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UNIDO SUPPORT TO THE IRON AND STEEL INDUSTRY: THREE EXAMPLES OF TECHNICAL ASSISTANCE

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SECTORAL WORKING PAPERS

In the course of the work on major sectoral studies carried out by the UNIDO Division for Industrial Studies, several working papers are produced by the secretariat and by outside experts. Selected papers that are believed to be of interest to a wider audience are presented in the Sectoral Working Papers series. These papers are more exploratory and tentative than the sectoral studies. They are therefore subject to revision and modification before being incorporated into the sectoral studies.

Preface

This paper has been prepared by UNIDO's Sectoral Studies Branch at the invitation of the United Nations Commission for Europe (ECE) for presentation at the latter's seminar on the requirements of steel industries in developing countries, to be held at Izmir/Cesme (Turkey), 5-9 May 1986.

Contents

1. UNIDO'S ACTIVITIES IN THE IRON AND STEEL INDUSTRY: A QUICK OVERVIEW

It can be said that the iron and steel industry is a basic nation bui'ding techno-economic activity. It supplies the steel semi-finished products for the light, medium and heavy engineering industries and construction. It promotes overall economic development and economic growth of the country. It creates income, employment and other social benefits, and it provides training for workers, technicians and managers alike. In developing countries, the iron and steel industry reduces the drain of foreign currency and can be an export earner. And, from the long term point of view, it promotes self-reliance and transfer of technology thus ultimately contributing to a more equitable and efficient allocation of wealth and resources in the world.

As with other industries, the iron and steel industry is not without its problems either. It is energy intensive, there are substantial pollution issues, the technology is in some cases time worn, and the health associated risks are not always negligible. However, these less desirable aspects of the industry can, and are, minimized through technological development and responsible management. Other serious problems for the iron and steel industry include those of finance, labour and a relatively reduced demand in many developed country markets, the emergence of more and new substitutes, and the existence of over capacity in some parts of the world. Technological and economic research is applied to tackle these issues.

In 1982, UNIDO's technical co-operation expenditures under the heading metallurgical industries amounted to $9.2 million. Some 76 per cent of the total implementation came from UNDP resources. In 1983, the corresponding figures were $5.7 million and 70 per cent rising to $6.3 million and 85 per cent in 1984 and again in 1985 to $7.3 million of which some 85 per cent came from UNDP resources. A total of 150 technical assistance projects were implemented or under implementation in 1985. The metallurgical industries regularly account for between seven to ten per cent of UNIDO's total expenditures on technical assistance.

In addition to the direct technical assistance activities, UNIDO undertakes and supports research, technological transfer and investment promotion projects as well as global and regional meetings and training activities in the iron and steel sector.

UNIDO's basic role in the development of the iron and steel industry in the developing countries is of a promotional character catalyzing the co-operation between developed and developing countries. UNIDO does not engage in the construction and running of industrial plants except for pilot plants and training centres for demonstration purposes. Specifically, UNIDO's activities to promote the establishment of an iron and steel industry or to improve the operations of an existing plant or industry include:

(a) Comprehensive techno-economic pre-feasibility and feasibility studies;

(b) Appraisals of capital and production costs and contracts for the acquisition of services and equipment;

(c) Detailed evaluations of expansion and modernization plans;

(d) Technical appraisals of raw materials including their processing, benefication, agglomeration, and pelletizing of iron ore;

(e) Optimum choice of production technology, technological process and equipment including the introduction of computerized managed maintenance and energy conservation;

(f) Adaptation of technologies, processes and equipment to the conditions of developing countries;

(g) Formulation of technical assistance project documents;

(h) Investment promotion;

(i) Sectoral development planning on national, regional and interregional levels;

(j) Sectoral research on various aspects of the iron and steel industry, including energy and environmental considerations;

(k) Market surveys and projections, including assessment of export possibilities;

(l) Provision of technical training;

(m) Establishment of centres for metallurgical development and research;

(n) Provision of expert services through both short term consultant contracts and UNIDO staff; and

(o) Organization of consultation meetings in the field of iron and steel.

Two major forms of operational activity can be distinguished. UNIDO quite often contracts the services of internationally renowned technical consultants to perform pre-feasibility or feasibility studies according to Terms of Reference specified by UNIDO and the recipient Government. On a more continuous basis but in smaller dosages, UNIDO also provides technical advisory services of its specialized technical personnel including its Senior Interregional Advisers. The organization has been particularly active in providing technical assistance and promoting the establishment of mini steel plants in several developing countries, for example in

- Peoples Democratic Republic of Yemen,
- Yemen Arab Republic,
- Afghanistan,
- Zambia,
- Tanzania,
- Paraguay,
- Uruguay,
- Mozambique,
- Angola, and
- Mongolia.

In determining the economic-technical feasibility of establishing an iron and steel industry in a given country, or expanding/improving an existing one, many factors play an important role. Among the most important ones considered by UNIDO in its technical assistance programme is the question whether a developing country would be better off with a small iron and steel plant or an integrated iron and steel industry with an annual output in the millions of tons.

Locational issues such as in-land vis-a-vis coastal sites, access to raw material, energy, labour, and markets as well as the availability and cost of transport and handling facilities are all important. Even such aspects as

initial size and expansion possibilities do not depend only on projected markets and raw material availibility but also on locational attributes.

Turn-key, all-in-one installations or in-tandem installations of constituent units represent potentially viable alternatives. One is expedient while the other may present greater opportunities for maximizing the use of indigenous design, engineering, and fabrication capacities. The choice of proper technological process - conventional blast furnace and direct reduction processes or modern top and bottom blown convertor processes - depends to a great deal on the type of fuel and iron ores available. Advanced countries can and do assist the developing countries in these choices by undertaking through UNIDO appropriate surveys of the local conditions and their impact on the available choices.

Is a top-modern, highly instrumental and remote control mill justified or should a developing country install a less sophisticated but more rugged and manually operated hand mill? That depends on a developing country's resources in terms of initial capital, possibilities for continuous provision of preventive maintenance and spare parts, and the availability of skilled labour. Surveys that go beyond the immediate boundaries of the iron and steel industry itself are needed to settle these questions.

Likewise, the availability of scrap and ore as well as the role of auxiliary plants such as iron and steel foundries and small metal working shops need to be clarified in an initial assessment of the economic potential and impact of a domestic iron and steel industry in a developing country.

Although all of the above factors figure in most examinations by UNIDO of a given iron and steel industry or plant, it is equally clear that the relative importance of individual factors and needs differ from one developing country to another. Thus, there is no iron-clad manual or set of procedures that are followed in each case. Nonetheless, a certain routine with variations has developed over the years of UNIDO's active involvement in the promotion of the iron and steel industry in the developing world. The following write-ups of three actual projects examplify UNIDO's technical assistance activities in this field.

2. ESTABLISHMENT OF A MINI STEEL PLANT IN THE PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN (PDRY)

The PDRY is a developing country with ambitious economic and industrial plans. In the past, the demand for steel by the construction and light and medium capital goods sector has been progressively increasing. By and by, steel will be required for the continued growth of other economic and social sectors as well, adding to the total future demand for steel products in the PDRY.

At the time of the conception of this project, the imports of various steel products were 5,522 tons in 1978, rising to 13,584 tons and 19,271 tons in 1979 and 1980, respectively. These imports drained the country's foreign reserves to the tune of $2.3 million in 1978, $6.3 million in 1978 and $10.3 million in 1979.

In the PDRY large quantities of high quality scrap were thought to exist. These arise from discarded transport equipment of all sorts, from cars and trucks to all types of ships and barges. Although these reserves of steel scrap could no doubt be sold on the international market for a high price, they could also be collected for use as raw material for a mini steel mill. A priori it appeared that the value added gained through the conversion of the scrap into new steel products needed by the economy could contribute significantly more to national income than would the mere export of the scrap. It was therefore concluded that it would be worthwhile investigating the feasibility of establishing a modest steel nucleus within the country to produce initially only relatively simple construction steel.

UNIDO in consultation with the government drew up a project document and related Terms of Reference for an appropriate pre-feasibility study to be financed from UNIDO's Special Industrial Services (SIS) funds. Following international competitive bidding the study work was awarded to a consulting engineers firm from the Federal Republic of Germany. UNIDO's contribution in dollar terms to the project amounted to $39,774 in all.

A three-member team from the consulting engineers undertook field investigations in the project area, subsequent to a briefing by UNIDO in Vienna. The team also made visits to selected locations where the mini steel complex could possibly be installed. A few of the most important scrap dumps were visited to determine the quantity and quality of scrap that would be available for sustained operations of the mini steel mill.

The projected demand for the years 1985, 1990 and 1992 were 16,000, 24,000 and 27,000 tons, respectively. Ninety per cent of this would be in the form of bars, rods and sections. Based on this, the envisaged finished steel production at the proposed mini steel complex was to be 20,000 tpy comprising the following:

	Size, mm	tons/year
Reinforced bars and rods	10-25	18,000
Flat bars	18-50	1,000
Angles	50 x 50 (max)	1,000
Total		20,000

Based on the available scrap in the PDRY it was estimated that plant operation at the envisaged level could be sustained over a period of at least 10 years. Of the other major raw materials required for the plant operation, limestone would be locally available. Other materials such as iron ore, ferro-silicon, ferro-manganese, aluminium and flourspar would have to be imported although the quantities are not very large and this was not expected to pose a major problem for the PDRY.

The recommended process route is the electric arc furnace -continuous casting- rolling. The continuously cast billets are proposed to be rolled by a single strand semi-continuous cross country mill. For the location of the mini steel complex, an area near Aden was recommended and an actual site was earmarked in consultation with the Ministry of Industry and Construction. From placement of orders for equipment etc., the total time required for implementation of the project was estimated to be 28 months, including

4 months of trial runs and commissioning. Preliminary work such as site surveys, soil investigation, and issuing of enquiries would take about one year from the time a firm policy decision is taken to implement the proposed project.

The financial estimates for the project at the time showed that the project would break-even at about 75 per cent of rated capacity and that the project would generate sufficient funds from the third year of operation on for repayment of long-term loans. The pay-back period of the period was estimated at about 8 years while the internal rate of return (IRR) was found to be approximately 11.5 per cent.

Based on these findings, the project was deemed feasible and a plan for action to implement the project was presented to the PDRY Government. However, since then other constraints have prevented the Government from acting on these recommendations.

3. ESTABLISHMENT OF A MINI STEEL PLANT IN THE REPUBLIC OF MONGOLIA

The Republic of Mongolia is a landlocked country that today ranks among the least developed countries. However, it is posed for rapid economic growth through well planned industrial and other economic development. In this strategy, the iron and steel sector is seen to occupy a pivotal position. In the early 1980s, the country's imports of rolled steel products were of the order of over 150,000 tons per year. These were projected to grow to 190,000 tons in 1985, to 225,000 tons in 1990, and 370,000 tons by the year 2000. The foreign exchange spent on imports of steel bars and rods for construction alone were projected to amount over a 10 year period to $0.5 billion at constant 1983 prices. While the imports of steel products were rising the iron and steel scrap resources and reserves in the country were also accumulating. In the early 1980s, the internal collections of scrap exceeded 60,000 tons per year and were projected to increase to 70,000 tons in 1985, to 114,000 tons in 1990, and to 183,000 tons per annum by the year 2000. A small fraction of this scrap was being exported to neighbouring countries while the rest was building up in stocks representing a significant potential reserve for a mini steel mill in Mongolia.

The heavy imports of steel products together with the projected demand for such products and the growing supply of scrap favoured the undertaking of a thorough study of the feasibility of a mini steel mill with an annual capacity of about 100,000 tons per year. To cover the contracting component of such a study, estimated to cost $70,000, UNIDO approached individual member countries regarding the possibility of obtaining a Special Purpose Contribution for the project. The remaining components ($14,750) of the proposed project were to be financed from General Purpose Convertible Contribution funds of the United Nations Industrial Development Fund (UNIDF). In the end, however, the project was financed entirely from UNIDF funds.

The immediate objectives of the project were specified as follows:

(a) Provide technical assistance and promote the establishment of a mini steel plant in Mongolia based on:

- Maximum utilization of national resources such as available iron and steel scrap, water, power, limestone etc;

- Optimum choice of technology for the production of steel in a mini steel plant and the application of the latest appropriate technological innovations and developments;

- Formulation of a requisite steel product mix;

- Detailed study of the home market over the next 15 years; and

(b) Formulate a capital financing plan for the mini steel plant taking into account suppliers' credit, bilateral financial aid and other assistance.

The actual feasibility study was carried out by a consulting engineers firm from the Federal Republic of Germany, selected by UNIDO from a short list approved by the Mongolian Government.

In December 1984, a three-member team from the consulting engineers undertook a field investigation in the project area. The draft report was submitted to UNIDO in May the next year and, following discussions among the Government, UNIDO and the consultants, the final report was ready in July 1985, some eight months after commissioning.

The study showed that the proposed mini steel mill is techno-economically and commercially viable. It was estimated that through the operations of the plant, Mongolia would save annually $35 million in foreign currency. The products of the plant - reinforced and plain bars, and small angles - could be supplied to consumers at prices 30 per cent lower than the prevailing prices for imported steel goods. The plant would directly employ 336 people and indirectly many more as it was clear that local manufacturing activities would be stimulated through the lower prices for steel products. The installation of the plant would increase the utilization of available raw material resources in the country.

The recommended plant capacity in terms of finished steel products was 100,000 tons per year broken down as follows:

	Size, mm	tons/year
Reinforced bars and plain bars	10 - 40	80,000
Angles	65x65 (max)	20,000
Total		100,000

The major raw material for the proposed steel plant would be steel scrap, the total annual requirement being about 119,000 tons. It was envisaged that this demand could be met from domestic sources, including plant return scrap. Limestone of required quantity and quality would be available from domestic sources. Other materials such as ferro-alloys, aluminium, petroleum, coke etc. would have to be imported. Although there exist several iron ore deposits in Mongolia, few are situated near the proposed site and further analysis is needed before their suitability for the proposed mini mill could be determined. Similarly, tests are necessary before the suitability of Mongolia's extensive deposits of coal for use as reductant can be evaluated.

Steel scrap would be used in an arc furnace for the production of liquid steel. Continuous casting was recommended for the production of billets. For this, the widely used curved mould machine was suggested. Considering the required plant capacity, a continuous bar and section rolling mill was recommended.

Three alternative plant locations were considered. Based on raw materials, assembly cost, product distribution cost, sustained availability of water, and the Government's emphasis on an agrarian/industrial economy, one of the sites was suggested. The design allowed for future expansion of the steel melt shop through additional arc furnaces and continuous casting machines. There were also provisions for a future installation of a ladle furnace.

Based on preliminary design estimates, it was envisaged that from the go-ahead date, the plant could be commissioned in 36 months.

Based on a selling price 10 per cent lower than the prevailing price for imported bars and angles, and certain assumptions regarding the cost of borrowed capital, the financial analysis at the time showed break-even at about 50 per cent of the rated capacity. The plant would be in a position to repay short term loans from the second year of operation and long term loans from the third year on. The pay-back period of the proposed project was estimated at about 6 years. The internal rate of return over a 20 year period of operation was estimated at 12.6 per cent.

Following the completion of the consultant engineers' draft report, UNIDO approached the international investment banks regarding Mongolia's possibility of obtaining a loan for the purpose of acquiring equipment for the proposed mini steel plant. Favourable offers in principle were obtained which were taken into account in the preparation of the financial analyses for the final report.

Following the completion of the pre-feasibility study, a follow-up project was undertaken with UNIDO assistance:

- To formulate specifications for equipment, machinery and auxiliaries for the proposed mini steel plant in Mongolia in accordance with the requirements of the principal lending institution; and

- To co-ordinate financial arrangements and prepare contractual terms for the major equipment suppliers, and to prepare a working plan for the acquisition, installation and commissioning of equipment and machinery.

Concurrently, a follow-up large scale project to provide assistance for the establishment of an experimental mini steel plant in Mongolia is in the planning stage for the next UNDP Country Planning Cycle starting in 1987 with a suggested UNDP input of $2.4 million. UNIDO also proposed that the establishment of a foundry demonstration plant as well as the participation of Mongolian nationals in the Foundry Training Program in Poland be considered for financing.

4. CHOICE AND FORMULATION OF TECHNOLOGICAL PROCESS ROUTES FOR IRON AND STEEL PRODUCTION IN BOLIVIA

Bolivia has one of the largest iron ore deposits in the world, proved to exceed 42 billion tons of iron ore containing 54 per cent Fe and between 15 to 20 per cent silica. Such ore can be economically beneficiated through optimum grinding and wet magnetic separation cycles to yield a grade concentrate that can be pelletized. In addition, Bolivia has abundant reserves of natural gas in the Santa Cruz area.

The demand for steel products in Bolivia has been steadily growing in recent years. The annual imports of steel products in the early 1980s amount to some $15 million and this is expected to grow as the national economy develops.

Despite these facts there were lingering doubts about the economic feasibility of working the Mutun iron ore deposits on a large scale in the near future. Therefore, in 1984 UNIDO's Inter-regional Advisor in Metallurgy together with the appropriate Government officials and the UNDP Resident Representative formulated a so called Special Industrial Services (SIS)[1/] project proposal to assist in the choice and formulation of technological process routes for iron and steel production in Bolivia based on domestic raw materials and natural resources.

The immediate objective of this project was to prepare a comprehensive plan for the phased growth of the iron and steel industry in Bolivia based on:

- Maximum exploitation and metallurgical utilization of the country's mineral wealth and other resources, such as natural gas and hydro power;

- Optimum choice of technology and technological process routes, including the latest appropriate technological innovations and developments;

1/ SIS funds are confined to a narrow range of expert services provided for unexpected high-priority projects that are called for from time to time. The programme is restricted to short-term projects of limited cost. During recent years $3.5 million have been set aside annually to support the programme.

- Detailed study of the current and projected domestic market and of export possibilities over the next 15 years;

- Alternative sites and related locational issues;

- Export of Mutun iron ores to Argentina in exchange for steel billets for re-rolling in Bolivia;

- Rail transport of Mutun iron ores to the Santa Cruz gas fields where an optimum sized plant could be established for the production of directly reduced sponge iron using natural gas in an electric arc furnace;

- Utilization of Mutun iron ore in the Mutun region itself using charcoal (carbonized from wood) in a blast furnace;

- A proper steel product mix given the requirements of the domestic market; and

- A capital financing plan that takes into account bi- and multilateral economic and technical assistance, and other aid such as transfer of technology, expatriate services, and human resources training.

The initial project design envisaged a steel plant that in the first phase would have a capacity between 150,000 to 200,000 tons per year. This would be raised to 300,000 to 400,000 tpy by the addition of a second module later on.

Alternatively, a re-rolling mill might be set up to handle steel billets imported from Argentina in exchange for the export of Mutun iron ore currently taking place.

The project was approved in early 1985 for Special Industrial Services funding at a total cost of $72,500 comprising $7,500 for a UN technical expert, $62,500 for consulting services and $2,500 for study tours. The total duration of the project was set at 5 months.

After competitive international bidding, the implementation of the project was awarded to a Spanish consulting company. Following their study of the local conditions according to the project plan, the consulting engineers analyzed two alternatives for the production of liquid steel: (1) Blast furnace with charcoal for pig iron, later on refined into steel through an LD converter, and (2) Sponge iron (DRI) obtained through a direct reduction process followed by melting and refining in an electric arc furnace. These alternatives were then compared to the third alternative identified in the project proposal, namely direct rolling of imported billets.

For the two first alternatives, the consumption of iron ore and/or scrap was calculated and the relative economics, given different proportions of ore to scrap and domestic prices, were compared. Similarly, the production costs for producing liquid steel were calculated. The consulting engineers then determined that alternative 1 - a blast furnace with charcoal and LD converter - was the most economical route for the production of steel in Bolivia. This selection was heavily influenced by the low price for the lump ore to be used. In order to take full advantage of this low price, the most suitable location for the steel complex would be Mutun.

Finally it was found that for the production of 55,000 tons of rolled products per year, the rolled product fabricating cost under alternative 1 would be $79 per ton or 30 per cent lower than under the third alternative - re-rolling of imported billets. However, this is without accounting for depreciation, overhead and financing expenses that would naturally be much lower for the re-rolling alternative as the required investment would be much lower than in alternative 1.

When all costs and two hypothetical sales prices of $450/ton and $500/ton[2/] were considered, alternative 1 yielded internal rates of return of 8.3 and 16.5 per cent, respectively. The corresponding IRRs for alternative 3 were estimated at 36.6 and 51.8 per cent, respectively. The analogous break-even points were at the time estimated at 80 and 65 per cent of an average annual production of 51,340 tpy for alternative 1 and roughly one half of those for alternative 3.

In summary, alternative 1 when compared to the alternative of re-rolling imported billets required more investment and gave a higher fabricating cost. The basic advantage of the first alternative was to provide $6.9 million more in annual foreign currency savings than did alternative 3. Considering these savings and their true economic value to Bolivia, it is now expected that the country will in the near future invest in the establishment of a local sponge iron/steel industry.

2/ as compared to an average international figure of $400 per ton.

5. PLANNED UNIDO ACTIVITIES IN THE IRON AND STEEL SECTOR

In June this year UNIDO will hold the Fourth Consultation Meeting in the the Iron and Steel Industry. The main issues to be discussed at this meeting are the integrated development of the iron and steel and the capital goods sector, mastering of technology, and the financial perspectives of the iron and steel industry. The Division for Industrial Studies will continue its research programmes in the sector during the biennium 1986/87.

The technical assistance programme in the iron and steel sector will continue along established lines with emphasis on a catalyzing role for UNIDO in the furthering of the sector in the developing countries.

Abstract

The paper describes UNIDO's activities to promote the iron and steel industry in developing countries. The first section gives a general overview. This is followed by three case studies of actual projects undertaken by UNIDO.

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Q U E S T I O N N A I R E

UNIDO support to the iron and steel industry:
three examples of technical assistance

		(please check appropriate box) yes	no
(1)	Were the data contained in the study useful?	☐	☐
(2)	Was the analysis sound?	☐	☐
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