ABOUT THE BOOK

Steel re-rolling mills (SRRMs) constitute an important link in the overall supply chain of steel in the country, supplying a majority of India’s long steel products. The direct energy-use in the SRRM sector includes heating fuels (furnace oil, natural gas, and coal) and electrical energy. The cost of energy is estimated at 25%–30% of the overall production cost. This is a significant proportion, and a result of continued reliance on obsolete technology by the SRRM sector. Another result is the increasing greenhouse gas (GHG) emissions from the sector. It has thus become imperative for the SRRMs to tread the energy-efficient path.

This was the context in which the United Nations Development Programme (UNDP) launched a technical assistance project in 2004 with the Ministry of Steel, called ‘Removal of Barriers to Energy Efficiency Improvement in the Steel Re-Rolling Mill Sector in India’. The ‘Steel Project’ has contributions from the Global Environment Facility (GEF) and the Government of India through the Ministry of Steel’s Steel Development Fund.

During its journey, the Steel Project promoted ‘EcoTech’ packages and ‘process-improvement’ initiatives among model SRRM units. All these steps have succeeded in reducing their energy consumption and GHG emissions significantly. The publication, titled Energy-efficient Steel Re-rolling, documents this story of ‘transformation’ as it happened over the years.

This ‘process document’ would be of help to development practitioners, energy and environment professionals, researchers, captains of SRRM units, programme and project managers, and policy makers.
ENERGY-EFFICIENT STEEL RE-ROLLING
ENERGY-EFFICIENT STEEL RE-ROLLING

How a pioneering project is transforming the Indian secondary steel sector

EDITORS
S N Srinivas | A C R Das | Srinivasan Iyer
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MESSAGE

Beni Prasad Verma
Minister of Steel
Government of India

I am extremely pleased to note the remarkable progress of the United Nations Development Programme-Global Environment Facility (UNDP-GEF) Project (Steel), being implemented by my Ministry. The Steel Re-Rolling Mill (SRRM) sector, which contributes over 60% of steel products to the country, has long been neglected in terms of operational parameters such as energy consumption and greenhouse gas (GHG) emissions. It is in this background that when UNDP–GEF proposed this project, the Ministry took the lead in implementing it across the country. Identifying and solving the problems, empowering the mill owners and workers through capacity building measures were taken up during the course of this Project. The results of the efforts in reducing energy consumption and GHG emissions have been impressive to say the least. I am sure these model units would serve as an example for others in the sector, as the potential for improvement demonstrated by these model units is immense.

Having started this initiative, the Government would do all that is necessary to further the cause of energy efficiency, GHG emissions reduction and improve the health and profitability of units in the Steel Re-Rolling Mill (SRRM) sector.

I compliment UNDP–GEF, consultants and the entire Project Team in implementing this Project, and applaud all model Steel Re-Rolling Mill units for coming forward to take part in this Project voluntarily.

I wish you all the very best!

Beni Prasad Verma
G Mohan Kumar
Secretary, Ministry of Steel
Government of India

‘Removal of Barriers to Energy Efficiency Improvement in the Steel Re-Rolling Mill Sector in India’ is a project that has caught the imagination of the steel re-rolling mill (SRRM) sector in the country. Project Steel is also in a way a positive acknowledgement of the contribution of the SRRM sector and of the fact that the country needs more from this sector, but in an environment-friendly manner.

Started in 2004, the Project Steel has many firsts to its credit. This Project has produced model units in the SRRM sector who prompted many units to adopt newer technologies. The project has also developed and demonstrated several ‘EcoTech’ options to SRRM units in the country. Further, many units participated in this Project voluntarily. The project also showcased that going greener and energy-efficient would actually be profitable, with the payback period ranging from just 6 to 18 months. It has lessons for all – governments, funding agencies, energy experts, technology developers, mill owners, and researchers.

I congratulate the entire team – United Nations Development Programme, Global Environment Facility, Project Management Cell, the model units, and all those who worked behind this Project – on successfully executing the project and opening up new areas of research and development in the SRRM sector. I am sure this publication would guide other units come forward and adopt energy-efficient, clean and green technologies in the sector.

G Mohan Kumar
Lise Grande
United Nations Resident Coordinator and UNDP Resident Representative

The aim of this publication is to document the adoption of energy-efficient technology by small-scale steel re-rolling mills. The barriers to adoption and the nature of the technical support provided by the Ministry of Steel and UNDP to help overcome these are discussed.

The partnership between the Ministry of Steel and UNDP has delivered striking results in 40 model units. Specific fuel consumption has declined by 20%–25% in oil-fired units and by 35% in coal-fired units. Greenhouse gas emissions have been reduced by 25% and model units are on track to recover the costs of the energy saving measures within two years.

Based on the successful pilot in the model units, the Ministry of Steel and UNDP have already helped to introduce energy-efficient technologies in 160 additional units and aims to introduce the technologies to 1800 units in the near future.

Scaling up the use of energy-efficient technologies makes good sense. A reduction in specific energy consumption and associated greenhouse gas emissions promotes cleaner and more sustainable growth.

Energy-efficient technologies have the added benefit of reducing energy costs and improving the commercial viability of sectors that employ large numbers of workers. Under favourable market conditions, investment in energy-saving measures is expected to generate substantial additional employment and contribute to inclusive growth.

We hope this publication contributes to the widespread adoption of technologies, which we know will have many positive benefits.

Lise Grande
FOREWORD

Syedain Abbasi  
National Project Director  
Joint Secretary, Ministry of Steel  
Government of India

India is witnessing a period of sustained economic development, with a sharp rise in the demand of steel and a resultant increase in its production. From a modest output of 38 million tonnes in 2004/05, steel production in India had nearly doubled in eight years to a total of 77 million tonnes in 2012/13, making it the world’s fourth largest steel producer. Analysts predict that steel output by India would reach an estimated 200 million tonnes in 2020, which would catapult it to the position of the world’s second largest steel producer after China.

The Indian Steel Re-Rolling Mill (SRRM) sector plays a major role in India’s steel production. The sector – comprising over 1800 small- and medium-sized mills spread across the country – produces almost 70% of all long steel products produced in India. Over the years, these mills have grown haphazardly with outdated, low-investment high-cost technologies, and poor information and awareness levels. This has major implications for India’s future as a steel power. The SRRM units in the country must be empowered to produce higher quality steel with greater efficiency, using modern technology and processes.

A step in this direction was taken in 2004 with the launch of the project – ‘Removal of Barriers to Energy Efficiency in the Steel Re-Rolling Mill Sector in India.’ The Project is the result of Global Environment Facility’s (GEF) environmental concerns and the need of the Indian steel industry to identify economically viable energy-efficient technologies (EETs). Funded by GEF, the Project is a major component of United Nation Development Programme’s (UNDP) Climate Change and Energy Efficiency Division and features under the UNDP’s project strategy of ‘Removal of Barriers to Energy Efficiency and Energy Conservation.’ A collaborative effort of the Ministry of Steel and
UNDP, the Project seeks to facilitate the removal of obstacles to the adoption of energy-efficient, low-carbon technologies in the SRRM sector, enabling a reduction in end-use energy levels, improvements in productivity and cost-competitiveness, and a reduction in associated emissions of greenhouse gases (GHGs) and related pollutant levels.

The basic objective of the Steel Project was to convey the message to SRRM units about achieving cost savings by reducing energy consumption. The project wished to demonstrate the validity of its message by supporting the adoption of EETs by SRRM units. However, whenever there is exposure to new ideas or new technologies there is resistance. The Project Team had to work hard for many years to convince the first set of units to sign up as model units. However, once mills in the sector saw the dramatic impact energy efficiency was making to operations in model units, their enthusiasm for the project increased manifold.

After almost ten years of implementation, the Project has achieved some significant milestones, and attained many of its objectives. Over 30 model units have commissioned new EETs, and are benefitting in terms of reduction in consumption of fuel and electricity. It is estimated that in monetary terms, the project’s technology interventions have realized savings of over Rs 1500 million. The Project’s efforts have also enabled model units to reduce carbon emissions to the tune of 64,000 tonnes of carbon dioxide (average lifetime, i.e. 20 years, reduction).

I compliment the Project Team for their active role in pioneering an intervention of this scale in the Indian SRRM sector. A very credible beginning has been made towards modernising this crucial industrial sector, and I am confident that EETs will penetrate deeper into the sector as more and more mills become aware of significant benefits of adopting these technologies.

Syedain Abbasi
The rapid growth and expansion of the Indian steel sector has resulted in the rise of several challenges that must be addressed, the foremost being extreme energy shortages and pressures on the already weak environmental fabric of the country. Amongst the eight major steel producing countries in the world, the intensity of energy use is the highest in India. The production of one tonne of crude steel from iron ore in India generates approximately 2.5 tonnes of CO₂ emission and other pollutants. This situation compels urgent actions for rationalized use of energy consumption, to reduce pollution, even while lowering production costs.

Steel re-rolling mills (SRRMs) constitute an important link in the overall supply chain of steel in the country, supplying a majority of India’s long steel products. The direct energy-use in this sector includes heating fuels (furnace oil, natural gas, and coal) and electrical energy. Indirect energy consumption is due to use of energy-intensive raw materials. The energy losses would thus comprise direct losses and indirect losses, which are due to scale loss and low yields. The direct energy cost in SRRMs is estimated at 25%–30% of overall production cost. This is a significant proportion, and a result of continued reliance on obsolete technology by the SRRM sector. It has thus become imperative for the SRRMs to tread the energy-efficient path.

The Indian SRRM sector can achieve globally comparable business and product performance standards only by moving towards reliable,
sustainable, and affordable supplies of energy, along with adoption of modern commercially viable and available technologies, and developing new indigenous technologies through research on native requirements and parameters.

This was the context in which the United Nations Development Programme (UNDP) launched a technical assistance project with the Ministry of Steel, called ‘Removal of Barriers to Energy Efficiency Improvement in the Steel Re-Rolling Mill Sector in India.’ The project has contributions from the Global Environment Facility (GEF) and the Government of India through the Ministry of Steel’s Steel Development Fund.

The project was designed to achieve seven outcomes:

1. *Establishment of benchmarks* for energy-efficient and/or environmentally friendly technology packages, called ‘EcoTech Options and Packages,’ standards and benchmarks for equipment, devices, and processes used in SRRMs.

2. *Strengthening of institutional arrangements* for long-term sustainability of the project objectives. This included improved utilisation of existing institutions, facilities, and resource persons as well as development of business and commercial networks (business support system) and encouraging cooperative procurement of technologies and services.

3. *Effective information dissemination* by means of establishment of a database on current and new development in technology, their sources and investment requirements, projects in progress, market trends, resource personnel as well as the development of communication channels including web-based EE-Net for information dissemination on technology markets and funding schemes.

4. *Enhanced stakeholders’ capacity*, including assessment of capacity building needs of major stakeholders to facilitate implementation and absorption of advanced energy efficient technologies (EETs) in the SRRM sector (mapping of clusters) as well as developing and implementing a capacity building strategy.
5. *Establishing technical and financial feasibility* of EcoTech options and technology packages. The technology packages were to be demonstrated in 30 sample units spread across geographical clusters to demonstrate techno-economic viability.

6. *Innovative financing mechanisms such as ESCOs* were to be introduced for the first time in an industry that had a high risk-perception, coupled with the development of ‘investment portfolios’ with banks and financial institutions.

7. *A self-sustained Technology Information Resource and Facilitation Centre (TIRFAC)* to be set up that would continue to provide various technical assistance services to the SRRM sector in the post-project period.

To achieve these objectives, the Project Management Cell (PMC) adopted a two-pronged strategy: firstly, the identification of the technology, which is relevant for the SRRM sector, and secondly, the actual demonstration of the technology through the model unit programme. Identifying core technical assistance as a major strategy to build capacity in the sector, several initiatives such as national-level awareness workshops, brainstorming sessions, and localized training programmes were organized by the PMC throughout the tenure of the project. These workshops marked the first time that employees in SRRM units were exposed to modern technology and processes such as advanced roll pass design, standard operating practices, standard manufacturing practices, and 5S Lean Manufacturing System all contributing to energy efficiency and productivity.

Aiding the PMC in its agenda were the resident mission organisations, set up at the cluster level to manage the project’s activities on the ground. Headed by a Resident Manager, the resident missions served as important interface between the PMC and SRRMs.

The EcoTech packages promoted by the project have succeeded in significantly reducing energy consumption in model units. On an average, specific fuel consumption reduced by 20%–25% for oil-fired units and over 35% in coal-fired units. Not only has this yielded handsome monetary savings
for the model units, it has also slashed their emission loads, meeting the core project objectives. More encouraging was the adoption of radical and new technology by the mills such as direct rolling of continuous cast billets (eliminating the need to re-heat billets) and biomass gasifier technology (which leads to net zero carbon emissions from operations).

The success of such high-end technology augurs well for the future of EETs in the SRRM sector. As the project winds down its operations, it is our hope that captains of the SRRM sector will now take over the responsibility to guide India’s SRRM units towards energy efficiency.

Editors
Beginning in 2004, the nine-year journey of the UNDP–GEF Project (Steel) has been quite eventful, with several ‘highs’ and ‘lows’ marking it. While the ‘lows’ were taken up as challenges during the course of this journey and several of them being tackled at various levels even as we write this, the ‘highs’ were put through rigorous tests to ensure that they remained as ‘highs’ even after the closure of this Project. All these would not have been possible without the support of several individuals and institutions. As editors of this publication, we would like to place on record our appreciation and gratitude to all of them. However, we are listing below a few major players who have made substantial contributions to the success of this project.

- The Project Team at the Project Management Cell (including the members of the Project Steering Committee, Project Advisory Committee, resident missions, etc.) and senior officials of the Ministry of Steel, Government of India, for successfully leading the implementation of the Project. They deserve all the credit for their perseverance and determination in running the show on a day-to-day basis.
- UNDP and GEF for providing the much-needed support and guidance for this initiative.
- The two associations – the Steel Re-rolling Mills Association of India and the All India Steel Re-rollers Association – for taking active participation in the project.
- All the SRRM units who came forward as ‘model units’, especially the ones who enrolled themselves in the initial years. They are the ‘change-agents’ as far as this Project is concerned.
- All the stakeholder institutions who have been part of this Project at different points in time during the Project period. A few major ones are listed in Annex 2.

Finally, we would like to thank the Academic and Development Communication Services (ADCS), Chennai, for developing this process document and producing it in the current form.

S N Srinivas, A C R Das, and Srinivasan Iyer
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<td>Asian Development Bank</td>
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<td>ADCS</td>
<td>Academic and Development Communication Services</td>
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<td>AISRA</td>
<td>All India Steel Re-rollers Association</td>
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<td>BEE</td>
<td>Bureau of Energy Efficiency</td>
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<td>BFR</td>
<td>Bank Feasibility Report</td>
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<td>BPNSI</td>
<td>Biju Patnaik National Steel Institute</td>
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<td>BTOR</td>
<td>Back-to-Office Report</td>
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<td>CCE</td>
<td>Cost of Conserved Energy</td>
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<td>CFD</td>
<td>Computational Fluid Dynamics</td>
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<td>CII</td>
<td>Confederation of Indian Industry</td>
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<td>CPCB</td>
<td>Central Pollution Control Board</td>
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<tr>
<td>CREDA</td>
<td>Chhattisgarh Renewable Energy Development Agency</td>
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<tr>
<td>CTA</td>
<td>Chief Technical Adviser</td>
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<tr>
<td>DFID</td>
<td>Department of International Development, Government of United Kingdom</td>
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<td>DEM</td>
<td>Domestic Equipment Manufacturer</td>
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<td>DSIR</td>
<td>Department of Scientific and Industrial Research</td>
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<td>Department of Science and Technology</td>
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<td>EET</td>
<td>Energy-efficient Technology</td>
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<td>EMS</td>
<td>Environment Management System</td>
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<td>ESCO</td>
<td>Energy Service Company</td>
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<td>FICCI</td>
<td>Federation of Indian Chambers of Commerce and Industry</td>
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<td>GDP</td>
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<td>HSD</td>
<td>High Strength Deformed</td>
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<td>IISCO</td>
<td>Indian Iron and Steel Company</td>
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<td>IREDA</td>
<td>Indian Renewable Energy Development Agency</td>
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<td>ITCOT</td>
<td>Industrial and Technical Consultancy Organisation of Tamilnadu</td>
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<tr>
<td>LCA</td>
<td>Life Cycle Analysis</td>
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<td>M&amp;E</td>
<td>Monitoring and Evaluation</td>
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<td>MDG</td>
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<td>MITCON</td>
<td>MITCON Consultancy and Engineering Services Limited</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>MNRE</td>
<td>Ministry of New and Renewable Energy</td>
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<td>MT</td>
<td>Million Tonnes</td>
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<td>MTPA</td>
<td>Million Tonnes per Annum</td>
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<td>NCDMA</td>
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<td>National Institute of Secondary Steel Technology</td>
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<td>NITRA</td>
<td>Northern India Textile Research Association</td>
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<td>National Mineral Development Corporation</td>
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<td>Operational Focal Point of GEF</td>
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<td>Small Industries Development Bank of India</td>
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<td>SME</td>
<td>Small and Medium Enterprise</td>
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<td>SPM</td>
<td>Suspended Particulate Matter</td>
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<td>TIRFAC</td>
<td>Technology Information and Resource Facilitation Centre</td>
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<td>Thermo-mechanically Treated rods</td>
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<td>Tonnes per Day</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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CHAPTER 1

THE WEB OF STEEL

An introduction to the Indian steel re-rolling industry
STEEL: THE FOUNDATION OF MODERN CIVILIZATION

A brief history of steel

The Oxford Dictionary defines steel as ‘a hard, strong grey or bluish-grey alloy of iron with carbon and usually other elements, used as a structural and fabricating material.’ But for 21st century humankind, steel is much more than just an alloy of iron. It forms the basic building block – so to speak – of all the trappings of modern life, so much so that the entire engine of modern industrial civilization is highly dependent on this strong and durable metal. There is hardly a single manufacturing industry that does not use steel at some point in the production process. It finds application in the construction of houses and offices, cars, ships, airplanes, railways, roads, electricity generation and transmission, and in the strategic defence sector, among others (Figure 1). Steel is ubiquitous, visible in avatars as small as a bolt, and as gigantic as an interplanetary rocket.

Without it, much of the technological advances of the past 200 years, including the epochal Industrial Revolution, would have been impossible. Indeed, it is certainly no understatement to call steel the backbone of modern civilization.

Why is steel accorded such an exalted place in human progress? The answer to that lies in its unique combination of high tensile strength and malleability, which are bestowed on steel by iron ore and carbon (and other complementary chemicals). This results in a metal that not only possesses a tremendous ability to sustain stress, but one which is also versatile enough to be moulded into an infinite variety of shapes and sizes. In its hot state, steel can be bent, squeezed, pulled, and coiled into shapes as diverse as plates, rods, beams, and cables, enabling it to be used in the manufacture of almost everything.

Yet the process of manufacturing steel is a complex and delicate process that has been described as part science and part art. Steel has been known to humanity for 4000 years. One of the key breakthroughs in the development of early steel manufacturing was achieved in around 300 BC in the Indian subcontinent. This was the production of high-carbon steel called Damascus Steel (also known as Wootz Steel). Pioneered by enterprising anonymous metallurgists in Sri Lanka and India, this technique involved forging steel in a specially devised wind furnace, which used the power of the monsoon winds to fire iron-rich soil with wood, enabling the manufacture of a high-carbon steel that soon gained a reputation for its capacity to hold an edge, as also an ability to bend under pressure without fracturing, making it ideal for swords. The Chinese imported the idea from India around the 5th century AD, while in the west of the Indian subcontinent, Damascus Steel became the preferred raw material for weapons during the crusades.
In the middle ages, advances in steel making were focused in Europe – then basking in the enlightenment bestowed by the Renaissance. European metallurgists developed the modern blast furnace in the 15th century, which enabled rapid production of larger quantities of the alloy. Another significant innovation in this period was the replacement of charcoal with coal as the heating and reducing agent in iron smelting.

But the most far-reaching advancement in the history of steel manufacturing was achieved in the year 1855, when Henry Bessemer debuted his ‘Bessemer Process.’ At its crux, the Bessemer Process was simply the removal of impurities from molten iron through oxidation, achieved by the application of heated air. While the principle was known to metallurgists since time immemorial, it was seldom used because it was a resource- and labour-intensive process. But Henry Bessemer’s process was unique in that it was tremendously fast compared to older methods through the use of a Bessemer Converter (Figure 2). This dramatically reduced the cost of steel production, even as it enabled mass production of the metal. For the first time, steel was now available in quantities large enough for it to be used in the construction of bridges, railways, ships, and buildings.

**Figure 2** A sketch of the Bessemer Converter

*Source* The Davistown Museum (*Picture courtesy*)
The Bessemer Process is widely credited with catalysing the Industrial Revolution, and making steel the bedrock of industrialization. Indicative of its importance in industrial expansion was the case of Britain, where the Bessemer Process was first deployed commercially. From an annual production of 2.3 million tonnes in 1850, Britain was producing 13.5 million tonnes of steel by the turn of the century,¹ a 400% increase.

Further developments in technology, this time focused primarily in the United States, consolidated and expanded the role of steel in building not just modern economies, but also modern nation-states. The years after the First World War, which itself saw a big jump in steel production to build machines of war, led to even greater demand for steel as war-torn nations began massive reconstruction and rebuilding projects. Indeed, by the time World War II broke out, steel had established itself as the alpha metal in the world. It may not have the lustre of gold, but it was the metal that separated world powers from lesser nations. A broad timeline on the evolution of steel is shown in Figure 3.

Steel in modern India

With the dream of independence getting closer to reality in the early decades of the 20th century, there was growing recognition in India of the importance of steel for national strength and progress. There was general consensus among the leading lights of the Indian independence movement that heavy industries were key to the new nation’s progress, and that in turn depended on a nation’s ability to forge steel. As the first government of independent India settled down to govern the vast country, policy-makers emphasized that economic planning in the country must have two ‘essential

bases’ – power generation and steel production. Yet, at the time of independence, there were only two large steel plants in the country – Tata Iron and Steel Company Ltd (TISCO) and Indian Iron and Steel Company Ltd (IISCO), together producing only about 2 million tonnes of steel annually.2 (Figure 4 shows the picture of IISCO, in Burnpur, West Bengal.) This amounted to just about one per cent of the global steel production in 1950, which stood at 189 million tonnes.3 But within a decade, three new steel plants had been commissioned – one in Bhilai, made with Russian assistance; one in Rourkela, built with German help; and one in Durgapur, this time with the help of British technicians and engineers.

Slowly but surely, steel production in India started showing an upward trend. Between 1950 and 1970, steel production grew

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at an annualized average of eight per cent. By 1980, the country was producing 12.6 million tonnes of crude steel annually.\(^4\) But as with other sectors of the Indian economy, steel production really took off in the 1990s on the back of dramatic economic reforms in 1991. Steel, hitherto a sector that was largely off-limits to private investments, was thrown open to private players. As a result, state-owned integrated plants and privately operated plants together were churning out about 30 million tonnes of steel by 2002.\(^5\) Additionally, from around one per cent in 1950, India’s share in global steel production had risen to over three per cent.

This proved to be just the beginning of a sustained Indian push into the global steel market. In 2010, India became the fourth

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largest producer of steel in the world (behind China, Japan, and the US), producing about 71 million tonnes of the metal annually (Figure 5). For some more perspective on how far the Indian steel industry has come since independence, analysts predict that India is on course to become the second largest producer of steel by 2020, behind only China.

**Figure 5** Leading steel producers of the world, 2011


From two steel plants in 1947, India today boasts of 11 large integrated steel plants, each capable of producing between 1 and 7 million tonnes of steel per annum. While most of them are owned and operated by the public sector, there is a significant (and growing) private sector presence too.

However, the Indian steel story is not limited to the large steel plants alone. Equally important to the narrative is the vibrant and thriving secondary steel sector, which comprises privately owned small- and medium-sized steel re-rolling mills (SRRMs). By contributing close to 70% of India’s long steel output (bars, sections, industrial products, etc.), SRRMs hold the key to India’s
rush to the top of the global steel charts. How this sub-sector – usually forgotten in the shadows cast by the mammoth steel plants – performs will most certainly determine India’s fortunes in steel in the 21st century. But for more insight into SRRMs, one must first acquaint oneself with the process of steel re-rolling.

Figure 6 tries to capture broadly the evolution of steel in India.

THE STEEL RE-ROLLING MILL SECTOR

What is steel re-rolling

Steel re-rolling is the process of converting raw/unprocessed steel into finished steel products by rolling and re-rolling them in their hot state into desired shapes such as bars, TMT (thermo-mechanically treated) rods, sectional products, and wires (Figures 7 and 8). A bulk of these finished products finds application in the construction sector.
Figure 7 Steel being rolled into a TMT bar in a re-rolling mill

Figure 8 Freshly rolled bars cooling in a re-rolling mill in Punjab
The technology for steel re-rolling has existed since medieval times, when slitting mills in Belgium began passing flat bars of iron through rollers to create iron plates. Steel re-rolling as it exists today, however, was developed in England in the 16th century. Today, depending on the kind of technology used, SRRMs can be classified into ‘bar mills’ or ‘structural rolling mills’. While bar mills exclusively produce HSD (high strength deformed) bars, structural rolling mills are equipped to produce flats, angles, and other structural steel products.

The production process in a typical SRRM unit begins with hot charging of raw billets, ingots or blooms in an oil-, coal- or gas-fired re-heating furnace. Once the raw material achieves the desired temperature, it is manually or automatically pushed out into the rolling floor, where iron rollers (also called drums) are used to squeeze and stretch them into finished steel products. In the entire process, the re-heating furnace is central to efficient production. The amount of energy required to fire and keep it heated has a direct bearing not only on production efficiency, but also on bottom lines and more crucially on greenhouse gas (GHG) emissions.

**Global steel re-rolling**

Steel re-rolling mills, also called ‘reduction mills’, are widely distributed across the world. Unlike the millions of tonnes produced in a large integrated steel plant every year, an SRRM is typically a small or medium enterprise, with steel production capacity at 10–30 tonnes per hour and an annual production varying from 10,000 to 400,000 tonnes per year. A feature of these mills is their presence in countries not historically known for steel production, such as Bangladesh, Mexico, and Egypt. Because steel re-rollers can locally manufacture billets using scrap steel from automobiles, ships, and by-products of manufacturing, re-rolling mills tend to be less dependent on direct access to crude steel.
sources. The sector enjoys a competitive advantage over larger steel producers because of its flexibility and ability to rapidly meet low tonnage requirements in various grades, shapes, and sizes. They thus fulfil an important function by meeting the local demand for cheap steel, and most of their products are typically consumed by the domestic construction sector.

Due to the paucity of consolidated data on the global SRRM sector, it is difficult to ascertain their significance to the worldwide steel industry. However, data regarding the Indian SRRM sector are much more accessible. On the evidence of India, one can make the reasonable extrapolation that the SRRM sector is the primary source of finished steel products for individual consumers, particularly in the developing world, whose demand for steel, unlike institutional consumers, is for small quantities at cheaper prices.

The SRRM sector in India

In 1928, a small SRRM unit was established in the industrial town of Kanpur in Uttar Pradesh, inaugurating the advent of modern steel re-rolling in India. As has been the feature of Indian industrialization, the technology may have arrived late by global standards, but once available, it was quickly adopted by entrepreneurs leading to a profusion of SRRMs in the country. By 1968, the re-rolling industry was producing nearly 5 million tonnes of steel annually, and was generating about ₹ 170 million (USD 30 million) through exports, a significant and valuable contribution to the GDP (gross domestic product) of the newly independent nation. Another significant milestone was achieved by the Indian SRRM sector in 1996, when its share in the country’s total output of finished steel crossed 50%. In other words, more than half of the steel products used in the

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7 Steel Re-Rolling Mills Association of India Retrospect (http://www.srma.co.in/retrosspect.html)
8 Ibid.
9 Ibid.
country came not from the giant integrated steel mills but from the secondary steel sector.

ENERGY PROFILE OF THE INDIAN SRRM SECTOR

To fuel its dramatic industrial growth in the new millennium, India has rapidly risen in the list of global energy consumers. Increasingly dependent on larger quantities of fossil fuel, the country is currently the world’s third largest consumer of energy. Subsequently, it is also the fourth largest source of GHG emissions, contributing over four per cent of the 25.2 billion tonnes of CO₂ released by the world every year.

Of the 1.7 billion tonnes of GHGs emitted by India annually, the industrial sector accounts for more than 500 million tonnes. The Indian steel sector is one of the biggest contributors to this figure, emitting 70 million tonnes of CO₂ per year.

For its direct energy needs, the SRRM sector is heavily dependent on furnace oil, coal, or natural gas. This dependence is a drain on these small- and medium-sized units, forming over a quarter of production costs. To compound the issue, fossil fuel use also increases their emission load.

While technical interventions to improve production efficiency and reduce energy costs are available, their existence is largely unknown to the SRRM sector. There is low awareness about energy efficiency and most units lack the engineering and technical manpower to adopt energy-efficient practices.

Today, there are an estimated 1800 working steel re-rolling mills in India, scattered across the country and producing 19.4 million tonnes of steel. This works out to about 68% of the total production of non-flat steel products in the country. It is also reported that 80% of India’s total exports of bars are sourced
from the secondary steel sector. It has also been estimated that the sector employs, directly and indirectly, about 400,000 people. These employees are a mix of skilled engineers, semi-skilled foremen and technicians, and unskilled shop-floor workers.

Geographically speaking, most of the SRRMs in the country tend to be grouped around their primary source of raw material – crude steel from integrated steel plants. Thus, the 2.5-million-tonne-capacity Bhilai Steel Plant in Chhattisgarh supports the raw material needs of over 200 SRRMs in central India. Likewise, 150 SRRMs in West Bengal, Odisha, and Jharkhand receive crude steel from the 4-million-tonne-capacity Durgapur Steel Plant in West Bengal and the 2-million-tonne-capacity Rourkela Steel Plant in Odisha.

A notable exception to this geographic clustering of SRRMs around integrated steel mills is Punjab, where over 400 mills operate relatively far from the nearest integrated steel plant. Grouped around the cities of Ludhiana and Mandi Gobindgarh, this region has a long history of steel re-rolling, so much so that Mandi Gobindgarh is often referred to as ‘Loha Mandi’ or Steel Bazaar, in trade circles.

While the strong performance of the SRRM sector has undoubtedly added muscle to India’s steel sector, it cannot mask the deficiencies and drawbacks that have long plagued the sector and prevented it from achieving global standards of production efficiency. A majority of the SRRMs in the country are small- or medium-sized family-run units, and lack a cohesive and forward-looking corporate vision. A vast majority of them are still struggling with obsolete and inefficient technologies and

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energy-efficient steel re-rolling

chapter 1
the web of steel
rolling in the changes
into the field
the ecotech edge
forging new skills
impacts and insights
the road ahead

Today’s SRRM scenarios

- Inefficient technologies and process
- Lack of awareness and motivation to upgrade
- Higher production cost due to higher energy consumption
- Higher GHG emissions collectively

Energy-efficient Steel Re-rolling

processes. This is symptomatic of a wider malaise affecting the secondary steel sector – the lack of awareness and motivation to upgrade and innovate for greater productivity and profitability. Without adequate perspective on technical innovations in the sector, there has set in reluctance to disturb the status quo approach to production, inhibiting the sector from achieving its full potential.

Attendant to the issue of awareness is the lack of sufficient technical and managerial capacity to operate and maintain modern technology and processes (Figures 9 and 10). Production in most mills is supervised by a foreman, who is usually a semi-skilled and untrained worker whose only qualification for the position is long experience on the shop floor.

Further, in terms of pollution abatement and emissions control, the lack of exposure to modern technology has reduced the SRRM sector to one of the most poorly performing industrial sectors in the country. There is very little awareness of sustainable business practices at the managerial level, not to mention the absence of workable regulatory frameworks that penalize non-compliance with environmental guidelines, or that motivate and incentivize environment-friendly practices, by SRRMs.

As is evident, these issues directly impact bottom lines, and as a result, the sector ends up being flagged as having poor investment potential. This, in turn, reduces access to credit, inhibiting SRRMs from modernizing or upgrading. This vicious cycle of impediments creating more obstacles, if unchecked, can seriously dent India’s steel output, so much so that rather than moving up, India may even slip down the list of top global steel producers.

It is in this context that the project ‘Removal of Barriers to Energy Efficiency Improvement in the Steel Re-Rolling

Entry of the UNDP-GEF-MoS Project
Steel for removing several barriers
Figure 9  An example of lack of technical capacity: rolls awaiting repair in a steel re-rolling mill in Tamil Nadu

Figure 10  Workers manually insert hot billets into rollers in most Indian SRRM units: an unhealthy practice
Mill Sector in India' assumes importance. With its focus on improving energy efficiency in the sector, not only has the United Nations Development Programme–Global Environment Facility–Ministry of Steel (UNDP–GEF–MoS) project ushered in sustainable and efficient methods of production, it has also exposed SRRMs to modern technology and practices. More crucially, it has effected a change in mindsets among SRRMs. No longer are foremen in the SRRM sector stumped by modern technology, and neither are decision makers reluctant to adopt new ideas.
Energy-efficient Steel Re-rolling

The Web of Steel
Rolling in the Changes

Impacts and Insights

Forging New Skills into the Field

The Road Ahead
The Ecotech Edge
Chapter 1
CHAPTER 2

ROLLING IN THE CHANGES

A pioneering intervention in the SRRM sector takes shape
ASSESSING THE NEED FOR INTERVENTION

Energy efficiency and Indian industry

Worldwide, ever-increasing consumption of energy has gone hand in hand with rising concerns about its conservation. Apart from being expensive and prone to sudden price fluctuations, the overwhelming majority of energy sources are non-renewable. Therefore, the conservation of energy is considered vital not just to avoid wastage of a precious resource, but also to slow down the rapid depletion of coal, oil, and natural gas resources. However, with the environmental movement gaining ground in the past 30 years, the ramifications of unsustainable energy use are no longer confined to economics alone. As the bulk of greenhouse gas (GHG) emissions is a result of fossil fuel burning, conservation of energy is today intrinsically linked to the climate question. As halting fossil fuel use is not an option without the viability of alternative sources, the only way to reduce energy use and manage emissions is therefore to maximize its efficiency.

One of the people who first gave shape to the idea of energy efficiency was the American physicist and environmental activist Amory Lovins. Like most Americans shaken by the oil crisis of 1973, Lovins postulated and popularized the concept of ‘negawatts’, a system of meeting one’s energy requirements not by exploiting greater quantities of energy, but by increasing the efficiency of existing quantities. In other words, to use an American expression, getting the most bang from the buck. Since then, scientists and engineers world over have fine-tuned existing technology or devised completely new solutions that maximize the value derived from each unit of energy. They have been aided by support from governments and civic bodies, who have created an enabling environment of incentives and rewards to motivate industries to use energy efficiently.

In the Indian context, energy efficiency and energy conservation have occupied policy makers for a long time. Beginning in the
1970s, successive governments have launched initiatives to reduce energy consumption by adopting efficient technology and processes. The Oil Industry Development Board founded the Petroleum Conservation Research Association (PCRA) in 1978. In 1983, the government constituted the Inter-Ministerial Working Group on Energy Conservation, tasked with suggesting policy options to promote energy efficiency. During the Ninth Five-Year Plan (1997–2002), the need was felt to design a national energy conservation act, which would bring the disparate attempts to promote energy efficiency together and back it with the full authority of the state. The result was the Energy Conservation Act, 2001. The Act created the Bureau of Energy Efficiency (BEE) as the regulatory and promotional authority for all energy-efficiency-related policies and programmes.

However, the struggle to maximize energy efficiency was not driven exclusively by the government. Industry bodies like the Confederation of Indian Industry (CII), non-profit and R&D institutions such as PCRA, and bilateral and multilateral bodies such as The World Bank, the Asian Development Bank (ADB), Department for International Development (DFID, UK), and the Swiss Agency for Development and Cooperation (SDC) also made significant contributions to energy efficiency in Indian industry.

The cumulative efforts of the government, industry, and bilateral and multilateral stakeholders have given a positive fillip to energy efficiency in India. This is reflected in the energy elasticity of gross domestic product (GDP), which reduced from 1.26 in 1980 to 1.06 in the 1990s. This meant that for every one per cent increase in GDP, the national demand for energy had risen by 1.06 per cent. About a decade later, India’s energy elasticity of GDP stood at 0.80 in 2005,¹ lower than the 1.5 managed by China.²

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Unfortunately, the focus of energy-efficiency initiatives in India has been limited mostly to the large industries. There has been little progress in creating an energy-efficiency ‘culture’ among the thousands of small and medium enterprises (SMEs) dotting the industrial landscape, even though it is an acknowledged fact that the nation can achieve tremendous energy savings through interventions in the SME sector (defined as enterprises with a cumulative investment of between ₹ 2.5 million to ₹ 100 million in the Indian context\(^3\)). The steel re-rolling mill (SRRM) sector too has largely been overlooked, with most energy-efficiency interventions in the steel sector being limited to the large integrated steel plants. The significance of Steel Project can also be seen in this context. The project marked the first time that an intervention in the SRRM sector was initiated, which sought to understand, analyse, and remove barriers that prevented re-rolling units from achieving energy efficiency. Additionally, the project sought to incorporate non-financial instruments such as providing knowledge, supply-chain services, and matchmaking on technology package, thus going beyond the classic intervention model of finance provision only.

**Barriers to energy efficiency in the SRRM sector**

When the Steel Project was first conceived, the performance of the Indian SRRM sector on key energy-efficiency parameters was far from optimum. When compared with global SRRMs, it was found that re-rolling mills in India tend to consume up to 1.8 times more fuel oil than their foreign counterparts. Where coal is used instead of fuel oil, the difference is as much as three times more. While this disparity directly dents the competitiveness of Indian re-rollers, the implications of this excessive energy consumption go beyond the balance sheet. With coal being the preferred fuel in most SRRM units, the Indian secondary

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\(^3\) Reserve Bank of India (http://www.rbi.org.in/commonman/English/scripts/FAQs.aspx?Id=966)
steel sector is saddled with a huge emission load – a burden that can be easily avoided by implementing energy-efficient technologies (EETs) and processes.

What then is stopping the SRRM sector from grasping these implications and, more importantly, acting to rectify the situation? The answer to that question lies in the character of this niche industrial sector. For the most part, the 1800-odd SRRMs currently operating in the country are small, family-owned-and-run units. They are mostly legacies from an earlier generation of pioneers, with descendants entrusted with keeping the family trade alive. This has resulted in a mindset that focuses only on maintaining the mill’s short-term profitability while neglecting to develop a long-term vision of sustainable business objectives. It consequently makes most SRRM units hesitant to adopt technology or practices that are unfamiliar. In that respect, these small- and medium-sized mills are not unique to Indian industry. Most SMEs in sectors such as glass and agribusiness too tend to be family-owned and operated. But what makes the family-run re-rolling mill unique is that it operates in a core industrial sector, which requires access to modern technical skills and advanced methods of production to stay competitive.

While not all SRRMs fit this stereotype of a somnambulant family-owned mill resistant to change (indeed, some are efficiently-run conglomerates that are ahead of the curve in terms of technical expertise and management practices), the general lack of foresight and vision has meant that much of the secondary steel sector has been stuck with obsolete technology, low technical capacity, and little awareness of the environmental concerns of the day and how they impact business. In many cases, machinery and tools being operated by steel re-rollers are decades old, kept running by repeated and haphazard ad-hoc repair jobs. Pollution control mechanisms are lax, and occupational health and safety issues – even basics like...
Outdated technologies and practices
Low information and awareness levels on the developments in the sector
Inappropriateness of generic energy-efficient technologies (EETs) developed
Lack of incentives to cater to small-scale energy efficiency projects
Lack of experience in accessing external funds
High investment costs of EETs
Low research and engineering base and other institutional linkages

protective helmets and boots – are given a low priority. In cases where SRRM units have attempted energy-efficiency measures, they are stymied by the lack of technologies that cater to the specific needs of the sector. As a result, generic solutions are deployed, which often make no difference to fuel efficiency or emissions.

To be fair to the SRRM sector, investments in EETs are not small, and the lack of workable incentive regimes for adopting energy efficiency makes re-rollers all the more reluctant to invest in EETs. To compound the issue, steel re-rollers traditionally tend to keep their books off-the-record, making it difficult for them to access finance for investments in EETs.

In sum, a combination of low awareness, lack of technical capacity, and absence of incentives is inhibiting the Indian SRRM sector from achieving its full potential, both as a globally competitive powerhouse of finished steel products as well as a sustainable environmentally conscious industry. This assessment was the trigger that started off the Steel Project’s journey – a journey that has effected a sea change in mindsets
among steel re-rollers, and that has convincingly demonstrated to the Indian SRRM sector that an efficient, modern, sustainable, and profitable future is possible, and within reach.

**A CONFLUENCE OF INTERESTS**

**The Ministry of Steel: breaching a lacuna**

India has committed itself to sustainable development by ratifying the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 and the Kyoto Protocol in 2002. The national government has consequently been actively promoting sustainable development as a core principle in all economic policies. The Ministry of Steel, conscious of the fact that it has the responsibility of stewarding one of the most energy-intensive industries, has translated many of the government’s environmental preoccupations into actionable programmes.

**STEEL PROJECT SNAPSHOT**

**Official Project Title**
Removal of Barriers to Energy Efficiency Improvement in the Steel Re-rolling Mill Sector

**Global Development Objective**
Increase end-use energy efficiency of the steel re-rolling mills (SRRM) sector and reduce associated emissions of greenhouse gases (GHGs)

**Immediate Objective**
Accelerate the penetration of environmentally sustainable energy-efficient technologies (EETs) through removal of barriers to technology upgradation, leading to large-scale commercialization of EETs in the sector

**Project Partners**
Ministry of Steel, Government of India; United Nations Development Programme in India; and Global Environment Facility
Along with the Central Pollution Control Board (CPCB) and the Ministry of Environment and Forests (MoEF), the Ministry of Steel has launched the Charter on Corporate Responsibility for Environment Protection. Under this, major steel plants in the country have agreed to go beyond the compliance to regulatory norms and achieve higher environmental targets, defined after mutual agreement in the charter. The charter has focused on reducing energy consumption in blast furnaces, fugitive emissions from coke ovens, reduction in water consumption, and improvement in ambient air quality. The Ministry has also been facilitating adoption of cleaner and more efficient technologies in large steel plants through the National Clean Development Mechanism Authority (NCDMA). Over 158 projects have been approved so far, amounting to a reduction of 103 million tonnes of CO₂ equivalent. The Ministry has also rallied around the National Mission for Enhanced Energy Efficiency (NMEEE), creating an incentive regime of energy-saving certificates to motivate steel plants consuming over 30,000 million tonnes of oil equivalent to adopt EETs. In addition to these initiatives, organizations within the Ministry operating steel plants, such as the Steel Authority of India Limited (SAIL) and the National Mineral Development Corporation (NMDC), have their own projects and programmes that facilitate the spread of environmentally conscious steel production.

However, the long-standing lacuna in the Ministry’s efforts to promote energy efficiency has been the lack of viable interventions in the SRRM sector. The unique circumstances of these small- and medium-sized units, and their specific requirements had traditionally received little attention in energy-efficiency programmes. This is despite the fact that the SRRM sector contributes bulk of long steel products, and

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5 Ibid.
their underperformance on efficiency parameters threatens to undermine the larger vision of an energy-efficient steel industry.

In such a context, the project to eliminate barriers to energy efficiency in the SRRM sector was welcomed by the Ministry. The project held the potential not just to bring the SRRM sector firmly into the ambit of the emerging energy-efficiency matrix, but also to boost the quality of steel produced by the SRRM sector, buttress its economic viability, support SMEs, and create additional employment potential. In all respects, the Steel Project was a perfect fit in the Ministry’s phalanx of energy conservation schemes. Consequently, the Ministry agreed to join the project as the National Executing Agency.

**UNDP India and GEF: partners in progress**

The United Nations Development Programme (UNDP) has a long history of being in the frontlines of sustainable human development. Its interventions across the world have stressed on the protection and regeneration of the environment without compromising on the socio-economic aspirations of local communities. UNDP-supported programmes are today making a difference in several areas that have a direct bearing on global environmental sustainability. These include natural resources management, capacity building for decision-making, mainstreaming global environment issues into the development process, and information dissemination and advocacy.

In India, UNDP has a rich history of partnership with governments and communities alike. UNDP India assists the government through a range of technical assistance programmes to provide inputs to national policies and strategies for promoting environmentally sustainable solutions. UNDP’s environment strategy in the country targets three types of interventions: biodiversity conservation, natural resources management (e.g. water, forests), and clean energy technology promotion. As
energy forms one of the organization’s core areas of engagement, the Steel Project meets several of UNDP’s developmental targets. It is also consistent with the seventh goal of the millennium development goals (MDGs) (environmental sustainability). With the potential to not just reduce emissions but also to augment capacity and stimulate sustainable growth among small businesses, the project dovetailed neatly into UNDP’s mandate.

Further, facilitating UNDP’s entry into the project was its partnership with the Global Environment Facility (GEF). As the lead implementing agency for GEF in India, UNDP has executed many GEF-supported programmes in the country. For GEF, the world’s largest public funder of environmental interventions, the Steel Project was an attractive opportunity and is consistent with its Operational Program No. 5 on ‘Removing Barriers to Energy Efficiency and Energy Conservation’ and GEF 2 Cycle.

FROM VISION TO ACTION

Project implementation structure

The Steel Project, officially titled ‘Removal of Barriers to Energy Efficiency Improvement in the Steel Re-rolling Sector in India’ was launched in 2004 by the Ministry of Steel – the executing agency for the project. In scale, scope, and ambition, it was nothing that was ever seen before in the world of Indian steel re-rolling. The project promised to herald an emphatic shift in the way the Indian SRRM sector perceives its business, not to mention make a big contribution to the reduction of GHG emissions from the steel sector.

However, for it to meet its objectives, what the project needed most was a dynamic organization that would give it direction, set its pace, and monitor its progress. With over 1200 steel re-rolling mills then operating in the country, and with limited resources at their disposal, the project stakeholders understood the value
of creating an organization that was lean but had the capacity to rapidly reach out to each and every working re-rolling mill in the country, spreading its message of energy efficiency and facilitating the transfer of technology that could make it happen. The project consequently adopted a consensual organizational structure involving multiple stakeholders at key decision points.

At the apex was the Project Steering Committee or PSC, with the Secretary (Ministry of Steel) serving as chairman. The PSC was constituted of members from various cross-sectoral ministries such as the Ministry of Finance (MoF), Ministry of Power (MoP), Ministry of Coal (MoC), Planning Commission, Ministry of Petroleum and Natural Gas (MoPNG), Ministry of New and Renewable Energy (MNRE), and MoEF. The Committee also had representation from the Department of Science and Technology (DST), the Department of Scientific and Industrial Research (DSIR), the GEF Operational Focal Point (OFP), the All India Steel Re-rolling Mills Association (AISRMA), Steel Re-Rolling Mills Association (SRMA), and UNDP India.

As per the project charter, the PSC was expected to oversee the implementation of the project, and scheduled to meet at least once in six months to take stock of progress. Its functions included making policy decisions, reviewing and monitoring project activities, facilitating inter-ministerial coordination as and when required, and identifying gaps in national policies that hinder adoption of EETs.

While the PSC gave policy direction to the project, the Project Advisory Committee (PAC) was tasked with overseeing the implementation agenda. The PAC was chaired by a National Project Director (NPD), appointed by the Ministry of Steel, which also created the post of National Project Coordinator (NPC) to serve as member secretary of the PAC. Like the PSC, the PAC was composed of experts from large integrated steel
plants, consultancies, and organizations such as the Indian Renewable Energy Development Agency (IREDA), the Small Industries Development Bank of India (SIDBI), and government officials.

Meeting once every quarter, the PAC was entrusted to make decisions on project management. Creating institutional linkages and cooperation among stakeholders was defined as one of its key functions. It was also expected to undertake periodic reviews of project activities, and implement a participatory monitoring and evaluation strategy. The PAC was also authorised to co-opt experts and appoint special task forces to meet specific project objectives. In a bid to keep the PAC engaged at the grassroots, the project also called for the Committee to build linkages with local government agencies for smoother implementation of the project in individual steel re-rolling mills. Additionally, the PAC was envisaged to be a formal vehicle for stakeholder consultations and interactions with project participants.

The supervisory and administrative needs of the project were adequately met by the PSC and the PAC. But the actual implementation of the project on the ground needed another arm. This was the Project Management Cell (PMC), set up to execute project strategies in steel re-rolling mills. The member secretary of the PAC, the NPC, was to head this unit, supported by a Manager (Projects and Contracts), a Manager of Administration and Finance (M-A&F), and a Human Resource Development (HRD) Manager (M-HRD). In addition, the project provided for technical experts in different disciplines to be attached to the PMC. The PMC was also empowered to employ additional experts as and when the need arose.

As the face of the project, the PMC was expected to form strong associations with the SRRM sector and create the conditions for
the transfer of EETs to the mills. It was also asked to monitor and evaluate project activities and report on the project’s progress to the PAC. Much of the project’s success depended on the PMC’s ability to engage with the SRRM sector, and as such, the PMC had a vital role to play as the project moved from the drawing board to the field.

The implementation structure of the project is encapsulated in Table 1.

<table>
<thead>
<tr>
<th>TABLE 1 PROJECT IMPLEMENTATION STRUCTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEF Implementing Agency: UNDP India</td>
</tr>
<tr>
<td>Project Steering Committee</td>
</tr>
<tr>
<td>Chairperson: Secretary, Ministry of Steel</td>
</tr>
<tr>
<td>Member Secretary: National Project Director</td>
</tr>
<tr>
<td>Members: UNDP; Ministry of Environment and Forests; Ministry of Power; Ministry of Industry; Ministry of Small and Medium Enterprises; Department of Science and Technology; Department of Scientific and Industrial Research; Indian Renewable Energy Development Agency; Small Industries Development Bank of India; ICICI Bank; National Institute of Secondary Steel Technology (NISST); steel re-rolling industrial associations (Steel Re-rolling Mills Association of India [SRMAI], All India Steel Re-rollers Association [AISRA], Global Environment Facility Operational Focal Point (GEF-OFP), Bureau of Energy Efficiency (BEE), etc.)</td>
</tr>
<tr>
<td>National Project Director: Joint Secretary, Ministry of Steel</td>
</tr>
<tr>
<td>Project Advisory Committee Chairperson: National Project Director</td>
</tr>
</tbody>
</table>

Table 1 contd...
Strategizing and planning

The global development objective of the project was to increase the end-use efficiency of the SRRM sector, thereby effecting a reduction in GHG emissions by the sector. To achieve this, the immediate aim of the project was defined as rapidly facilitating the adoption of EETs by SRRM units by removing the barriers that inhibit technology upgrades in the sector.

To accomplish this goal, the PMC first quantified the objective into specific targets that the project must meet. These are listed in Table 2.

As Table 2 illustrates, the project aimed to considerably lower consumption of energy, targeting a 40% decrease in coal consumption alone, which is significant not only because coal is one of the largest sources of GHG emissions, but also because a vast majority of SRRM units – particularly the smaller ones – use coal as the primary source of energy.

Once the targets were quantified, the harder part of chalking out strategies to meet them occupied the project team’s attention.
One of the most difficult barriers that the project foresaw was ignorance and apathy in the sector on the value of EETs. There was an acute need to convince a skeptical SRRM sector that EETs are more than just a way to control pollution. Without the participation of the mills, the project could not go very far. The PMC, therefore, proposed to set up ‘model units’. The model units are nothing by showpiece mills that would demonstrate to the sector that EETs not only lower emission loads, but also lead to savings on energy costs and consequently higher profits.

Along with technology demonstration, the project team also committed to build capacity in the sector to maintain the new technology, as also facilitate the development of a network of energy service companies (ESCOs) that would deliver off-the-shelf technical solutions to mills seeking greater efficiency and reduced emission loads. A technology resource institute was also envisaged as a centre where training and research on EETs for the re-rolling industry would be conducted.

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Project Targets</th>
<th>Status in the beginning of the project</th>
<th>Target / expected outcome after project completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil consumption in the re-heating furnace (litres/T)</td>
<td>42–45</td>
<td>&lt;30</td>
<td></td>
</tr>
<tr>
<td>Coal consumption (kg/T)</td>
<td>70–80</td>
<td>45–55</td>
<td></td>
</tr>
<tr>
<td>Gas consumption (Nm³/T)</td>
<td>48</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Productivity of furnace (kg/m²/h)</td>
<td>120–220</td>
<td>300–350</td>
<td></td>
</tr>
<tr>
<td>Scale loss (%)</td>
<td>2.5–3.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Power consumption (kWh/T)</td>
<td>90–120</td>
<td>60–80</td>
<td></td>
</tr>
<tr>
<td>Yield (%)</td>
<td>89–93</td>
<td>94–95</td>
<td></td>
</tr>
<tr>
<td>Utilization of mill (%)</td>
<td>65–70</td>
<td>80–85</td>
<td></td>
</tr>
</tbody>
</table>

Strategies for setting up model units
facilitating adoption of clean technology by the sector
developing financing schemes
awareness generation
To further facilitate the adoption of green and clean technology by the sector, the project identified the need to create new avenues of credit for technology upgrades. These could vary from traditional mechanisms like subsidies to innovative ‘win-win’ financing schemes for attracting private investment in EETs.

These technical and financial strategies were to be enveloped in a broad information dissemination and awareness framework, where the project team would engage with the sector directly to introduce them to the project and its objectives. This was seen as crucial to building confidence and trust in the project, facilitating smoother adoption of EETs by re-rolling mills.

**Understanding the risks**

The project team took adequate care to analyse the risks inherent to the project, enabling it to prepare for extreme eventualities. For instance, most EET packages demand specific operating conditions in mills, which may or may not be feasible. Further, the lack of adequate technical capacity in the sector may also hinder adoption of EETs. The project hoped to mitigate this first by creating EET packages that meet current operational levels in mills, and secondly through aggressive capacity building programmes.

Alongside technical risks, the project team also factored in commercial risks. Chief among these was the project’s strategy of partnering with ESCOs and financial institutions for EET investments in the SRRM sector. But these institutions and companies have limited experience in the SRRM sector, and may waver from committing to investments. The project team hoped to mitigate this risk by directly establishing investment support mechanisms for a few ‘model units,’ enabling the building of confidence in EETs among stakeholders.
Backed by a strong institutional arrangement, a consensus on objectives, a clear understanding of the targets, and with a basket of strategies in hand, the project team was now ready to take the project to the field. From its headquarters in New Delhi, the project fanned out to all corners of the country, reaching out to steel re-rollers, big and small, with its offer of technical assistance to reduce energy consumption, boost productivity, and cut down GHG emissions. The question that was foremost in the minds of the project team was:

Will the steel re-rolling mills respond?
ROLLING IN THE CHANGES

Energy-efficient Steel Re-rolling

the web of steel rolling in the changes

impacts and insights

forging new skills into the field

the road ahead

the ecotech edge

chapter 2
CHAPTER 3

INTO THE FIELD

Turning re-rolling mills into agents of change
LOCATING AND IDENTIFYING
Understanding the geographical context

It is famously said of India that whatever is true about the country, the opposite is also true. India’s sheer size and demographic diversity manifests itself in innumerable local variations in language, customs, habits, and, most crucially, in ways of doing business.

For an intervention on the scale of the Steel Project, it was, therefore, important to understand the law of the land, to gain insights into steel re-rolling in different parts of the country. Accordingly, the project team felt the need to map the geography of steel re-rolling in India, locating steel re-rolling mills (SRRMs) in the country and assessing sectorial baselines on parameters such as energy consumption. The project team, therefore, sought the services of the Petroleum Conservation Research Association (PCRA) to situate the project in a geographical context.

The PCRA team had analysed the SRRM sector by 2006, and found that the (then) 1200-odd re-rolling mills in the country were concentrated in geographically distinct clusters. Fortuitously, the SRRM sector in India seemed to be concentrated in specific regions. While clustering as a model of economic development is well established and not unique to the SRRM sector, it offered SRRM units distinct competitive advantages, including the opportunity to tap into a shared labour force and a common knowledge pool. More importantly for the project, the physical proximity between the mills made it easier – in theory at least – for new technology to spread.

The clustering of SRRM units, in turn, triggered a ‘clusterization’ of industries and services tailored to meet the needs of the SRRM sector. What this meant for the project was that the fundamentals that could be harnessed to support new energy-efficient technologies (EETs) were already present in these clusters.
In its Report, PCRA divided all re-rolling mills in the country into six geographical clusters – South, West, Central, East, North I, and North II (Figure 1). Following its field visits to sizeable samples in each cluster, the PCRA team drew broad conclusions about the SRRM sector in India.

Analysing data from 300 SRRM units across the country, the report confirmed that a majority of SRRM units in the country were indeed using obsolete and inefficient technology that was...
A SNAPSHOT OF SRRM CLUSTERS

SOUTH
Spread across the states of Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, and the Union Territory of Puducherry, the South Cluster consisted of 198 re-rolling mills. Integrated steel plants in Vishakhapatnam in Andhra Pradesh and Vijayanagar in Karnataka supply much of the raw material to these mills.

WEST
This cluster of about 250 re-rolling mills was concentrated in the district of Jalna, Maharashtra. Jalna city itself was (and continues to be) a major manufacturing hub of TMT bars. Other mills were located near Pune, Nashik, Silvasa, Ahmedabad, and Bhavnagar. For the past decade, the mills in this cluster have experienced a boom in the market, their products making their way to the growing construction industry in the urban centres of Mumbai, Pune, and Ahmedabad.

CENTRAL
Covering the states of Madhya Pradesh and Chhattisgarh and the Vidarbha region of Maharashtra, the Central Cluster was home to 214 re-rolling mills. With the Raipur–Bhilai region of Chhattisgarh rich in mineral ores, most

hurting their bottom lines and adding to environmental stress (Figure 2). The industry as a whole was also gradually moving away from furnace oil – prices of which were always rising – to coal. It was observed that almost 65% of SRRM units in the Central cluster alone were fuelled by lump coal (Figure 3). Inadequate laboratory facilities, reliance on scrap iron as raw material, and poor power supply were other issues that impacted product quality and plant efficiency.

The Report, therefore, noted the opportunity to introduce clean technology – pulverized coal-based systems in particular – to help boost energy efficiency and productivity.
re-rolling mills were clustered in this region. The SRRM units were typically located in industrial parks in this region, outside the urban centres of Raipur, Bilai, Indore, Bhopal, and Nagpur. With production outstripping local demand for steel products, much of the steel produced by this cluster is sent to national markets.

**EAST**
Spread across the states of West Bengal, Odisha, Jharkhand, and Bihar, the East Cluster had an estimated 150 re-rolling mills, sourcing raw material from integrated steel plants in Jamshedpur (Jharkhand), Durgapur (West Bengal), and Rourkela (Odisha); and producing mainly for markets in East and North-East India.

**NORTH (I and II)**
The northern region is the biggest market for construction and building materials in India. It is no surprise then that this region is densely dotted with SRRM units, with over 300 units located in the Ludhiana–Mandi Gobindgarh industrial belt alone. Therefore, PCRA further divided this region into North I, consisting of 409 mills in the states of Punjab, Himachal Pradesh, and Jammu and Kashmir, and North II, consisting of 206 SRRM units in the states of Delhi, Rajasthan, Haryana, Uttaranchal, and Uttar Pradesh.
The SRRM clusters studied by PCRA also revealed an acute shortage of skilled manpower (Figure 4). Most mills were run by foremen, who were poorly trained and lacking in willingness to adopt new processes.

At the management level, most mill owners were indifferent to modern steel re-rolling practices, suspicious of government agencies, and reluctant to part with data. Health and safety were accorded low priority, with management vision confined to keeping the plants running to stay above the red.

Further, although the SRRM industry has had its own associations, there was hardly any cohesion or collaboration as seen among industry associations in other SME sectors (textiles, for instance). In fact, re-rolling mills continued to be largely unorganized and devoid of a unified business vision.

On the other hand, the Report also noted that many SRRM units were to become increasingly aware that technology was a competitive tool in the market place. However, for want of
channels of information and viable credit mechanisms, their access to new technology was limited. This presented an opportunity that the project could exploit. By bringing new technology literally to the doorstep of SRRM units, and creating an enabling policy environment to aid their adoption, it could help mill owners realize their aspirations to conduct business in a modern and sustainable way.

**Delivering information, creating awareness**

While the Cluster Report was tasked with locating India’s SRRM units and analysing their strengths and weaknesses, the project simultaneously launched initiatives to introduce itself to the sector, as a first step in a planned awareness and information dissemination programme. It was recognized that unlike other small and medium enterprise (SME) sectors, the SRRM sector was unfamiliar with the kind of collaboration and partnership...
proposed by the project. It was felt necessary to first introduce the idea of energy efficiency and the mandate of the Steel Project, both of which would help decision makers consider adopting the project’s technology packages. Therefore, a series of inception workshops were held at New Delhi, Nagpur, and Coimbatore in 2004, in which about 150–200 participants from industry, consultants, domestic equipment manufacturers (DEMs), and financial institutions participated. This was followed by several national-level workshops and meetings in the clusters. The project also conducted more intense interactive meetings with smaller groups involving associations and mill owners (Figures 5 and 6).

At these interactions, technical experts and project officials presented emerging EET options in steel re-rolling, emphasizing their cost-saving potential. The project’s objectives and intervention modalities were also introduced, and applications for inclusion in the model unit programme were solicited.

Figure 5 Delegates registering at a national seminar organized by the Project Management Cell
Brochures and other advocacy material, prepared specially for these interactions, were distributed, and these were supplemented by a newsletter and a website that was a portal to the project, publishing information and updates and inviting participation.

Information and awareness drives continued throughout the duration of the project, and international exposure visits were soon added to the project’s information dissemination strategy. Two visits were organized to Sweden in 2006, and two more to China between 2007 and 2008. The delegations sent by the project on these exposure tours included owners of SRRM units, and they returned with fresh insight into the technical paradigm of 21st century steel re-rolling. In China, for instance, they visited institutes like the School of Energy and Thermal Engineering, Changsa, and toured re-rolling mills where new technologies such as pulverized coal-fired furnaces and hot charging of continuous cast billets were being successfully used.
The Steel Project also regularly participated in trade fairs and industry events as a means to introduce itself to stakeholders in the SRRM sector.

The project’s information dissemination strategy played a vital role by arousing interest among SRRM units, thereby fulfilling the objective of technology demonstration (Figure 7). They succeeded in triggering a desire among mills to upgrade, uplift, and benefit by implementing EETs. Many of these applied to participate in the project, and they subsequently became ‘model units’ that showcased EET packages in an actual working environment.

**Figure 7** A graphic from awareness generation material disseminated by the Project Management Cell
SELECTING AGENTS OF CHANGE

The principal implementation strategy adopted by the project was to deploy EET packages in a select group of mills, chosen through a comprehensive selection process. These units – deemed ‘Model Units’ – were to receive technical support and training as well as financial incentives to implement their chosen EET package. In exchange, they were to open their mills for peers wanting to understand and see the technology at work. The idea was to create demonstration units to showcase the technology, to build confidence that the technology is foolproof. It was hoped that these units would play the role of change agents, as news of their improved performance spread across the clusters.

The road to attain ‘Model Unit’ status was rigorous (Figure 8). As and when requests for participation (RFP) from SRRM units were received, the PMC sent out a structured form, seeking detailed information on their facilities (furnace, mill stands, motors, etc.) and the present status of specific energy consumption (SEC) (furnace oil, coal, gas, power, burning loss, etc.). This data was then analysed by the PMC and subsequently, a team visit was organized to the shortlisted units. During the visits, the experts analysed the existing conditions and the facilities installed in the units, and also deliberated with the management. Next, ‘visit reports’ comprising observations and customized recommendations were forwarded to the units, seeking their consent for implementation. Once consent was received, the units were placed for formal approval by the competent authorities. On approval, project development agreements (PDAs) were signed with selected units, along with bank guarantees. Selected units were subsequently approved/ratified by the Project Advisory Committee (PAC) and Project Steering Committee (PSC).

The selection of model units, apart from being based on scientifically designed criteria, also factored in distribution...
patterns of the industry in the five geographical clusters. These units represented the ‘critical mass’ of the SRRM sector, where the potential benefits accruing to the SRRM industry on account of EETs would be demonstrated. Beginning in 2005, the project selected a total of 67 SRRM units as model units, exceeding its initial target of 50 such units. Of these, 34 have commissioned their chosen technical packages. ‘Pipeline units’ were also selected during this process.
IMPLEMENTING THE PROJECT

Technical support and capacity building

Soon after their selection as model units, the PMC carried out in-depth baseline studies in the mills, held design meetings, drew up a schedule for detailed engineering plans, including supply of equipment, erection and commissioning, and commenced monitoring and verification of the results of project implementation.

The Indian SRRM sector has been historically disadvantaged in terms of technology and technical capacity. Technology research and development (R&D) for the steel industry in the country tended to cater to the needs of big integrated steel plants, many of whom have in-house R&D institutions. But the smaller SRRM units do not have such institutional linkages, and consequently little has been done in terms of technology development or R&D for the sector. The Steel Project marked the first time that a technology solution was prepared specifically for the needs of the SRRM sector. In association with MECON
Ltd (Metallurgical and Engineering Consultants Limited), a public sector undertaking of the Ministry of Steel, the project developed EET packages for furnaces as well as rolling mills, branded under the name EcoTech. In keeping with the acute sensitivity to new investments in the SRRM sector due to its low equity base, the packages consisted of both low-end (i.e. less expensive) and high-end (i.e. more expensive) options. These options and their modes of implementation have been discussed in detail in the following chapter.

Building capacity in the sector was the second half of the core technical objective of the project. Concurrent to the implementation of technology packages in the model units, several structured training programmes were launched to train shop-floor workers and mill management officials and expose them to best practices in modern steel re-rolling operations. These included quality enhancement programmes such as 5S Lean Manufacturing System and ISO 9001 and 14001, training programmes such as PIT or Performance Improvement Training, and more design-specific modules such as on Roll Pass Design (RPD). This was in addition to larger regional technology workshops, all of which followed a capacity building Master Plan developed by the PMC. The Master Plan and the numerous capacity building initiatives that sprang from it are discussed in a subsequent chapter.

**Removing financial barriers**

**Subsidy schemes**

As mentioned, the low equity base of the SRRM sector necessitated the development of low-cost technologies that could be realistically adopted by the mills. And to further make the adoption of EETs attractive, the project worked on creating innovative financing mechanisms. The first financing model attempted was a subsidy on interest, where SRRM units availing loans from banks would receive subsidized interest
rates through a dedicated ₹ 90 million fund set aside by the project. However, this model did not find much favour among SRRM units, who contended that the financial support be more concrete and immediate.

In response, the project launched a capital subsidy scheme. Each model unit, upon achieving a minimum of 10% reduction in specific energy consumption (SEC) and specific CO₂ emissions, was eligible for a direct 25% capital subsidy. Depending on the investment made, the capital subsidy could be between ₹ 3 million maximum (for low-end EcoTech packages) and ₹ 7.5 million maximum (for high-end EcoTech packages). This scheme elicited much more interest among SRRM units, and the project began to receive more support.

Apart from subsidy schemes, the project also reimbursed consultancy fees (up to a maximum of ₹ 500,000), and prepared several bankable feasibility reports (BFRs). The BFR was the project’s attempt to bridge the knowledge gap in financial institutions, which typically do not possess the technical capacity to evaluate the feasibility of energy-efficiency projects in SRRM units.

**The ESCO experience**

Yet another financial mechanism sought to be leveraged by the project was the Energy Services Company (ESCO) model. Globally, ESCOs have established their relevance to energy efficiency projects by implementing EETs through a performance contracting approach. In India, ESCOs have been in operation for over two decades, but when the Steel Project was conceived, their exposure to the manufacturing industry in general and the SRRM sector in particular was minimal. The project, therefore, took up the challenge of leveraging ESCOs to overcome the financial barriers inhibiting EET growth in the SRRM sector. The move was welcomed by industry associations as it mitigated
the high-risk perception associated with EET investments, and could potentially facilitate financial arrangements with banks and financial institutions. From the project's perspective, the involvement of ESCOs in turnkey project implementation and training of operating personnel could be a significant force-multiplier.

Beginning 2005, the modalities for operationalization of an ESCOs guarantee fund were discussed while a stakeholder consultation was held among ESCOs, banks/financial institutions, and industry. ESCO representatives regularly attended the awareness workshops organized by the PMC, and a search was launched to identify ESCOs suitable for the SRRM sector. The immediate objective was to have at least four to five ESCOs working in the sector by 2007. However, the search yielded little result, and the mid-term review of the Steel Project concluded that the concept of performance contracting did not seem to be applicable to the SRRM sector, and consequently the sector is not attractive enough for ESCO participation.

The PMC subsequently scaled down its activities on the ESCO front, but retained its commitment to the fundamental soundness of the concept. In September 2010, a brainstorming workshop titled Role of ESCOs, Third Party Financing, and Financial Linkages was organized in Chennai. Speakers from BEE-listed Grade 1 and Grade 2 ESCOs\(^1\) shared their experiences and possible areas of convergence with the top management of several SRRM units. There was general agreement that there was scope for participation in the areas of lighting, renewable fuels, fuel switching, motor replacement, cogeneration, biomass gasification, thermal optimization, furnaces, and variable frequency drives, and compressors.

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\(^1\) Grade 1: ESCOs having ‘very high ability’ to carry out energy efficiency audits and implement energy saving projects. Grade 2: ESCOs having ‘high ability’ to carry out energy efficiency audits and implement energy saving projects.
Subsequently, in September 2011, the PMC organized another workshop in New Delhi titled *Interactive Programmes for ESCOs*. ESCO representatives presented three case studies to the participating units, which included implementation modalities and a proposal to SRRM units on potential interventions. These and other attempts continue to explore options for the eventual

**EXPERT SPEAK**

In the initial three years of the project, it was difficult to enter these SRRM units seeing their mindset for the energy-efficient technologies. None of the units were giving answers to our letters, to our queries, etc. for implementation of these technologies. It was a hard time for us and we started thinking on the viability of the project. But success in one unit showed us the way forward. Lessons learnt from these initial units were widely disseminated to the entire sector. Because of this, a large number of units started showing interest in the project and the capital subsidy scheme further boosted the process.

For example, in Mandi Gobindgarh, which houses about 400-odd units, they were very reluctant to share data and did not show much interest in the initial stages of the project. But now when we go to this cluster, almost all units know about the project and appreciate the project and the personnel of PMC. Whenever PMC officials visit the cluster, they want the PMC team to visit their unit and suggest something. This is how the entire transformation took place in Mandi Gobindgarh within a few years.

*Arindam Mukherjee*

Project Manager – Technical Project Management Cell, UNDP–GEF Project (Steel)

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*Energy-efficient Steel Re-rolling*
convergence of ESCO and SRRM interests to further accelerate EET implementation in the sector.

**Institutional arrangements**

**Resident missions**

The nature of the Steel Project necessitated constant and visible collaboration on the ground. But the PMC was based in New Delhi, keeping a tab on a project that was national in scope and scale. In this scenario, the PMC set up a ‘Resident Mission’ in each of the six SRRM clusters (Table 1). The Resident Mission was defined as the institutional arm of the PMC on the ground, helping to implement the national vision of the Steel Project. The six resident missions were managed by the PMC.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Cluster</th>
<th>Resident mission organization</th>
<th>States covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESIDENT MISSIONS APPOINTED BY THE PROJECT MANAGEMENT CELL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North II</td>
<td>Petroleum Conservation Research Association (PCRA)</td>
<td>Delhi, Rajasthan, Uttar Pradesh, Uttaranchal</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>NISST</td>
<td>Chhattisgarh, Madhya Pradesh, Maharashtra (only Nagpur)</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>NISST</td>
<td>West Bengal, Odisha, Bihar, Jharkhand</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>MITCON Consultancy Services Ltd</td>
<td>Gujarat, Maharashtra (except nagpur), Goa, Daman, Diu</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>NISST</td>
<td>Tamil Nadu, Kerala, Karnataka, Andhra Pradesh</td>
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in collaboration with three ‘Resident Mission Organisations’ – the National Institute of Secondary Steel Technology (NISST), the PCRA, and MITCON Consultancy and Engineering Services Ltd (MITCON). The Resident Mission programme initially also included organizations such as Biju Patnaik National Steel Institute (BPNSI), Maharashtra Energy Development Agency (MEDA), Chhattisgarh Renewable Energy Development Agency (CREDA), and Industrial and Technical Consultancy Organisation of Tamilnadu (ITCOT).

Placed on the frontlines, the Resident Missions had to fulfil a multiplicity of functions and propel the project forward. This included forming networks with stakeholders at the cluster level. Resident Missions routinely engaged in interactions with state pollution control boards, energy utilities, R&D institutions, equipment manufacturers, and industry associations. Additionally, the Missions sought a better understanding of state and national policies on industrial pollution and energy consumption, in a bid to further the project’s objectives by harnessing moments of synergy and avoiding areas of conflict. In the latter case, the Missions typically briefed the PMC and then put together a reconciliation plan.

The Missions also helped assess the state of technology in the model units and their specific capacity building needs. Additionally, to help introduce a better understanding of contemporary best practices, the Missions organized technical workshops and awareness exercises in their respective clusters.

The overriding concern of the Resident Missions was the business of persuasion and the ability to back it up with relevant data and reasoning in order to carry conviction with a sector that is reluctant to step out of its comfort zone – outdated and outmoded as it has become. In this context, they performed a critical function for the PMC. They were effectively the most
important tool of liaison among SRRM units, the Ministry of Steel, and the PMC.

**The Technology Information and Resource Facilitation Centre**

While the Resident Missions offered institutional support at the field level, the Steel Project also mooted a national centre that would provide technical support to SRRM units, both during and post-project implementation. This institution, christened Technology Information and Resource Facilitation Centre (TIRFAC), was envisaged as having two resource centres: a hardware centre that served as a demonstration unit testing new EET options for steel re-rolling, and a software centre that created, developed, and disseminated tools and knowledge pertaining to all facets of modern steel rolling. It was proposed that as the project matures, the PMC could be merged with TIRFAC, which, in turn, can be registered as a society. Its eventual objective was defined as emerging as a credible and independent R&D institution dedicated to the needs of the SRRM sector.

While noble in vision, the idea of a hardware centre was later found to be an unsustainable proposition. For one, the centre called for the construction of a small mill where technology could be tested and demonstrations given. However, it was unclear about what would happen to the finished products. Further, sources of funding for procurement and maintenance were nebulous. These and other issues were noted in a report by a committee set up to evaluate the feasibility of the hardware centre. The report also observed that centres such as the one planned under TIRFAC were found to be unsustainable all over the world, and were largely supported by industry associations. But support from an unorganized SME sector – one that was also skeptical about energy efficiency to boot – was too much to expect, and funding support from the Ministry of Steel was
not forthcoming. Therefore, the TIRFAC hardware centre was dropped from the project design. Soon afterwards, activities of the proposed software centre were also subsumed by the PMC.

LUDHIANA STEEL
THE ROAD TO ENERGY EFFICIENCY

Ludhiana Steel Re-Rolling Mills was established in 1989 in Ludhiana, Punjab. By the early 2000s, it had a capacity of 8 TPH (tonnes per hour), producing alloy steel for fabrication and construction. However, the mill stood at the cusp of an emerging crisis, battling rising prices of furnace oil, which seriously dented their competitiveness. The mill ran on an oil-fired furnace, and unlike most mills which responded to the rise in oil price by switching to coal-fired furnaces, Ludhiana Steel could not make the switch to coal. As a firing agent, coal tended to pass on impurities to billets, making them unsuitable for the mill’s primary product – graded alloy steel. Adding further stress on bottom lines were outdated and inefficient furnace and rolling mill technology. Subsequently, its oil consumption stood at 48 litres per tonne of steel.

Realizing the serious implications of persisting with the technical status quo, the management at Ludhiana Steel applied to the PMC to be included as a model unit. Once selected as such, technical consultation facilitated by the PMC and the North I Cluster Resident Mission identified the nature of technology intervention required in the mill. The challenge was to improve the efficiency of the furnace to reduce oil consumption. The Steel Project recommended a re-design of the furnace, in addition to improvements in the rolling mill, implementation of modern management...
systems such as 5S Lean Manufacturing System and ISO standardization, and rigorous technical training of foremen and shop-floor workers.

The unit installed a new, properly designed furnace fitted with eight burners, a high-efficiency recuperator, hydraulic pushers, mechanical injectors, etc. The furnace started production in 2008, and since then Ludhiana Steel has reported significant improvements in capacity, fuel cost savings, and quality of the final product. The mill today has enhanced its capacity from 8 TPH to 12 TPH, and slashed oil consumption from 48 litres per tonne to 34.6 litres per tonne. In addition, several modifications were made in the rolling mill with an eye on reducing electricity consumption. These included universal spindles and anti-friction bearings, and they have enabled Ludhiana Steel to reduce its power consumption by 27%.
CHAPTER 4

THE ECOTECH EDGE

Delivering energy-efficient technology to the steel re-rolling industry
THE NEED FOR ENERGY-EFFICIENT TECHNOLOGY

Extant technology paradigm in the Indian SRRM sector

The Steel Project’s core technical objective was to facilitate access to energy-efficient technologies (EETs) for steel re-rolling mills (SRRMs). Establishing benchmarks for EET packages formed an important component of this objective, as did demonstration of feasibility. As a first step towards this, a status report on the SRRM sector in India was commissioned during the project development phase (2001/02). The report surveyed SRRM units across clusters, observing technology and production processes and identifying opportunities for EET interventions.

The report stated that SRRMs in India are typically of two types, each having its own technical specifications. Bar mills are ingot-/billet-based rolling mills, with a typical capacity of 50–100 tonnes per day (TPD). They are equipped with a roughing mill, an intermediate mill, a finishing mill, rotary shearing, repeaters, and a thermo-mechanically treated (TMT) line with a cooling system (i.e., TMT cooling line, hot water pump, cold water pump, pinch roll, controls, and DC motors). The material flow in a typical SRRM unit is shown in Figure 1 for better understanding of the whole process. Similarly, Figure 2 depicts the cumulative energy consumption pattern in the SRRM sector.

The second type of re-rolling mill observed in India is the structural rolling mill. These mills could be either semi-automatic or manual, employing coal- or oil-fired furnaces. Their primary raw material may be ingots/billets. Their main products are structural steel products such as flats and angles, and have a typical capacity of 50–200 TPD. Standard equipment in such mills include rolling mill stands, pinion and reduction gear boxes, fly wheels, electric motors, and hot and cold shearing machines.
During the project development phase, the project also examined technology interface issues and developed energy supply curves (cost of conserved energy or CCE) at a 30% discount factor. Main sources of direct energy-use in the sector as a whole include firing agents (coal, furnace oil, or in some cases natural gas) for the furnace and electrical energy for the rolling process. The direct energy cost in SRRMs is estimated...
at 25%–30% of the conversion cost. However, the sector is also characterized by high indirect energy usage, accounted for by the use of energy-intensive raw materials and obsolete technology. These indirect losses result in higher energy costs, scale loss\(^1\), and low yields. SRRM units also consume electrical energy during the rolling process as well as for the operation of auxiliary installations (e.g. fans, lights, and pumps).

The absolute quantity of thermal energy needed to re-heat billets and ingots was highlighted as the main environmental concern in the SRRM sector. Related to this energy consumption are emissions that arise because of combustion, releasing oxides of nitrogen, sulphur dioxide, carbon monoxide, and suspended particulate matter (SPM) into the environment. Additionally, inefficient equipment and processes result in higher electricity consumption. Concerns about water use were also noted, with losses due to direct cooling and groundwater contamination due to oil loads of used water being particularly noticeable.

\(^1\) Scale loss: Burning loss of input material in the furnace
THE OPPORTUNITY FOR ENERGY-EFFICIENT TECHNOLOGIES

Despite high energy costs borne by SRRM units and the associated environmental burden faced by them, the All India Status Report noted that there was negligible penetration of EETs in the sector. One of the principal reasons identified was the unproven commercial viability of energy-efficient technical packages, which inhibited investor confidence. But, at the same time, significant market potential was detected for EETs, estimated at close to USD 250 million. There were several technical gaps such as a lack of efficient production processes and machinery in the sector that could be breached by EETs, and these formed the project’s focus as it developed its technology packages.

In designing EET solutions for the sector, the project gave utmost importance to successful demonstrations of the technology. The fact that most of the technology options were completely new to the sector added to the need for credible technology demonstration. Further, it was recognized that the introduction of new technologies needs to be supported by an enabling environment of efficient and modern management practices, improved maintenance standards, and an adequately trained workforce.

The project had also to take into account the impact of high transaction costs attached to advanced technologies, costs that may not deter large-scale producers but intimidate the smaller-scale SRRM units. These costs could include re-engineering, replacement or modification of existing plant and facilities, loss of production, etc. This motivated the project to start with low-cost packages followed by more expensive

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2 PMC (Project Management Cell). 2001/02. All India Status Report on Rolling Mills. New Delhi: PMC.
high-end packages. Each package was optimally designed with a suitable combination of options so that the industry has sufficient willingness to pay and global and national objectives are served.

**ECOTECH OPTIONS AND TECHNOLOGY PACKAGES**

The project team identified a basket of technology packages and options in partnership with MECON (Metallurgical and Engineering Consultants) Limited. A total of 11 technology packages were developed for re-heating furnaces, all configured to reduce the consumption of thermal energy in furnaces. These were complemented by 19 technology options for the rolling mill.

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**ECOTECH OPTIONS DEVELOPED BY THE STEEL PROJECT TEAM FOR THE STEEL RE-ROLLING MILL SECTOR**

### Technology options for rolling mill

1. Crop length optimisation
2. Rollers guide
3. Spindle and couplings
4. Anti-friction roller bearing
5. Installation of Y-roller table
6. Installation of drop tilter
7. Installation of tilting table
8. Quenching and self-tempering (QST) of re-bars
9. Oval repeater
10. No-twist block
11. Slit rolling
12. Computerised roll pass design
13. Lubrication technology
14. Cast in carbide rolls in conventional stands
15. Pre-stressed housing less stands
16. Endless welding roll
17. Reactive power compensation
18. Energy-efficient drives
19. High voltage (HT) AC motor

### Technology packages for re-heating furnace

#### Low-end Packages
**Investment:** ₹ 15–20 million | **Energy Saving:** 20%–25%
1. High efficiency recuperator with improved furnace design
2. Technology for the use of coal-based producer gas as fuel
3. Technology for the use of pulverised coal as fuel
4. Technology for the use of biomass gas as fuel
5. Technology for the use of coal-bed methane (CBM) as fuel

#### High-end Packages
**Investment:** ₹ 50–60 million | **Energy Saving:** 30%–40%
1. Regenerative burner system
2. Hot charging of continuous cast billets
3. Top-and-bottom firing system
4. Oxy-fuel combustion system
5. Walking hearth/beam furnace
6. Direct rolling of continuous cast billets
process, which focused on reducing electricity consumption. These were together marketed as EcoTech, or economically viable and ecologically sound technology.

**Technology packages for re-heating furnaces**

The 11 technology packages developed for re-heating furnaces are briefly described below.

**High-efficiency metallic recuperator with improved furnace design**

This technology package (high-efficiency metallic recuperator with improved furnace design) redresses fundamental design imperfections (such as geometry and material of tubes inside the recuperator and the dimensions, refractories/insulation, combustion systems, etc. in the furnace) in re-heating furnaces that lead to low hearth utilization, reduced heat input, and improper heat distribution as well as the resultant high specific fuel consumption (SFC) and scale loss. Outdated and inefficient furnace equipment is replaced with high efficiency equipment like a metallic recuperator (Figure 3), proper refractories and insulation, and some automation and control system. All this is supplemented by an energy-efficient furnace design.

The investment required, potential reduction in fuel consumption, and the payback period for this technology package are given below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Investment</td>
<td>₹ 10–20 million</td>
</tr>
<tr>
<td>Reduction in fuel consumption (per tonne of furnace throughput)</td>
<td>20%–25%</td>
</tr>
<tr>
<td>Simple payback period</td>
<td>6–12 months</td>
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* Hourly rate of discharge (tonnes/hour) of material from the furnace.
**Technology for the use of coal-based producer gas as fuel**

The use of lump coal is widely prevalent in the sector. The use of lump coal results in the inability to control furnace temperature, which means incomplete combustion and subsequently higher SFC. This technology package (Figure 4) modifies the re-heating furnace to replace lump coal with coal-based producer gas as the firing agent. Producer gas allows for a greater degree of control over combustion, and is made available in two forms: (1) hot raw gas and (2) cleaned cold gas. The package also includes an improved furnace design that is able to make optimum use of the producer gas. This technology package leads to higher thermal efficiency, lower burning loss, and low pressure and temperature during operation. By replacing lump coal with a cleaner fuel, the emissions load of the mill is also reduced.

![Figure 4](image)

The investment required, potential reduction in fuel consumption, and the payback period for this technology package are given below.

- **Investment** : ₹15–20 million
- **Reduction in fuel consumption** (per tonne of furnace throughput) : 25%–30%
- **Simple payback period** : 6–12 months
Technology for the use of pulverized coal as fuel

A slightly more cost-effective alternative to lump coal, this technology package re-designs the furnace to enable pulverized coal firing. It also makes provisions for the use of hot combustion air, an improved-design pulverizer that allows controlled feeding of pulverized coal, and installs a shell-in-shell type recuperator. Automation and control systems are also installed as part of the package, as is an improved energy-efficient furnace. Figure 5 shows workers in an SRRM unit using pulverized coal as fuel.

Figure 5  Workers using pulverized coal in a steel re-rolling mill

The investment required, potential reduction in fuel consumption, and the payback period for this technology package are given below.

- Investment : ₹7–10 million
- Reduction in fuel consumption (per tonne of furnace throughput) : 25%–30%
- Simple payback period : 6 months
Technology for the use of biomass gas as fuel

The biomass package developed by the project is in some sense a revolution, as there existed no precedence of using biomass gas as the primary fuel in such an energy-intensive process as steel re-rolling. Targeted mainly at oil-fired furnaces, the package replaces furnace oil with producer gas from biomass briquettes, made with agricultural and forestry residue (Figure 6). The use of producer gas ensures proper combustion, lowering burning loss. The package, which comes with an improved furnace design, also eradicates emission-related metrics, because bioenergy is considered a net zero CO₂ emission fuel.

Given below are the investment required, potential reduction in fuel consumption, and the payback period for this biomass-based technology package.

- **Investment**: ₹15–20 million
- **Reduction in fuel consumption** (per tonne of furnace throughput): 20%-25% (net zero CO₂ emissions)
- **Simple payback period**: 6–12 months
Technology for the use of coal-bed methane as fuel

Coal-bed methane (CBM), coal-bed gas, or coal-mine methane is a form of natural gas extracted from coal beds. CBM is a clean replacement for coal- and furnace oil-based furnaces and has all the advantages of a gaseous fuel. This package also installs safety equipment for the use, maintenance, and monitoring of coal. Figure 7 shows the functioning of this technology graphically.

The investment required, potential reduction in fuel consumption, and the payback period for the CBM technology package are given below.

- **Investment**: ₹ 10.0–12.5 million
- **Reduction in fuel consumption** (per tonne of furnace throughput): 25%–30%
- **Simple payback period**: 6–12 months
Regenerative burner system

Regenerative burners use the heat of flue gases to pre-heat the combustion air and gases going to the burners thus optimizing the heat input at the source itself. Regeneration uses a pair of burners in cycle to alternately heat the combustion air or recover and store the heat from the furnace exhaust gas. Air pre-heat temperatures up to 1000 °C are achievable resulting in exceptionally high thermal efficiency.

Figure 8
A regenerative burner system

Source
http://www.priorindustries.com/hotwork_comb_tech.htm

The investment required, potential reduction in fuel consumption, and the payback period for this technology package are given below.

- Investment : ₹ 40-60 million
- Reduction in fuel consumption (per tonne of furnace throughput) : 35%
- Simple payback period : 10 months
Hot charging of continuous cast billets

In virtually every re-rolling mill, billets and ingots are cold charged in re-heating furnaces. This means heating billets from room temperature to 1200 °C, leading to significant wastage of sensible heat. The hot charging process offers a solution that enables re-heating of hot billets as they emerge from the caster at temperatures of 600–800 °C, resulting in reduced fuel consumption for re-heating. The package also has the provision of a buffer furnace to compensate for mill delays.

The investment required, potential reduction in fuel consumption, and the payback period for this technology package are given below.

- **Investment**: ₹ 30 million
- **Reduction in fuel consumption** (per tonne of furnace throughput): 30%
- **Simple payback period**: 6 months

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**EXPERT SPEAK**

In the beginning, the mill owners didn’t even let us enter their units. But once they realized that we are giving them standard, established technology, their minds started changing. They were told that if they are making ₹ 100 as margin now, with this technology they would make ₹ 150. Being entrepreneurs, the mill owners quickly understood this language. This proved to be the turning point. Inception workshops were organized in the beginning to change mindsets, and in these workshops they started realizing that we are talking sense.

In my view, finance is not a problem for SRRM units. Many new units are coming to us and they don’t want capital subsidy. Their biggest problem is lack of skilled workforce. None of the institutes in India have the curriculum where the needs of these units are fulfilled. So the concerned authorities should look at including SRRM-related courses in engineering colleges across the country.

G Madan  
Former Manager (Monitoring and Evaluation)  
Project Management Cell, UNDP–GEF Project Steel
Direct rolling of continuous cast billets

Direct rolling is a technical evolution of hot charging, where continuous cast billet is directly pushed to the rolling mill, without the need for an intermediate process of re-heating. In this process, the need for a re-heating furnace is eliminated, resulting in a complete heat saving due to this redundancy. The direct rolling process can be adopted in composite units by controlling the secondary cooling of the continuous casting machine by means of Programmable Logic Control (PLC), hydraulic cutting of billets, high-speed transfers of hot billets, and a canopy covering over the conveyer belt (Figure 9).

The investment required, potential reduction in fuel consumption, and the payback period for this top-and-bottom firing system are given below.

- Investment : ₹ 30 million
- Reduction in fuel consumption (per tonne of furnace throughput) : 60%
- Simple payback period : 3 months

Figure 9 A snapshot of direct rolling technology

4 Units that have both induction furnaces and rolling mills in the same premises.
**Top-and-bottom firing system**

In typical pusher type furnaces, burners are located at the top. In the case of billets with higher cross-sections, this results in improper heating and soaking. The higher retention of charge in the furnace leads to higher levels of SFC and scale loss. This EcoTech package provides heat input into the furnace from both top and bottom, creating uniformity of heating charge, lower scale loss and fuel consumption, and increased furnace productivity (Figure 10).

![Figure 10](http://www.fivesgroup.com/FivesStein/EN/Expertise/Steel/Products/FurnacesForLongProducts/PublishingImages/zagaroza2_pusher_furnace.jpg)

The investment required, potential reduction in fuel consumption, and the payback period for this top-and-bottom firing system are given below.

- Investment: ₹ 50–60 million
- Reduction in fuel consumption (per tonne of furnace throughput): 25%–30%
- Simple payback period: 12–14 months
Recuperators are normally used to increase combustion air temperature. This results in heat loss through nitrogen in conventional air-fuel burner systems. The oxy-fuel burners developed under this package partly use oxygen instead of combustion air and thus eliminate heat loss through nitrogen (Figure 11). In comparison to air-fuel flame temperature, the oxy-fuel burner flame can achieve much higher temperatures. The furnace thus operates at high temperatures which increases productivity, lowers retention time, and cuts down scale loss.

The investment required, potential reduction in fuel consumption, and the payback period for the oxy-fuel combustion system are given below.

- **Investment**: ₹ 25–50 million
- **Reduction in fuel consumption**
  - (per tonne of furnace throughput): 25%–30%
- **Simple payback period**: 6–12 months

*Figure 11* The oxy-fuel combustion system

*Source* [http://members.questline.com/Article.aspx?articleID=8920&accountID=1874&nl=10350](http://members.questline.com/Article.aspx?articleID=8920&accountID=1874&nl=10350) (*Photo courtesy Praxair*)
Walking hearth/beam furnace
This technology package consists of a state-of-the-art re-heating furnace for heating high cross-section (150 × 150 mm and above) material. Compared to conventional pusher furnaces, the length of the beam furnace is shorter, enables higher productivity, minimizes scale loss, and negligible markings on the stock (Figure 12).

**Figure 12** A walking hearth/beam furnace  

The investment required, potential reduction in fuel consumption, and the payback period for this technology package are given below.

- **Investment**: ₹ 60–80 million
- **Reduction in fuel consumption**
  - (per tonne of furnace throughput): 30%–35%
- **Simple payback period**: 18–24 months
Technology options for rolling mills

Options developed for the rolling process under EcoTech sought to reduce power consumption, boost mill utilization and yield, enhance the longevity of equipment, and make a positive difference to product quality. A total of 19 such options were unveiled, and presented below is a sampling of some of these options and their envisaged benefits.

**Crop length optimization**

Requiring an investment of approximately ₹ 200,000, this option suggests automation of existing shears and reduction in crops to 50–100 mm (Figure 13). It envisages an increase in mill yield by 0.5% by minimizing wastage through inefficient cropping.

**Rollers guide**

Applicable for bar and rod rolling, this EcoTech option reduces misrolls leading to higher yield and mill utilization and improved surface quality (Figure 14). It requires an investment of ₹ 300,000 approximately.

**Universal spindle and couplings**

At an investment of approximately ₹ 520,000 (for a set of seven), universal spindles and couplings enable uniform loading of drive motors, reduced power consumption, and increased roll life (Figure 15).

*Source*

*Source*
http://publiccorp1064472010.en.china.cn/selling-leads/img_1065325069_1.html
**Anti-friction roller bearing**

Lower power consumption, higher bearing life, reduced roll jumping, and better product quality are assured through the installation of these roller bearings on roll necks/mill stands (Figure 16). It carries an investment of approximately ₹ 800,000 to 1,000,000 for three 16-inch 3-Hi mill stands.

**Y-roller table**

Y-roller tables enable uniform temperature drops and ensure minimal damage to front and back ends of the stock during feeding (Figure 17). It also ensures reduced crop-cutting and misrolls, and has the added advantage of not being dependent on manpower. The investment required for this option is about ₹ 600,000.

**No-twist block**

Costing ₹ 10 million for a 6-stand block, the No-twist block technology consumes less power, is easy to maintain, and enables close tolerances and faster pass changings (Figure 18).

**Computerized roll pass design (Figure 19)**

Typically, rolling in an SRRM unit follows a design developed by the foreman, who is not formally trained and is not liable to employ
scientific methods of roll pass design (RPD). Developed by a Swedish software company, the computerized RPD offered under EcoTech rationalizes power consumption, increases the life of drive motors, and delivers better product quality.

**DEMONSTRATING ECOTECH**

For all the potential benefits EcoTech could deliver to SRRM operations, its launch in a workshop in Surajkund in 2002 was met with deafening silence by the sector. The next few years proved to be some of the most testing times for the project, as officials from the PMC tried to overcome the obstinacy of prevailing attitudes in the sector. These tended to be traditionalist and conservative, with very little appetite for new technology, and practically no interest in it if it meant substantial investments on their part. Stories of officials denied even an entry into mills were part of personal narratives at the PMC and among the resident missions.

However, the project’s awareness and information campaigns were beginning to have some effect. These, together with the launch of the capital subsidy scheme, eventually coaxed mills to apply for ‘model unit’ status. In 2005, the first mill signed up as a model unit, and this eventually grew to 67 model units (of which 34 have commissioned their chosen technology package). In terms of the kinds of EcoTech packages preferred by participating units, the aversion to investments in new technology by the sector was underlined with most model units preferring to go for low-cost options. The modified furnace with high efficiency recuperator was particularly favoured, as was the pulverized coal package. However, the response was heartening, considering this was the first time such technology was being promoted in the sector. Of particular note was the implementation of biomass gasifier technology by Pulkit Steel Rolling Mills in Puducherry (South cluster). The initiative was the first of its kind by a steel re-rolling mill, and after commissioning
in 2009, the productivity has risen by 53% in the mill. The gasifier has proven the efficacy of biomass as a viable alternative firing agent to coal or furnace oil, and five more units have since agreed to implement the technology.

Another breakthrough was achieved in 2008, when a re-rolling mill from the East cluster – Vaishanavi Ispat – opted to implement hot charging of continuous cast billets. This marked the first time a mill had shown faith in a high-end technology package. Post commissioning in 2009, the mill has reduced fuel consumption from the cluster-average of 42 litres per tonne of steel to 23–24 litres per tonne of steel. Vaishanavi’s success with hot charging has prompted more mills to seek the technology, with one model unit in the South cluster in the process of implementing it.

The slow but steady adoption of EcoTech packages by SRRM units indicates the sector is warming up to energy efficiency. With the SRRM sector poised to play an even greater role in Indian steel exports, this is a welcome sign. The PMC hopes that the EcoTech packages would eventually be replaced by a set of even more advanced technologies (informally referred to as ‘Alltech’), which may not necessarily be economically viable at present, but will constitute opportunities as energy prices continue their upward movement.

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5 As quoted by Director of Vaishanavi Ispat Mr S Bhattacharya in the film “The Power of Energy Efficiency: The Vaishanavi Ispat Story” (UNDP, 2012).
ARS METALS INDUSTRIES PVT. LTD
ENERGY EFFICIENCY FOR BUSINESS GROWTH

The UNDP–GEF Project (Steel) has resulted in immense benefits for our unit. We are delighted with the results in terms of improved energy efficiency and quality of products, which have significantly benefitted our business. Moreover, we are glad that we are contributing to a larger environmental cause by achieving significant reduction of GHG emissions from our unit.

C V S Murthy
Technical Director, ARS Metals Industries Pvt. Ltd, Chennai

ARS Metals Industries Pvt. Ltd, established in 2005 and located at Gummidipundi near Chennai, manufactures thermo-mechanically treated (TMT) reinforcement bars of 8–32-mm size from billets and ingots.

An awareness workshop in Bhubaneshwar in 2006 motivated the company management to partner with the UNDP–GEF Project (Steel). The company partnered with the project in 2007 to bring about an improvement in the energy efficiency of its unit while also upgrading its manufacturing processes. The mill was operating with an old re-heating furnace, an inefficient recuperator, and no automation to control critical parameters. Most of the operations were handled manually in semi-continuous rolling mills and a cooling bed. As is the procedure, the technical experts studied the mill and recommended a modification of the existing furnace to an energy-efficient top-fired pusher-type re-heating furnace with two-row charging, using furnace oil as main fuel and producer gas as substitute fuel. Several technology options contd...
to improve productivity and reduce power consumption were also suggested for rolling mill operations.

The project resulted in a reduction of specific fuel consumption by 25.18% and the average specific power consumption by 14.35% from the energy-efficient drives for the rolling mills. The specific energy consumption, calculated as the sum of thermal and electrical energy consumption, was reduced by 23.21%. Improved furnace design and optimized heating zones resulted in a reduction of average burning losses from 1.61% to 1.10%, i.e., a reduction of 31.68%. Overall, the lifetime (calculated for 10 years), greenhouse gas emission savings from the unit can be put at 24,967 tCO₂ (tonnes of carbon dioxide).

ARS Metals invested about ₹ 13 million for the modification of its furnace and rolling mills within the project framework. Against this investment, the total savings from fuel and power consumption were calculated at Rs 2.6 million per year. The mill yield (in terms of weight of output material as compared to weight of input material) also improved from 93.86% to 96.54%, i.e., an improvement of 2.88%, due to the changes in bearings, roll pass design, and greater automation in the rolling process.
SHREE PRITHVI STEEL ROLLING MILLS PVT. LTD
GROWTH AND PERFORMANCE THROUGH ENERGY EFFICIENCY

The UNDP–GEF Project (Steel) has proved to be a significant support for us, paving a path for future growth and performance. Through this project, we have been able to revamp our working methods and adopt energy-efficient techniques coupled with production enhancement of the plant. The quality of our products has significantly improved through mill automation and better process control.

Sudesh Sharma
Managing Director
Shree Prithvi Steel Rolling Mills Pvt. Ltd, Jaipur

Shree Prithvi Steel Rolling Mills Pvt. Ltd, established in 1992, is a progressive re-rolling mill located near Jaipur, Rajasthan. It manufactures mild steel (MS) angles of 65-mm size from pencil ingots.

Prior to the implementation of the project, Prithvi Mills operated on an outdated low-capacity (8 TPH [tonnes per hour]) furnace with no automation. Most of the mill drives were inefficient and material handling was done manually, a major barrier to increasing productivity and mill utilization and to improving product quality. While the old re-heating furnace already used pulverized coal, the furnace and rolling mills were operated with indigenously developed technology, without effective control over critical parameters of the heating process.

contd...
Upon joining the project as a model unit, the mill followed the recommendations of the project team and opted for the installation of new energy-efficient, pusher-type coal/oil furnace equipped with a new set of coal burners.

To reduce electricity consumption in the rolling mill, several technology options were recommended by the project team. This included replacement of existing spindles and couplings by universal-type spindles and couplings; and installation of tilting table and stationary wall tilters to reduce manual handling and increase productivity.

The company benefitted from the project in terms of enhanced productivity (18.62%), reduction in production costs, higher efficiency in operations, and enhanced quality of products. The total fuel and power cost reduction per month is calculated as ₹ 700,000. Thus, the energy-efficiency interventions have been successful in achieving a payback period of about 20 months against a total investment of ₹ 13.5 million.
chapter 4

Energy-efficient Steel Re-rolling
CHAPTER 5

FORGING NEW SKILLS

Enhancing capacity to roll steel efficiently, cleanly, and profitably
PLANNING FOR CAPACITY ADDITION

Capacity is defined as the amalgamation of knowledge, skills, and competencies held both by a person at an individual level and by the workforce at an organizational level. Capacity is understood to be an active state, part of a continuing process that enhances, upgrades, and extends professional skills.

Such were the terms in which capacity was defined as the Project Management Cell (PMC) embarked on implementing capacity building programmes for the steel re-rolling mill (SRRM) sector. Capacity building was a logical corollary of the project’s EcoTech programme, as it followed that new technology needed new skills to operate and maintain. But as the project understood the sector better, it was concluded that the sector was also in need of basic training. Foremen – the effective technical and operations heads on the shop floor – were found to be poorly trained on modern methods of mill management. Without reinforcing stereotypes, it was found that most relied on self-experience or second-hand experiential knowledge to run mills, and displayed hostility towards training in new technologies or processes. The rest of the workforce in a typical small- or medium-sized re-rolling mill composed semi-skilled and unskilled workers who have been trained on the job. While some mills employ the services of engineers to oversee technical matters on the shop floor, this is still an exception that underscores the norm. When the project studied the sector during the project development phase, capacity at the management level was also found to be lacking in strategic vision and day-to-day administrative skills. Mill owners and executives seemed to share their foremen’s aversion to new technology or systems.

In such a scenario, the project identified specific capacity building needs of the sector, such as training in energy-efficient technologies (EETs), problem solving and quality training, operational skill enhancement, and management best practices (Figure 1). Training modules were subsequently developed for
Figure 1 Capacity building matrix developed for the Steel Project
each need, and these were then implemented at the national, cluster, or mill levels as needed. These modules were designed keeping in mind simplicity, ease of comprehension, and maximum impact, as it was realized that early success of EET demonstrations on the ground will depend on how quickly the SRRM workforce can be trained.

The PMC’s capacity building agenda was updated annually, with the annual work plans assessing requirements both at the sectoral as well as at the individual model unit levels. Training programmes were also designed based on demand from the sector. Thus, along with training specific to model units (such as development of standard operating practices/standard management practices [SOPs/SMPs], performance improvement training [PIT], and 5S implementation), the Steel Project organized workshops that were open to participation by all SRRM units (Figure 2).

CAPACITY BUILDING PROGRAMMES

National workshops

The bulk of the project’s national-level workshops were awareness exercises, where an average of 100 or so delegates were invited to participate in discussions on a wide variety of issues related to energy efficiency in SRRM operations. Delegates were introduced to modern technology and processes by speakers from a host of energy services providers and equipment suppliers. PMC officials also presented EcoTech options and modalities for joining the project as a model unit. A total of 29 awareness workshops were organized between 2006 and 2012, covering all SRRM clusters. More than 2500 delegates participated, representing a sizeable chunk of all SRRM units in the country. The awareness workshops were preceded by three ‘Inception Workshops,’ held in 2004 in New Delhi, Coimbatore, and Nagpur. These were also attended by a large number of
delegates representing top- and mid-level management of the SRRM sector.

A series of visuals captured during the course of some of these programmes are shown in Figure 3.

In addition to general awareness and introduction workshops, the project’s national-level capacity building programme included two ‘brainstorming’ workshops. In 2009, Nagpur hosted a national brainstorming workshop on benchmarking and life cycle analysis (LCA), and another brainstorming session was held in Chennai the following year, this time on the role and relevance of energy service companies (ESCOs) and third-party financing in the context of EET projects.
L–R: Mr G K Basak, ES, JPC; Mr Sunil Arora, UNDP; Mr V P Saha, Chairman, Energy Commission, World Foundry Organization; Ms L N Tochhawng, Chief Controller of Accounts, Ministry of Steel, Government of India; Ms Neha Shah, PMC; Mr D Kashiva, PMC; Mr A C R Das, Industrial Advisor, Ministry of Steel, Government of India; Mr D C Manjunath, PMC; and Mr Amit Sinha, PMC at the inauguration of the National Technical Workshop held in Kochi, Kerala, on 9 April 2011.

Delegates interact with experts at a national awareness workshop.

Dignitaries and delegates at a national workshop.

Mr K K Mitra, Sr General Manager (Marketing & Technical), Lloyds Insulations, New Delhi.
Figure 3
Visuals of training/awareness programmes organized by the Project Management Cell at different locations

L–R: Mr G Mishra, PMC; Mr Sunil Arora, UNDP; Mr B M Beriwala, Chairman, Steel Re-Rolling Mills Association; Mr Sankar Kumar Sanyal, President, Howrah Chambers of Commerce; Mr Subhendu Bhattacharya, Convener, West Bengal Iron and Steel Manufacturers Association; Mr Arindam Mukherjee, PMC, at the inauguration of the National Awareness Workshop held in Kolkata on 3 December 2011

A technical session of the National Brainstorming Workshop on ESCO and Financial Linkages for SRRM Sector in progress held in Chennai on 2010

Delegates look on intently during one of the presentations

An ESCO expert delivers his speech at a National Workshop
A National Seminar in progress

Mr Govind Mishra, PMC

An international rolling expert from M/s Morgardshammer, Sweden, delivering his speech during the Workshop on Roll Pass Design held in New Delhi in 2010

Mr Sitaram Agrawal, President, Rajasthan Steel Rolling Mill Association

Mr Arindam Mukherjee, PMC

A still from Cluster Meet, Bhiwadi

A still from Cluster Meet, Bhiwadi

A still from Cluster Meet, Bhiwadi
National Technical Workshop held in Kolkata, West Bengal, on 3 December 2013

Mr Umesh Madan, President, Madras Steel Re-rolling Mill Association

National Awareness Workshop at Jaipur, Rajasthan

Mr Subhendu Bhattacharya, Convener, West Bengal Iron and Steel Manufacturers Association

Mr Sankar Kumar Sanyal, President, Howrah Chambers of Commerce
Two national technical seminars were also organized in Kolkata and Kochi in 2011. One hundred and fifty delegates from the SRRM sector were present. A series of technical papers on energy efficiency were presented, covering a range of topics such as waste heat recovery, optimized use of refractories and insulation, new concepts such as housing-less stands and cantilever stands, and hot charging of continuous cast billets.

These workshops were made possible by the involvement of a gamut of stakeholders ranging from public sector institutions such as Petroleum Conservation Research Association (PCRA), National Productivity Council (NPC), and Steel Authority of India Limited (SAIL) to private sector organizations like Morgardshammer AB and Ernst & Young.

**Roll pass design workshops**

The quality of finished products in an SRRM unit is critically dependent on the design of the roll pass process. Improper roll pass designs (RPDs) can lead to either underfill, which results in the formation of hairline cracks on the surface of finished bars, or overfill, which results in roll overloading and the formation of fins. Developing an optimum RPD ensures the production of the correct size and shape of end products, with defect-free surfaces and all intended mechanical properties, while also assuring maximum output at optimum energy consumption, easing the working conditions of the rolling crew, and minimizing roll wear.

In the RPD workshops organized by the project, participants were introduced to computerized RPD, one of the 19 technology options for the rolling mill under EcoTech. They were shown how computerized RPD ensures rationalized load distribution across all sections of a rolling mill, ensuring optimization in specific power consumption (SPC) and enhancing the surface finish of finished goods. Delegates in these workshops also received training on the RPD software procured by the PMC from the
Swedish technology firm Morgardshammer AB, and learned how the software can improve performance in terms of energy savings, quality and cost competitiveness, mill efficiency, and reduction in down time. Participants were also updated about other conventional methods to determine optimum RPD.

Till December 2012, the project had organized seven cluster-level RPD workshops – in Chandigarh (North I Cluster), Nagpur (Central Cluster), Kolkata (East Cluster), Jaipur (North II Cluster), and Pune (West Cluster), New Delhi (North II Cluster), and Bangalore (South Cluster). Thirty five SRRM model units participated in these workshops, and training was imparted by technical managers from the PMC, qualified experts from the resident missions. The overall workshop ratings given by the participants are shown in Figure 4.

**SOP and SMP workshops**

The absence of standard operating practices (SOPs) and standard maintenance practices (SMPs) accounts for a major part of excess energy consumption in the sector. Adoption of standard practices of operation and maintenance not only ensures energy savings, but also leads to better mill utilization, improvements in equipment efficiency, enhanced product quality, and reduced production costs.

Held in Chennai, Pune, New Delhi, Nagpur, and Kolkata, the project’s SOP and SMP workshops initiated representatives from 154 SRRM units into SOP and SMP concepts, processes, and metrics. Delegates in these workshops learnt about practices for optimizing operation of re-heating furnaces and rolling mills, SMPs for the rolling mill, and maintaining machine health. Interactive modules simulated practical shop-floor problems and encouraged problem solving. Efficient energy management

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1. PMC’s licensing agreement with the software provider limited participation in each workshop to no more than six people.
through automation and control systems, energy saving through innovative practices such as emulsification of furnace oil, and new technologies such as biomass were discussed in the workshops. Trainers from the PMC were joined in these workshops by experts from the Federation of Indian Chambers of Commerce and Industry (FICCI), New Delhi; Academy of Industrial Management, New Delhi; NPC, New Delhi; National Instruments, Bengaluru; and the private sector technology services provider Celeste Tech, Goa. The project also developed base documents on SOPs and SMPs and disseminated the same to almost 1000 SRRM units. At a subsequent stage, the project also developed customized SOP/SMP manuals and implemented the same in 15 units. The overall ratings given by the delegates who participated in SOP/SMP workshops are shown in Figure 5.

**Performance improvement training**

Performance improvement training or PIT was a specialized on-the-job training programme that was conducted in partnership
with SAIL, a public sector undertaking. Trainers from SAIL visited model units and performed an exhaustive technical analysis of the mill, before conducting a 2-day training programme for both technical and managerial/administrative mill staff aimed at boosting all-round performance of the mill. A typical PIT session spanned topics such as minimizing heat loss in furnaces through optimum design, instrumentation and automation review, rolling practices that reduce energy consumption and enhance end-product quality, and on systematic approaches to performance improvement.

The project had conducted PITs in 29 model units by December 2012, and feedback from units indicate that the exercise has succeeded in bringing about a positive change in furnace performance and rolling operations, contributing to reduced energy consumption by the mills.
5S Lean manufacturing system

5S is abbreviated from the Japanese words Seiri (Sort), Seito (Systemize), Seiso (Sweep), Seiketsu (Standardize), and Shitsuke (Self-discipline). It is an integrated concept of actions, conditions, and culture that has to be built by any organization aiming for spontaneous and continuous improvement of the working environment. When fully implemented, the 5S system increases

PERFORMANCE IMPROVEMENT TRAINING (PIT): CUSTOMIZED TECHNICAL INSIGHT FOR SRRM UNITS

Presented below is an excerpt from a PIT Report, indicating the range of technical inputs provided to mills by the SAIL technical training team.

The refractory pattern of the furnaces and their life were discussed, and it was felt that using Mag-Carb instead of magnesite (sic.) being used currently would increase the life of the hearth. The use of fibre lining for better utilization of heat in a batch furnace like the furnaces at Sharda Ispat Ltd was also discussed.

It was observed that only the soaking zone burners were on, and heating zone burners were not on. The amount of pulverized coal being consumed was 80 kg/tonne of metal, which is on the higher side. The SAIL team also had discussions on problems being faced by Sharda Ispat Ltd while rolling, which could possibly be because of improper heating or input material. The problem of pipy (sic.) and improper cutting at flying shear and refractory inclusions in the finished metal were also discussed.

Excerpted from ‘Report on Performance Improvement Training at M/s Sharda Ispat Ltd, Nagpur, 5–9 April 2012.'
EXPERT SPEAK

In order to meet its objectives, the project team worked closely with the model units. The awareness workshops at the cluster level generated many expressions of interest (EoIs). This initiated the process of achieving model unit status, which culminated in PMC’s energy-efficiency recommendations. Here the unit owners could make a decision about going in for the recommendations.

Once the decision was made, the PMC helped the units implement the technology options. So hand-holding happened throughout the project. The PMC also developed training manuals both in English and Hindi so that shop-floor workers are able to read and understand the new technology. These manuals have reached not only the model units but also all the other re-rolling mills in the country. These manuals have helped them in understanding different measures and thematic areas of the steel re-rolling process.

Further, Performance Improvement Training conducted for a period of 5 days at the unit by experts reinforced implementation of learning thereby creating a cycle of awareness leading to EoIs, training leading to understanding, and finally internalizing of new knowledge into shop-floor operations and mill management.

S N Srinivas
Programme Analyst
UNDP–GEF Steel Project
United Nations Development Programme
production, improves quality, reduces cost, improves safety, and improves employee morale. In the context of the SRRM sector, 5S comprises a set of simple practices that keep workplaces clean and well-organized, and established standards of waste disposal and inventory management.

Thirteen cluster-level workshops on 5S were held between 2006 and 2008. This was followed by 5S implementation in model units by the NPC and the Andhra Pradesh Productivity Council (Hyderabad). Adopting the ‘Plan-Do-Check-Act’ or Deming Cycle approach to implementing 5S, the two organizations implemented the system in all participating model units.

**ISO 9001 and ISO 14001 training**

ISO 9001 and 14001 are international benchmarks for the quality of an organization’s products and services and its environmental management practices, respectively. Together, these help organizations to enhance customer satisfaction, achieve continual improvement in performance, and implement necessary environment management systems (EMS) to minimize the environmental impact of its activities.

The PMC had organized five workshops each on ISO 9001 and 14001 till December 2011. In addition, ISO 9001 and 14001 implementation and training in SRRM model units was supervised by MECON (10 units) and the NPC (16 units).

**Electrical energy audit**

Electrical energy audits were designed by the PMC not only to evaluate electricity consumption patterns in model units, but also to train mill staff on efficient utilization of electricity. The audits were conducted by PCRA, the National Institute of Secondary Steel Technology (NISST), the Northern India Textile Research Association (NITRA), and the Nagpur-based private services provider SEE-Tech Pvt. Ltd.
KNOWLEDGE DISSEMINATION

The capacity building plan of the Steel Project extended beyond physical interactions and workshops to include training manuals. Published in Hindi and English, these catered to both shop-floor workers and senior management executives of SRRM units. Content for the manuals was developed and designed by the PMC in partnership with SAIL’s Management Training Institute (MTI). Sixty-eight thousand (68,000) copies of 34 titles were published in all, and these were disseminated in every cluster by the PMC and the resident missions. Some of the important training manuals published by the Steel Project are listed below.

1. Manual on Furnace Basics
2. Manual on Furnace Advanced
3. Manual on Rolling Mill Basics
4. Manual on Rolling Mill Advanced
5. Manual on Statistical Process Control
8. Manual on Electrical Basics
10. Manual on Steel Making
11. Manual on Fuel Storage and Handling System
12. Manual on Utility Services
13. Manual on Safety and Firefighting
15. Manual on Management Information System
17. Manual on Operation Management/Supply Chain Management
BENGAL HAMMER: TRANSFORMING BUSINESS STRATEGY THROUGH ENERGY EFFICIENCY

The Steel Project significantly influenced the strategic policy of the company. It changed our vision of business development, which was nearly stagnant for 40 years. In fact, we have been immensely benefitted by the expert advice and guidance to upgrade our unit. This is a win-win situation for all the stakeholders of the project.

B K Pal
CEO, Bengal Hammer Pvt. Ltd, Howrah

Bengal Hammer Pvt. Ltd manufactures specialized and heavy steel sections, produced from billets and ingots. Established in 1964, the company has achieved the ISO 9001:2008 status for its steel re-rolling facility in Howrah, West Bengal. The unit partnered with the United Nations Development Programme–Global Environment Facility (UNDP–GEF) Project (Steel) to adopt energy-efficient technologies (EETs) in their plant and improve the overall performance of the unit.

Initial assessments by the Project Management Cell (PMC) revealed that the manufacturing process was highly energy-inefficient. The mill used outdated components and practised manual handling of materials, limiting the efficiency, hindering product quality, and increasing hazards to worker health and safety.

After the unit signed on as a model unit, the following key changes were carried out in the plant:

- Installation of a new energy-efficient, pusher type, top-fired reheating furnace of 15 TPH (tonnes per hour) capacity,
with two-row charging system and improved automation and control.

- Installation of new energy-efficient metallic recuperator and burners.
- Adoption of anti-friction roller bearings and enhanced automation for materials handling.

These technological changes were supplemented by various training and capacity-building programmes such as performance improvement training (PIT), developing customized standard operating practices (SOPs) and standard maintenance practices (SMPs), and dissemination of technical manuals to shop-floor workers and senior managers.

As a result of these interventions, the productivity of the unit increased by 103.49%, the specific fuel consumption (SFC) was reduced by 25.39%, the specific power consumption (SPC) was reduced by 12.01%, the mill's yield improved by 1.14%, mill utilization increased by 32.17%, and burning losses were reduced by 51.58%. The greenhouse gas (GHG) emissions from the plant were reduced from 0.28 tCO₂/t (tonnes of carbon dioxide equivalent per tonne of steel) to 0.21 tCO₂/t, resulting in an overall annual GHG emission reduction of 1343 tCO₂ per year (for a baseline productivity of 6.30 TPH).

The total cost of intervention due to installation of the new furnace, improvizations in rolling mills, and upgradation of facilities at the unit was ₹ 17.5 million. After the project's implementation, the unit was able to save ₹ 1.37 million per month through reduction of fuel and power costs, resulting in a

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payback period of less than 13 months. The unit was also one of the earliest recipients of a capital subsidy of ₹ 3 million from the Ministry of Steel, Government of India, and ₹ 0.5 million as reimbursement against consultancy fees towards capacity building of designers and consultants from the UNDP fund under this project.
CHAPTER 6

IMPACTS AND INSIGHTS

Reviewing the outcomes and lessons of the Steel Project
MONITORING AND EVALUATION FRAMEWORK

The Steel Project’s monitoring and evaluation (M&E) system was designed as an all-encompassing framework that focused not just on internal metrics such as the progress of project activities, but also on the impact of these activities on beneficiaries. In this regard, it sought to retain in its design the traditional ‘results-based management’ approach to M&E (which is concerned mostly with a project’s internal results), while including at the same time the emerging M&E concept of ‘management for development results’ (which places emphasis on real and meaningful results on the ground) (Figure 1).

To implement this vision, the project document had envisaged an integrated M&E Cell housed within the Project Management Cell (PMC), and networked with all six steel re-rolling mill (SRRM) clusters through the resident missions. The main function of the Cell was to measure and document a set of indicators to track project health and progress. The M&E Cell was expected to set up credible baselines for measuring the impact of its energy-efficient technology (EET) packages, and develop a comprehensive manual that would govern how the project is to be monitored and evaluated.

The project’s internal metrics were to be assessed through mid-term, terminal, and ex-post evaluations, conducted by the National Project Coordinator (NPC), the Chief Technical Adviser (CTA), and officers from the PMC. These reports were to be reviewed by the Project Advisory Committee (PAC), which would, if required, advise on mid-course corrections based on evaluation results. In addition, annual participatory evaluation exercises with key stakeholders, local committees, financial institutions, and partner organizations were to be organized as platforms where evaluation results could be shared and discussed.
The project document also envisaged using the evaluation reports as a data bank on the project, forming a cumulative learning tool that offers insight into project design, management, and challenges.

The evaluation of the project’s impact on model units was to be conducted by third-party auditors and resident missions. The project document as well as the project operating manual sought to monitor each model unit by first establishing clear
baselines and subsequently documenting changes to these post-implementation. It was stressed that this activity would be one of the key inputs that would create the case for replication.

The following review of the project’s impact and key lessons therein are based on the series of evaluation reports mandated by the M&E system.

**TECHNOLOGY IMPACT**

Of the 11 technology packages identified by the project for re-heating furnaces, nine technology packages were successfully commissioned by model units. These nine packages were demonstrated in a total of 34 model units (Table 1), with the M&E Cell conducting project impact studies on 31 of them.

Similarly, out of the 19 EcoTech options for rolling mills, 13 were successfully demonstrated through the course of the project (Table 2).

**ENERGY IMPACT**

**Specific fuel consumption**

The implementation of the project-promoted technology packages realized into significant savings of furnace oil and coal, together the primary sources of fuel in the sector. Conclusions about the project’s impact on energy-efficiency parameters can be drawn from the 31-unit Project Impact Study prepared by the PMC. Discussed below are the general impact trends on fuel consumption.

**Furnace oil**

Five model units implemented energy-efficient furnaces fuelled by furnace oil. These units achieved a saving of 17%–25% in specific fuel consumption (SFC) (from baselines). Additionally, four model units switched from furnace oil-based furnaces to
coal-based producer-gas-fired furnaces. The average SFC saving in these units was 50%. Three units converted their furnace-oil based re-heating furnaces to biomass-based producer-gas-fired furnaces. The average savings in SFC in these units was between
10% and 15%. One unit switched to direct rolling, achieving a 100% saving in SFC (Figure 2).

**Figure 2** Change in specific fuel consumption among model units using furnace oil-fired furnaces

*Source* Project Impact Study, PMC, 2013

**Coal**

Thirteen model units adopted pulverized coal technology as fuel, and achieved savings in SFC between 30% and 50%. Two model units changed over from coal-based producer-gas-based furnaces to direct rolling, achieving 100% savings in SFC. One unit converted from lump coal to furnace oil, achieving a saving of 47% in SFC (Figure 3).

**Natural gas**

Two units (KL Rathi Steel and Someshwar Ispat) implemented energy-efficient furnaces with natural gas as fuel. Savings in SFC achieved by these units were in the range of 20%–30% (Figure 4).
A review of these numbers indicates that, with a number of individual mills cutting energy consumption by more than 50%, and every model unit securing a minimum 10% reduction in energy consumption, the potential of EcoTech to reduce production costs has been amply demonstrated, meeting one of the principal technical objectives of the Steel Project.
ESTABLISHING TECHNOLOGY BENCHMARKS

The technical component of the Steel Project’s agenda includes the establishment of benchmarks for its EET packages. The project document called for reviewing the techno-economic and commercial status of EcoTech packages as well as developing labels, standards, and benchmarks for equipment, devices, and processes used in the SRRM sector.

The benchmarking process was kicked off in 2009 when the first benchmarking workshop was held by the PMC. The chief outcome of this workshop was the preparation and subsequent publishing of a global tender inviting bids for preparing a benchmarking report. In 2011, discussions were held with the consultant to finalize methodologies for benchmarking studies proposed in eight model units, as also for standards and labelling for major equipment and life cycle analysis (LCA). This includes the labelling of furnaces, which, if adopted, would mark the first instance of labelling industrial appliances in India. With regression analysis for benchmarking based on the available data currently in progress, and with the project on its final lap, the benchmarking report is expected to be released soon.

Specific power consumption

The EcoTech paradigm sought to reduce electrical energy consumption in SRRM units through a basket of 19 technology options for the rolling mill. These options have had success in reducing electricity use in the model units by an average of 18%, with seven of the 31 evaluated mills achieving more than 30% reduction in electricity consumption.
RECOGNIZING ENERGY EFFICIENCY

The energy savings experienced by the model units have been noticed by state and national government authorities. MPK Steels was felicitated with the Rajasthan Energy Conservation Award (RECA), Pulkit Steel was recognized with a similar award by the Government of Puducherry, and Prithvi Steel, awarded with the RECA in 2009, also received the National Energy Conservation Award in 2010.

The awards received by these mills have created an aspirational need in the sector to achieve similar recognition, leading to a healthy competition to post greater energy savings.

1. The Energy Conservation Award received by Pulkit Steel

2. Shree Prithvi Steel Rolling Mills has received the following awards: Rajasthan Energy Conservation Award for 2008/09 and National Energy Conservation Award for 2009/10

3. Mr S K Upadhyaya, Chairman, and Mr M K Upadhyaya, Managing Director, of MPK Steels, which received the Rajasthan Energy Conservation Award for 2010/11 and 2011/12
THE FINANCIAL IMPACT

The EcoTech packages promoted by the Steel Project, as noted, involved investments between ₹ 0.7 million and ₹ 60 million, with a promise of a full return on investment within 6–18 months. This by itself proved insufficient to attract SRRM units, a situation already anticipated in the project design. However, alternative financial mechanisms such as co-financing through energy service companies (ESCOs) and financial institutions did not fructify despite several initiatives. Eventually, it was the project’s direct capital subsidy scheme that managed to

PULKIT STEEL:
UNLEASHING THE POWER OF BIOMASS

Perhaps the most significant impact of the Steel Project’s EcoTech initiative was the successful demonstration of biomass gasification-powered RHF technology. This was implemented by the Puducherry-based Pulkit Steel in the South cluster.

In early 2004, when the Government of Puducherry enforced a blanket ban on coal use for industrial applications, the steel re-rolling mills (SRRMs) in the Union Territory were forced to switch to the more expensive furnace oil. But Pulkit Steel sought the help of the Steel Project in seeking a more sustainable solution.
open the doors to EcoTech. To the SRRM sector, the capital subsidy scheme signalled the project’s willingness to back its technology packages with a financial guarantee, easing their skepticism of new technology. It has been estimated that the 31 evaluated model units have together invested over ₹ 410 million in implementing EcoTech packages, and the project has released over ₹ 100 million as financial support.

Against this investment, monetization of annual thermal and electrical energy savings in 31 model units for which data are available indicates substantial returns. Together, these units

The result was a pioneering project to run a re-heating furnace (RHF) on biomass gas. Conventional wisdom suggested the tremendous heat required to heat billets may not be possible through biomass. Indeed, there was no precedence in the country of any re-rolling mill operating a biomass gasifier plant for thermal energy needs.

The gasifier installed in the mill runs on biomass briquettes, sourced from a captive briquette manufacturing plant where groundnut shells are compressed into combustible biomass briquettes. The technology has enabled the mill to save ₹ 1500–2000 per tonne of steel in energy costs, enabling it to recoup the cost of investment within six months. Additionally, using a renewable energy source has made the mill a net zero carbon emission plant. The mill’s radical switch to renewable energy has not only been vindicated through energy savings, but has also raised its profile, with the Puducherry government awarding Pulkit Steel its Energy Conservation Award in 2009. The management at Pulkit is justifiably enthused about the potential of biomass as an alternative fuel, and the mill is in the process of commissioning another biomass gasifier to replace the mill’s back-up furnace oil unit.
have already achieved thermal energy savings totalling ₹ 327 million thus far. This works out to an average thermal energy saving of ₹ 10.5 million, with five model units achieving savings of ₹ 20 million and above. These savings from reduced thermal energy consumption are complemented by electrical energy savings, which when monetized translate to savings of ₹ 100 million thus far, or an average of ₹ 3.3 million per mill.

These numbers mean that over the lifetime of these EET interventions (assumed at 10 years), these 31 model units would achieve energy savings of over ₹ 4000 million or USD 66 million.

Apart from the direct monetary benefits accruing from energy savings, the interventions in the model mills also led to significant improvements in their productivity. Bengal Hammer in the East cluster and AC Strips in the Central cluster doubled annual production, and MPK Steels in the North II cluster increased annual production by 67%, these being on the higher scale of an average increase in annual production by 30% noted in all evaluated units. Such direct and indirect financial benefits enabled most model units to achieve a return on investment within the 6–18-month period as envisaged by the project.

**THE ENVIRONMENTAL IMPACT**

The Steel Project has succeeded in implementing the sustainable ethos of its mandate through significant reductions in energy use in the model units. The 31 model units that have been evaluated so far have recorded savings of 11,550 kilo litres of furnace oil, 12,956 tonnes of coal, and 20,357 MWh of electricity. Together, this amounts to energy savings of 2,407,170,075 MJ (2.40 PJ) of energy. This translates to a cumulative emission reduction of 192,891 tCO₂e (tonnes of carbon dioxide equivalent) (June 2013), with a total lifetime (10 years) reduction of carbon dioxide calculated at 642,630 tonnes (Figure 5).
These commendable reductions of greenhouse gas (GHG) emissions are a result of direct technology interventions. However, a progressive environment-conscious approach to business is still to emerge in the sector. It has been observed that the SRRM units participating in the project are motivated not by environmental concerns but by the promise of reduced energy costs. This is an understandable situation given the context of the small-and-medium-enterprise (SME) sector to which they belong, and it is expected that the environment will gradually also figure in their calculations with more exposure to EETs.

**ENHANCING CAPACITY IN THE SECTOR**

Unlike energy savings and productivity improvements that are tangible and can be quantified, the success of the Steel Project’s capacity building programme is not easily quantifiable. Yet its intangible impact on the sector has been no less significant and
The various events, capacity building programmes, and information dissemination campaigns organized by the PMC helped spread the message of energy efficiency in SRRMs in the country.

as far-reaching. This is related to possibly the biggest challenge faced by the PMC – that of changing mindsets of decision makers in the SRRM sector, a task which had seemed Herculean in the beginning of the project. The inception and national workshops, technical seminars, and brainstorming sessions organized by the project chipped away at traditional attitudes towards technology and environment-friendly practices, introducing – for the first time ever in the sector – debate, discussion, and insight into modern, energy-efficient steel re-rolling concepts.

On an average, each of the 29 workshops organized by the project was attended by 80–90 executives from the SRRM sector.

The face-to-face interactions facilitated by the workshops and seminars were backed with information dissemination tools such as brochures, newsletters, and films propagating the project’s mandate and showcasing the benefits of EcoTech packages and options. With direct technical interventions in the sector possible only in a few select units, the project’s workshops and information dissemination campaigns therefore served their purpose by extending the message of energy efficiency to virtually every re-rolling mill in the country, creating an enabling environment for the growth of EET services and equipment in the sector.

The attitudinal shift brought about in the project’s workshops was complemented by the building up of technical capacity through specialized technical workshops and training programmes. The principal beneficiaries of these initiatives were foremen and shop-floor workers, a majority of whom were receiving technical training for the first time in their careers. The RPD workshops and the SOP/SMP workshops, in particular, received enthusiastic response, with participant feedback indicating the need for the extension of such workshops to the shop floor where live
demonstrations and customized solutions can be facilitated. The project’s quality and management programmes such as ISO, PIT, and 5S Lean Manufacturing System added further depth to the SRRM workforce and have made quality-consciousness a part of day-to-day mill operations.

The PMC’s partners in fulfilling capacity development objectives were MTI (SAIL), MECON, APITCO Limited (formerly Andhra Pradesh Industrial and Technical Consultancy Organisation Limited), and the National Productivity Council. These agencies brought into the project vast institutional experience of steel making and industrial management practices, and their involvement in structuring and conducting training programmes marked the first time the SRRM sector achieved exposure to such levels of training.

While the Steel Project’s capacity building activities achieved most of its envisaged outcomes, there is recognition of the fact that one of its key objectives – enabling the emergence of ‘energy managers’ at the cluster level – could not be fully realized, preventing a further consolidation and sustainability of the capacity development agenda in all clusters. In essence, the ‘green manager’ concept is to follow a ‘train-the-trainer’ approach to develop local experts in each SRRM cluster, enabling them to offer prompt consultancy services to SRRM units. These consultants were to not only advise on technical performance and training needs, but also serve as investment managers, helping mills to seek finance for EET projects. The idea behind the concept was to leave behind a class of professionals having the capacity to support the consolidation, expansion, and penetration of EETs in the sector. While the activity could be implemented only partially, the concept remains sound and reflects an urgent need in the sector, providing an opportunity for future interventions in the sector.
INSIGHTS FROM PROJECT MANAGEMENT

The resident mission of the North I cluster shares an anecdote about an SRRM unit selected as a model unit. As per defined protocol, the PMC analysed the mill and presented its recommended technical modifications. Accordingly, and again as per protocol, the mill was asked to prepare a design to develop the project development agreement. After getting no response from the mill, the resident mission enquired about the status of the design, only to be greeted with the news that the mill had long implemented the PMC’s recommendations, and was already benefitting from them.

This one incident is an apt example of the quirky and ad-hoc decision making that drives a typical SRRM unit. It also indicates that the need for efficient technology is palpable, as is willingness to pay. But due diligence is not the sector’s strong suit, characterized by an aversion to paperwork and its rather ‘closed’ nature of functioning. Thrust into such an environment, the PMC – comprising professionals with years of experience in highly organized and efficiently managed integrated steel plants with capacities of over one million tonnes per annum – found itself grappling with the challenging task of developing technologies for mills with one-tenth that capacity.

Delays in decision making added to organizational sluggishness during the early years of the project. Considerable time was also consumed in pursuing the TIRFAC concept, only for the activity to be scrapped. While TIRFAC could have provided national institutional support to the sector, concerns raised by the Project Steering Committee (PSC) regarding its sustainability could not be sufficiently addressed (see Chapter 3).

At the cluster level, the resident missions provided key institutional support to model units, but record their observation that the missions could have been more effective with adequate
INFORMATION DISSEMINATION AND AWARENESS THROUGH FILMS AND PUBLICATIONS

The PMC’s information dissemination strategy included the production and dissemination of short films depicting the project’s objectives, strategies, impacts, and benefits. Subsequently, *The Power of Energy Efficiency* – a series comprising 14 films of varying lengths – was produced in early 2012. The implementation of EcoTech in six model units was documented, with an emphasis on first-person accounts of the monetary savings resulting from the technology intervention. In addition, the film series contained 30-second audiovisual clips that focused on giving a snapshot of the project and its benefits. One of these 30-second films was broadcast on national TV channels over several days, generating considerable awareness about the project. Over 1000 copies of the films were published as DVDs, and these were distributed to units in each cluster. These films are also available online at

- [www.undp.org/india](http://www.undp.org/india)
- [www.undpgefsteel.gov.in](http://www.undpgefsteel.gov.in)
- [www.youtube.com/adcsfilms](http://www.youtube.com/adcsfilms)

The publication you are holding, *Energy-efficient Steel Re-rolling*, is another attempt at creating awareness. Another publication emerged from the Steel Project is a set of five successful case studies.

administrative and secretarial support. A greater consultative role for the missions during technology implementation was also cited as an unfulfilled need.

One of the most daunting management challenges that dogged the project till the end was low conversion from project commissioning to project closure in model units. The primary
hurdle behind this appears to be inordinate delays in releasing the capital subsidy funds due to eligible model units. Submission of applications by model units was affected by stringent criteria, which were revised and the process repeated. The processing of applications for capital subsidy speeded up subsequent to initial hurdles.

**EXPERT SPEAK**

Initially nobody knew about the shape of the project and whether it will be successful or not. In fact we had our reservations because all of us who were there in the PMC had a different experience of working in an integrated steel plant with a minimum capacity of one million tonnes per annum. Now we had to deal with steel re-rolling mills, which produce 10,000 tonnes of steel per annum. One can imagine the change of concept in the design.

It was difficult to visualize the type of technology that will be useful. It was really a challenging task for us. Thankfully, we have been reasonably successful after years of effort. So far, none of the commissioned model units have complained that they have made losses because of us. There was a time around 2007 when not a single unit was commissioned and a serious thinking was going on in the Ministry of Steel regarding whether to continue with the project or not. However, because of the consistent efforts of the team members, today the Steel Project is a success in many respects.

Govind Mishra
Consultant-Technical
Project Management Cell, UNDP-GEF Project (Steel)
MPK STEELS: PROFITING FROM ENERGY EFFICIENCY

A view of the organized product yard of MPK Steels, Jaipur

This project has brought in very useful learning for managers and workers on technological and process changes for achieving energy efficiency and better work culture. Guidance from technical experts was instrumental in implementing recommendations for improved energy efficiency in the unit.

S K Upadhyaya
Chairman, MPK Steels (I) Pvt. Ltd, Jaipur

MPK Steels (I) Pvt. Ltd, based in Jaipur, partnered with the UNDP–GEF Project (Steel) to upgrade its manufacturing unit and introduce greater energy efficiency and standardization in their operations. It has since won two Energy Conservation Awards from the Government of Rajasthan.

Prior to the project, MPK Steels’ re-rolling mills faced constraints in energy efficiency in its operations. The unit used an old re-heating furnace of 10 TPH (tonnes per hour) capacity, inadequate and outdated burners, and no automation in the plant. Most of the operations – such as charging and discharging the re-heating furnace, handling materials in the rolling mills, and operations of the cooling

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bed – were manually handled. This resulted in high consumption of fuel and energy, resulting in greater production cost and high greenhouse gas (GHG) emissions.

MPK Steels had recognized that the technology used in their existing plant was outdated and energy-intensive. The company was already planning to install a new furnace to replace the old obsolete furnace in its unit when they considered collaborating with UNDP–GEF Project (Steel) to implement EETs and upgrade their manufacturing unit.

The project team recommended a slew of changes to the mill, including installation of a new 18 TPH, energy-efficient, top-fired, pusher-type re-heating furnace with optimum design for higher hearth utilization and three heating zones for a higher range of production. For the rolling mill, project experts recommended technology such as an 18-inch rolling mill train to roll higher cross sections (150–200 mm blooms) and installation of a drop tilter and tilting table to reduce manual handling.

As a result of such interventions, there was reduction in the plant’s specific fuel consumption (SFC) by 45.37%, specific power consumption (SPC) by 29.86%, and burning losses by 30%. GHG emissions from the plant reduced from 0.29 tCO₂/t to 0.17 tCO₂/t, resulting in overall annual GHG emission reduction of 2945 tCO₂, considering baseline productivity of 5.40 TPH.

The total cost of installing a new furnace, improvisation in the rolling mills, and upgradation of facilities was ₹ 14.5 million. However, the unit was able to save ₹ 0.82 million per month after project implementation due to the reduction in fuel and power costs. In addition, productivity increased by 67.96%, mill yield by 1.04%, and mill utilization by 14.14%. Payback on investment was achieved in less than 18 months.
CHAPTE R 7

THE ROAD AHEAD

The future of energy efficiency in the SRRM sector
SUSTAINABILITY AND REPLICATION

Throughout the Steel Project’s duration, ensuring the sustainability of the project had been a major preoccupation. Well before the commencement of activities, the project document had envisioned a post-project scenario where a number of model units serve as centres of excellence in every cluster, driving technical transformation. These were envisaged to be serviced by an adequately trained workforce and a growing class of energy managers and consultants. The Technology Information and Resource Facilitation Centre (TIRFAC) was expected to be playing the role of a catalyst, facilitating capacity building and giving overall technical direction. A culture of ‘willingness to finance’ would have emerged among financial institutions, and that energy service companies (ESCOs) and banks would be prepared to provide investment support to mills as they seek to replicate EcoTech options.

A few years later, the Mid-Term Review of the project noted that while some steel re-rolling mill (SRRM) units are adopting technologies without the project’s support, indicating replication potential, the sustainability of the project would depend on the emerging of a niche market for energy-efficient investments in the SRRM sector. The project’s activities, it noted, must result in a coming together of industry associations, technology providers, domestic and international experts, government agencies, and financial organizations. Like the project document before it, the Mid-Term Review also mooted TIRFAC as providing technology information resource services and optimum solution design support to the sector. However, the TIRFAC hardware centre was dropped soon after over concerns about its own sustainability, and the ESCO concept did not find favour among both re-rolling mills and ESCOs themselves. On the other hand, the project’s experience has shown that finance is not really a key constraint for the SRRM units, however, financial incentives helped breaking the
ice. Once convinced, mills have been known to readily fund technology upgrades. In this scenario, the project's focus is on enabling them to make the transformation.

The ideas and vision put forth by these documents were matched with actual effectiveness of the project on the ground in the Replication Study carried out by the Steel Authority of India Limited (SAIL). The Study observed that 61% of the 300 mills surveyed by it were aware of the project's mandate, and 166 mills (55% of mills surveyed) had implemented energy-efficient technology (EET) options in some form or the other (Figure 1). Fifty four of these mills had implemented EET packages through the direct involvement of the project, whereas 112 had implemented packages through their own initiative (Figure 2).

In addition, the Study found that 41% of the remaining surveyed units have plans to implement EETs in their mills in the future (Figure 3). These figures indicate that replication as hoped by the project is gaining traction as more mills become aware of the benefits of EETs.

![Figure 1](image-url)  
*Figure 1: Awareness among surveyed steel re-rolling mills on UNDP-GEF Project (Steel)*
Corroborating the perception that funds are not a key concern for SRRM units, the Replication Study also found that investments of ₹ 1894 million on furnace technology and ₹ 1011 million on rolling mill technology options have been made in the surveyed units, for a cumulative investment of ₹ 2905 million in EETs. This indicates a healthy appetite for investment in EETs, leading towards greater replication potential.
These encouraging signs of replication underline the increasing significance of EET adoption by the SRRM sector. The market opportunity for the sector is positive in the near to long term. Already producing 80% of India’s long steel output, the sector is poised for accelerated growth on the back of projections that put India as the second largest steel producer in the world by 2020. With no new integrated steel projects due to be commissioned in the short term, the SRRM sector has been presented with an opportunity to drive growth in the Indian steel sector. However, this opportunity is incumbent on a transformation in the way the sector approaches steel re-rolling. With much of the demand for their steel expected to come from international markets, re-rolling enterprises must look to translate concepts like quality and efficiency into competitive advantages in a global marketplace. Upgrading technology, in terms of equipment design and processes, and also introducing process automation and computerization on a large scale, are activities that the sector urgently needs to take up.

The Steel Project has made a beginning in this direction by ending the technical and institutional isolation of the SRRM sector, making a strong business case for the adoption of EETs, and leaving behind demonstrable technology that can be replicated without much difficulty. This legacy can be harnessed by the sector to its advantage, cutting production costs, reducing emissions loads, enhancing product quality, and becoming a force to be reckoned with in the global steel market. At the same time, it is recognized that SRRM participation in energy efficiency projects is linked to the emergence of an enabling environment that creates the conditions for the growth of EETs in the sector.

**RECOMMENDATIONS AND WAY FORWARD**

Before the Steel Project was launched, the Indian SRRM sector was characterized by low awareness about EETs. The sector
The project has helped steel re-rolling mills (SRRMs) to address barriers for large-scale commercialization of energy-efficient technologies (EETs). The objective of the project was to accelerate penetration of environmentally sustainable EETs through barrier removal activities, leading to large-scale commercialization of EETs in the SRRMs sector further leading to improved energy efficiency in the sector and reduced emissions of greenhouse gases.

As of now, the project has successfully implemented EETs in 34 model units. The model SRRM units have reduced specific thermal energy consumption by 20%–50% and specific electrical energy consumption by 10%–30%. They have also reported annual monetary savings of between USD 200,000 (₹ 10 million) to USD 500,000 (₹ 25 million). The investment can be recovered in 6–18 months. A study carried out by the project also shows that the project has been able to influence a significant portion of other SRRMs units across India to implement these EETs.

There are around 1,890 SRRM units in India. The project has developed a vast knowledge base that can provide technical assistance to the sector. An important task of the project is to develop an exit strategy to ensure that the project activities are sustained beyond the project period. Both UNDP and the Ministry of Steel are working out a strategy to take care of this issue.

Butchaiah Gadde
Regional Technical Specialist
UNDP–Global Environment Facility
United Nations Development Programme, Bangkok

was dependent for its technology needs on locally developed equipment and technical consultants isolated from the emerging EET paradigm. These manufacturers and consultants catered primarily to large steel plants, and their technology and equipment were essentially knocked-down versions of
those provided to 100-TPH (tonnes per hour) capacity mills. Additionally, the SRRM sector was straddled with a low equity base and an insufficiently trained workforce that did not appreciate the value of energy-efficient processes.

About 10 years of interventions by the Steel Project has effected a considerable shift in this scenario. The SRRM sector has today been sensitized to the manifold benefits of EETs, and more crucially, has seen it in action making a difference to bottom lines in model units. The project’s activities have lowered many barriers inhibiting access to EETs by the sector, most notably the technology and capacity barriers. It has also busted many myths in the SRRM sector about the costs of energy efficiency and its

THE POST-PROJECT SCENARIO: DEVELOPING AN EXIT STRATEGY

The Steel Project has played a direct role in implementing EETs in 34 SRRM units across India, and in providing technical assistance to 40 pipeline units in the form of feasibility reports. In addition, 166 SRRM units have replicated the technologies through project efforts. With most of its envisaged activities now completed, the project is scheduled to come to a conclusive end by December 2013.

In order to sustain the work done under the project and to provide services on upcoming technologies to the SRRM sector going forward, the PMC has initiated the development of an exit strategy for the project; including appointing a succeeding agency, and developing a sustainable business model for this agency. The key objectives of the exit strategy would be to proliferate energy efficiency measures by continuing to support and facilitate knowledge inputs to prepare the units for adoption of EETs. It would also facilitate training, deliver information, and strengthen capacity on a sustained basis.

The exit strategy – currently in advanced stages of preparation – would also provide institutional linkages to provide off-the-shelf technologies and customized technical interventions.
monetary benefits. It has bridged the distance between SRRM units and the Ministry of Steel, negating to a great degree the perception in the sector that the Ministry is a distant authority preoccupied only with the welfare of integrated steel plants. And finally, it has brought the SRRM sector within the ambit of sustainable business, with model units seeing their emission burden reduce even as productivity continues to improve.

To carry forward the momentum created and increase the penetration of EETs in the sector, the cumulative experience of the Steel Project has thrown up the following observations, recommendations, and suggestions for discussion and action.

- With technology paradigms changing rapidly, cluster mapping such as the one carried out by the project needs to be conducted every five years.

- Often, diffusion of interventions may take long time in absence of catalytic support. Explore a window of support to fast track energy efficiency interventions to replicate the proven energy efficiency measures in model units to other 1800 plus steel rerolling mills in India.

- Though the present project has proved energy savings of about 30% on an average, still there exists scope for introduction of new set of technologies. Introduction of new technologies has to be supported by integrated operations, more efficient operation and maintenance practices, improved level of personnel and technological disciplines, and increased usage of instrumentation, automation, and computerization. Introduction of modern technologies must also be complemented by adequate training of personnel. To enhance capacity, there is a need to include SRRM-specific technology courses in government engineering colleges, from where the bulk of the sector’s technical workforce is drawn.
While SRRM units have demonstrated willingness to invest, financing schemes such as a revolving fund or soft funding can still be explored.

Though the project attempted introduction of ESCOs which did not succeed, ESCOs can be effective method for market transformation. Scope for ESCO involvement may be investigated.

A steel development fund may be considered, catering to specific R&D programmes working towards improving energy efficiency standards in the sector.

Greater interaction must be fostered between and among R&D establishments, design institutes, equipment manufacturers, and users of EETs.

In a bid to develop energy consciousness, the SRRM sector should also be rid of power cross-subsidies, and power made available to mills through an open access mechanism.

The SRRM sector’s long-standing request to reduce excise duty on steel can be re-examined, especially for the import of equipment, spares, and instrumentation related to energy efficiency improvement and pollution control.

To overcome slowdown of domestic demand of steel, relevant government authorities should encourage exports of long steel products by re-introducing Duty Entitlement Pass Book (DEPB) and a higher Duty Drawback Rate.

Policy attention also needs to be focused on giving infrastructure status to the industry, enabling investments in infrastructure projects through incentivized public-private partnerships.
• Recognition is a big motivator in the SRRM sector, and therefore regulatory authorities can consider offering incentives to SRRM units such as awards for energy efficiency and quality improvements, along the lines of awards for the integrated steel plants.
The publication draws all its data, figures, and statistics from documents made available by Project Management Cell of the UNDP–GEF Steel project. Most of these documents are publicly available at http://undpgefsteel.gov.in/. The full list of documents referred to in this book are given below. References external to these sources are marked with footnotes.

1. All India Status Report on Steel Re-Rolling Mills
   2001; SAIL - PMC (UNDP-GEF-STEEL)

2. Study Report to Ascertaining Extent of Replication of Energy Efficient Technologies in Steel Re-Rolling Mill Sector in India
   2012: SAIL - PMC UNDP-GEF-STEEL

3. Project Implementation Reports: UNDP-GEF-STEEL
   2005 - 2012; UNDP India

4. Project Document – Removal of Barriers to Energy Efficiency in the Steel Re-Rolling Mill Sector in India
   2002; UNDP India

   2007; Ernst & Young, PMC UNDP-GEF-STEEL

   2007; Akker, Jan van dan and Singh, Rajesh Kumar; UNDP India

7. Cluster Mapping Report
   2004; PCRA and PMC (UNDP-GEF-STEEL)

8. Project Operation Manual
   2005; PMC (UNDP-GEF-STEEL)
    2010; PMC (UNDP-GEF-STEEL)


Data and insight into the project have also been sourced from Back-to-Office Reports (BTORs), training manuals, Model Unit case studies, PowerPoint presentations; commissioning reports, project website, project newsletters, project documentary films and from one-on-one interviews with PMC officials, resident missions, mill owners, foremen, and workers.

The editorial team of ADCS (Academic and Development Communication Services) thanks the PMC and UNDP India for giving access to these sources.
## ANNEXE 1

### LIST OF MODEL UNITS

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<th>S. no.</th>
<th>List of model unit and contact details</th>
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<tr>
<td>1</td>
<td><strong>A C Strips (P) Ltd</strong>&lt;br&gt;&lt;br&gt;Mr Ashok Surana and Mr Virendra Surana&lt;br&gt;<strong>Regd. Office:</strong> 23/130, R.S. Shukla Road, Raipur - 492 001, Chhattisgarh&lt;br&gt;<strong>Fact:</strong> 31-32, Sector-C, Urla Industrial Area, Raipur (C.G) – 493 221&lt;br&gt;&lt;br&gt;E-mail: <a href="mailto:acstrips@hotmail.com">acstrips@hotmail.com</a></td>
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<td>2</td>
<td><strong>Adarsh Ispat Udyog (P) Ltd</strong>&lt;br&gt;&lt;br&gt;Mr Bimlesh Gupta, (Director)&lt;br&gt;56, Akash Ganga Complex, Supela, Bhilai – 490 023&lt;br&gt;&lt;br&gt;E-mail: <a href="mailto:adarshispat@yahoo.com">adarshispat@yahoo.com</a>&lt;br&gt;<strong>Tel.:</strong> 0788-2220105&lt;br&gt;<strong>Fax:</strong> 0788-4030025</td>
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<td><strong>Advait Steel Rolling Mills P. Ltd</strong>&lt;br&gt;&lt;br&gt;Mr Bharat Garg, Director&lt;br&gt;RS no 62/6 Theethambakkam, Suthukenni Post, Mannadipet Commune, Puducherry – 605 502&lt;br&gt;&lt;br&gt;E-mail: <a href="mailto:bharat.gargtmt@gmail.com">bharat.gargtmt@gmail.com</a>&lt;br&gt;<strong>Tel.:</strong> 0413-2674954&lt;br&gt;<strong>Fax:</strong> 0413-2674954</td>
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<td>4</td>
<td><strong>Arora Iron and Steel Rolling Mills (P) Ltd</strong>&lt;br&gt;&lt;br&gt;Mr Raminder Pal Singh Dua&lt;br&gt;Dhandari Khurd, Near Phase-VII, Focal Point, Ludhiana – 141 010 (Punjab)&lt;br&gt;&lt;br&gt;E-mail: <a href="mailto:arorairon.raminder@gmail.com">arorairon.raminder@gmail.com</a>&lt;br&gt;<strong>Tel.:</strong> 0161-2677404 / 5085403&lt;br&gt;<strong>Fax:</strong> 0161-2674777</td>
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<td><strong>ARS Metals (P) Ltd</strong>&lt;br&gt;&lt;br&gt;Mr C V S Murthy (TD) and Mr Deepak Bhatia (ED)&lt;br&gt;B-1/S, Sipcot Industrial Complex, Gummidipoondi - 601 201, Chennai, Tamil Nadu&lt;br&gt;<strong>Office:</strong> D-109, 2nd Floor, LBR Complex, Anna Nagar (E), Chennai – 600 102&lt;br&gt;&lt;br&gt;E-mail: <a href="mailto:murthychinta@yahoo.co.in">murthychinta@yahoo.co.in</a></td>
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<td><strong>Ashok Steel Industries</strong></td>
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<td></td>
<td>Mr Harmesh Kumar Jain, Director</td>
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<tr>
<td></td>
<td>G.T. Road, Sirhind Side, Mandi Gobindgarh – 147 301, Punjab</td>
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<tr>
<td></td>
<td>Mr Kamal Chaudhary (Director) and Mr B K Pal (CEO)</td>
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<td></td>
<td>SR-8, “Neelamber”, 28-B Shakespeare Sarani, Kolkata – 700 017, West Bengal</td>
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<td></td>
<td>Mr S S Bhambari, Director</td>
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<td></td>
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<td>Mr Rajan Ghai</td>
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<td>Mr Dinesh Kumar, Managing Director</td>
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<td>Mr Lalit Kumar Singhania, Managing Director</td>
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<tr>
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<td>14</td>
<td><strong>Industrial Steel Rolling Mill and Co.</strong></td>
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<tr>
<td></td>
<td>Mr Sanjeev Sharma</td>
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<td></td>
<td>Mr Deepak Rathi, Director</td>
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<tr>
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<td><strong>Ludhiana Steel Rolling Mills</strong></td>
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<td>Mr Sandeep Jain, Mr Sanjay Jain, and Mr S K Choudhary (AGM)</td>
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<tr>
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| 18 | **M P K Steels (I) Pvt. Ltd**  
Mr Manoj Sharma, Director  
A - 195, RIICO Industrial Area (Ext.), Phase-IInd  
Bagru, Jaipur – 303 007, Rajasthan  
E-mail: mpkgroup@gmail.com  
Tel.: 0141-3264216  
Fax: 0141-2235129 |
| 19 | **Mahalaxmi Dhatu Udhyog Pvt. Ltd**  
M L Rathi, Director  
Office: Anaj Bazar, Itwari Nagpur – 440 002  
Works: C-52 MIDC, Industrial Area Hingna, Nagpur – 440 028  
Tel.: 0712-2762550 / 3243709 / 234127 / 07104-235452 |
| 20 | **Mongia Hi-Tech (P) Ltd**  
Mr Gunwant Singh Saluja  
P Burhiadih, Tundi Road, Giridih – 815 301, Jharkhand  
Tel.: 06532-222562  
Fax: 06532-222562 |
| 21 | **Orient Steel Re-rolling Mill**  
Mr Rajesh Ahuja, (Director)  
26 – Akash Ganga Complex Supela, Bhilai – 490 023  
E-mail: orientsteel@gmail.com  
Tel.: 0788-2223543  
Fax: 0788-4031893 |
| 22 | **Premier Bars (P) Ltd**  
402, Nidhi Kamal Tower, 37 & 38 B, Ajmer Road,  
Jaipur – 302 006, Rajasthan  
Tel.: 0141-4053400  
Fax: 0141-4053401 |
| 23 | **Premium Ferro Alloys Ltd**  
Mr SS Agareal, Managing Director  
39/3490 A, 1st Floor, Ravipuram Road, Cochin – 682 016, Kerala  
E-mail: premiumferro@vsnl.com  
Tel.: 0484-2356735  
Fax: 0484-2356717 |
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<td>Mr Raajesh Goyel, General Manager</td>
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<tr>
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<tr>
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</tr>
<tr>
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<tr>
<td>25</td>
<td><strong>Ramsons TMT Pvt. Ltd</strong></td>
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<tr>
<td></td>
<td>Mr Rajesh R. Sarda (Director)</td>
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<tr>
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<tr>
<td></td>
<td>Mr J S Khurana, Managing Director</td>
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<td>Tel.: 0161-2672879</td>
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<td>28</td>
<td><strong>Shree Prithvi Steel Rolling Mills (P) Ltd</strong></td>
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<tr>
<td></td>
<td>Mr Sudesh Sharma, Director</td>
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<td></td>
<td>B-230, Road No-9, V.K.I. Area, Jaipur – 302 013</td>
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<td></td>
<td>Tel.: 0141-2330478 / 2332522</td>
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<td><strong>Shri Bajrang Power and Ispat Ltd</strong></td>
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<td></td>
<td>Mr Sandeep Goel, Director</td>
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<td>Kh. No. 2/3, Vill. – Gondwara, Ura Industrial Complex, Raipur – 493 221, Chhattisgarh</td>
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<td>30</td>
<td><strong>Someshwar Ispat Pvt. Ltd</strong></td>
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<tr>
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<td>31</td>
<td><strong>Sujana Metal Products Ltd</strong></td>
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<tr>
<td></td>
<td>Mr Seemakurti Ramesh, Chief Operating Officer and Mr K V Krishna Rao</td>
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<td>Rajeev Nagar, Sanivada Village, Visakhapatnam – 530 046, Andhra Pradesh</td>
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<tr>
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<td><strong>Suryadev Alloys and Power Pvt. Ltd</strong></td>
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<td>Mr Mukesh Agarwal (MD)</td>
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<td><strong>T K Steels Rolling Mills Pvt. Ltd</strong></td>
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<td><strong>Vivek Re-Rolling Mills</strong></td>
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<tr>
<td></td>
<td>Mr Raj Jindal, Managing Director</td>
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<td>Almoh Road, PO Box No. 75, Mandi Gobindgarh – 147 301, Punjab</td>
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# ANNEXE 2

## LIST OF STAKEHOLDERS

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<tr>
<td>1</td>
<td>NATIONAL PRODUCTIVITY COUNCIL (DELHI)</td>
<td>🌟 5S Lean Manufacturing Implementation (Model Units) (2011/12)</td>
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<tr>
<td></td>
<td>Dr S K Chakravorty</td>
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<tr>
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<td>Dy Director General</td>
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<tr>
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<td>Mr Subarat Pal</td>
<td>🌟 Feasibility Reports (Pipeline Units) (2011/12)</td>
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<td></td>
<td>Director – Process Management</td>
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<tr>
<td></td>
<td>Mr A K Sinha,</td>
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</tr>
<tr>
<td></td>
<td>Director – Energy Management</td>
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<td>Mr M L Suryaprakash</td>
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<td>AMBEDKAR INSTITUTE OF PRODUCTIVITY (TRAINING INSTITUTE) (NATIONAL PRODUCTIVITY COUNCIL - CHENNAI)</td>
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<td>Mr P Dharmalingam</td>
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<tr>
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<td>❖ Performance Improvement Training (Model Units) (2009–12)</td>
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<td>Mr Manas R Panda</td>
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<td>Dr B B Aggarwal</td>
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<td><strong>APITCO LIMITED</strong></td>
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<td><strong>MECON LIMITED</strong></td>
<td>◁ Development of Standard Operating and Maintenance Practices (Model Units) (2011/12)</td>
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<td><strong>PETROLEUM CONSERVATION RESEARCH ASSOCIATION (PCRA)</strong></td>
<td>◁ Cluster Mapping Study (General) (2007/08)</td>
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<tr>
<td></td>
<td>Mr A K Goel</td>
<td>◁ Electrical Audit (Model Unit) (2010–12)</td>
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<td>Mr Kapil Mathur</td>
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<td>Sanrakshan Bhavan</td>
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<td>S. no.</td>
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<td>11</td>
<td>ERNST &amp; YOUNG</td>
<td>- Development of Monitoring and Evaluation Manual (2005/06)</td>
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<td></td>
<td>Mr Dipankar Ghosh</td>
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<td>Mr Joseph Prakash</td>
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<td></td>
<td>1st Floor, Tower A</td>
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<td>Building No. 8, DLF Cyber City Phase 2, Sector – 25</td>
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<td>12</td>
<td>PRICEWATERHOUSECOOPERS PVT. LTD</td>
<td>- Developing Benchmarking and Minimum Energy Performance Standards for Steel Re-Rolling Mills in India (Ongoing)</td>
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<tr>
<td></td>
<td>Mr Amit Kumar</td>
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<td>Mr Rajeev Ralhan</td>
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<td>17th and 18th Floor</td>
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<td>Building 10, Tower C DLF Cyber City, Gurgaon</td>
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<td>ACADEMIC AND DEVELOPMENT COMMUNICATION SERVICES (ADCS)</td>
<td>- Documentary Films (2011/12)</td>
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<td>Mr K P Eashwar</td>
<td>- Process Documentation (2012/13)</td>
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<td>Managing Director</td>
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<td>17/12, Venkittarathinam Nagar Extn</td>
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<td>Second Street, Adyar, Chennai – 600 020</td>
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ABOUT THE BOOK
Steel re-rolling mills (SRRMs) constitute an important link in the overall supply chain of steel in the country, supplying a majority of India’s long steel products. The direct energy-use in the SRRM sector includes heating fuels (furnace oil, natural gas, and coal) and electrical energy. The cost of energy is estimated at 25%–30% of the overall production cost. This is a significant proportion, and a result of continued reliance on obsolete technology by the SRRM sector. Another result is the increasing greenhouse gas (GHG) emissions from the sector. It has thus become imperative for the SRRMs to tread the energy-efficient path.

This was the context in which the United Nations Development Programme (UNDP) launched a technical assistance project in 2004 with the Ministry of Steel, called ‘Removal of Barriers to Energy Efficiency Improvement in the Steel Re-Rolling Mill Sector in India’. The ‘Steel Project’ has contributions from the Global Environment Facility (GEF) and the Government of India through the Ministry of Steel’s Steel Development Fund.

During its journey, the Steel Project promoted ‘EcoTech’ packages and ‘process-improvement’ initiatives among model SRRM units. All these steps have succeeded in reducing their energy consumption and GHG emissions significantly. The publication, titled Energy-efficient Steel Re-rolling, documents this story of ‘transformation’ as it happened over the years.

This ‘process document’ would be of help to development practitioners, energy and environment professionals, researchers, captains of SRRM units, programme and project managers, and policy makers.