas of casting and rolling in hot coil manufacturing, and of new metallic source manufacturing technology to provide a clean materials for EAF. Some technologies have been established while others are not.

The technology for hot coil production by EAF mill is a proven one, though limited to making of low-grade products. There are proven technologies in direct reduction processes using natural gas, while others utilizing coal are being established. Construction of India's first Romelt plant is in progress. Nucor, first runner of EAF-based flat products, closed its iron carbide plant in Trinidad due to operation problems and is building a Hismelt plant. Experimentation of DIOS (Direct Iron Ore Smelting Reduction Process) was completed at a pilot plant in Japan but construction of practical plant has not started.

It might be useful for the Vietnamese steel industry to adopt the suitable technologies among them as they become established.

Second, the scale and size of equipment should meet the required minimum for efficient operations, indicated in Fig. 3. As VSC learned from TISCO, limited-capacity equipment used at one step in the manufacturing process necessitates small equipment at other steps in the process, limiting the scale of operations.

Third, primary business operations must remain integrated. We mean that each step in the whole process must flow in an organized fashion from procurement of raw materials to manufacturing, distribution, customer purchase and use. The same rule applies to in-house processes at steelworks as well as those between business processes. For example, steelworks that use imported materials should be located near a coast. Plants engaged in iron-making, steel-making and rolling should be located near one another, either as integrated or separate steelworks, while transportation routes between a steelworks and consumption areas should be secured.

Maintaining a balance in the various processes is also important. For example, a shortage in one process in the chain will slow the flow of goods in whole industry, while excess capacity will cause a drop in operating rates.

Fourth, infrastructure is needed. Ports with adequate water depth for vessels are necessary, as are

[52] D'Costa, *op. cit.* for the fast-second approach. However, it should be noted that D'Costa's was interested in state of the art technology and did not pay much attention to proven technology.

loading and unloading facilities, roads for transporting goods and stable and affordable supplies of water and electricity. The location of ports should be considered especially for integrated steelworks. These infrastructure factors are displayed in Table 12.

3-2 Selection of plant sites and technologies in the master plan

The author evaluated the master plan on the principles mentioned above. The following points are noteworthy.

First are the plan's limitations. It adopts a strategy of partial import substitution and does not assume rapid growth in demand. Also, it calls for gradual construction of facilities from the downstream division. They make it difficult to achieve the minimum efficient scale of equipment and consistent business flow.

Second, in spite of the difficulties mentioned above, the plan excels in its planned adoption of equipment that meets world standards and proven technologies. Most facilities satisfy the minimum efficient scale. Assuming normal operations, most mills will enjoy profits of latecomers and be able to offer keep operating costs low while offering products with standard quality.

Third are concerns about the second phase of TISCO's expansion. As previously mentioned, an expansion in equipment for long-products rolling at TISCO could lead to overproduction in the market for long-products. Also, the plan envisions use of technology of the Romelt process that is not yet proven. Moscow Institute of Steel and Alloy in 1995 constructed a prototype plant, and Nippon Steel introduced the technology but it does not use it for commercial production. Romelt-Sail in India reportedly constructed a plant, scheduled to begin operations in July 2001, with an annual capacity of 300,000 tons using the equipment from National Mineral Development.[53] As it is uncertain that the technology will be established soon, introduction of Romelt process is too risky. For TISCO, procuring raw materials and semi-finished products from outside will lead to high transportation costs. TISCO should not increase its capacity over the extent that it steadily produces metallic sources. If the government protects TISCO with unreasonable expansion, it will cause bureaucratic controls on growth of other steelmakers' market shares and fuel widespread inefficiency.

Fourth, production costs of direct reduced iron (DRI), in the base case, vary greatly based on prices of natural gas used as a reducing agent, though DRI plant is a proven technology. A feasibility study by an U.S. company on construction of a Midrex-based DRI plant in the South has revealed that natural gas should be priced at USD 1.75 per one million BTU for project viability. However, Petro Viet Nam states a price of USD 3 for one million BTU.[54] According to VSC, if no agreement is

[53] *Shin Tetsugen (New Metallic Sources)*, NK Techno Service Co., Ltd., 1998, p.48, 74 (Japanese). "NMCD at a Glance," http://www.nmdc-india.com /introduction.htm. Tapan Chakravorti, "NMDC to install India's first Romelt plant," *The financial Express*, July 7, 1999.
http://www.expressindia.com/fe/daily/1999070 /fec /fec07.html.

[54] *Saigon Times Daily*, November 2, 2000.

reached, the project will be postponed until production begins in a new gas field. Currently, the DRI plant's feasibility is in doubt.

Fifth, care should be exercised in choosing the location of No.1 hot strip mill (HSM). It is logical that it be adjacent to No.1 cold rolling mill (CRM), which is recommended to be built in Phu My industrial park. According to a feasibility study for No.1 CRM, the Phu My is the best location for No.1 HSM from the viewpoints of existence of port facilities, transportation of products to consumption areas and availability of infrastructure. There are great advantages in locating the No.1 CRM and No.1 HSM near each other, such as minimizing transportation costs of hot coils for cold rolling, technology exchanges, information exchange, and cost reductions through shared maintenance employees as well as spare stock and inspection equipment.[55] There have been some opinions to construct No.1 HSM as the initial investment in the integrated steelworks. If No.1 HSM starts operation between 2005 and 2006 as targeted in the master plan, this location involves a too large risk. Firstly, construction of the integrated steelworks will be a lengthy process and it is feared that the plan will be forced to change halfway. More specifically, there is a risk that construction of No.1 HSM is delayed. Another risk is that construction of a blast furnace and basic oxygen furnace will be delayed after construction of No.1 HSM is completed. In the latter case, operations of No.1 CRM and No.1 HSM will be done separately and create extreme inefficiencies. Therefore, the author recommend that No.1 HSM be built in Phu My and No.2 HSM should be established as a part of the integrated steelworks.

Sixth, there are options regarding hot coil production process prior to construction of the integrated steelworks. The master plan calls for the integrated steelworks finally to supply flat products. This is an appropriate selection. Meanwhile, VSC sees a need for an early start in manufacturing of flat products. For that reason, both the base and low cases include a plan for hot coil production prior to construction of the integrated steelworks. The base case assumes slab imports while the low case assumes slab manufacturing by an EAF mill. As stated previously, these processes are undergoing innovations in the world's steel industry, which may offer the Vietnamese industry increased options in 2007. Also, construction time for an EAF mill is short for. Then it is not necessary now to make a final decision for equipment configuration for a slab procuring route prior to construction of the integrated steelworks. Instead, we recommend that information for various technologies be collected and analyzed, while domestic resources be studied in details, and make preparation for speedy adoption of proven technologies.

The seventh point is lack of an action plan to overcome fragile infrastructure. The extent of difficulties in constructing an integrated steelworks differs greatly depending on problems of infrastructure. Also, large problems for EAF mills are high electricity costs and a dual price system. As covered in Part 1, foreign-affiliated venture companies engaged in long product rolling cite high electricity costs as a

[55] *Cold Rolling F/S Report*, IX-2-1, 2.

prohibitive factor in EAF installation.[56] Electricity costs in Viet Nam are higher than those in other Southeast Asian countries, according to a survey by the Japanese members of General Commentary Group. Further, electricity prices are expected to climb, which is giving rise to concerns about the future of steelmakers. Steelmakers alone cannot resolve infrastructure problems; discussions with the relevant government agencies and companies concerned are necessary.

4. Technology transfers and technology formation

4-1 Various steps for technology transfer and technology formation

In this section the author discusses technology from the viewpoint of software. One issue is the management of technology transfer process. The Vietnamese steel industry must learn technology of overseas companies, through a contract for technology introduction or requesting investment of a foreign company. Another issue is to improve the technological capabilities. The Vietnamese steel industry need to not only acquire technologies through transfers but to build up technologies within the country. This is generally understood as a five-step process that requires; (1) mastering operation method; (2) development of skills to maintain introduced plants and equipment; (3) development of skills to make repairs and minor improvements, (4) participation in design and planning, and (5) home manufacturing.[57] In these steps, completion of construction project for a steelworks, which is hardware, represents not the end but the elementary step of technology transfers.

The problem calling for immediate attention in Viet Nam is mastering the skills to operate and maintenance of introduced equipment. In the steel industry, the degree of embodiment of relevant technology in equipment is higher than that of assembling industry, but lower than that in the other processing industries. Though basic operations at an integrated steelworks are automated, production systems are extremely complicated and many works require human management and operation. Production is typically made complicated by the following factors:[58] 1) A large number of orders and various products manufactured separately; 2) large batch-type units and machines placed in a series; 3) ordered lots that are not always equal in number to manufacturing lots; 4) long lead time for production; 5) production activities that are easily disrupted at each process; 6) a production system that includes technologies in various fields; and 7) continuous operations without a break. Whether machines and units operate according to designed specifications is largely dependent on operation methods, production control and technologies of peripheral industries. Integrated steelworks, in short

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[56] Interview at a joint venture company.

[57] Takeshi Hayashi, *Gijutsu to Syakai: Nihon no Keiken (Technology and Society: The Experience of Japan)*, University of Tokyo Press, 1986, pp.57-73 (Japanese), Akira Suehiro, *Kyacchi Appu Gata Kogyouka Ron (Catch up Model of Industrialization)*, The University of Nagoya Press, 2000, pp. 234-240 (Japanese).

[58] Yoshisuke Inoue, *Seisankeieikanri to Joho Sisutemu (Management and Control Systems for Production Activities and Information Systems of the Japanese Steel Industry)*, Dobunkan, 1988, pp. 71-77 (Japanese).

require integrated management of processes.

4-2 Technology transfers and technology formation suitable for conditions in Viet Nam

Based on the foregoing circumstances, the author discusses transfer and formation of technology meeting with conditions in Viet Nam.

First, the author discusses the method of introducing technology. More specifically, a method to procure equipment and the scope of technology transfers.

A study of past cases shows that recipient countries tend to acquire equipment from different companies in different countries with the purpose of reducing costs and making loans available from various sources. It is the so-called "Olympic method." However, this method often makes it difficult to achieve integrated management at steelworks and invites operation troubles.

One example is Mexico's Sicartsa II, which acquired its equipment through the "Olympic method." However, since various contractors who had installed their own particular programs for computerized control had supplied the equipment, formulation of control program for the entire steelworks was very difficult.[59] South Korea also followed the Olympic contract method in constructing its Pohang Steelworks from 1970 to 1981. However, the different facilities were not plagued by differing technologies as the work was contracted mainly with Japanese equipment manufacturers experienced in steelworks construction in Japan.[60]

To lower costs for equipment and foster domestic technology, there are some cases in which the scope of contract is limited to facilities and start-up preparations. However, for developing countries planning an integrated steelworks, it is preferable that contracts cover the entire transfer process from basic planning to stable operations.

When Kawasaki Steel transferred its technology to CST, it also provided management techniques such as production planning and control, quality control, and provided assistance for equipment maintenance, sales and purchase.[61] In the case of Pohang Steelworks, the parties signed contracts for plant sale in the early stage. Actually, a construction director was dispatched to the site for supervision and to provide assurances of performance. The work took on the nature of turnkey system. Training in facility operations was also formally provided in the contract for the 4th stage of construction.[62]

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[59] Nakaoka, *op. cit.*

[60] Mitsubishi Research Institute, *1980 Nendai ni Okeru Nikkan Kokusai Bungyo no Doko ni Kansuru Kesu Sutadi (Case Studies on the International Division of Labor between Japan and South Korea in 1980's)*, National Institute for Research and Advancement, October 1981 (Japanese).

[61] Nihon Tekko Kyokai Syakai Tekko Kogaku Bukai (Division of Social Engineering of Iron and Steel Industry, The Iron and Steel Institute of Japan), *op. cit.*

[62] Mitsubishi Research Institute, *op. cit.*

Acquiring proven technologies including management techniques will raise a new steelwork's operating rate. We cannot overemphasize the importance of learning standard technologies.

Given that as the starting point, it is then necessary to develop operation methods that suit Viet Nam's characteristics and conditions. Partial improvements in equipment and facilities are also required. For example, unlike Japanese mills, the rolling plant at Vina Kyoei has a well-hole structure to suit the country's climate. Equipment and operations should also be modified in line with Viet Nam's low wage levels and simpler product variety compared with industrialized countries. When domestic raw materials are used for integrated steelworks, it will require still further modifications.

The Vietnamese steel industry is encouraged to earnestly learn standard technologies while also pursuing technologies and developments suited to its specific needs and characteristics. To this end, discussion based on specific technological and social conditions is required but not according to bureaucratic intervention such as uniformed rate for local contents.

Second, efforts should be focused on developing human resources. Vietnamese managers, engineers and workers are encouraged to commit process of introducing technology and receive training in a country that provides technology. Some Japanese-affiliated companies in developing countries invite group leaders, foremen and engineers to Japan to give them training for a few weeks to up to more than a year. It is important that these skills be learned and brought back to Viet Nam. Proper treatment of trainees is important to encourage their commitment to their companies, using such technology, preventing them from quitting the company. On the other, to promote employees to upper-level jobs where they cannot utilize their skills is not recommended. Employee training programs and proper compensation are issues worth deeper study.

Third, it is important to note that a steelworks is supported not only by steel technologies but also by peripheral technologies. For example, the some 3,000 researchers at Nippon Steel Corporation have various specialties: mechanics (35%), electric engineering (15%), construction (10%), metallurgy (22%), chemistry (12%), physics (5%), and other (1%). In addition, system engineers are working at the affiliated companies.[63] Technologies in those fields must be nurtured within the steel industry and also in the peripheral industries. From an angle of business function, peripheral technologies include maintenance, machine design and manufacture, product development, metallurgy engineering and environmental control. For immediate purpose, technology for maintenance should be secured. Technology-recipient countries often experience a drop in operating rates due to shortages in spare parts or inadequate equipment maintenance and repairs.

According to a survey by the Japan Plant Association in 1984, about half the plants exported from Japan posted operating rate of 60% or less, 10 to 20 years after delivery, due mainly to shortages of spare parts, and also by poor

[63] According to the cold rolling F/S team.

operations and unstable electricity supplies.[64] One engineer who participated in a cement plant transfer cited poor warehouse management as a reason for the spare parts shortage. Other problems mentioned were failures in the operations, maintenance, order and budget departments to work more closely and a shortage of foreign currency to purchase parts.

Currently in Viet Nam, TISCO and SSC have engineering departments, but their technological level cannot support modern steelworks. The scale and system of domestically manufactured Cevimetal's rolling mills and Da Nang Steel's EAFs are below world standards. According to an executive of Vina Kyoei , most of the spare parts for rolling mills are secured from overseas since they cannot be procured in Viet Nam. In the medium- and long-term view, efforts are needed to develop and improve peripheral industries and upgrade the engineering industry, while in the short-term view trying to secure spare parts and services from overseas.

5. *Procurement of raw materials and semi-finished products*

As the master plan shows, individual plants will require various raw materials and semi-finished products depending on their production processes. For example, integrated steelworks use iron ore and coal, EAF mills utilize scrap and hot strip mills require slabs.

A retrospective view of the steel industry reveals that a domestic supply of raw materials is considered less critical after World War II than before that.[65] As is reflected in the growth of Japan's steel industry, the location of the source has become comparatively unimportant; obtaining the highest quality raw material at low prices has been essential..

Aside from market fluctuations, there are no particular constraints in importing iron ore and coal from foreign countries to secure a supply. With regard to contracts with mining companies, lessons can be learned from Japan and South Korea's experiences. As to the supply of iron ore, the major question concerns the use of ore from the Thach Khe mine. At present, all we know about the mine is that its ore contains a high percentage of zinc content and its estimated reserves exceed 500 million tons. It is known that a high zinc content causes various operational problems if ore is loaded into a blast furnace in a lump state. However, the author cannot comment in detail since thorough investigations have not yet been carried out. A feasibility study is required before a decision can be made on the use of Thach Khe ore. For now, it is not advised to determine the location or design facilities for steelworks on the assumption Thach Khe's ore will be a main raw material.

Scrap prices fluctuate in the market between USD 100 and USD 200 per ton. Supplies can be hard to

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[64] Jiro Takabayashi, Semento Puranto Ni Yoru Gijutsu Iten Jouno Mondaiten Ni Tsuiteno Kosatsu (Cases of the Low Wroking Rate of Exported Plants: The Case of Cement Plants), *Ajia Keizai (Asian Economy)*, Institute of Developing Economies, October and November 1989 (Japanese).

[65] Etsuro Abe and Yoshitaka Suzuki eds., *Changing Patterns of International Rivalry: Some Lessons from the Steel Industry*, University of Tokyo Press, 1991.

come by in a boom situation. South Korea is beefing up its self-sufficiency rate in iron scraps and is expected to be completely self-sufficient by around 2010. This will in turn reduce the amount of Korean imports, which totaled 5.57 million tons in 1998.[66] This reduction will be favorable to Viet Nam when it imports scrap. Meanwhile, EAF steelmakers are enjoying a global growth, and demand for scrap is certain to increase in the long term. To secure a stable supply of metallic sources for EAFs, these steel makers should also consider iron production with direct reduction. However, a thorough feasibility study is necessary.

Slab prices fluctuate in the market between USD 140 and USD 270 per ton. Securing a supply also becomes difficult in a boom situation. It will be suitable to import low-grade slabs from the former Soviet Union countries or China and high-grade slabs from developed countries or Brazil. Moves by Brazil's CST, which produced 4.393 million tons of slabs in 1999, should be watched. CST plans to begin operations of a hot strip mill with a capacity of 3.2 million tons a year in 2002.[67] With this mill, CST is expected to consume much of its own slab output to manufacture hot coils internally. Meanwhile, Japanese integrated steelmakers have recently been boosting exports of slabs to increase the operating rate of their blast and basic oxygen furnaces. It is possible that some of Japanese makers are willing to sign a long-term contract with Vietnamese enterprises.

6. *Product and sales policies*

Price competition in the global steel industry is turning fierce for two reasons: 1) Steelmakers in the former Soviet Union countries are exporting massive products at below cost: 2) Oligopoly in developed countries is weakening due to the growth at EAF steelmakers and globalization of business. Such price competition can negatively affect profits that would otherwise be obtained in the market of certain types of steel products.

The Vietnamese steel industry must take this situation into account when seeking to expand production. One measure is to enact trade laws, an issue that is not discussed here. Instead, the author discusses product and sales policies.

First, product mix should be discussed. Figure 9 shows the relationship between grades of steel and production processes. New steelworks should concentrate on the production of high-grade items as far as there is domestic demand. Table 13 shows the relationship between grades, domestic demand and feasibility of domestic production. High-grade steel products yield high profits at the normal operating rate. However, demand for high-grade steel is low in Viet Nam. The opposite is true for low-grade steel products. It is necessary to select an appropriate product mix based on these relationships.

After conducting market research, JICA's F/S team made recommendations on cold rolled flat products

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66 *Tekko Shimbun (Japan Metal Daily)*, October 26, 2000.

67 http://www.tubarao. com.br/cst_ingles/index_ingles. html.

with a view to large demand and higher profits. Cold rolling mills scheduled to start operations in 2003 will be able to profit from manufacturing cold rolled flat products for the manufacturers of galvanized sheet, furniture for export, and switchboard.[68]

Companies are urged to be cautious about producing low-grade steel such as general-purpose cold rolled flat products, where cutthroat competition is now under way. Although such production is technologically easy in Viet Nam, profits are unlikely. The author recommends, therefore, that domestic demand of these products be satisfied through imports rather than domestic production, a move that will free the government from adopting a protective stance against the flow of low-priced imports. This is better for the Viet Nam's economy.

With the exception of cold rolled flat products, market research for other areas is insufficient. In depth research will be needed for each phase in construction projects to pursue the expansion of production volume and high added value.

Second, sales and service strategies should be discussed. In pursuing a strategy of import substitution, the Vietnamese steel industry needs to be managed with a global perspective to prevent a flood of imports. The country's steel industry has not experienced customer service and demand for high-quality products. However, to meet diversified customer needs and offer the high quality required in products such as cold rolled flat products, the appropriate production method and meticulous manufacturing procedures must be employed. Preventative measures to avoid problems and appropriate problem-solving steps should be drawn up. Mills in a downstream process are good places to learn solutions to problems from the viewpoint of end users. It should be particularly remembered that many of the customers purchasing high added value products are expected to be foreign-affiliated companies. They may expect the quality, delivery and service that are standard in newly industrialized or advanced countries. To provide less than that may encourage them to look for sources outside of Viet Nam. The Vietnamese steel industry should learn from foreign customers' experience in world' standard quality, delivery and services. Customers will be good teachers.

In the shift to the manufacture of higher-quality products, the integrated control of all processes becomes all the more necessary. For example, a customer request for high-quality products should be quickly conveyed to the steelworks, which should maintain highly stable operation. All processes are linked, and it is impossible to produce high-quality products without smooth operations at each step of the process.

7. *The importance of a step-by-step approach*

7-1 General considerations

A gradual approach in nurturing a steel industry in a developing country is often realistic due to limited access to funds. This is especially true for Viet Nam, which is facing a more severe international

[68] CRM F/S Report.

financing environment than either Japan or South Korea during their construction of integrated steelworks.

The gradual approach also has merits by enabling a smooth learning of know-how and technology. Much can be learned about customer needs, problem-solving and service by managing a mill in the downstream process in particular. It is important to establish an organized system that allows the Vietnamese industry to learn at each step and then to take that knowledge to the next step.

The risks in the gradual approach in construction of a steelworks are related to risks involved in long lead time for completion of all projects. Construction plans may be changed due to difficulties in raising funds or changes in the political situations, production technologies or market structure. Two measures can help lessen such risks. One is to implement construction of individual projects promptly, which makes them less vulnerable to the effect of changes. The longer the construction period, the more changes occur halfway of constructing each facilities. The other measure is to allow certain flexibility in projects while maintaining their integration. Namely, develop a system in which changes in plans do not adversely affect competitiveness.

7-2 *Effective utilization of the two-track approach*

Ultimate objective of the master plan is to achieve a stable supply of flat products through construction of an integrated steelworks. Toward that end, the base and low cases offer two-track approaches. It calls for initial construction of a rolling mill for flat products, independently, followed by construction of an integrated steelworks.

From a financial viewpoint, the low case is more realistic than the base case. Ohno paper shows it in detail. The low case is also preferable as it provides sufficient time to learn know-how and skills.

To reduce the risks inherent in a long-term project, two suggestions are offered. One is to build No.1 HSM in Phu My. Stable operations can be secured at Phu My rolling mills, even when the plan for constructing integrated steelworks is changed. The second suggestion is to maintain a flexible stance regarding slab procurement prior to construction of integrated steelworks to take advantage of on-going technological innovation.

For effective accumulation and learning of experiences, there are some suggestions. First, VSC can learn management know-how of foreign companies based on the information from managers that has been dispatched to joint ventures from VSC. Such actions can be taken immediately.

There is an example in non-steel industries with such moves.[69] Japanese automobile producers successfully raised the competitiveness centering on their compact cars in the 1970s and 1980s based on production control, parts procurement

[69] Poul Ingrassia and Joseph B. White, *Comeback: The Fall and Rise of the American Automobile Industry*, Touchstone Books, 1995. Koichi Shimokawa, *Nichibei Jidousha Sangyo Koubou no Yukue (The Battle between the American and Japanese Automobile Industries)*, Jiji Press, 1997 (Japanese).

system and workers' organization. Some western automobile producers sought to overcome their weakness through technical tie-ups and joint ventures with Japanese automakers to learn Japanese production system.

General Motors (GM), the world's biggest carmaker, and Japan's Toyota jointly established the NUMMI in 1984. However, in the beginning GM did not regard NUMMI's production system. GM team members that were sent to NUMMI thought GM should introduce that system. But their voice was too weak to make GM's executives turn toward them. Those who learned at NUMMI were scattered to different divisions and had no power to reform production system. Rather, reform of the GM system in the 1970s and 1980s centered on advanced technology and increased use of robots. In the end, neither productivity nor product quality improved. In the 1990s, GM finally introduced NUMMI production system to other plants.

Second, the planned project to construct No.1 CRM should be used as a measuring tool in ascertaining the difficulty of future projects. While technology, location and product variety are being determined for No.1 CRM, financing method and planned profitability are still to be determined.[70] When the construction plan for No.1 HSM starts, financing and profitability will be great problems as well. The Japanese members of General Commentary Group holds the view that construction of the No.1 HSM should start after it is confirmed that No.1 CRM can secure a stable cash flow.[71] The Vietnamese government and VSC are urged to consider this view. It is necessary to apply the lessons in No.1 CRM project to the construction of No.1 HSM and other facilities. Without the success of No.1 CRM, later construction of other facilities will not see a success.

Third, a system should be implemented to promote the technology diffusion in Viet Nam. Sharing know-how and technologies acquired by a plant or individuals across the nation will boost the level of technology in the whole steel industry. However, some difficulties are expected when experiences in other developing countries are studied.

As an example, it has been found that engineers and technicians in Thailand who acquire know-how and knowledge in domestic training programs or abroad keep it to themselves rather than sharing it. Company B, a Japanese-affiliated automobile parts manufacturer had sent managerial candidates in Thailand to Japan for training each year for 10 years. The company discontinued the practice after too many of the candidates quit after returning home. It is suspected that these candidates used their acquired know-how to advance their own careers rather than raise productivity at the production site or the company.[72]

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70 *CRM F/S Report* and interview at VSC.

71 Koichiro Fukui, Takao Aiba and Hiroko Hashimoto, Long-term Scenario on Import Substitution/ Capital-intensive Industry Furtherance, *Viet Nam-Japan Joint Research Project: Workshop on Economic Development Policy*, JICA and MPI, The Socialist Republic of Viet Nam, Ha Noi, 8-9 December 2000, p.48.

72 Suehiro, *op. cit.* p.242.

Situation can be more complicated if multiple companies may manage the newly built plants provided in the master plan. In such a case, cross-company technology exchange is necessary.

As noted previously, employees who received training should be encouraged to commit the expected work. In addition, there should be some system to make them responsible for information sharing. For technology exchanges between companies, VSC or non-profit academic societies may need to take the initiative. Creating a link between the forums for technology diffusion and scientific research also could be beneficial. For example, member companies of the Iron and Steel Institute of Japan are improving the industry's level of technology while maintaining corporate confidentiality. Their research covers a range from basic areas in metallurgy to production control and social development. This example provided may be instructive and useful for the Vietnamese steel industry.

III. Conclusion of Part 2

Construction of a flat product mill and integrated steelworks will greatly change the prospects for the Vietnamese steel industry. The task facing the industry is not limited to construction of plants and equipment. Rather, it is to create a new business sector. Both the Vietnamese government and steel enterprises are encouraged to pursue improvements in technological, managerial and policymaking capabilities while engaged in projects. Toward that goal, this report has offered various basic suggestions.

Among capital-intensive industries and manufacturing industries in Viet Nam, the plan for the steel industry is the most comprehensive and organized. Therefore, the industry's problems and potentials brought to light by the Joint Viet Nam-Japan Research may become useful material for other industries as well. Industrial development strategies should not be based on abstract propositions but rather detailed studies of the real situation. Concerned organizations and enterprises in Viet Nam are expected to conduct studies of many other industries and to draw up strategies based on their findings.

Table 1. The steel consumption and crude steel production in East Asia

(Unit: million ton)

		Apparent steel consumption				Crude steel production			
		96	97	98	99	96	97	98	99
China		97.3	103.5	113.9	125.0	101.2	108.9	114.6	123.3
Japan		80.6	82.1	70.3	68.3	98.8	104.5	93.5	94.2
Korea		37.6	38.1	24.9	32.1	38.9	42.6	39.9	41.0
Taiwan		18.0	21.0	20.2	20.3	12.4	13.0	16.9	15.4
	Indonesia	6.3	6.8	2.8	3.5	4.1	3.8	2.7	2.8
	Malaysia	7.9	8.1	3.6	n.a.	3.2	3.0	1.9	2.0
	Thailand	8.8	7.6	4.1	n.a.	2.1	2.1	1.8	1.9
ASEAN	Philippines	2.8	4.2	3.0	3.0	0.9	1.0	0.9	0.9
	Singapore	3.8	4.0	3.3	2.9	0.5	0.4	0.5	0.5
	Viet Nam	1.6	1.7	1.9	2.3	0.3	0.3	0.3	0.3
		31.2	31.8	19.5	n.a.	11.2	10.6	8.1	8.5
Total East Asia		264.7	276.5	248.8	n.a.	262.5	282.6	273.0	282.4
Total World		658.7	698.2	693.3	698.8	750.0	798.8	775.9	784.2

Source: Edited by Japan Iron and Steel Federation, from data of South East Asia Iron and Steel Institute

Table 2. Steel production, consumption and import situation from 1992 to 2000 February 5, 2001

Unit: 1,000t

	1992	1993	1994	1995	1996	1997	1998	1999	2000 (est.)	2001 (expect.)
Steel consumption	560	863	854	1,180	1,638	1,822	2,128	2,379	2,850	3,170
Domestic production (Long product)	220	280	360	490	865	977	1,150	1,300	1,588	1,770
VSC	190	230	270	370	464	443	464	464	524	540
JVs of VSC	0	0	0	68	351	484	586	678	814	837
Others	30	50	90	52	50	50	100	150	250	393
Import	343	686	600	866	947	807	917	1,146	1,429	1,400
Stock										
at beginning	0	3	106	0	176	350	312	251	318	485
at ending	3	106	0	176	350	312	251	318	485	485

Source: VSC (from Mr. Tanaka, JICA Expert).

Table 3. Imports of finished steel products

(Unit: 1.000 tons)

Year	1998	1999
Total	846	1,144
Flat Products	685	966
Plate	234	292
Sheets and strip	342	564
Hot rolled sheets and strip	166	273
Cold rolled sheets and strip	176	291
Surface treatment sheets	100	103
Tin plate	25	26
Galvanized sheets	27	16
Colored galvanized sheets	48	62
Electrical sheets	9	7
Non flat products	162	178
Stainless steel	22	42
Steel products for construction	11	13
Sections and shapes	53	47
Structural steel	22	26
Spring steel	0	0
Wire rod	11	14
Other products	43	36

Source: General Customs Office, VSC.

Quoted from CRM F/S Report, Ⅲ-2-2.

Table 4. Billet demand and production/import

Unit: 1,000t

	1992	1993	1994	1995	1996	1997	1998	1999	2000 (est.)	2001 (expect.)
A Steel production	220	280	360	490	826	976	1,150	1,300	1,550	1,770
B Billet demand*	265	333	424	576	918	1,073	1,265	1,430	1,712	1,956
C Billet (domestic production)	(219)	(270)	(301)	(271)	(311)	(314)	306	307	306	396
D Billet (outside) (B-C)	46	63	123	305	607	759	959	1,123	1,406	1,560

( ) : from IISI statistics

*: estimated A/B (yield of rolling) = 83% ~ 90.5%

Source: VSC (from Mr. Tanaka, JICA Expert).

Table 5. Main steel companies of Vietnam Steel Corporation and the related JVs

Name of company	Form	Production amount (1000t/year)						Steel plants	Production capacity (1000T/Y)	Products
		1995	1996	1997	1998	1999	2000			
Vietnam Steel Corporation (VSC)	**Head Quarters VSC total**	**362.2**	**463.6**	**442.7**	**464.3**	**464.4**	524.2	**TISCO, SSC, Danang and JVs**	**total rolling capacity (1,590)**	**Wire rod, Bar Angle/section**
Thai Nguyen Iron and Steel Corporation (TISCO)	VSC Member	147.5	178.2	177.9	163.3	145.2	166.3	Luu Xa, Gia Sang (BF, EAF, CC, Rolling)	240	Wire rod, Bar Angle/section
Southern Steel Corporation (SSC)	VSC Member	207.9	278.9	256.6	284.9	292.0	321.8	BienHoa, Thu Duc, NhaBe, Tan Thuan (EAF, CC, Rolling)	460	Wire rod, Bar Angle/section
Danang Steel Corporation	VSC Member	6.8	6.5	8.3	13.9	20.4	25.5	Danang (EAF, Rolling)	40	Wire rod
Cevimetal	VSC Member				2.1	7.0	10.4			Bar
Vinakyoei	VSC JV (Japan)	13.0	130.1	197.5	235.7	229.0	257.1	Phu My (Rolling)	240	Wire rod, Bar
VSC-Posco Steel	VSC JV (Korea)	13.0	85.6	147.8	151.6	198.0	223.4	Hai Phong (Rolling)	200	Wire rod, Bar
Natsteel Vina *	VSC JV (Singapore)	33.4	62.1	69.3	72.5	82.3	98.2	Thai Nguyen (Rolling)	110	Wire rod, Bar
Vinausteel	VSC JV (Australia)	8.9	75.1	69.9	80.2	114.3	158.5	Hai Phong (Rolling)	180	Wire rod, Bar
Tay Do Steel	SSC JV (Taiwan)	-	-	2.0	37.7	65.0	76.9	Can Tho (Rolling)	120	Wire rod, Bar
JV total (hot rolled product)		**68.3**	**353.6**	**484.5**	**577.6**	**688.6**	**814.1**			
Vinapipe	VSC JV (Korea)	12.6	17.6	19.3	20.7	11.4	14.1	Hai Phong	piping 30	Welded pipe
Vingal	VSC JV (Aust.)				4.5	7.1	8.4	Dong nai	piping 40	Welded pipe
POSVINA	SSC JV (Korea)	41.1	39.2	20.0	10.0	22.0	19.05	HCM City (Galvanizing Line)	galva. 50	Galvanized sheet
SSSC	SSC JV (Japan, Malaysia)	-	-	7.0	17.7	38.7	42.3	Phuong Nam (Galvanizing Line)	galva. 50	Galvanized sheet

* JV share of TISCO transferred to VSC since 1999

Table 6. Improvement of coke rate at the mini-blast furnace in Shanxi Province, China

(t/t)

Company	A	A	B	B
Internal volume	$28m^3$	$47m^3$	$34m^3$	$125m^3$
1994	1.65	1.60	1.50	1.20
1995	1.65	1.60	1.50	1.20
1996	1.30	1.30	1.20	1.00
1997	1.30	0.90	1.50	0.90
1998	1.20	1.00	1.10	0.90
1999	1.10	1.15	0.80	0.80
2000	0.95	0.85	0.80	0.74

Source: Society on the Environment of China, Tohoku University.

Table 7. Investment plan for the Vietnamese steel industry: base case (2000-2015)

Project	Products	Capacity (1000t/y)	Start year	Year of operation in full capacity
1. Modify existing plants	Billet	500	2003	2003
	Long product	700	2003	2003
2. TISCO (second stage)	Billet	300	2005	2006
	Long product	250	2006	2006
3. Phu my steel plant	Billet	500	2004	2005
	Long product	300	2005	2006
4. Cold rolling mill (CRM)	Cold rolled coil	450	2003	2007
5. Billet center in north	Billet	500	2005	2005
6. Special steel plant	Special steel	100	2008	2012
7. DRI plant	Direct reduction iron	1200	2006	2008
8. Hot strip mill	Hot rolled coil	1000	2005	2007
9. Thach Khe mine	Iron ore	10000	2012	2015
10. Integrated steel works				
HSM	Hot rolled coil	3000	2009	2010
CRM	Cold rolled coil	1000	2010	2015
BF, BOF, Slab CC	Slab	4500	2012	2015

Source: Edited by Authors from the material of VSC.

Table 8. Investment plan for the Vietnamese steel industry: low case (2000-2010)

Project	Products	Capacity (1000t/y)	Start year	Year of operation in full capacity
1. Modify existing plants	Billet	500	2003	2003
	Long product	700	2003	2003
2. TISCO (2nd stage)	Billet	300	2005	2006
	Long product	250	2006	2006
3. Phu My steel plant	Billet	500	2004	2005
	Long product	300	2005	2006
4. Cold rolling mill	Colled rolled coil	450	2003	2007
5. Hot strip mill Based on EAF				
1st step (slab imported)	Hot rolled coil	1000	2006	2007
2nd step (slab produced)	Slab	1100	2009	2010
6. Preparation for ISW	none till 2010			

Source: Author edited from the material of VSC.

Table 9. Steel balance projection (based on VSC plan. base case)

(Unit: 1,000 tons)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Final domestic consumption	2500	2729	2982	3259	3564	3900	4247	4627	5043	5500	6000	6531	7112	7746	8440	9198
Long product	1500	1610	1729	1856	1993	2140	2290	2450	2621	2804	3000	3209	3432	3670	3925	4198
Flat product	1000	1119	1252	1402	1571	1760	1957	2177	2422	2696	3000	3323	3680	4076	4514	5000
Hot rolled product	625	689	760	839	925	1020	1122	1233	1356	1491	1640	1812	2002	2212	2444	2700
Cold rolled product	375	430	492	564	646	740	836	944	1066	1204	1360	1511	1678	1864	2071	2300
Domestic production (plan)																
Long product	1400	1494	1595	1703	1817	1940	2407	2454	2502	2550	2600	2775	2961	3161	3373	3600
Cold rolled product				200	250	250	400	450	450	450	1050	1050	1050	1050	1050	1450
Hot rolled product						600	800	1000	1000	2000	2500	2500	2500	2500	2500	4000
Billet	295	295	295	500	800	1700	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Scrap and other metallic sources for EAF	343	343	343	416	433	650	1550	1750	1950	1950	1950	1950	1950	1950	1950	1950
Crude steel/slab (incl. NISW)													2000	2000	2000	4500
Input to domestic production																
Billet	1540	1624	1734	1851	1976	2109	2616	2667	2719	2772	2826	3016	3219	3435	3666	3913
Yield	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920
Hot rolled product				213	266	266	426	479	479	479	1117	1117	1117	1117	1117	1543
Yield	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Scrap and other metallic sources	343	343	343	581	930	1977	2093	2093	2093	2093	2093	2093	2093	2093	2093	2093
Yield	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860
Crude steel/slab						638	851	1064	1064	2128	2660	2660	2660	2660	2660	4255
Yield						0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Gross domestic use																
Long product	1500	1610	1729	1856	1993	2140	2290	2450	2621	2804	3000	3209	3432	3670	3925	4198
Cold rolled product	375	430	492	564	646	740	836	944	1066	1204	1360	1511	1678	1864	2071	2300
Hot rolled product	625	689	760	1051	1191	1286	1547	1712	1835	1970	2757	2929	3119	3329	3561	4243
Billet	1540	1624	1734	1851	1976	2109	2616	2667	2719	2772	2826	3016	3219	3435	3666	3913
Scrap and other metallic sources	343	343	343	581	930	1977	2093	2093	2093	2093	2093	2093	2093	2093	2093	2093
Crude steel/slab	0	0	0	0	0	638	851	1064	1064	2128	2660	2660	2660	2660	2660	4255
Imports																
Long product	100	116	134	154	176	200	-117	-4	119	254	400	434	470	509	552	598
Cold rolled product	375	430	492	364	396	490	436	494	616	754	310	461	628	814	1021	850
Hot rolled product	625	689	760	1051	1191	686	747	712	835	-30	257	429	619	829	1061	243
Billet	1245	1329	1439	1351	1176	409	816	867	919	972	1026	1216	1419	1635	1866	2113
Scrap and other metallic sources	0	0	0	165	498	1327	543	343	143	143	143	143	143	143	143	143
Crude steel/slab	0	0	0	0	0	638	851	1064	1064	2128	2660	2660	660	660	660	-245
Import ratio (%)																
Long product	6.7	7.2	7.7	8.3	8.8	9.3	-5.1	-0.2	4.5	9.0	13.3	13.5	13.7	13.9	14.1	14.2
Cold rolled product	100.0	100.0	100.0	64.5	61.3	66.2	52.1	52.3	57.8	62.6	22.8	30.5	37.4	43.7	49.3	37.0
Hot rolled product	100.0	100.0	100.0	100.0	100.0	53.3	48.3	41.6	45.5	-1.5	9.3	14.6	19.8	24.9	29.8	5.7
Billet	80.8	81.8	83.0	73.0	59.5	19.4	31.2	32.5	33.8	35.1	36.3	40.3	44.1	47.6	50.9	54.0
Scrap and other metallic sources	0.0	0.0	0.0	28.4	53.5	67.1	25.9	16.4	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Crude steel/slab							100.0	100.0	100.0	100.0	100.0	100.0	24.8	24.8	24.8	-5.7
GDP growth (%)	5-6	7.5	7.5	7.5	7.5	7.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Industrial production growth (%)	9-10	8-9	8-9	8-9	8-9	8-9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Steel consumption (%)	5.1	9.2	9.2	9.3	9.4	9.4	8.9	8.9	9.0	9.0	9.1	8.9	8.9	8.9	9.0	9.0

Source: Composed by Nobuyoshi Tanaka, Kenichi Ohno and the Author.

Table 10. Steel balance projection (based on VSC plan. low case)

(Unit: 1,000 tons)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Final domestic consumption	2500	2729	2982	3259	3564	3900	4247	4627	5043	5500	6000	6531	7112	7746	8440	9198
Long product	1500	1610	1729	1856	1993	2140	2290	2450	2621	2804	3000	3209	3432	3670	3925	4198
Flat product	1000	1119	1252	1402	1571	1760	1957	2177	2422	2696	3000	3323	3680	4076	4514	5000
Hot rolled product	625	689	760	839	925	1020	1122	1233	1356	1491	1640	1812	2002	2212	2444	2700
Cold rolled product	375	430	492	564	646	740	836	944	1066	1204	1360	1511	1678	1864	2071	2300
Domestic production (plan)																
Long product	1400	1494	1595	1703	1817	1940	2407	2454	2502	2550	2600					
Cold rolled product				200	250	250	400	450	450	450	450					
Hot rolled product							800	1000	1000	1000	1000					
Billet	295	295	295	500	800	1200	1300	1300	1300	1300	1300					
Scrap and other metallic sources for EAF	343	343	343	416	433	650	750	750	750	750	750					
Crude steel/slab (incl. NISW)										1000	1100					
Input to domestic production																
Billet	1540	1624	1734	1851	1976	2109	2616	2667	2719	2772	2826					
Yield	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920					
Hot rolled product				213	266	266	426	479	479	479	479					
Yield	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940					
Scrap and other metallic sources	343	343	343	581	930	1395	1512	1512	1512	2675	2791					
Yield	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860					
Crude steel/slab						0	851	1064	1064	1064	1064					
Yield						0.940	0.940	0.940	0.940	0.940	0.940					
Gross domestic use																
Long product	1500	1610	1729	1856	1993	2140	2290	2450	2621	2804	3000					
Cold rolled product	375	430	492	564	646	740	836	944	1066	1204	1360					
Hot rolled product	625	689	760	1051	1191	1286	1547	1712	1835	1970	2119					
Billet	1540	1624	1734	1851	1976	2109	2616	2667	2719	2772	2826					
Scrap and other metallic sources	343	343	343	581	930	1395	1512	1512	1512	2675	2791					
Crude steel/slab	0	0	0	0	0	0	851	1064	1064	1064	1064					
Imports																
Long product	100	116	134	154	176	200	-117	-4	119	254	400					
Cold rolled product	375	430	492	364	396	490	436	494	616	754	910					
Hot rolled product	625	689	760	1051	1191	1286	747	712	835	970	1119					
Billet	1245	1329	1439	1351	1176	909	1316	1367	1419	1472	1526					
Scrap and other metallic sources	0	0	0	165	498	745	762	762	762	1925	2041					
Crude steel/slab	0	0	0	0	0	0	851	1064	1064	64	-36					
Import ratio (%)																
Long product	6.7	7.2	7.7	8.3	8.8	9.3	-5.1	-0.2	4.5	9.0	13.3					
Cold rolled product	100.0	100.0	100.0	64.5	61.3	66.2	52.1	52.3	57.8	62.6	66.9					
Hot rolled product	100.0	100.0	100.0	100.0	100.0	100.0	48.3	41.6	45.5	49.2	52.8					
Billet	80.8	81.8	83.0	73.0	59.5	43.1	50.3	51.3	52.2	53.1	54.0					
Scrap and other metallic sources	0.0	0.0	0.0	28.4	53.5	53.4	50.4	50.4	50.4	72.0	73.1					
Crude steel/slab							100.0	100.0	100.0	6.0	-3.4					
GDP growth (%)	5-6	7.5	7.5	7.5	7.5	7.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Industrial production growth (%)	9-10	8-9	8-9	8-9	8-9	8-9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Steel consumption (%)	5.1	9.2	9.2	9.3	9.4	9.4	8.9	8.9	9.0	9.0	9.1	8.9	8.9	8.9	9.0	9.0

Source: Composed by Nobuyoshi Tanaka, Kenichi Ohno and the Author.

Table 11. Cost structure in the steel industry (a), Brazil and selected industrialized countries, June 1985

(USD per ton)

Country	Total cost	Labour costs	Coal	Iron	Energy	Ferro alloy and fluxes	Depreciation	Miscellaneous	Subtotal	Financial expenses
Brazil (b)	431	76	67	17	13	17	44	37	271	160
West Germany	339	81	73	50	34	21	18	50	327	12
Japan	370	68	60	52	43	22	31	66	342	28
United States	507	132	59	85	76	22	30	83	492	15

(a) At 90 per cent capacity utilization.

(b) SIDEBRAS.

Source: Bernhard Fisher, Peter Nunnenkamp et al., *Capital—Intensive Industries in Newly Industrializing Countries*, Mohr, 1988, p.203. ASP (Associc,a~o das Sideru'rgicas Privadas), Encontro do Presidente Jose' Sarney com Siderurgia. Brasilia. 1986.

Table 12. Condition for new integrated steelworks

	Capacity of NISW	
	3 million t/y	6 million t/y
Land area	300-350ha	550-650ha
Wharf area		
Extension	1000-1200m	2500-3000m
Depth for raw material	17-18m	17-18m
Ship for raw material	150,000-250,000t	150,000-250,000t
Electric power	150MW	300MW
Electric consumption	450kWh/t	450kWh/t
Water supply	120,000m³/day	240,000m³/day
Water consumption	14m³/t	14m³/t

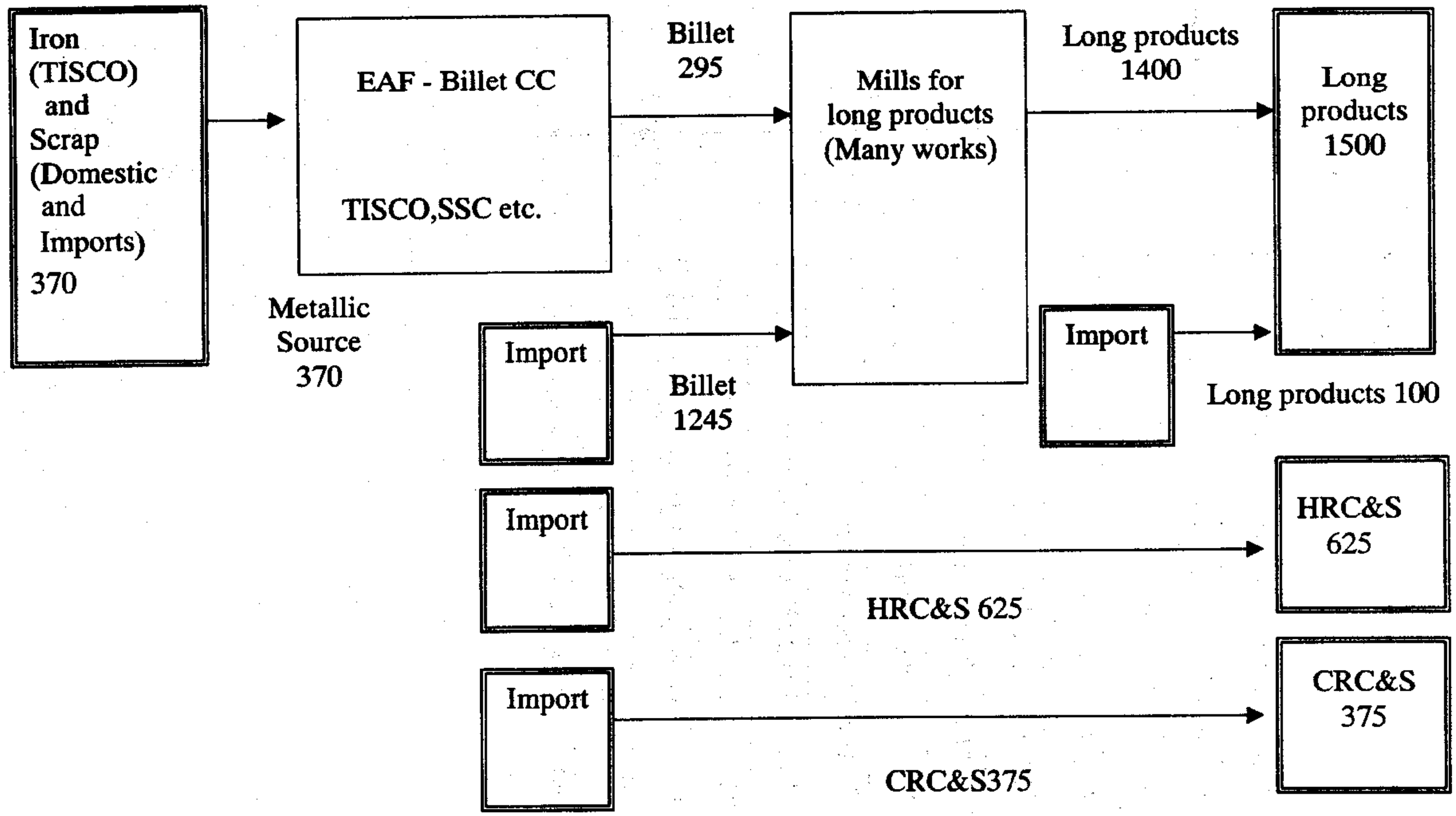
Source: Nippon Steel Corporation, from Mr. Tanaka.

Table 13. Schematic representation about the feasibility of production of various products in Viet Nam

Grade of products	Example	Volume of domestic consumption	Profitability at standard operating rate	Estimated operating rate in Viet Nam	Estimated profit in Viet Nam	Feasibility
Very high grade	Hot- dip Zn-Fe alloy coated sheet for automobile	very small	very high	very low	no profit	×
High grade	Cold rolled coil for electrical equipment	2005 small 2020 larger	high	low→ higher	low or high (It depends on the actual operating rate)	2005 × 2010 or 2020 ○
Middle grade	Cold rolled coil for galvanizing sheet	2005 medium 2010 large	middle	high	high	○
Low grade	Bar and wire rod for construction	large	low	It depends on the business condition	low or high (It depends on the actual operating rate)	△ or ○
Low grade (products under the cut-throat competition)	Steel mill products under the competition with imported products made in CIS	large	low	not so high	low or no profit	×

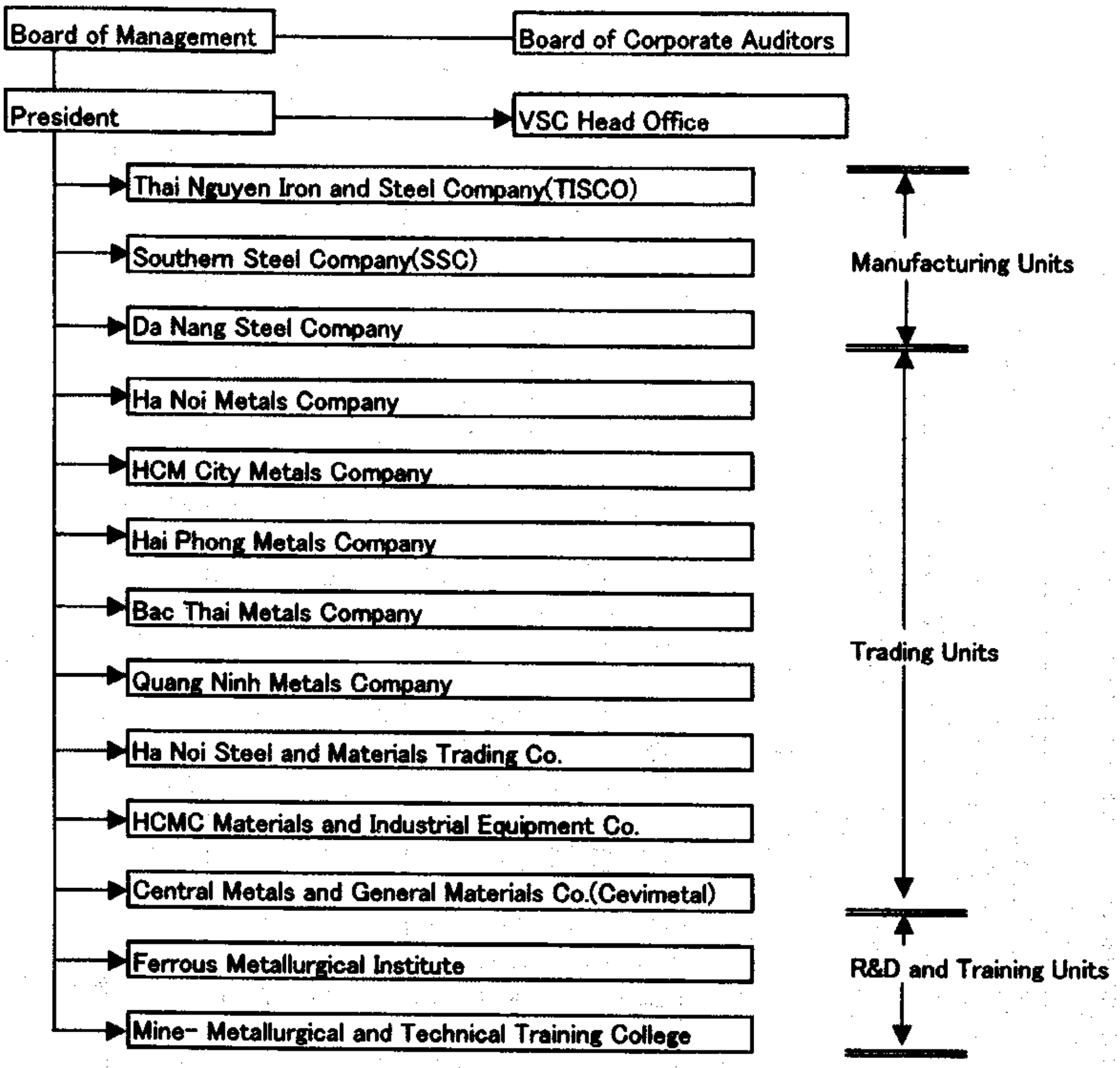
Source: The author edited.

Figure 1. Material flow of the Vietnamese steel industry in 2000 (estimated in autumn, 2000)



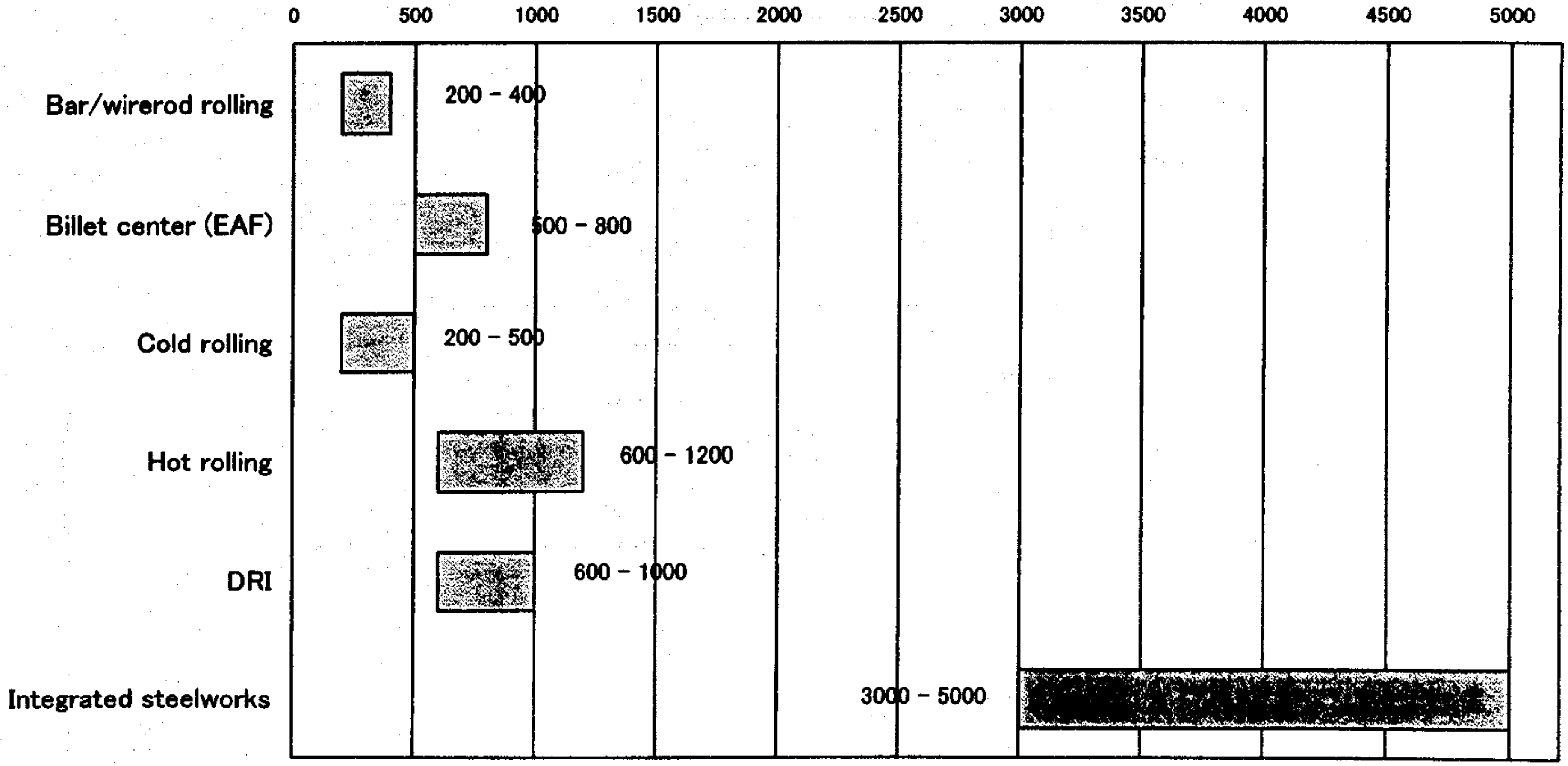
Source: VSC.

Figure 2. Organizational structure of Vietnam Steel Corporation



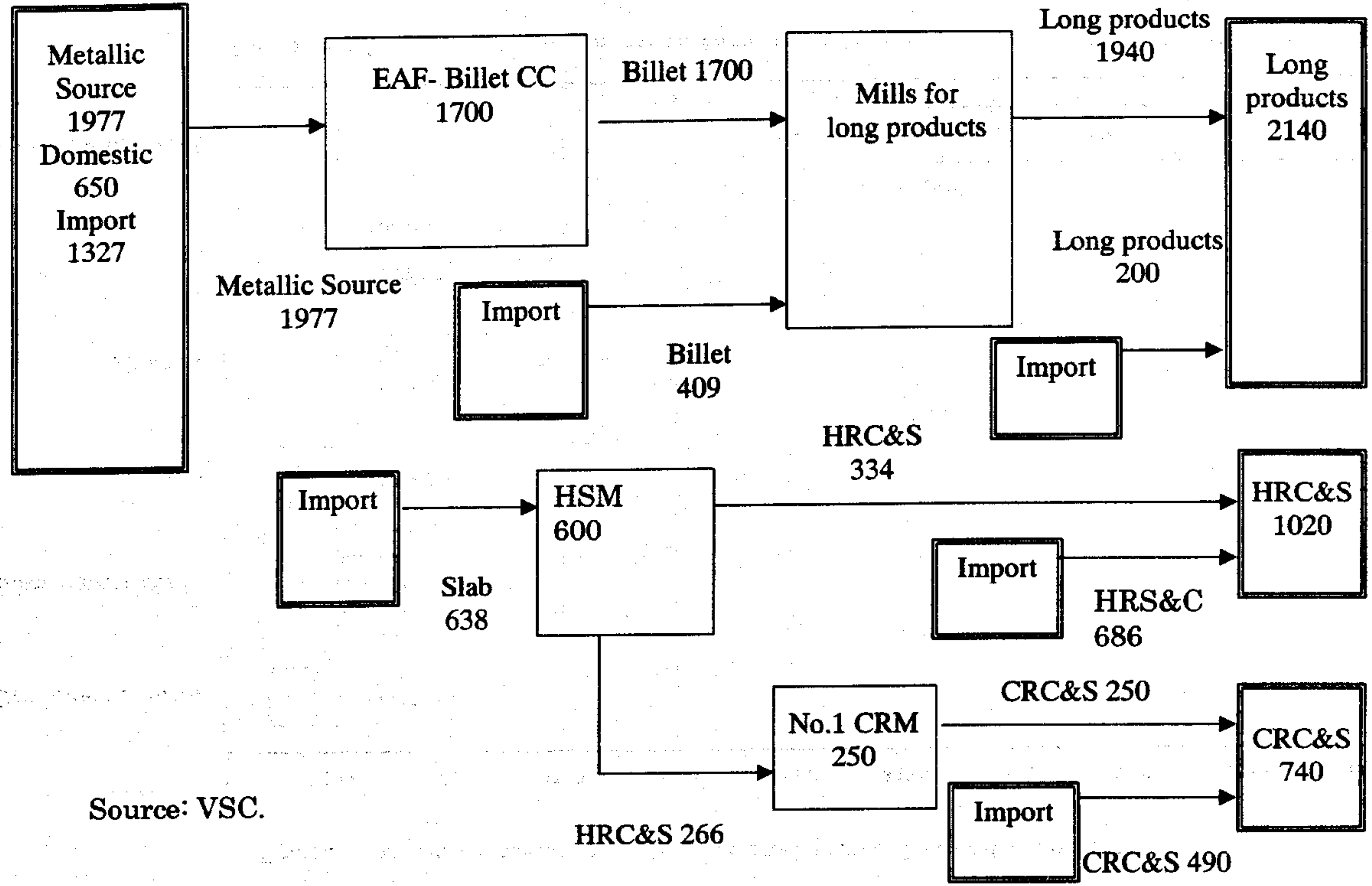
Source: VSC.

Figure 3. Appropriate production capacity of medium-sized mills (Thousand tons per year)



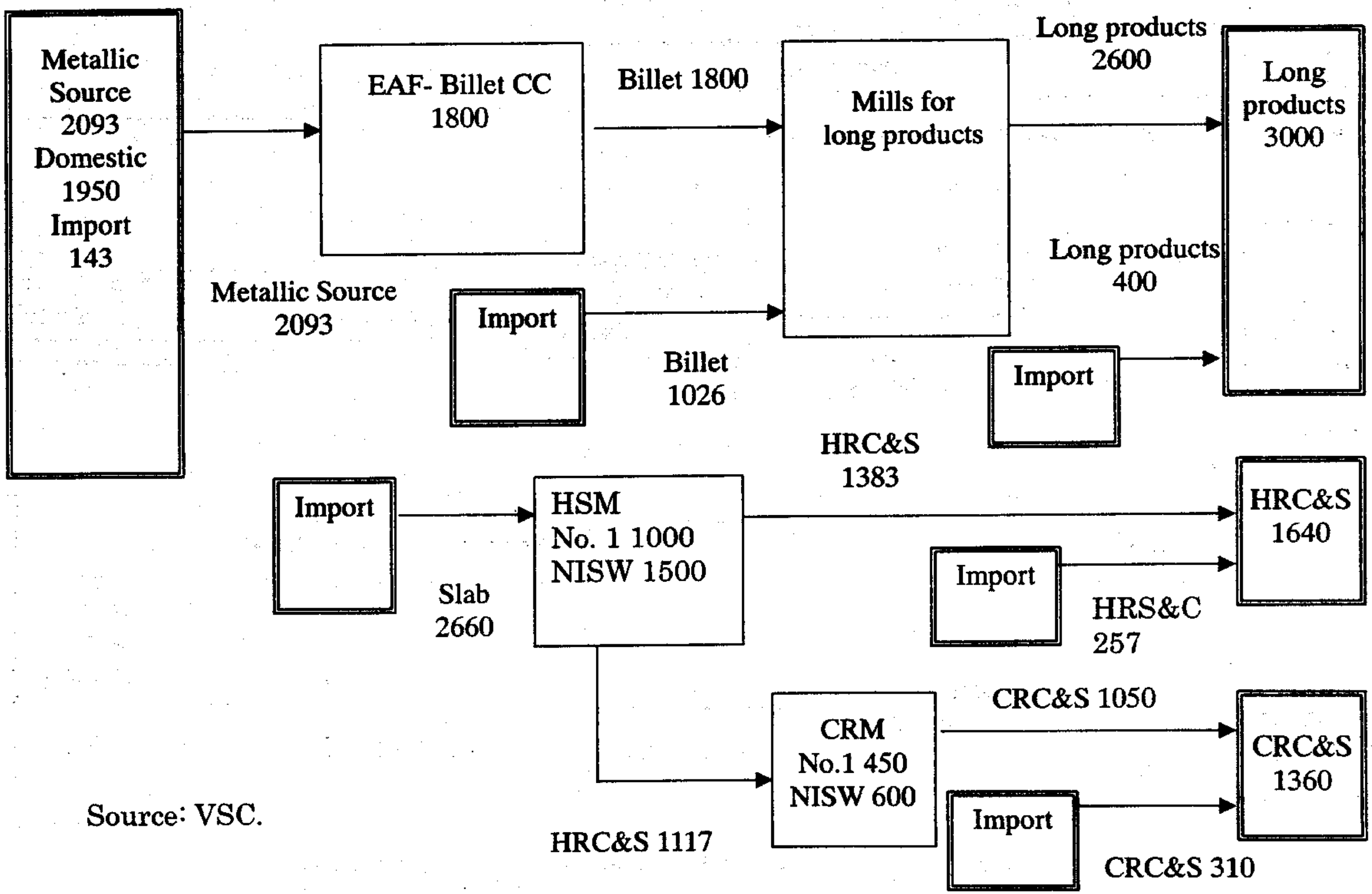
Source: Prof. Ohno's estimate based on information by JICA expert and F/S team and in light of Viet Nam's circumstances.

Figure 4. Material flow of the Vietnamese steel industry in 2005 based on the VSC master plan (base case)



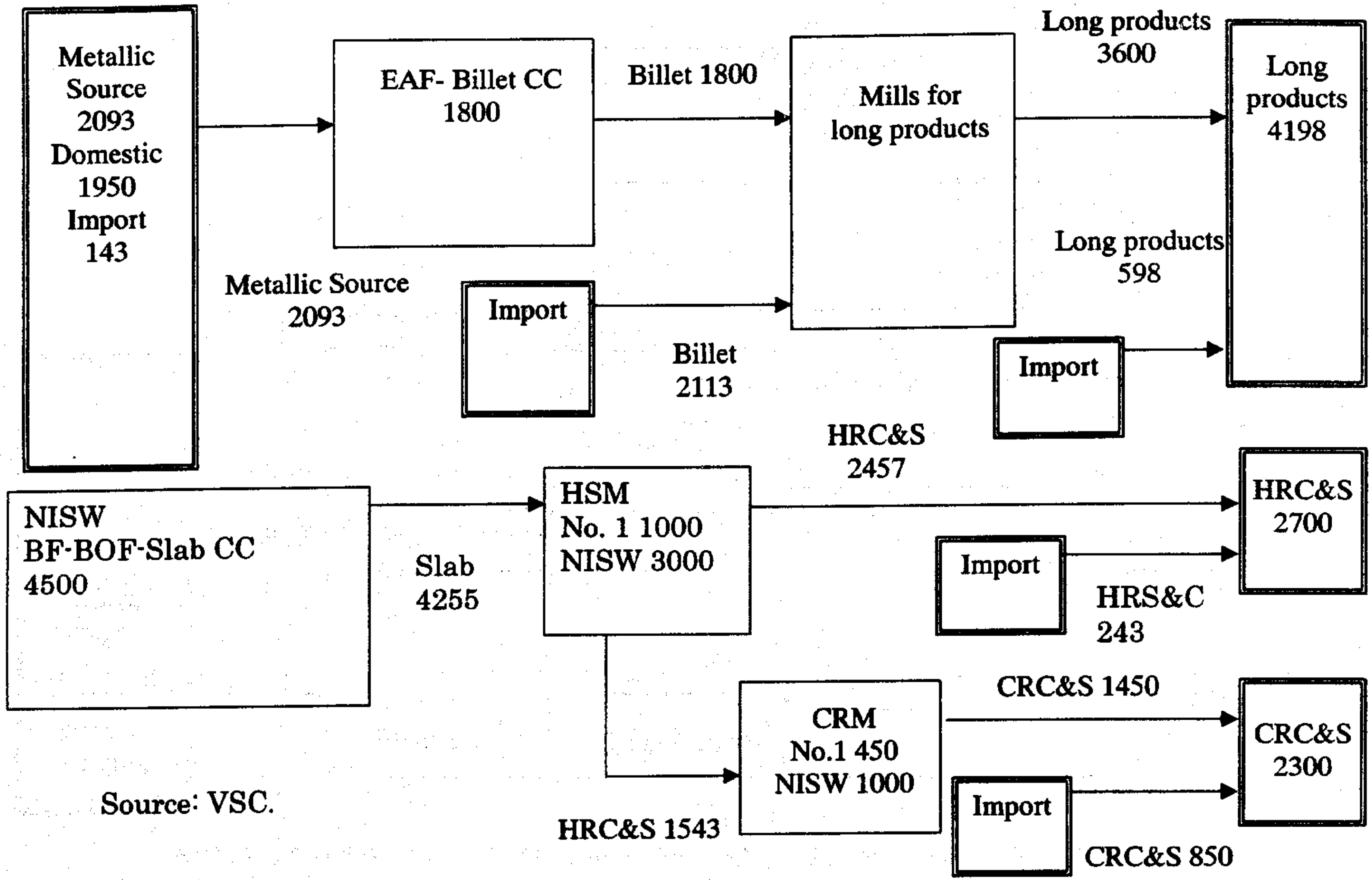
Source: VSC.

Figure 5. Material flow of the Vietnamese steel industry in 2010 based on the VSC master plan (base case)



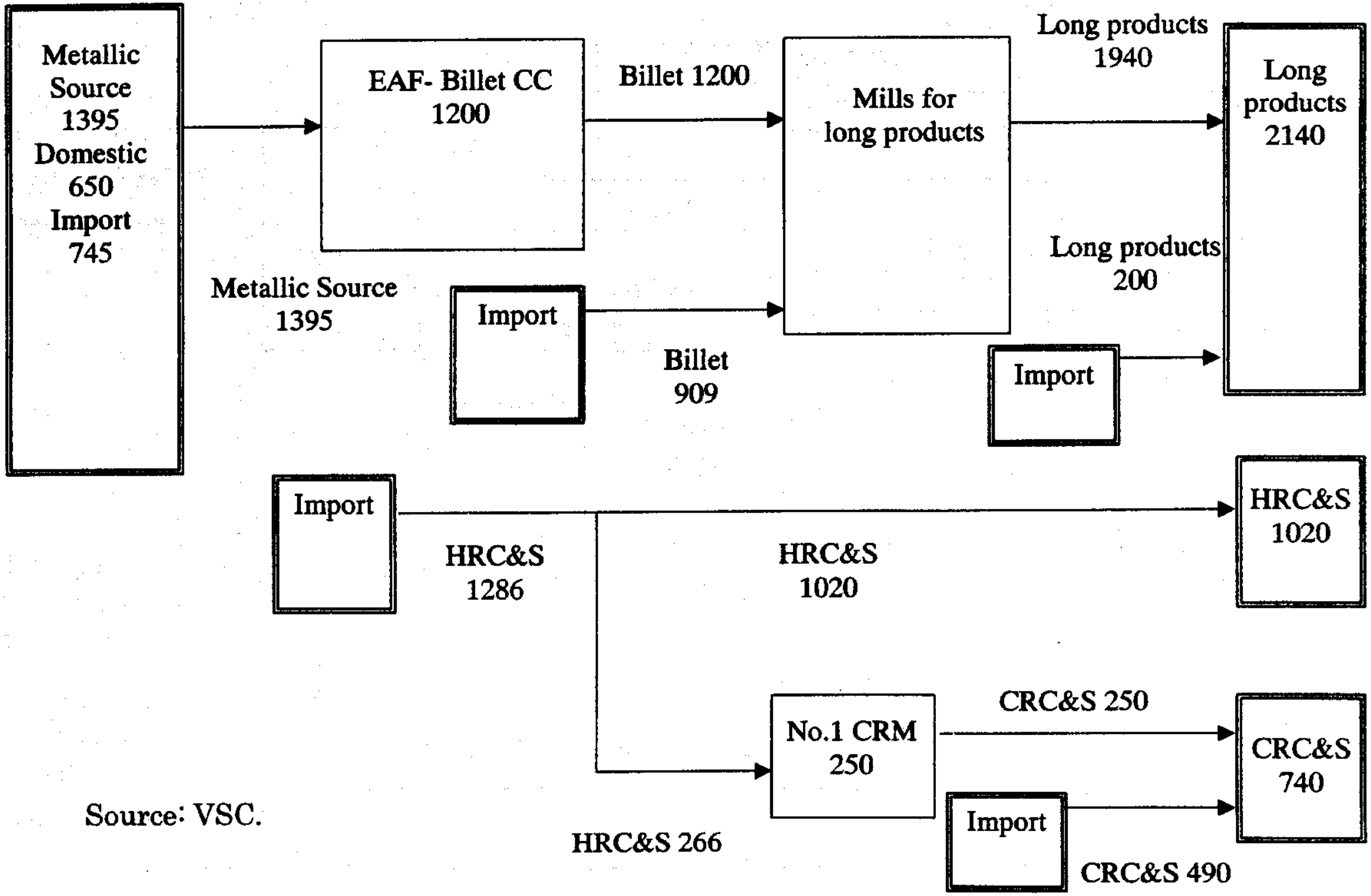
Source: VSC.

Figure 6. Material flow of the Vietnamese steel industry in 2015 based on the VSC master plan (base case)



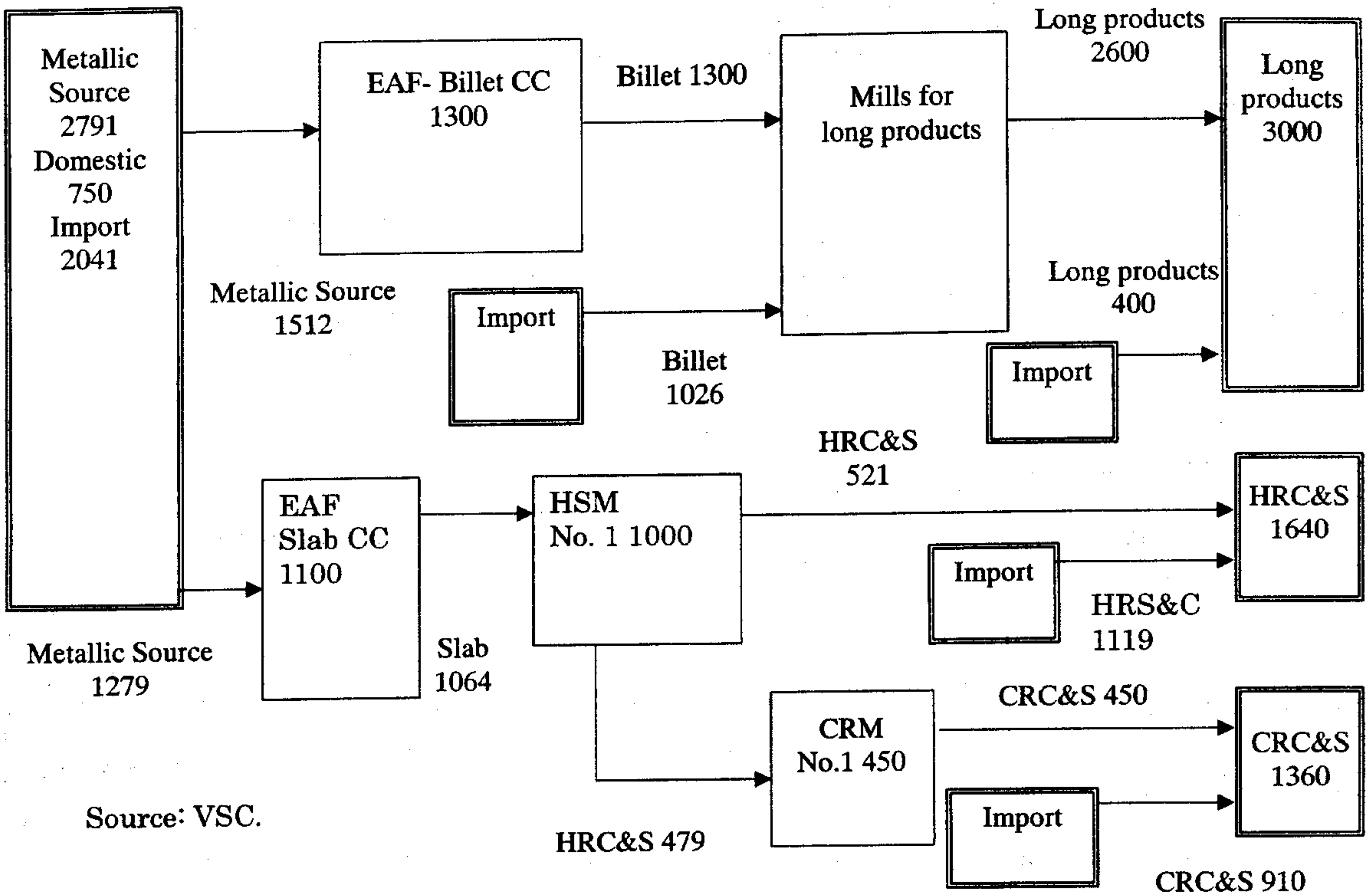
Source: VSC.

Figure 7. Material flow of the Vietnamese steel industry in 2005 based on the VSC master plan (low case)



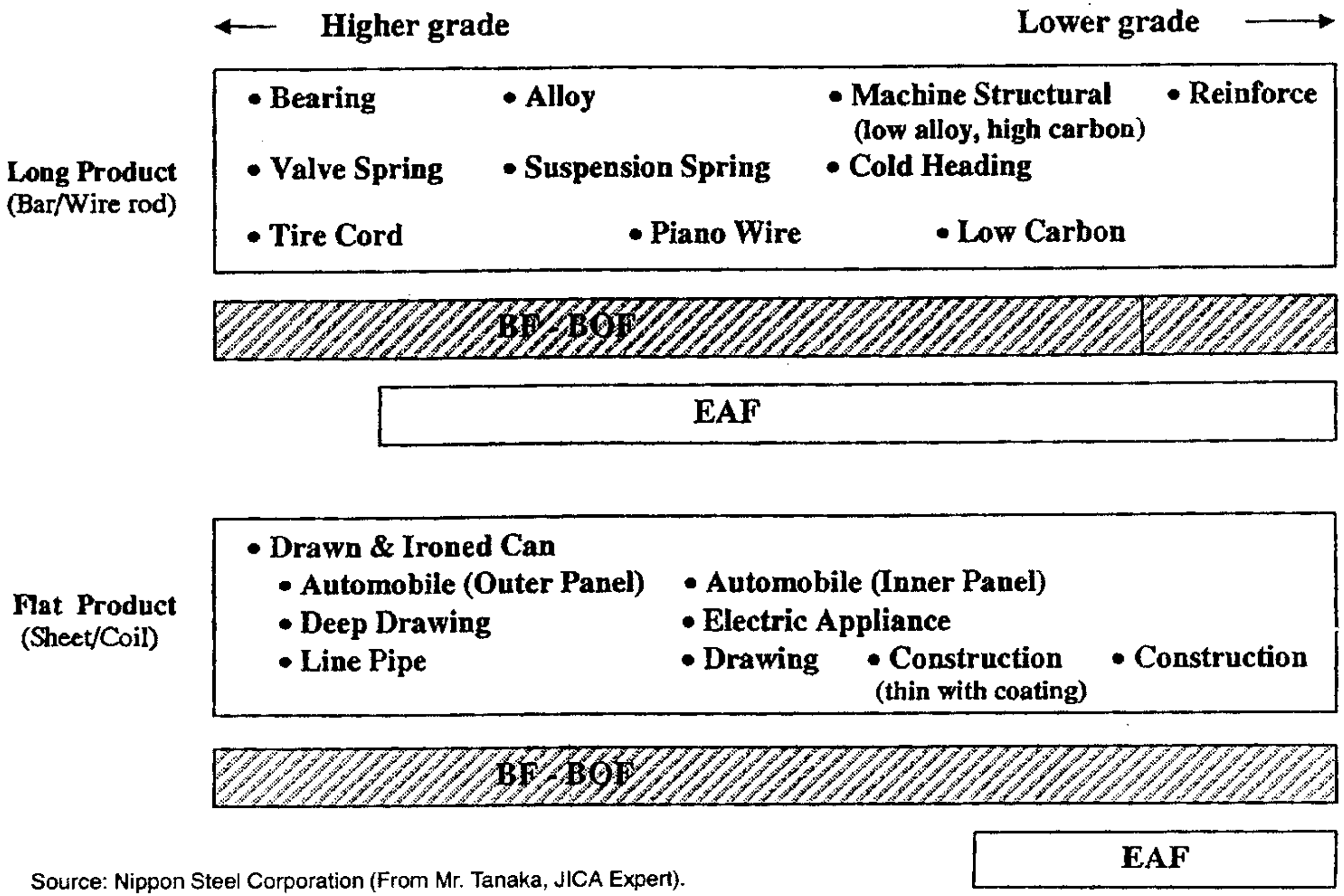
Source: VSC.

Figure 8. Material flow of the Vietnamese steel industry in 2010 based on the VSC master plan (low case)



Source: VSC.

Figure 9. Schematic productive capability by steelmaking process



Source: Nippon Steel Corporation (From Mr. Tanaka, JICA Expert).

2 − 6

Evaluating Alternative Scenarios for Steel Industry Promotion

Quantification of Profitability and Risks[1]

Kenichi Ohno

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1. Introduction

Viet Nam's steel industry faces a formidable challenge. As the country deepens its integration with the global economy, especially through AFTA implementation and WTO entry negotiations, the steel industry has only a very limited time to renovate in order to survive and compete in the more open economic environment. The basic problems are common to all heavy industries in Viet Nam: insufficient management and marketing skills, inadequate policy framework, outdated equipment and the lack of financial resources to invest in new technology.

As the Vietnamese economy continues to grow steadily in the future (for example, at the speed of doubling real GDP every ten years implying average annual growth of 7.2 percent), domestic demand for steel products will also increase at a fairly rapid and predictable pace. It is forecast that domestic steel demand, currently 2.5 million tons, will quadruple to 10 million tons by 2017 (Figure 1). To meet at least some of this rising demand and to avoid heavy reliance on imported steel which strains the balance of payments, there is a great need to rapidly upgrade Viet Nam's steel industry.

However, risks of such undertaking are equally high. In the past, many developing countries have attempted to nurture a steel industry with highly mixed results. To succeed commercially, high capabilities of both domestic producers and government are required, and countries without such capabilities end up wasting enormous resources. According to various plans currently under consideration by the VSC and the Vietnamese

[1] I would like to thank the participants of Intensive Steel Seminar (October 16, 2000) and Hanoi Workshop (December 8-9, 2000) for fruitful discussions and comments, and officials and business leaders who kindly granted us the opportunities to interview them or visit their plants. Among them, I am particularly indebted to the following people: Do Quoc Sam (National Council for Investment Projects Appraisal); Do Huu Hao (Institute for Industry Policy and Strategy); Nguyen Kim Son, Pham Chi Cuong, Nguyen Huu Tho (VSC); Hoang Duc Than (NEU); Toshiki Yabuta (Nippon Steel Corporation), Takao Aiba (Japan Economic Research Institute) and Koichiro Fukui (KDDI). Above all, Nobuyoshi Tanaka (JICA expert and NSC) has continuously provided us with detailed and up-to-date information on Viet Nam's steel industry, without which this research could not be conducted. Nguyen Thi Huong Lan, Hisaki Kouno and Tadashi Kikuchi provided efficient research support.

government, the total amount of capital required to renovate the steel industry is extremely large relative to GDP (see below). Surely, the cost to the national economy would be very high should such an attempt fail. It is therefore very important to identify possible pitfalls in advance as well as to improve capabilities to deal with them, before the country decides to launch a steel promotion drive.

During the last several years, the Japan International Cooperation Agency (JICA) has extended intensive technical assistance to Viet Nam Steel Corporation (VSC), including the 1998 steel industry master plan, dispatch of a resident JICA expert, a feasibility study of the proposed cold rolling mill, an intensive steel seminar, and various studies under the Japan-Viet Nam Research Project (JVRP). Taking advantage of information gained through these cooperative studies, this paper attempts to evaluate, numerically and concretely, the various challenges on the way to renovating the Vietnamese steel industry.

This paper will not reach any definite conclusion as to whether or not the steel industry should be supported vigorously; that is up to the people and government of Viet Nam to decide. What the paper attempts to do is to provide some useful calculations and suggestions for making that decision. Certain future shocks are predictable, and even quantifiable. It is essential that any policy decision be made in the full knowledge of the size and nature of these shocks, with proper precautions to minimize them. Through this, Viet Nam's steel industry will be in a better position to meet the challenge. Promotion without such knowledge would be too risky.

2. Status quo and policy goals

Current situation [2]

Viet Nam's steel industry consists of three layers of producers: (i) joint ventures with VSC which boast relatively high technology and competitiveness; (ii) state-owned enterprises under VSC with large production capacity but with technology lower than the global standard; and (iii) small independent producers with most outdated production method. While joint venture production has expanded rapidly in recent years, VSC production remains stagnant. At present, a majority of domestic users prefer low price and low quality to high price and high quality. However, the better quality of a few joint venture products has begun to be recognized by certain market segments, albeit slowly.

As in many other developing countries, Viet Nam's steel production is biased towards downstream processes,

[2] For a more detailed analysis of the current status of the Vietnamese steel industry, see Kawabata's contribution in this volume.

especially rolling of long products (bars and wire rods) and cutting, coating and galvanizing imported flat steel. As domestic steel demand rises, Viet Nam is beginning to import not only more finished flat products but also increasing amounts of intermediate inputs (Figures 2, 3). In 2000, domestic rolling capacity of long products was 2.5 million tons while actual production was only 1.4 million tons, with a utilization rate of 56 percent. Moreover, only 0.3 million tons of billets (intermediate input for long products) was domestically supplied, and the rest (about 1.2 million including yield losses) had to be imported. As for flat steel (hot and cold rolls and sheets) for which there is no domestic production capacity at present, the entire amount has to be imported.

The domestic prices of various steel products are set weekly by VSC with the cooperation of joint venture producers. However, small independent producers who supply low quality products do not observe VSC's price guidelines. As to import protection, products with sufficient domestic supply capacity are heavily protected while products in short supply are imported with zero or low tariffs. In particular, long products and galvanized flat products are subject to an import tariff (and tax) of 40 percent. In addition, since 1996 the importation of construction steel (bars and wire rods) has been banned. Billets as well as flat rolls and sheets carry low tariff rates (0-3 percent). Steel imports are dominated by VSC's eight trading units.

As Figure 4 shows, during the last several years the domestic price of construction bars (USD 358/ton, 1994-99 average) was USD 93 (or 35 percent) higher than the international price.[3] However, in 2000 the price gap in long products seems to have narrowed substantially to 5 percent or so as the international price rose and the domestic market remained stagnant due to overcapacity. For other steel products with little import protection (billets, hot rolled sheets/coils, and cold rolled sheets/coils) domestic and international prices match closely. The domestic scrap price is lower than the international price due to much lower quality of domestic scrap than abroad. In the near future, the tariff structure of various steel products must be revised significantly to reflect the new reality, including AFTA commitments and proposed domestic production of flat products and slabs/billets.

Four major goals

Under these circumstances, Viet Nam's steel industry faces the following challenges.

[3] The import price taken from Korea's customs data was USD 265/ton (1994-99 average). The result is little affected even if the European export price (USD 263/ton) is used.

(i) Rehabilitation of old mills operated by VSC's member companies

Rehabilitation of TISCO (Thai Nguyen Iron and Steel Corporation) and SSC (Southern Steel Corporation) is already underway and will continue. With TISCO, immediate tasks include improving efficiency through modest capacity expansion (for which Chinese assistance has been secured) and shedding of labor force. As to SSC, with better outlook than TISCO, the two-pronged approach of consolidating outdated equipment and investing in new plants simultaneously is the key.

(ii) Establishment of flat product mills

Viet Nam now imports all flat steel. VSC (with the help of JICA) has now completed the feasibility study for the nation's first cold rolling mill in the South with a capacity of 250,000 tons/year. As a next step, a hot strip mill with a capacity of 1 million tons/year is being contemplated but its location and timing remains undecided.

(iii) Expansion of steel making capacity

In order to stem the rising imports of intermediate inputs—billets and (in the future) slabs—steel making capacity needs to be enhanced. In the short run, this will be partly achieved by expanding the capacity of TISCO and SSC. In the longer run, building of new blast furnaces and/or other steel making plants such as DRI, DIOS, etc. must be the fundamental solution.

(iv) New integrated steelworks (NISW)

Building of a modern, large-scale NISW, if successful, would significantly strengthen and modernize Viet Nam's steel industry. But it would require huge investment over many years amounting to at least 20 percent of today's GDP, which entails significant risks. The most appropriate timing, location, input procurement and technical processes of NISW are currently hotly debated within the Vietnamese government (see below).

3. Key remaining issues

Through our policy discussions, interviews and plant visits, the following five unsettled issues have been identified regarding the renovation of Viet Nam's steel industry.[4]

Should steel be promoted at all?

Should steel be a high-priority industry? This fundamental question cannot be answered without a comprehensive and concrete long-term national development strategy, which is lacking in today's Viet Nam. Research of one individual industry alone is not sufficient to determine the desirability of its promotion. Under these circumstances, any evaluation of the steel industry (including this paper) remains partial and incomplete.[5] Generally speaking, the steel industry is regarded as a key to industrialization because of its extensive industrial linkage and favorable balance-of-payments impact. But its huge capital requirement, global oversupply and fierce international competition, and the need to adopt free trade in the near future militate against its promotion in a latecomer country like Viet Nam with abundant labor and limited financial resources. At present, the majority opinion in the government seems to be that the steel industry is worthy of official support, but the exact extent of the desirable support remains an open question. It is important to recognize that the feasibility of steel industry promotion depends critically on the ability of the industry and the government to identify and cope with various risks and shifting conditions.

New integrated steelworks (NISW)—fast or slow?

Perhaps the most hotly debated issue regarding the steel industry in Viet Nam is the speed and manner with which NISW should be constructed. This is closely connected with the question of whether NISW should be constructed in a single-track or two-track approach. In the single-track approach, all major steel investments from now on should be concentrated on establishing NISW as soon as possible. If successful, this would accelerate industrialization with all anticipated benefits (profits, industrial linkage, relieving balance-of-payments pressure, enhancing national economic security, etc). By contrast, the two-track approach advocates initially building downstream steel plants with relatively low capital requirements, while preparing for big investments for NISW later. This view recognizes the risk of quickly sinking enormous resources into NISW,

[4] For the concrete views of the Japanese side on these unsettled issues, see "Summary of Japanese Views on Steel Promotion and Trade Policy" included in this volume.

[5] In the followup phase (1998-99) of the Joint Japan-Viet Nam Research Project, the Japanese side emphasized the importance of designing a long-term development strategy, of which industrialization, integration, equitization and other policies should be integral parts. Without such a broad context, consistency in policy making is seriously compromised.

as well as the difficulty in obtaining necessary financing.

The two approaches also differ on the desirability of (i) keeping technical options open; and (ii) securing a sufficient learning time, during the construction period of NISW. The single-track approach assumes that best technology can (and should) be chosen at the outset, and necessary technical and management skills can be absorbed relatively quickly. On the other hand, the two-track approach considers it wise to proceed gradually, adjusting as global situations shift and new technical possibilities emerge; Vietnamese managers and engineers are assumed to need a long lead-time before they can respond effectively to these changes. If the economic environment becomes extremely adverse, the two-track approach even permits shelving the NISW plan.

Currently, the most accelerated plan calls for an immediate commitment to the construction of NISW, with its first blast furnace operational by 2010 or even before. The gradualists want to pace the construction of NISW in such a manner that allows flexible adjustments along the way, with the first blast furnace completed around 2017. VSC's master plan ("basic case") adopts a two-track approach but proposes to build the first blast furnace relatively quickly, by 2012.[6]

Location of NISW and the use of domestic ore and coal

Apart from speed, the location of NISW is still undecided. This issue is closely related to the use of domestic raw materials. The majority view (including VSC) seems to prefer a coastal site in the Central Region. This assumes importation of main raw materials (ore and coal). For efficient transportation of both inputs and outputs, locating NISW at a newly constructed deep-water seaport is essential. However, from the viewpoint of utilizing domestically available raw materials, development of NISW and domestic iron sources simultaneously and at the same location (especially hitherto unexploited Thach Khe mine in Ha Tinh Province) becomes an important priority. Due to high zinc content, Thach Khe ore is not suitable for efficient operation of blast furnaces, but it may be possible to use it as a supplementary iron source, for example, for DRI or DIOS if such processes are to be adopted. However, a conclusive feasibility study on Thach Khe ore has not been conducted.

Some propose to locate NISW at TISCO. However, inland Thai Nguyen is hardly an ideal place to build a major steel complex in the 21st century. Additional land transportation costs would become a severe and permanent impediment on its competitiveness.

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6 As VSC contemplates a relatively accelerated two-track approach, some plants which would be build separately from NISW under a more gradualist approach are now included as prior investments to NISW in VSC's base scenario. The first HSM (hot strip mill) is the case in point.

The steel industry will face fierce foreign competition in the near future. In order to compete effectively, the location and input sourcing of NISW must be selected with utmost care, since any compromise on either will seriously undermine its commercial viability. If domestic materials are to be used, its cost and quality must be comparable to the internationally most efficient sources.

Import protection under AFTA and WTO

The current system of domestic price control and import protection of steel products must be drastically revised as the AFTA deadline of 2006 approaches and WTO entry negotiations begin in earnest. However, that does not necessarily imply eliminating all import protection at once. For a limited number of products and under concrete and feasible promotion plans, Viet Nam as a very latecomer country should be permitted to protect its industries as long as protection is not comprehensive, excessive or permanent. Safeguarding mechanisms against serious domestic injury, measures against foreign dumping or export subsidies, and defense against adverse global price shocks should also be allowed. At present, however, it is not clear whether and to what extent Viet Nam will be granted the right to implement these protective measures under AFTA or (future) WTO.

In order to overcome the price competitiveness gap that exists today, the following actions must be combined with appropriate weights and timing: (i) forward-looking productivity enhancement through new investment and better management; (ii) closure and consolidation of inefficient mills; and (iii) import protection. The main effort must of course be directed to the first two while the last (protection) should be used only sparingly, as ancillary and temporary measures.

One serious problem concerning the global steel market is the aggressive export behavior of some of the CIS countries such as Russia and Ukraine. These countries export at extremely low prices unthinkable in other countries. Export subsidies for the purpose of generating foreign exchange earning are suspected. International policing of such subsidies must be enforced. At the level of individual countries, unreasonably low prices from CIS must be countered by avoiding head-on competition with their low-end products as well as permissible trade measures.

Financing options

The largest practical barrier for industrial promotion is the lack of financial resources. A modern steel mill would cost up to a few hundred million dollars, and building NISW from scratch would cost several billion dollars spread over many years, including land preparation and port construction (Figures 5 and 6). With

GDP of approximately 30 billion dollars in 2000, NISW would be a very ambitious project for Viet Nam. According to the standard commercial loan criterion, the maximum amount that VSC can borrow commercially is only 100-150 million.[7] Of course, steel industry promotion will be a national project to which a pure commercial criterion may not apply. Nonetheless, difficulty in raising sufficient funds is already expectable.

Since the government budget and VSC's retained profits are limited, there seem to be only two ways to raise such a huge sum. The first is to grant the steel industry a status of highest priority industry and pour a large amount of domestic soft loans into it. The second is to seek foreign participation in the form of joint ventures. If neither of these is possible, VSC will have to resort to massive borrowing on commercial terms, but that would be extremely costly and most likely infeasible. Financing options are studied more in detail below.

4. The projection model

In order to numerically evaluate some (but not all) of these questions raised above, we have constructed a spreadsheet model which can represent alternative policies and external environments surrounding the steel industry. Ideally, industrial policy evaluation should be conducted in a general equilibrium framework. However, there is no general equilibrium model which can give sufficient details and dynamic implications for our purpose. We find more fully developed econometric models, such as the computable general equilibrium (CGE) model useful for some limited purposes but too general and static for evaluating the concrete questions raised above. We therefore opt for an analytically less elegant partial-equilibrium projection which can incorporate specific information we gathered on Viet Nam's steel industry. Our model consists of mutually linked spreadsheet tables: investment and financing, output and sales, costs and profits, and prices and tariffs. Tables for domestic demand, balance of payments impact, cash flow information and overall summary are also included. The projection period is from 2001 to 2030.

Our baseline projection is constructed as a relatively gradual two-track approach. In the initial years of 2001-2006, new plants[8] not directly connected with the future NISW are constructed and the TISCO/SSC rehabilitation and expansion plans are also implemented. These are essentially the same as VSC's "base case" investments in the initial years except that (i) a special steel plant and Thach Khe mine exploitation are excluded; and (ii) subsequent expansion of newly constructed plants are included in our baseline. Later,

[7] Takao Aiba at the Intensive Steel Seminar, Hanoi, October 16, 2000. If we assume VSC's annual cash flow to be USD11-13 million (precise figures are not reported), the normal commercial credit ceiling would be about ten times this amount.

[8] Two electrical arc furnace (EAF) plants (one in the north and the other in the south), a cold rolling mill (CRM), a hot strip mill (HSM), and a direct reduction iron (DRI) plant.

NISW will be built at a new port site, with the first blast furnace coming into operation in 2017 and the second in 2021. The technical specification of the NISW is the same as in the JICA 1998 master plan. Imported ore and coal are used.

In the baseline, all investments are assumed to be financed by domestic and foreign loans (suppliers or buyers credit) with equal weights. Interest rates are 7.5% for domestic loans and 10% for foreign loans, with the maturity of 10 years and the grace period of 2 years. Financial losses are covered by short-term domestic borrowing at the interest rate of 10%. Until the short-term debt due to cumulative losses is completely repaid, previous borrowings are rolled over each year. International prices of raw materials and various steel products are assumed to be the same as the averages of the 1990s. Tariffs on all steel products are within the AFTA bounds (0-5% by 2006) and tariffs on raw materials are zero.

Using this as a benchmark, we quantify the impacts of the following four major uncertainties: (i) alternative timing of NISW construction; (ii) alternative financing options; (iii) international price fluctuations; and (iv) alternative tariff policies. Unlike the standard sensitivity analysis where a key variable is increased or decreased mechanically by 5% or 10%, our analysis below is calibrated so as to represent the most realistic shock size and policy alternatives.

The model is not perfect. In addition to the partial-equilibrium characteristics mentioned above, the main ambiguities come from the rough nature of the current production and investment plans which do not specify technical and financial details. Various components of operating costs of each mill are also uncertain. We have used our best judgment to fill the information gap by consulting steel industry experts as well as the JICA master plan and the cold rolling mill F/S report. But naturally, our assumptions are subject to further revisions. Our projections of profits, debt service, balance of payments impact, etc. pertain only to new investments, and therefore do not include those made to the existing bar and wire rod rolling mills and other downstream production.

5. Quantifying major uncertainties

<u>Timing of building NISW</u>

If NISW is to be built, its timing is crucial. As noted earlier, many opinions exist on this issue. In 2000, VSC presented three investment scenarios to the government. Without revealing the details, these scenarios can be characterized roughly as follows:

- VSC's base scenario—a relatively accelerated two-track approach, with the first blast furnace (BF) operational by 2012;

-- VSC's high scenario-a single—track approach, with the first BF operational by 2010;

-- VSC's low scenario-a gradual two—track approach, with no initiation of NISW construction even by 2010.

These scenarios are contrasted with our baseline scenario explained above, which is a relatively gradual two-track approach. In order to make meaningful comparisons, the VSC scenarios must be given sufficient technical and financial details which are currently not available to the author. In addition, very little concrete information is given on the production and investment plans beyond 2010. These missing parameters and variables are supplemented by the JICA 1998 master plan, steel experts' opinions and author's estimates, while respecting the spirit of each scenario.

Figure 7 shows annual investment requirements of the four scenarios. Although cumulative investments vary somewhat across scenarios,[9] this should not be construed to mean that certain scenarios cost less than others. In our projection, two-track scenarios tend to be more costly than single-track scenarios only because the former include new plant constructions in the early years, in addition to NISW. But single-track scenarios do not properly take into account expansion and additional construction which will later become necessary. At any rate, these investment plans are open-ended. Our assumption that steel investment stops at certain future dates is arbitrary and necessitated only to keep projections manageable.

This graph (Figure 7) highlights the potential difficulty in securing funds if an accelerated investment plan is adopted. The VSC high scenario requires investing USD 700 million or more, consecutively in the relatively early years of 2005-09. Whether such large sums can be raised is highly questionable. Not only the amount is large relative to the size of the Vietnamese economy, but also Viet Nam may not have accumulated sufficient knowledge and reputation as an efficient steel producer by that time. Jumping from today's outdated technology to modern large-scale technology may be risky, and this may deter potential investors (banks, foreigners, etc.) from extending loans or FDI to Viet Nam.

Alternatively, if the VSC base scenario is chosen, annual investment will remain much lower during 2001-07 and VSC can meanwhile acquire sufficient skill to operate modern steel mills in an internationally integrated environment. If this is successfully done, from around 2007, VSC can begin large investments to establish NISW. However, if this is considered still premature and enough funds are not forthcoming, our baseline

[9] The total cumulative investment is as follows: our baseline (USD 6.75 billion), VSC base (USD 7.16 billion), VSC high (USD 6.86 billion), VSC low (USD 6.36 billion). Investments are assumed to be completed by 2015 by the earliest (VSC high) and by 2022 by the latest (VSC low).

provides a more gradual path towards building NISW. In this case, annual investment will never exceed USD 400 million during 2001-2012. The VSC low scenario is similar, but it does not include as many early investments as our baseline.

Figure 8 presents the performance of each scenario as measured by current profit (i.e., profit after interest payments but before tax). It is clear that the ambitious VSC high scenario—and to a lesser extent the VSC base scenario also—will encounter a long period of cumulative losses during 2008-2018. Our baseline and VSC low scenario do not face such a long string of large losses. Eventually, when NISW is established and debt repayments are completed, all scenarios generate substantial profits in the 2020s (if promotion is executed successfully without serious policy errors or unexpected adverse shocks). In our baseline, another small profit peak occurs around 2015 as initial investments are paid off.

For the sustainability of the overall promotion plan, it is crucial that large losses be avoided in the initial years. Since the government and VSC face severe cash constraints, and since the time horizon of bankers and foreign investors is short, accumulation of large losses will discourage further mobilization of resources into that industry, and the promotion plan will be judged a failure (even if profits are expected in the very long run).

Figure 9 shows the balance of payments impact of each scenario. Generally speaking, the faster NISW is built and operated, the larger (more positive) the balance of payments impact. This is because the positive import substitution effect of finished and intermediate steel products outweighs the increased imports of raw materials and interest payments abroad. If everything goes as planned, annual saving in foreign exchange by 2030 will be USD 1.7 billion for our baseline and VSC base scenario while it is USD 1.4 billion and USD 1.2 billion for the VSC high and low case, respectively.

Figure 10 illustrates the annual debt service and Figure 11 illustrates the outstanding debt stock for each scenario (short-term debt rollover is included in Figure 11 but not in Figure 10). Naturally, more accelerated scenarios generate earlier and higher peaks in debt service. The strikingly high debt stock for the VSC high scenario—and to a lesser extent the VSC base scenario—reflects a large number of years of cumulative losses compared with other scenarios.

It is the consensus opinion of the Japanese researchers in this group that steel investment in Viet Nam should be implemented relatively gradually in two tracks. There are four reasons for this: (i) accumulating experience and reducing financing cost; (ii) acquiring management and operational skills; (iii) maximizing the degrees of freedom in choosing from changing technology; (iv) flexibility to respond to adverse shocks.

If a commitment to build NISW with detailed specification is made today, VSC will have no such learning time or flexibility to adjust.

Financing options

Financing is the largest practical problem for VSC's investment plan. At present, the financial source and terms of any of the proposed steel investments remain unidentified. In our projection, we will tentatively adopt the following five alternative financing options. For simplicity, these options are applied equally to all investment projects within each scenario. More detail is provided in Table 1. Loan terms are the same as assumed in our baseline.

-- 50% domestic bank loans and 50% foreign commercial loans (baseline)

-- Domestic bank loans only

-- Joint venture 1, with 45% foreign share and the rest financed by government budget or VSC's retained profit, and domestic and foreign loans

-- Joint venture 2, same as above except no foreign loans

-- (Suggested by JICA 1998 master plan) a combination of budget or VSC contribution, domestic and foreign loans, and ODA.[10]

Figure 12 presents the current profit profile of each financial option. The two loan options are very similar. The two joint venture options are also close to each other and offer smoother profit paths over time, without ever recording current losses. But in the long run, VSC can share only 55% of the profit in the case of joint ventures. Figure 13 shows the balance of payments impact of each scenario. Clearly, the greater the foreign loan component, the lower the positive impact. But overall trends are similar. Figures 14 and 15 present debt service and outstanding debt stock (including both domestic and foreign debt).

But even before calculating these impacts, VSC faces a more fundamental problem of finding a willing lender. If the investment plan looks too ambitious or uncertain, or if lenders lose confidence in VSC's ability to carry out the plan against possible shocks, there may not be any banks to extend the necessary credit. There are only two ways to overcome this problem (and none is assured of its feasibility at present).

First, if the government designates the steel industry as the most important national industry and provides sufficient amounts of policy loans on a priority basis (with a lower interest rate and a longer maturity than supposed here), the financial burden of VSC is significantly eased. However, whether the steel industry

[10] ODA is no longer available for financing industrial projects such as steel. This case is for illustrative and comparative purposes only.

deserves such a privileged treatment from the viewpoint of the overall economy remains moot. The opportunity cost of diverting the financial resources of other potentially competitive industries may be quite high.

Second, if foreign partners who are willing to share the costs (and profits) of steel investment are found, Viet Nam's financial requirements especially in the initial years are reduced as the projection shows. They will also bring technology, management skills, market information, etc. On the other hand, joint ventures mean that the Vietnamese side cannot fully control the management and cannot therefore guarantee industrial promotion in the best interest of Viet Nam. Foreign partners are after their own (often short-term) profits and not necessarily the sound development of the Vietnamese economy.

If foreign loans (denominated in US dollar) are utilized, exchange risk arising from possible devaluation of the Vietnamese dong must be taken into account. The possibility of borrowing in a low-interest rate currency (such as yen) may also be studied.[11]

<u>International price fluctuations</u>

The global steel market exhibits medium-term cycles (Figure 16). In Asia, the most recent price peak occurred in 1995 and the subsequent bottom was reached in 1999. Since late 1999 the market began to recover.[12] Prices of various steel products are highly correlated, and the price margin for each production process (scrap to billet, billet to bar/wire rod, slab to hot roll, hot roll to cold roll, cold roll to galvanized sheet, etc.) has fluctuated around constant means during the 1990s.[13] For all intermediate processes and at all times, price margins have remained positive. As noted above (Figure 4), except for long products and scrap metal, the Vietnamese steel market is currently well integrated with the global market. The Asian and European steel markets are closely related but not perfectly integrated; the prices in these markets sometimes deviate from each other.[14]

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[11] We have calculated the impact of borrowing in yen instead of US dollar. If the foreign loan component (50% of financing in our baseline) were borrowed in yen-denominated long-term commercial credit, and if the yen appreciated 5% per annum on average against the US dollar (with historically typical fluctuations), the current profit would be reduced by a cumulative USD 1.358 billion, with the largest annual loss of USD 175 million recorded in 2019, relative to the case where the yen did not appreciate in the long run. For this simulation, we assumed the maturity of 10 years, grace of 2 years and the interest rate of 4% for yen borrowing.

[12] However, the price of hot rolls continued to decline significantly in 2000.

[13] Using monthly Korean export and import prices, price margins for various production processes during January 1990-December 1999 were calculated as follows. The unit is USD/ton: billet (mean 97.6, standard deviation 24.8); hot rolled coil (mean 99.7, s.d. 29.2); cold rolled coil of thickness 0.5-1.0 mm (mean 93.0, s.d. 23.5); and cold rolled coil of thickness less than 0.5 mm (mean 137.2, s.d. 37.8).

Our baseline projection assumes that the average prices of the 1990s will continue to prevail in the global steel market (with no fluctuations). The second and third scenarios assume relatively high prices (in 1996) or low prices (in 2000) will continue to prevail for the entire projection period. However, since we know the prices will fluctuate, these fixed price assumptions are unrealistic. The fourth and fifth scenarios assume that prices will fluctuate roughly the same way as in the 1990s, with different initial phases.

Figures 17 and 18 show the results. Viewed broadly, these graphs suggest the range of fluctuation of profit or balance-of-payments that can be expected when prices behave the same way as in the 1990s and tariff protection is lowered. Year by year, both profit and the balance of payments are affected very significantly by price fluctuation. This is especially so after NISW is established and both upstream and downstream processes are integrated within the country. VSC should be prepared to ride out a profit roller coaster of at least this amplitude. That can be achieved by retaining enough profits for a rainy day, rather than becoming overconfident and squandering all profits during good times.

Needless to say, if the global steel market changes fundamentally in the 21st century for better or worse, these projections based on past patterns will have to be significantly revised.

Tariff scenarios

The future import protection policy for the steel industry remains unclear. Here, for the purpose of projection, we assume the following five tariff scenarios (with immediate removal of NTBs). For more details on assumed tariff rates, see Table 2.

-- AFTA scenario: all tariffs are reduced to 0-5% by 2006 and applied to all imports;[15]
-- No protection (0%): any remaining tariffs and NTBs are removed by January 2001;
-- Permanently high protection—30% tariff is maintained for downstream products, with cascading (lower) tariffs for other products (currently zero tariffs are raised when domestic production begins);
-- Permanently moderate protection—same as above except the maximum tariff is 15%.
-- Temporary moderate protection—same as above except tariff rates are gradually lowered to 0-5% during 2012-2016.

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[14] Using price data from January 1994 to March 2000 and with lag lengths determined by the AIC criterion, the following pair-wise co-integrating relationships were discovered at the significance level of 5%. For hot rolled coils, the prices of Japan, Korea, China and CIS are mutually co-integrated (except between China and Korea). For cold rolled coils with thickness of less than 0.5 mm, the Japanese price is bilaterally co-integrated with Korean, Chinese and CIS prices, but co-integration among the latter three was not detected.

[15] For the purpose of projection, we assume that these tariff rates apply to all imports, not just imports from other ASEAN countries.

Current profit for each tariff scenario is shown in Figure 19. Naturally, high protection gives the steel industry much larger profits. However, two considerations must be added in evaluating these results. First, because of the international commitments to AFTA and (future) WTO, it is very difficult for Viet Nam to maintain high or even moderate tariffs on steel products permanently without damaging diplomatic and economic relations with major trading partners. Second, domestic steel-using industries will also be hurt by high or permanent protection. From the perspective of the overall national economy, excessive steel protection is not necessarily optimal (this point must be analyzed more deeply in the future).

Because of these reasons, permanent protection of steel is neither permissible nor desirable. Under these circumstances, it can safely be said that the only realistic tariff option for Viet Nam's steel industry is either the first (observing AFTA) or the last (temporary moderate protection). Their effects converge after 2016, but until then, temporary protection can provide a margin of safety above the AFTA rates for the domestic steel industry. The size of this margin is indicated in the graph. It is not very large, but it can prevent VSC from running current losses. Beyond this, the steel industry should not expect any protection on a permanent basis. All future investments should be made under the assumption of free trade in principle.

However, this does not rule out the possibility of temporary safeguard or anti-dumping measures if the domestic industry is suddenly and severely injured for unexpected external reasons. Possible sources of such injuries may include regional currency crises or intense underpricing by some CIS countries. If dumping, export subsidies, or other unreasonable behavior by foreign competitors are detected, the Vietnamese government should take adequate protective measures within the constraint of AFTA and WTO. Detailed suggestions on the preparation for such contingencies must be given separately.

6. Concluding remarks

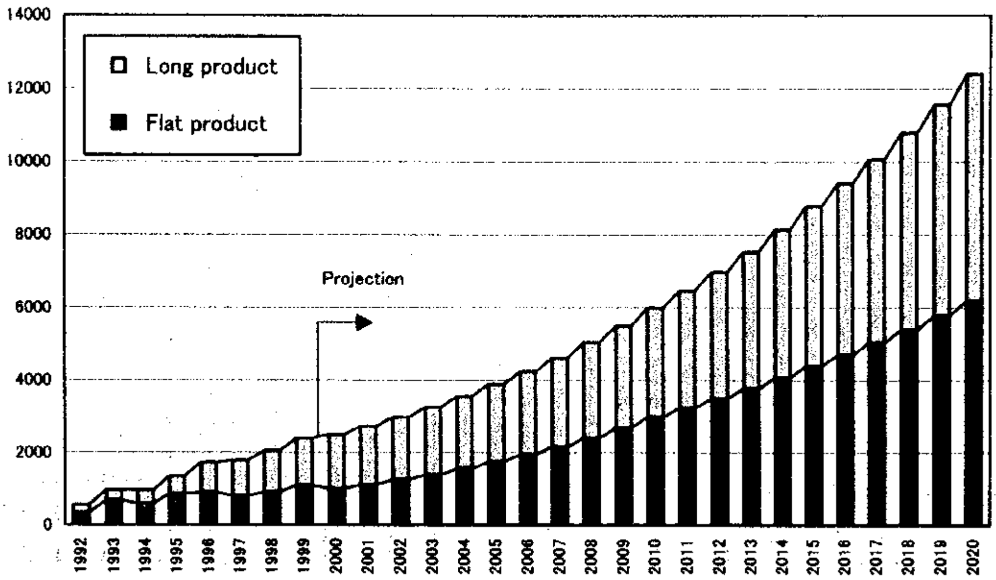
This paper has graphically presented the profitability of steel investments (including NISW) under various alternative scenarios. While our baseline projection is not to be taken as fixed or final, relative effects of alternative policies or external conditions should serve as a useful input to policy making. Two final remarks are in order.

First, our projection model can evaluate various quantifiable risks, but significant incalculable risks also exist. Most serious among them are policy errors committed through misjudgment or political pressure. In public policy, both economic efficiency and social considerations (e.g., job security, income distribution, regional equity, etc.) are important, and proper balance between them must be struck. However, international integration imposes a severe constraint on trade and industrial policy by shifting the terms of trade-off towards economic efficiency, as inefficient enterprises are no longer permitted to survive. Pursuit of social goals without regard to economic efficiency will now be punished by a heavy financial burden on the national economy. Accordingly, policy makers are compelled to avoid decisions that would lead to technical fragmentation and low competitiveness. Use of domestic raw materials, timing and location of new mills, and choice of technology must be carefully evaluated from this perspective.

Second, studying the steel industry alone is not enough. Priority industries must be selected from the broader context of the overall national economy. Industries compete with each other for limited human and financial resources. A large investment in steel might displace investment in other industries which have equally high (or higher) returns. The government should have an operational mechanism for proper allocation of public and private resources among competing industries. While abstract theory and complex econometric models can make general points, they are less helpful in actual, concrete decision-making. One possible method is to conduct very detailed studies of all candidate industries, in addition to steel, and let supporters of each industry debate on the merits and demerits of alternative investment strategies with the government acting as a referee. If such a forum existed, there would be a constant incentive for each industry to produce deeper analysis and design a more realistic promotion plan.

Figure 1 Steel demand projection

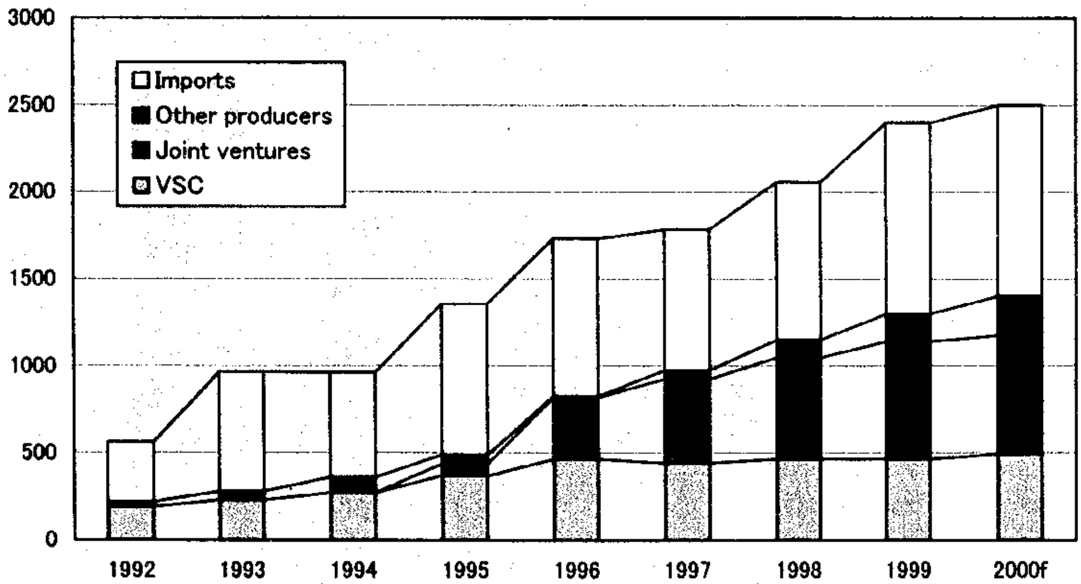
(Thousand tons)



Source: Projection by JICA expert and JICA F/S team as of May 2000.

Figure 2 Final products: production and imports

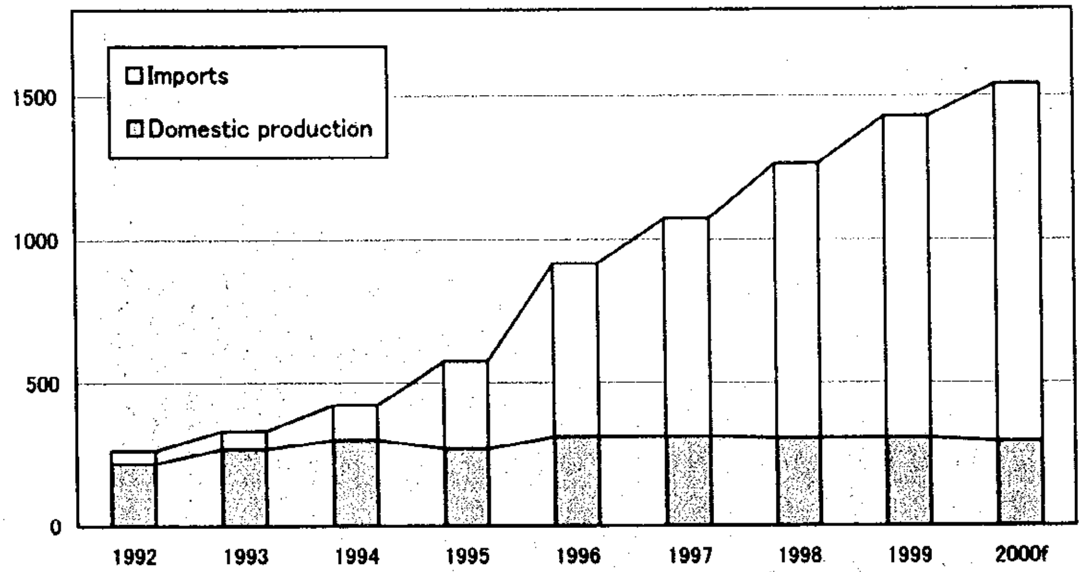
(Thousand tons)



Source: VSC

Figure 3 Billets: production and imports

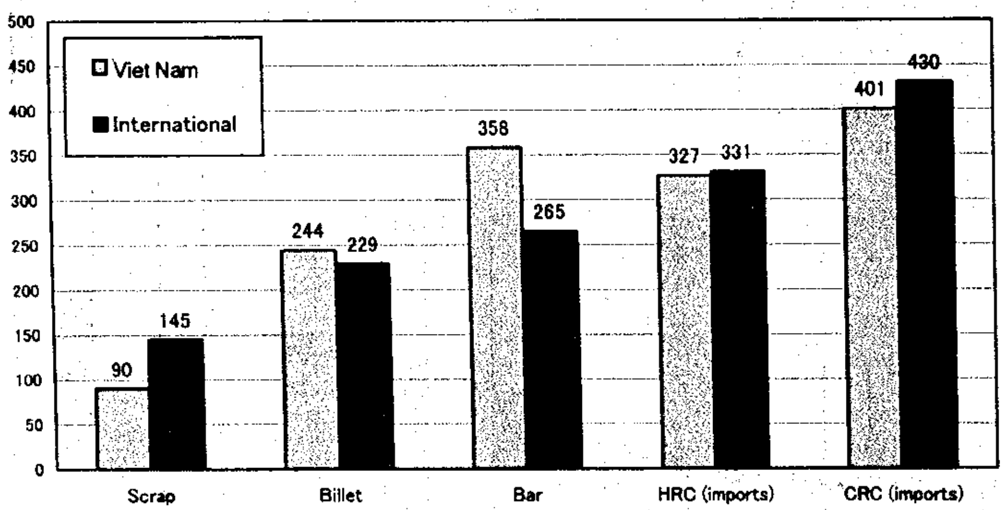
(Thousand tons)



Source: VSC.

Figure 4 Price comparison: average 1994-99

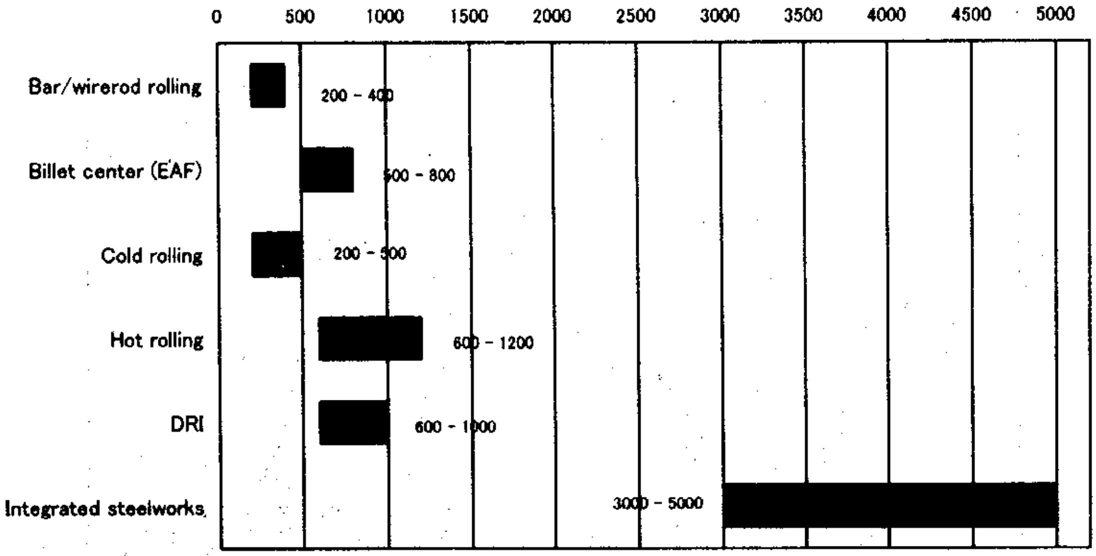
(USD per ton)



Sources: Vietnamese prices are from VSC; For international prices, Korea's import prices (scrap and billet) and export prices (bar, HRC and CRC (0.5-1.0mm)) are obtained from Korean customs statistics.

Figure 5 Appropriate production capacity of medium-sized mills

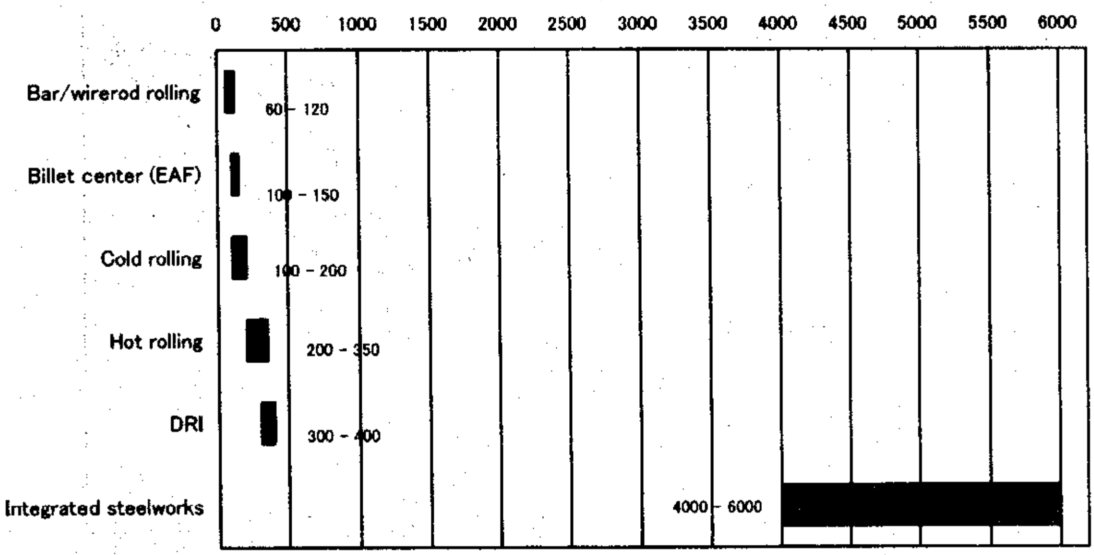
(Thousand tons per year)



Source: Author's estimate based on information by JICA expert and F/S team and in light of Viet Nam's circumstances.

Figure 6 Initial investment

(Million dollars)



Source: Author's estimate based on information by JICA expert and F/S team in light of Viet Nam's circumstances.

Figure 7 Alternative investment plans

(Annual investments in millions of USD)

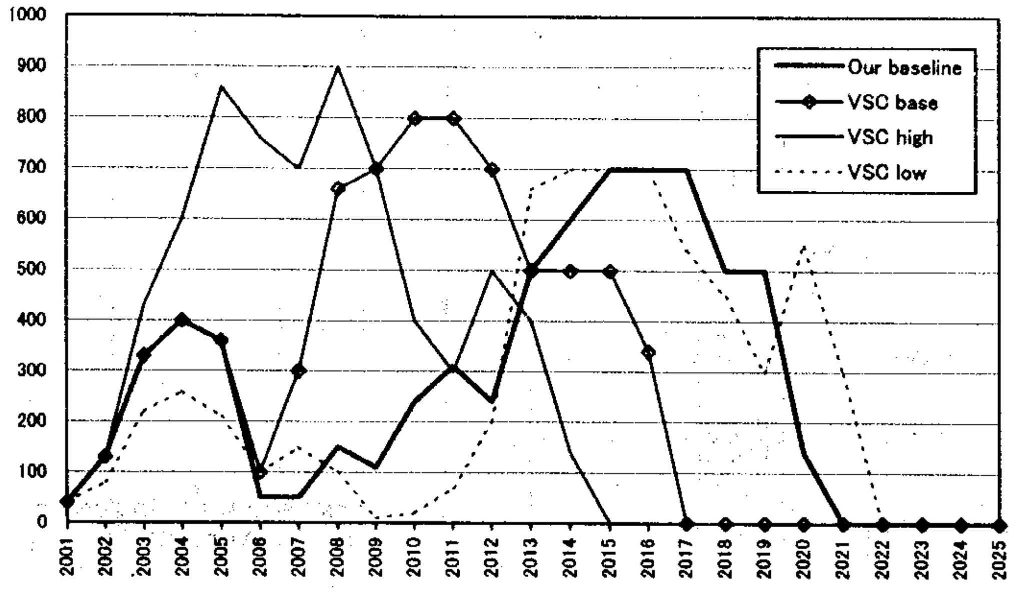


Figure 8 Current profit

(USD million)

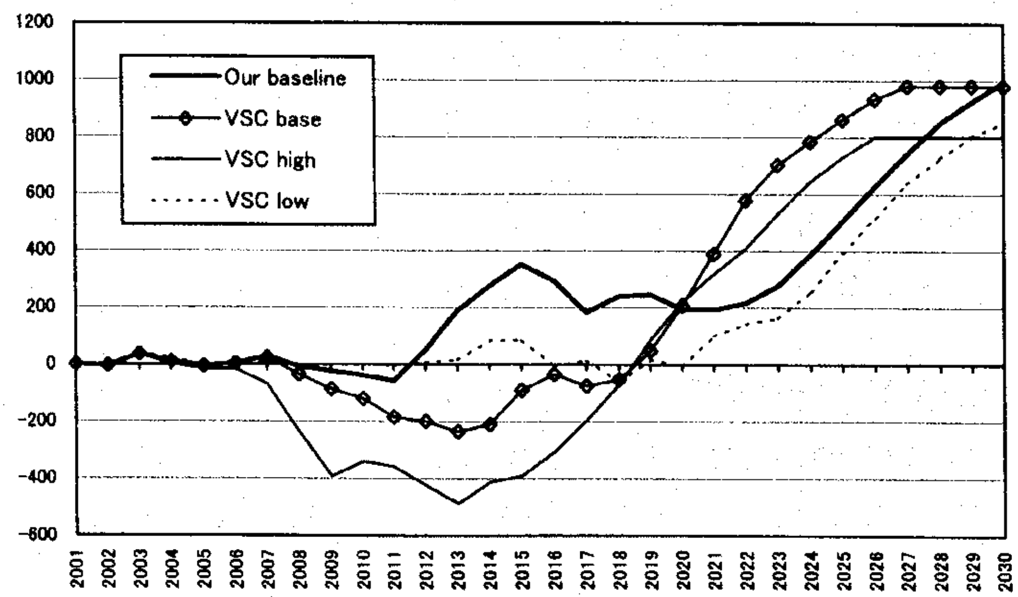


Figure 9 Balance of payments impact

(USD million)

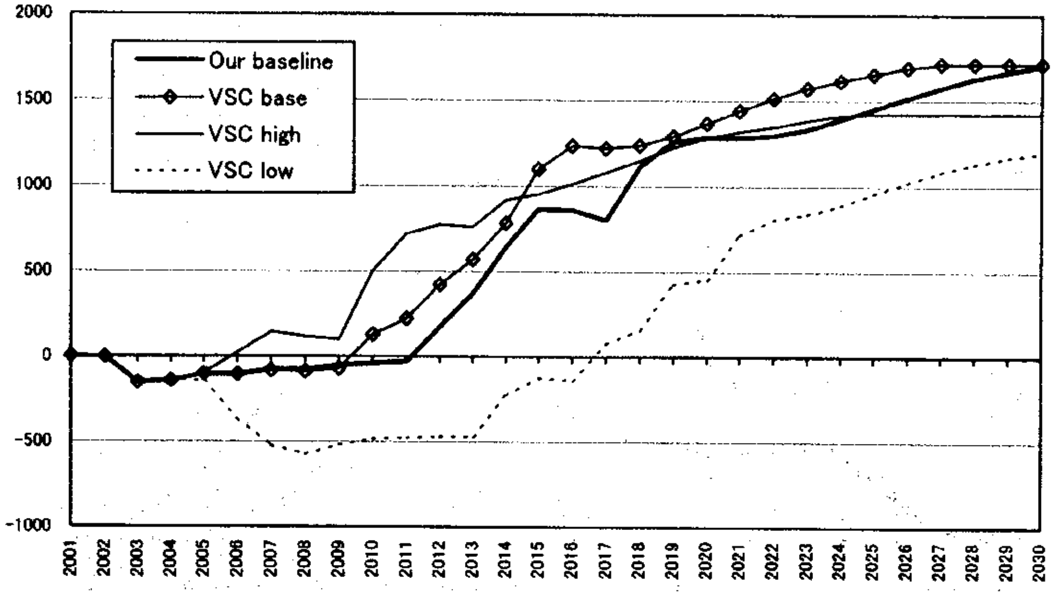


Figure 10 Debt service

(USD million)

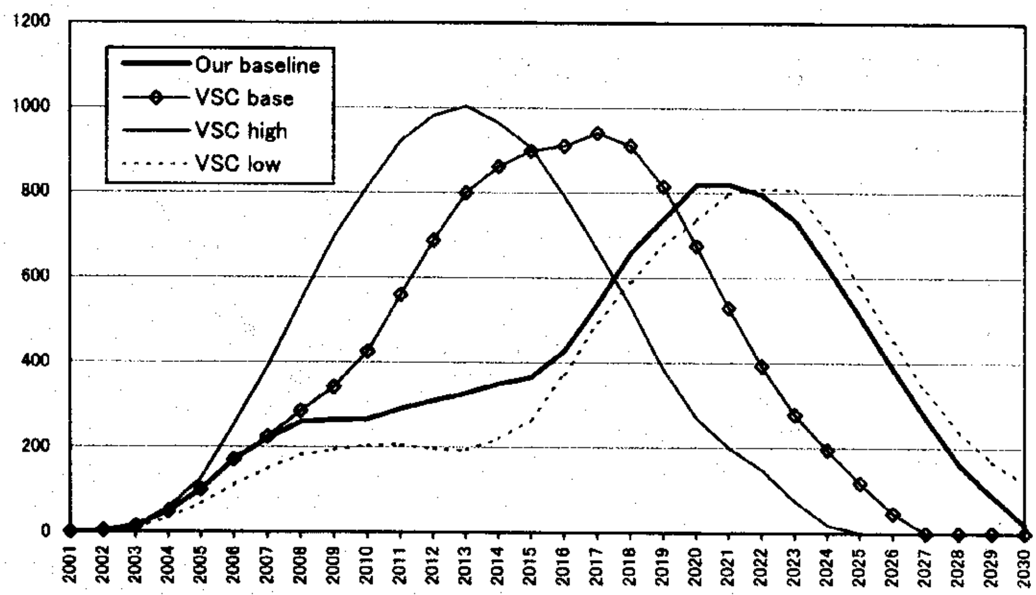


Figure 11 Debt stock

(USD million, including short-term and long-term, domestic and foreign)

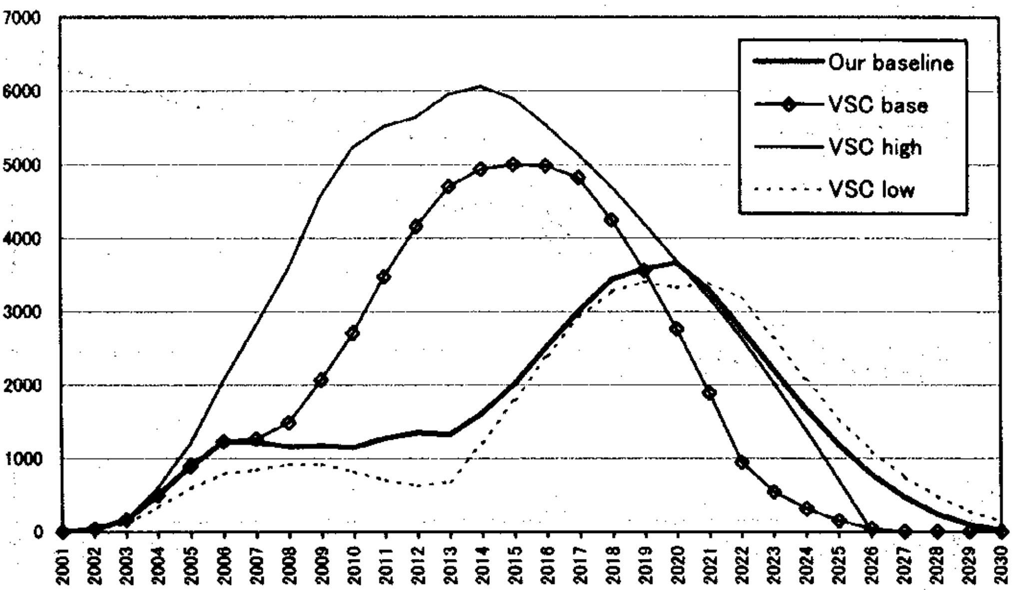


Figure 12 Current profit

(USD million)

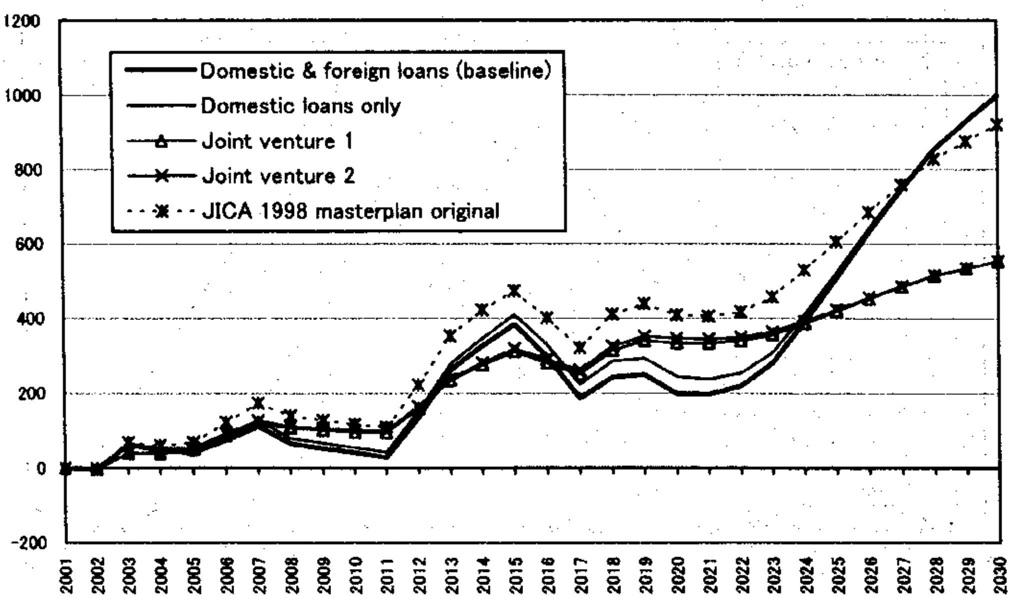


Figure 13 Balance of payments impact
(Improvement in USD million)

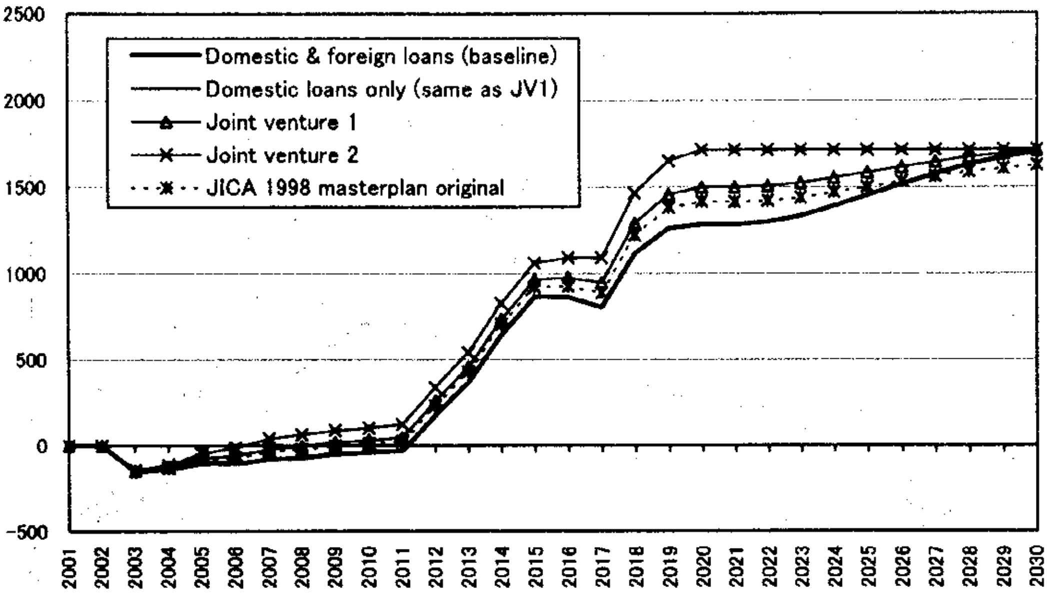


Figure 14 Debt service
(USD million)

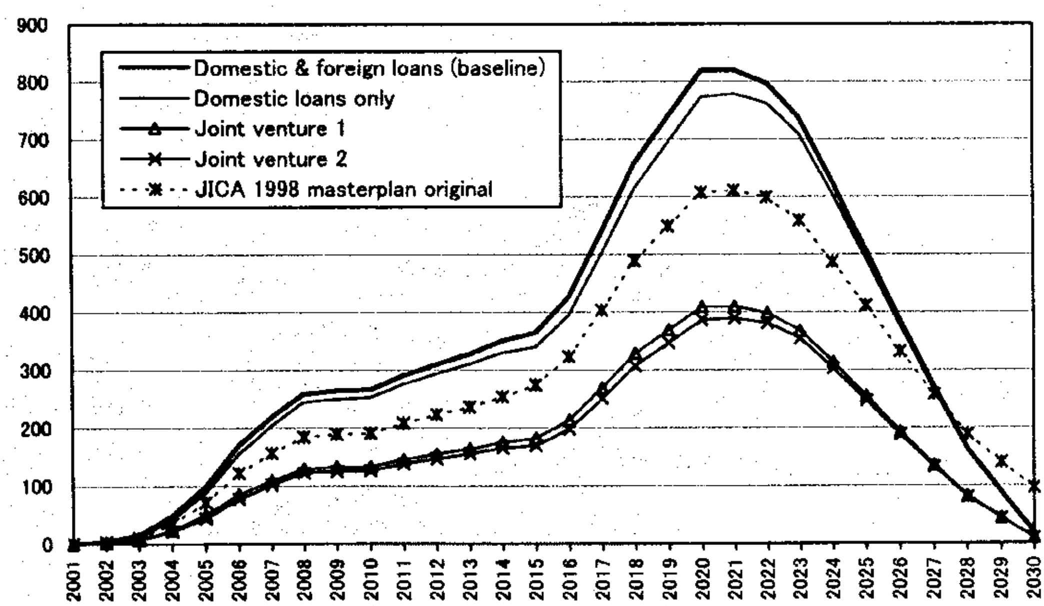


Figure 15 Debt stock

(USD million, including short-term and long-term, domestic and foreign)

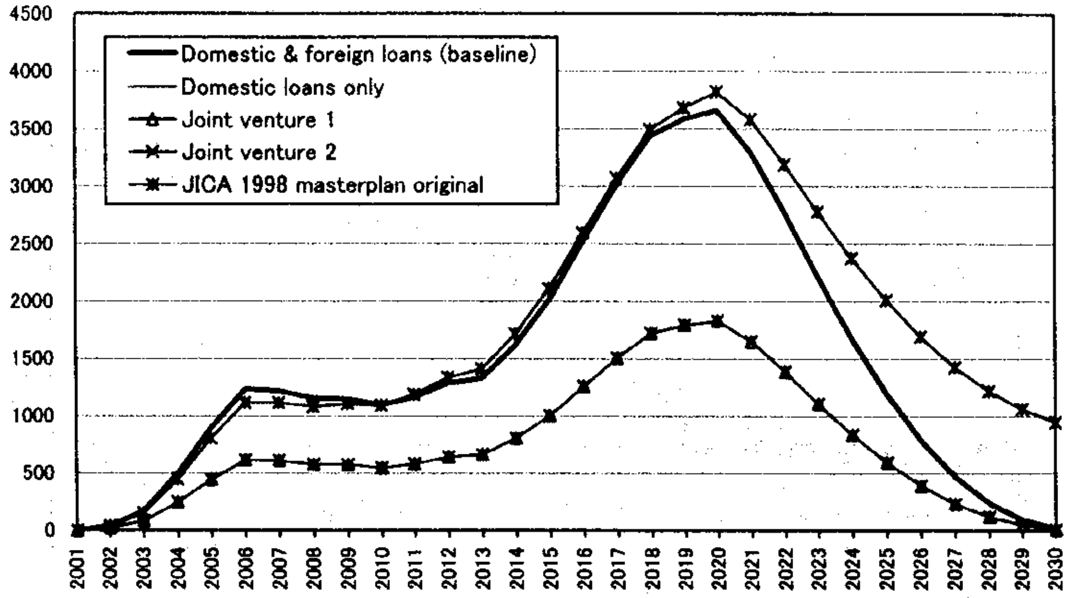


Figure 16 International price movement (actual)

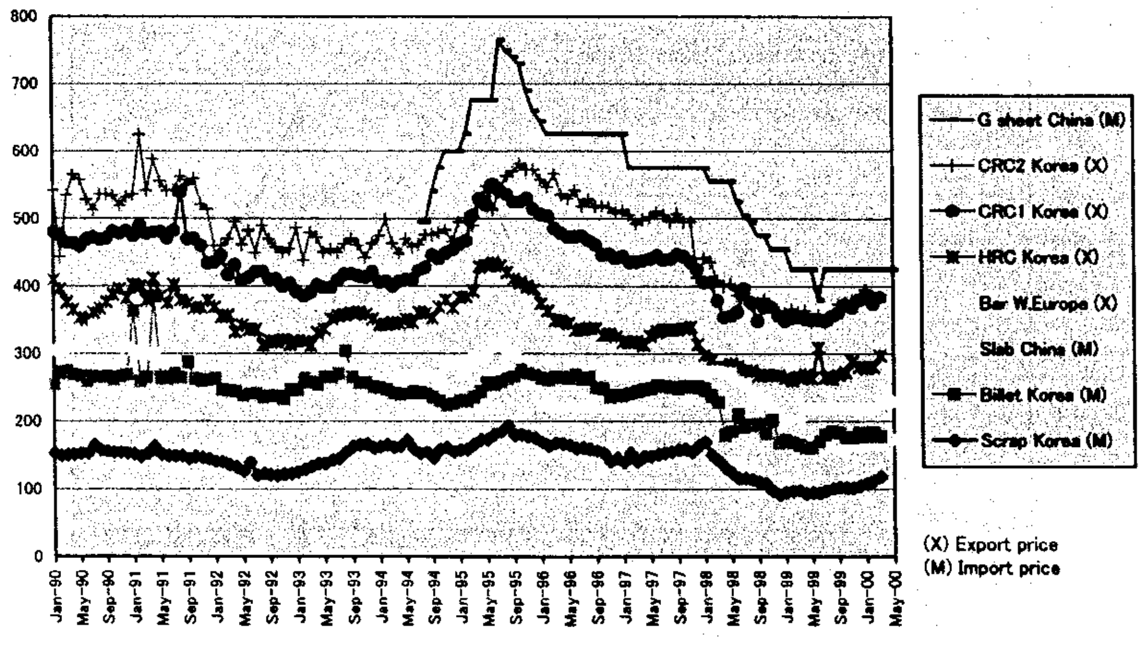


Figure 17 Current profit

(USD million)

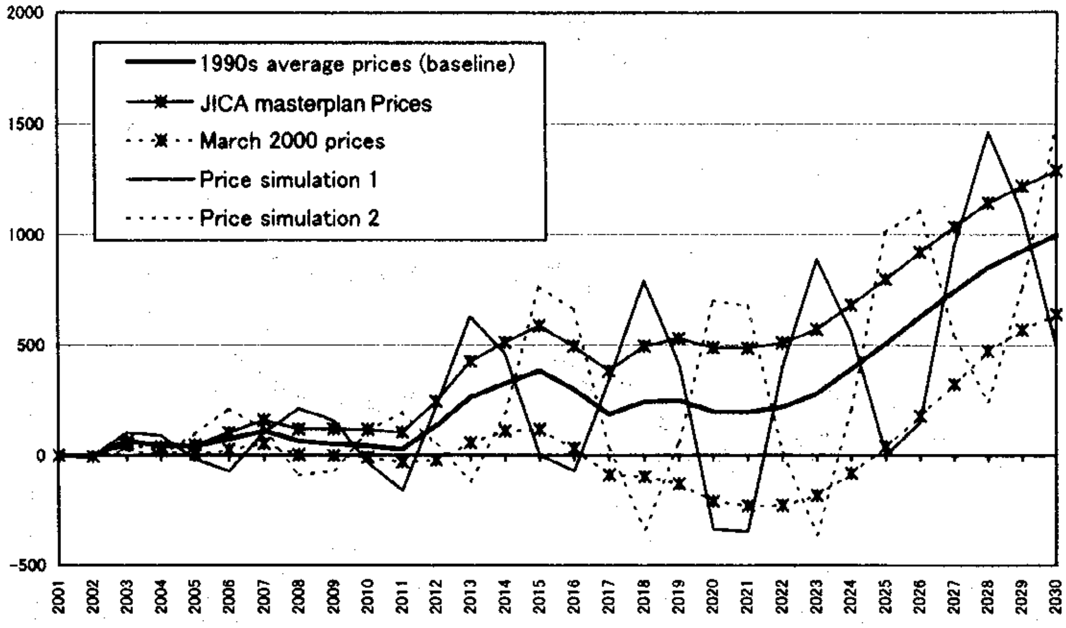


Figure 18 Balance of payments impact

(USD million)

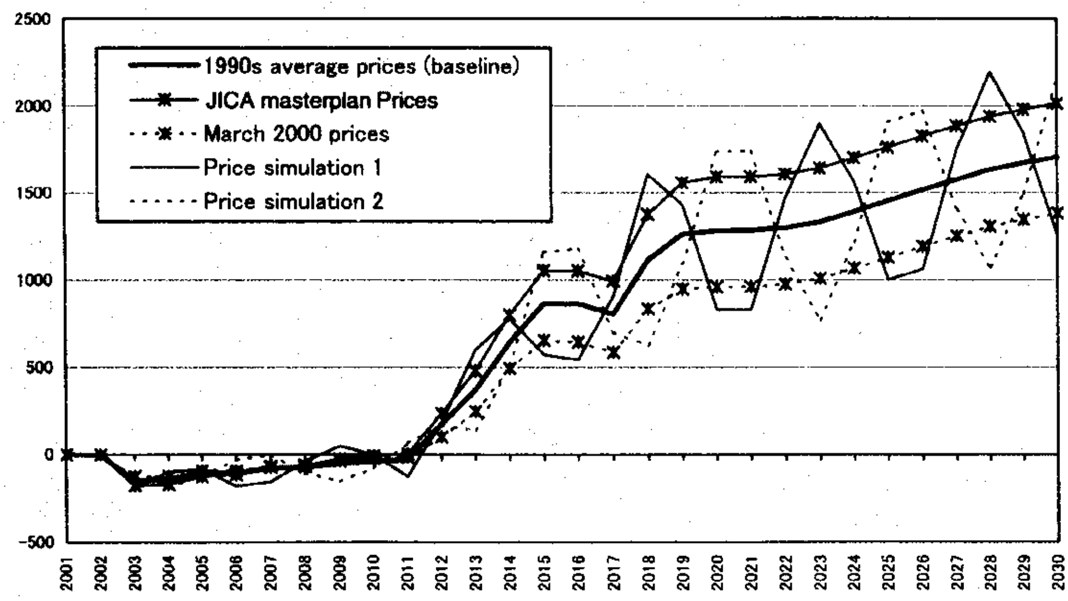


Figure 19 Current profit

(USD million)

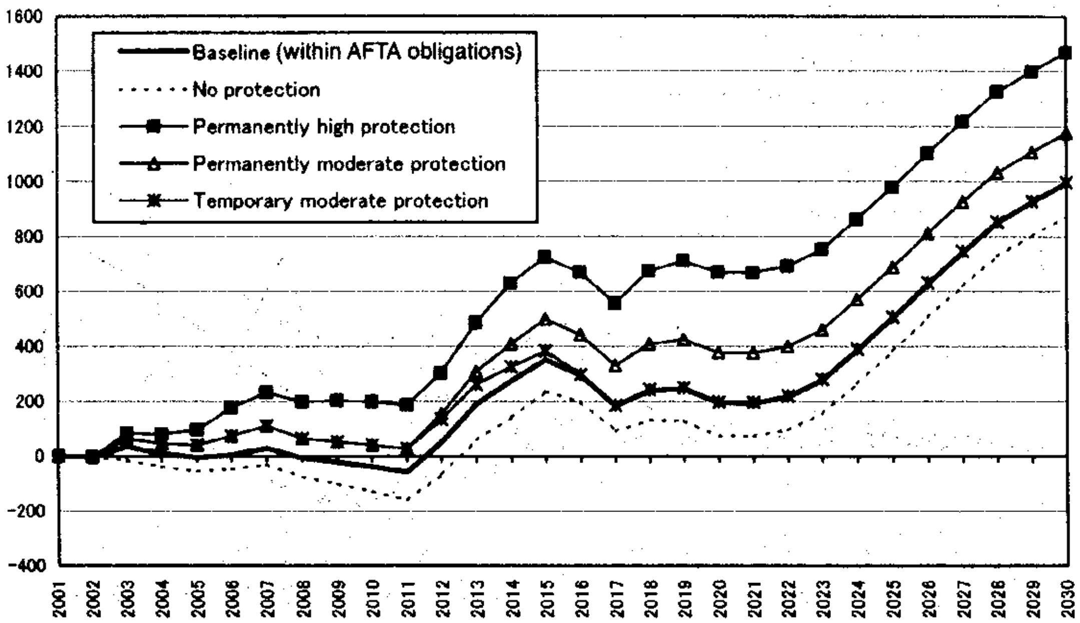


Table 1 Alternative financing options

	<Plan 1> Domestic & foreign loans	<Plan 2> Domestic loans only	<Plan 3> Joint venture 1	<Plan 4> Joint venture 2	<Plan 5> Original JICA master plan
Percent of total financing					
Equity	0%	0%	5%	5%	10%
Foreign partner	0%	0%	45%	45%	0%
Domestic loan	50%	100%	25%	50%	40%
Foreign commercial loan	50%	0%	25%	0%	30%
Foreign concessional loan	0%	0%	0%	0%	20%
Interest rate					
Domestic loan	7.5%	7.5%	7.5%	7.5%	7.5%
Foreign commercial loan	10.0%	...	10.0%	...	10.0%
Foreign concessional loan	...	...	...	...	1.8%
Maturity and grace period					
Domestic loan	M10/G2	M10/G2	M10/G2	M10/G2	M10/G2
Foreign commercial loan	M10/G2	...	M10/G2	...	M10/G2
Foreign concessional loan	...	...	...	...	M25/G10

Partner gets 45% of profit

Table 2 Tariff assumptions (percent)

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	…
Baseline (within AFTA obligations)																						
GI	Reduce gradually to 5% (AFTA)	30.0	25.0	20.0	15.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
CR	Raise to 15% in 2003 then reduce	0.0	0.0	15.0	10.0	7.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
HR	Raise to 5% in 2005	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Long product	Reduce gradually to 5% (AFTA)	30.0	25.0	20.0	15.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Billet	Keep at 3%	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Slab	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ore	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scrap	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No protection																						
GI	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HR	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long product	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Billet	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slab	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ore	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scrap	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanently high protection																						
GI	Maintain at 30%	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
CR	Raise to 25% in 2003	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
HR	Raise to 20% in 2005	0.0	0.0	0.0	0.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Long product	Maintain at 40%	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Billet	Raise to 10% in 2016	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Slab	Raise to 10% in 2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ore	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scrap	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanently moderate protection																						
GI	Reduce gradually to 15%	30.0	27.0	24.0	21.0	18.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
CR	Raise to 20% in 2003 then reduce	0.0	0.0	20.0	17.5	15.0	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
HR	Raise to 10% in 2005	0.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Long product	Reduce gradually to 20%	40.0	36.0	32.0	28.0	24.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Billet	Raise to 5% in 2016	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Slab	Raise to 5% in 2016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Ore	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scrap	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temporary moderate protection																						
Same as immediately above except:																						
GI	Reduce later to 5%	30.0	27.0	24.0	21.0	18.0	15.0	15.0	15.0	15.0	15.0	15.0	13.0	11.0	9.0	7.0	5.0	5.0	5.0	5.0	5.0	5.0
CR	Reduce later to 5%	0.0	0.0	20.0	17.5	15.0	12.5	12.5	12.5	12.5	12.5	12.5	11.0	9.5	8.0	6.5	5.0	5.0	5.0	5.0	5.0	5.0
HR	Reduce later to 5%	0.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0	8.0	7.0	6.0	5.0	5.0	5.0	5.0	5.0	5.0
Long product	Reduce later to 5%	40.0	36.0	32.0	28.0	24.0	20.0	20.0	20.0	20.0	20.0	20.0	17.0	14.0	11.0	8.0	5.0	5.0	5.0	5.0	5.0	5.0
Billet	Same as Scenario 3	3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Slab	Same as Scenario 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Ore	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scrap	Zero tariff	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0