2. Iron and Steel Process

Currently, there are two main routes for the production of steel: production of primary steel using iron ores and scrap and production of secondary steel using scrap as the main raw material. A wide variety of steel products are produced by the industry, ranging from slabs and ingots to thin sheets, which are used turn by a large number of manufacturing industries. Steel production requires several steps that can be accomplished with different processes. Both the input material of each step and the process substantially affect the total energy consumed during production. The following step by step process description is borrowed from Worrell et al. [1997, Pp. 727-744] and World Energy Council [1995].

2.2.1 Ore Concentration and Coke Production

The first step in the iron-making process is the concentration and pre-treating of the iron ores. The energy consumed in this first step depends not only on the process used but also on the quality of the iron ore.

2.2.2 Ore Reduction

Ore is either pelletized or sintered as part of the production process. In the blast furnace route, which accounts for most of the global iron production, coke is used as the reducing agent and primary fuel.

2.2.3 Iron Making

In the iron-making step, ore is reduced to either pig iron or sponge iron. Pig iron production occurs either in blast furnaces where coke is the primary fuel or in the most advanced corex process using smelt reduction; sponge iron is produced in small-scale plants by direct reduction (DR) processes using syngas from fossil fuels, and it is reduced at temperatures below the melting point of iron, usually to ambient temperatures.

The conversion of ore into pig iron is the most energy-intensive stage of steel making. In a conventional integrated steel plant, pig iron is produced in a blast furnace, using coke in combination with injected coal, oil, or gas to reduce the sintered or pelletized iron ore to pig iron, which is principally used in its molten state. Limestone is added as a fluxing agent. Coke is either imported or is produced in coke ovens either on-site or off-site. Reduction of coke demand by injection of coal or other fuels such as oil or natural gas is beneficial because it reduces the energy consumed for coke making and the capital requirement for coke ovens. The amount of coal that can be injected depends on the process conditions of the blast furnace and the quality of the injected fuel [see e.g., Gudenau, 1990].
an annual capacity of 75 kt/unit [Singh, 1991], to
the largest furnaces in Russia with an annual
capacity of 4 Mt/year [Ulakhovich, et al., 1991].
The furnaces’ high temperature (about 1500°C)
and strong reducing environment (high CO
content) produce molten iron with approximately
4 per cent dissolved carbon and some silicon,
manganese, sulfur, and trace materials.
By-products of the iron produced in blast furnaces
include blast furnace gases (which can be used
for heating purposes), electricity (if top
gas-pressure-recovery turbines are installed), and
slag (used as building material).

The COREX process using smelt reduction
presents one of the most advanced ironmaking
technologies available in the world. It combines
coal gasification with reduction of iron oxides to
produce pig iron and reusable gas as a by-product.
The use of coking coal is unnecessary. COREX
technology may be beneficial in saving energy
and investment costs, while reducing
environmental pollution. As of today, worldwide,
only one operating COREX plant exists.

Sponge iron, produced by direct reduction (DR)
processes, has different properties from pig iron.
In the DR process, iron is produced by reducing
the ores using syngas from different fossil fuels
(mainly oil or natural gas; in India coal or gas
based) in small-scale plants. DR iron (or sponge
iron) serves as high quality alternative for scrap
in secondary steelmaking.

2.2.4 Primary Steel Production

Steelmaking is the reduction of the amount of
carbon in the hot iron metal to a level below 1.9
per cent through the oxidation of carbon and
silicon. Most primary steel is produced by two
processes: open hearth furnace (OHF) and basic
oxygen furnace (BOF). While OHF is an older
technology and uses more energy, this process can
also use more scrap than the BOF process.
However, BOF process is rapidly replacing OHF
worldwide because of its greater productivity and
lower capital costs. In addition, this process needs
no net input of energy and can even be a net energy
exporter in the form of BOF-gas and steam. The
process operates through the injection of oxygen,
oxidizing the carbon in the hot metal. Several
configurations exist depending on the way the
oxygen is injected. The steel quality can be
improved further by ladle refining processes used
in the steel mill.

2.2.5 Secondary Steel

Secondary steel is produced in an electric arc
furnace (EAF) or in an induction furnace (IF)
using scrap. Induction furnaces are very unique
to India. The secondary steel industry includes
so-called ‘mini-mills’, which make relatively
simple products from low-priced scrap. In
secondary steel production, the scrap is melted
and refined, using a strong electric current. Several
process variations exist, using either AC
or DC currents, and fuels can be injected to reduce
electricity use. Steel making based on external
scrap (scrap from outside the steel sector) requires
less than half as much primary energy as steel
made from ore [Ross and Liu, 1991].

2.2.6 Casting

After raw steel is produced, it is cast in preparation
for rolling and finishing. Casting can be a batch
(ingots) or a continuous process (slabs, blooms,
billets). The cast material can be sold as ingots or
slabs to steel manufacturing industries. With
ingot casting, liquid steel is cast into ingots that
are cooled, then reheated and hot-rolled into slabs,
blooms, or billets in a primary mill. The
semi-finished steel is then cooled, de-scaled, and
inspected before moving to rolling mills where it
is again reheated. In continuous casting, the
reheating step is eliminated because the molten
steel is cast directly into slabs or blooms, which
can be passed to the reheating furnace while hot.
Continuous casting is therefore significantly
more efficient in energy, yield, quality, and labour productivity as it reduces material loss and improves production time.

Ingot casting is the classical process and is rapidly being replaced by continuous casting machines (CCM). In 1993 around 70 per cent of global crude steel production was cast continuously [IISI, 1994].

2.2.7 Rolling and Finishing

In the final production stages, the rough shapes produced by casting are rolled into thin sheets, bars, profiles (heavy sections and light profiles), or drawn into pipe or wire. Generally, the steel is first heated in a hot rolling mill to just below the melting point and then passed through heavy roller sections to reduce thickness. After hot rolling, some steel sheets are processed in cold rolling mills to produce even thinner sheets, which are used in numerous applications.

Finishing is the final production step, and may include a large number of different processes including annealing (heat treatment), pickling (removal of scale, coating, and oxides), and surface treatment. The amount of energy consumed in the finishing stage is small compared to other processes.

2.3 Iron and Steel Production in India

Although iron and steel is one of the most important industries in the Indian manufacturing sector, India is only the 15th largest steel producer in the world. Originating from the first set up of a single steel plant in 1911-12, the iron and steel sector included 7 integrated iron and steel plants in 1995-96. Due to the regulatory and political development of the sector only one of these plants is in private hands accounting for about 15 per cent of total steel production. The integrated steel units usually use the blast furnace - basic oxygen/open hearth furnace process route for iron and steel production. In addition, there are about 180 secondary producers employing the electric arc furnace process. Another 500 mostly smaller units rely on other processes such as induction furnace process, melting by re-rollers, and ship breaking units. Table 2.2 lists the different process routes and their shares in India and the world for 1993.

Table 2.2. Process Routes and their Shares in Production Volume (1993)

<table>
<thead>
<tr>
<th>Product</th>
<th>Process</th>
<th>World</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Volume (Mt)</td>
<td>Share (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Iron</td>
<td>Blast Furnace</td>
<td>513</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Direct Reduction</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Steel</td>
<td>Open Hearth Furnace</td>
<td>69</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Basic Oxygen Furnace</td>
<td>431</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Electric Arc Furnace</td>
<td>225</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Source: IISI [1994, 1997].
The economics of steel production in a conventional integrated steel plant is largely dictated by the iron-making operations. This is due to the high energy requirements for the conversion of iron ore into pig or sponge iron at the iron-making stage.

Table 2.3 presents pig iron and sponge iron production over the last 12 years. Production of sponge iron through the direct reduction/hot briquetted iron (HBI) process has grown from 0.05 to 4.20 Mt between 1983 and 1995. Due to constraints in the availability of scrap for secondary steel production sponge iron has increasingly been used as a high quality substitute for scrap in electric arc furnaces. Similarly, pig iron production has expanded continuously over the time horizon.

<table>
<thead>
<tr>
<th>Year</th>
<th>Pig Iron (Blast Furnace) (1)</th>
<th>Sponge Iron (Direct Reduction/HBI) (3)</th>
<th>Total (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983-84</td>
<td>9.16</td>
<td>0.05</td>
<td>9.21</td>
</tr>
<tr>
<td>1984-85</td>
<td>9.49</td>
<td>0.08</td>
<td>9.57</td>
</tr>
<tr>
<td>1985-86</td>
<td>9.84</td>
<td>0.10</td>
<td>9.94</td>
</tr>
<tr>
<td>1986-87</td>
<td>10.46</td>
<td>0.15</td>
<td>10.61</td>
</tr>
<tr>
<td>1987-88</td>
<td>10.81</td>
<td>0.19</td>
<td>11.00</td>
</tr>
<tr>
<td>1988-89</td>
<td>11.60</td>
<td>0.19</td>
<td>11.79</td>
</tr>
<tr>
<td>1989-90</td>
<td>11.93</td>
<td>0.26</td>
<td>12.19</td>
</tr>
<tr>
<td>1990-91</td>
<td>12.00</td>
<td>0.61</td>
<td>12.61</td>
</tr>
<tr>
<td>1991-92</td>
<td>14.18</td>
<td>1.15</td>
<td>15.33</td>
</tr>
<tr>
<td>1992-93</td>
<td>15.13</td>
<td>1.44</td>
<td>16.57</td>
</tr>
<tr>
<td>1993-94</td>
<td>15.67</td>
<td>2.21</td>
<td>17.88</td>
</tr>
<tr>
<td>1994-95</td>
<td>17.81</td>
<td>2.92</td>
<td>20.73</td>
</tr>
<tr>
<td>1995-96</td>
<td>19.03</td>
<td>4.20</td>
<td>23.23</td>
</tr>
</tbody>
</table>


Table 2.4 provides information on supply of crude steel in India split up by the different process types used. The primary steel producers hold the major share in India’s overall steel production. The 7 large integrated steel plants account for more than 70 per cent of India’s steel production. Modern integrated steel units use the Blast Furnace/Basic Oxygen Furnace route for steel production. However, around 20 per cent of total steel is still produced through the technologically less advanced Open Hearth Process (see Table 2.5). Some of the major sites have both basic oxygen and open hearth furnaces.

The secondary steel sector accounts for nearly 30 per cent of India’s crude steel production. The units producing secondary steel are usually relatively small of size. They were mostly set up in the early 1970s when suddenly the gap between demand and supply widened and more capacity was needed to meet local needs.
**Table 2.4. Crude Steel Production - Process-wise**

<table>
<thead>
<tr>
<th>Year</th>
<th>Open Hearth Furnace (million tons)</th>
<th>Basic Oxygen Furnace (million tons)</th>
<th>Total Integrated Steel Plants (million tons)</th>
<th>Electric Arc Furnace Furnace (million tons)</th>
<th>Others (million tons)</th>
<th>Total (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983-84</td>
<td>5.22</td>
<td>2.81</td>
<td>8.03</td>
<td>2.20</td>
<td>-</td>
<td>10.23</td>
</tr>
<tr>
<td>1984-85</td>
<td>4.86</td>
<td>3.44</td>
<td>8.30</td>
<td>2.26</td>
<td>-</td>
<td>10.56</td>
</tr>
<tr>
<td>1985-86</td>
<td>4.93</td>
<td>3.96</td>
<td>8.89</td>
<td>3.04</td>
<td>-</td>
<td>11.93</td>
</tr>
<tr>
<td>1986-87</td>
<td>4.66</td>
<td>4.34</td>
<td>9.00</td>
<td>3.20</td>
<td>0</td>
<td>12.20</td>
</tr>
<tr>
<td>1987-88</td>
<td>4.61</td>
<td>4.88</td>
<td>9.49</td>
<td>3.64</td>
<td>0</td>
<td>13.13</td>
</tr>
<tr>
<td>1988-89</td>
<td>4.88</td>
<td>5.64</td>
<td>10.52</td>
<td>3.79</td>
<td>0</td>
<td>14.31</td>
</tr>
<tr>
<td>1989-90</td>
<td>4.63</td>
<td>5.93</td>
<td>10.56</td>
<td>4.05</td>
<td>0</td>
<td>14.61</td>
</tr>
<tr>
<td>1990-91</td>
<td>4.68</td>
<td>6.17</td>
<td>10.85</td>
<td>4.11</td>
<td>0</td>
<td>14.96</td>
</tr>
<tr>
<td>1991-92</td>
<td>4.84</td>
<td>7.48</td>
<td>12.32</td>
<td>4.78</td>
<td>0</td>
<td>17.10</td>
</tr>
<tr>
<td>1992-93</td>
<td>4.76</td>
<td>8.25</td>
<td>13.01</td>
<td>5.11</td>
<td>0.001</td>
<td>18.12</td>
</tr>
<tr>
<td>1993-94</td>
<td>4.68</td>
<td>8.61</td>
<td>13.29</td>
<td>4.83</td>
<td>0.04</td>
<td>18.16</td>
</tr>
<tr>
<td>1994-95</td>
<td>4.93</td>
<td>9.36</td>
<td>14.29</td>
<td>4.97</td>
<td>0.02</td>
<td>19.28</td>
</tr>
<tr>
<td>1995-96</td>
<td>4.11</td>
<td>11.29</td>
<td>15.40</td>
<td>5.37</td>
<td>0</td>
<td>20.77</td>
</tr>
</tbody>
</table>


The electric arc furnace is still the most common process type to produce steel from scrap. The EAF industry in India has been mainly producing mild steel grades, although it would be more than equally well suited for producing alloy and special steel. As a result, mini steel plants have been challenged by economical problems over the past years. Many plants had to close down or reduce production leading to substantial idle capacity. The economic problems were mainly due to increased power tariffs in connection with high uncertainty about steady power supply, increases in cost and quality of essential inputs, particularly scrap, not only within India but also on the world market, and uneconomic sizes of furnaces.

With increasing competition in the steel sector both nationally and internationally the small steel plants, i.e., the EAF industry, are forced to go for modernization and expansion. EAF industries have started using upgraded technology, increasing the use of sponge iron through continuous feeding, scrap preheating and other modern and more efficient features. Furthermore, the secondary steel industry has more and more turned towards the combined use of mini blast furnaces (to supply hot metal) and electric arc furnaces. This combination basically presents a new approach to integrating steel production. However, although both process routes, direct reduction/mini blast furnace and electric arc furnace, present a cheaper and more easily available alternative they require substantially more energy input than scrap use or the blast furnace/basic oxygen route.

Another secondary steel producing technology, the induction furnace, has increasingly found application in India. Among all steel producing...
countries, India is probably the only country using it on a larger scale. The reorientation towards the use of induction furnace facilities for steel making started in the late 1970s or early 1980s. Today, some of the manufacturers even shut down their electric arc furnaces to install larger induction furnaces in the capacity range of 8-12 t. Overall, its share is still very small.

Total installed capacity for integrated steel plants and electric arc furnaces is shown in Table 2.6. Capacity utilization as in other industrial sectors presents a major drawback in the Indian iron and steel sector. Capacity utilization has historically been fluctuating. From a low start in 1970-71 of 67 per cent average capacity utilization, it increased to 84 per cent in 1977-78 and declined again thereafter to around 75 percent in 1981-82. In recent years capacity utilization improved again to around 85 per cent on average. It needs to be mentioned that the range of capacity utilization between plants is considerable. In 1970-71 it ranged from 40 per cent to 86 per cent, in 1977-78 two plants even registered capacity utilization of over 94 per cent. The capacity utilization in mini steel plants is usually very low (around 56 per cent) resulting largely from an inadequate supply of scrap and power [Datt and Sundharam, 1998].

Capacity underutilization resulted in high costs of production and losses. According to Datt and Sundharam [1998] it was due to inadequate supply of coal and power, transport bottlenecks and other infrastructural constraints, lack of proper maintenance, poor management (e.g. caused by frequent changes in the top management of public sector plants), extensive labour troubles and in more recent years due to lack of demand by engineering industries like railway wagons etc. Furthermore, public units seemed to be particularly inefficient. They show continuous losses since they were set up additionally due to heavy investments on social overheads and administered prices and controlled distribution that did not allow these units to receive reasonable returns for their products.

As a result of the difficulties within the sector, India needed to import steel since 1970-71. However, the industry recovered significantly with the introduction of overall modernization as well as decontrol and liberalization efforts in both domestic steel production and import of steel items in the early 1990s. Due to higher domestic production and switch-over to higher value product mixes imports were limited over time. Today, India is able to increasingly participate in the world market - as an exporter as well as importer of steel products.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Net Import</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982-83</td>
<td>9.13</td>
<td>1.37</td>
<td>10.50</td>
</tr>
<tr>
<td>1983-84</td>
<td>8.50</td>
<td>1.36</td>
<td>9.86</td>
</tr>
<tr>
<td>1984-85</td>
<td>8.78</td>
<td>0.77</td>
<td>9.56</td>
</tr>
<tr>
<td>1985-86</td>
<td>10.03</td>
<td>0.73</td>
<td>10.76</td>
</tr>
<tr>
<td>1986-87</td>
<td>10.54</td>
<td>1.34</td>
<td>11.88</td>
</tr>
<tr>
<td>1987-88</td>
<td>11.95</td>
<td>0.86</td>
<td>12.81</td>
</tr>
<tr>
<td>1988-89</td>
<td>13.36</td>
<td>0.77</td>
<td>14.13</td>
</tr>
<tr>
<td>1989-90</td>
<td>13.40</td>
<td>0.28</td>
<td>14.12</td>
</tr>
<tr>
<td>1990-91</td>
<td>13.83</td>
<td>0.73</td>
<td>14.55</td>
</tr>
<tr>
<td>1991-92</td>
<td>14.63</td>
<td>0.23</td>
<td>14.86</td>
</tr>
<tr>
<td>1992-93</td>
<td>15.51</td>
<td>-0.08</td>
<td>15.42</td>
</tr>
<tr>
<td>1993-94</td>
<td>15.20</td>
<td>-0.28</td>
<td>14.92</td>
</tr>
<tr>
<td>1994-95</td>
<td>17.22</td>
<td>0.43</td>
<td>17.65</td>
</tr>
</tbody>
</table>

Source: Centre for Monitoring Indian Economy [1996].
Continuous casting presents the most efficient technology to-date. It is increasingly substituting ingot casting all around the world as well as in India (see Table 2.8). In Indian integrated steel plants continuous casting accounted for less than 10 per cent of output in 1986-87. By 1991, however, it had increased its share to 14-15 per cent. Generally, most of the integrated steel plants are expected to switch over to continuous casting by the end of the century. As far as mini steel plants are concerned, in 1986-87, 75 per cent of the production was continuously cast. New mini plants set up in India have 90 per cent of their steel production through continuous casting.

Table 2.8. Casting Technologies for Steel Production in India - Output and Shares

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Mt</td>
<td>0.50</td>
<td>0.82</td>
<td>1.04</td>
<td>1.39</td>
<td>1.66</td>
<td>1.83</td>
<td>2.44</td>
<td>3.01</td>
<td>3.34</td>
<td>4.18</td>
<td>7.01</td>
</tr>
<tr>
<td>(incl. strip casting) % Share</td>
<td>4.20</td>
<td>6.80</td>
<td>8.10</td>
<td>9.90</td>
<td>11.60</td>
<td>12.50</td>
<td>14.60</td>
<td>17.00</td>
<td>19.30</td>
<td>22.40</td>
<td>33.80</td>
</tr>
<tr>
<td>% Share</td>
<td>95.80</td>
<td>93.20</td>
<td>91.90</td>
<td>90.10</td>
<td>88.40</td>
<td>87.50</td>
<td>85.40</td>
<td>83.00</td>
<td>80.70</td>
<td>77.60</td>
<td>66.20</td>
</tr>
</tbody>
</table>


2.3.1 Raw Materials

In general, India is well equipped with iron ore reserves. Furthermore, iron ore and coal can be extracted in close proximity to each other. However, quality of both iron ore and coal is very low. India’s iron ores have relatively high alumina and low iron contents which causes adverse slag chemistry. In addition, ores are less closely sized and contain larger amounts of undesirables fines than in other countries. Likewise, India’s coal is of low grade. Containing high ash and being metallurgical the coal is less than ideally suited for making coke for the reduction of iron.

Both iron ore and coal quality, therefore, have to be improved to serve as suitable inputs for steel production. Different types of ore can be blended to overcome part of the problem and only ores specifically suited for the respective reduction process should be used. Moreover, domestic coal can be washed, pre-carbonized by stamp charging or partial briquetting for more efficient coke production. It can further be substituted by high quality imported coal.

The availability and quality of Indian scrap for secondary steel production is rather limited. Domestic scrap has to be supplemented by scrap imports which are subject to highly uncertain world market pricing. Additionally, electrical energy as a second major input to secondary steel production is associated with uncertainty regarding the security of supply and prices.

2.3.2 Energy Use

Primary sources of energy utilized in the iron and steel sector encompass coking coal, non-coking coal, liquid hydrocarbons, and electricity. Out of these coking coal holds the major share of energy used (65-80 per cent). While coking coal, non-coking coal and liquid hydrocarbons are primarily used in integrated steel production, electricity by far presents the major input for steel making in mini plants using electric arc furnaces or induction furnaces.

Specific final energy consumption in India has reduced considerably in recent years. While in the 1980s final energy consumption had been on average 45 GJ/te (excluding energy used for
In the early 1990s it had already declined to around 35 GJ/tcs and has since further decreased to an average 33 GJ/tcs in 1995-96. However, specific energy consumption in India is still considerably higher than in the industrialized world (ranging from 17.1 GJ/tcs (Netherlands) to 20 GJ/tcs (France) in 1994)\(^1\) [IISI, 1996a].

Besides technology and process related factors there are several other general factors affecting specific energy consumption in steel plants. The product mix, for example, has impact on energy use. The manufacture of more complex and high quality products increases overall energy intensity. In addition there are factors specific to India that should be taken into account when trying to understand why specific energy consumption in Indian steel plants is higher. They include the quality of raw material that is available to Indian industries, the scale of operation, plant sizes and sizes of coke ovens, plant utilization factors, economic and political incentive structures for adoption of technology updates and modernization, and the installation of energy saving and recovery systems.

2.4 Past and Future Demand

Demand for steel products has almost continuously been higher than steel production in the past causing India to be a net importer of steel (Table 2.7). Due to various restrictive government regulations regarding distribution, pricing and importing of steel, consumption has to a significant extent been influenced by domestic availability of steel. In a liberalized economy consumption is expected to grow according to free market demand and no longer to be restricted by supply constraints. Steel as an input to the production of major capital goods, such as automobiles, railways, power plants etc. is highly dependent on the development of these sectors. Steel demand is therefore not only determined by the aggregate level of investment and industrial production but also by the allocation of resources across different sectors and their shares in total industrial production [Pal, 1997].

Both gross domestic capital formation in the construction sector and gross domestic capital formation in machinery and equipment have been identified as major contributors to steel demand. Further variables include sectoral as well as overall GDP and demand for consumer durables. Based on these factors Pal [1997] predicts demand for finished steel products to increase significantly at an average of 9.5 per cent from 20.4 Mt in 1996-97 to 33 Mt in 2001-02. Demand for pig iron is forecast to rise at an average 5 per cent during the same time period.

2.5 Policy

The Indian iron and steel sector has been under strict government control for almost the whole period since independence. Government intervention took place in the form of both direct and indirect intervention. Direct intervention happened in the form of government control over distribution of available steel among consumers and indirect intervention took the form of price control and import levies.

After independence in 1947, the government took full control over the iron and steel sector and established a policy of restricting development of new integrated steel plants to the public sector. From then on first two and after conversion of IISCO to a public entity only one integrated steel company was privately owned. In 1959 the government formally approved the setting up of privately owned EAF based mini plants by modifying the Industrial Policy Resolution, 1956.

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\(^1\) It should be noted that for an exact comparison between countries specific energy consumption would need to be adjusted for the country specific product and technology mix.
The policy change was due to sustained shortage of steel in the Indian economy. Although these units expanded their capacity rapidly they could not make up for the consequent neglect of expansion in the public steel sector during that time. However, they contributed significantly to the availability of steel keeping the amount of steel imports relatively low.

Prices of different steel products were determined by the government and announced by the Joint Plant Committee (JPC), a body constituted in 1964 under the Iron and Steel Control Order. The Committee is headed by the Development Commissioner for Iron and Steel. All major steel plants and the railways are members of the JPC. However, not all steel items were under immediate control of JPC. Re-rolling units, electric arc furnace units and alloy steel producers were allowed to fix their own prices for their products. From the main producers about 80 per cent of production of the plants under the Steel Authority of India Limited (SAIL) and about 65 per cent of the production of the private company (TISCO) were regulated by the JPC.

Prices were fixed by the JPC according to normative costs and certain levies like the Steel Development Fund (SDF), Engineering Goods Export Assistance Fund (EGEAF), JPC Cess, Freight Equalization Fund (FEF) etc. The SDF related to new development works and only applied to four large plants. JPC Cess was charged from consumers of steel for maintaining the JPC. Through the freight pooling system iron and steel materials were made available at a uniform price throughout the country. The price contained a freight component that was averaged over the country as a whole. The freight pooling system thus promoted equal industrial development all over the country. The distribution policy aimed at ensuring an equitable distribution among end users and meeting the requirements of the priority sectors like Railways, Defense and Power. Together with the price policy the government wanted to ensure iron and steel availability to consumers according to their priority at reasonable prices throughout the country.

From 1972 on, due to impeded growth in the steel industry, the government introduced dual pricing in the iron and steel industry. Certain steel products such as heavy structurals, flats and railway materials were made available at low prices. For other products, prices were allowed to increase significantly. Such asymmetric fixed prices remained active for a long period. In 1982, the Bureau of industrial Costs and Prices (BICP) officially observed what had been implied for a long time: Costs and prices of different categories of iron and steel did not show any systematic relationship under dual pricing. A comparison of actual and calculated ‘normated’ costs for each steel item revealed that only two items, i.e., heavy structurals and H.R. coils, had been priced adequately. Some products, such as pig iron and semi-finished steel, were substantially under-priced, others substantially overpriced.

In general, pig iron, semi-finished products and long products produced by the Integrated Steel Plants were under-priced. Prices for products, however, produced out of these semi-finished products were determined in the market. As a consequence many steel re-rolling companies were set up that used cheap semi-finished products for producing final products that could be sold at free market prices. This way the re-rolling units could gain enormous profits at the expense of the integrated steel industry.

Since 1992 the government has gradually decontrolled prices and distribution of steel. The new policy still includes control over distribution to priority sectors. Private production, however, has been totally decontrolled. The levies charged by JPC for the Steel Development Fund, Engineering Goods Exports Assistance Fund and JPC Cess will continue. Yet, freight equalization has been abandoned subject to certain conditions.
Furthermore import duties have been substantially reduced by 20 per cent and more on imports of various semi-finished and finished steel products.

In the progress of industrial development the government has also provided facilities to support mini-steel plants. These include (i) liberal import of melting scrap and sponge iron without import duty, (ii) free diversification into all grades of carbon and alloy steels, including stainless steel, (iii) installation of captive rolling units, (iv) addition of balancing facilities like continuous casting machines, heat treatment furnaces, etc.

Table 2.9. Overview of Policies Regarding the Iron and Steel Industry (1973 - 1993)

<table>
<thead>
<tr>
<th>Period</th>
<th>Policy</th>
<th>Specifics</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Before 1972</td>
<td>Price and Distribution Control</td>
<td>Price and Distribution Control determined by the Joint Plant Committee (JPC) (Iron and Steel Control Order). All major steel plants and railways are members of JPC. Not subject to price controls: rerolling units, electric arc furnace units, alloy steel producers.</td>
</tr>
<tr>
<td>1972</td>
<td>Dual Pricing</td>
<td>Heavy structurals, flats and railway materials (priority items) at low prices, other product prices allowed to increase significantly.</td>
</tr>
<tr>
<td>1982</td>
<td>Review of Dual Pricing</td>
<td>Review by Bureau of Industrial Costs and Prices</td>
</tr>
<tr>
<td>Reduction of Import Duties</td>
<td>Reduction of 20 per cent and more on imports of various semi-finished and finished steel products.</td>
<td></td>
</tr>
</tbody>
</table>


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