UNITED NATIONS DEVELOPMENT PROGRAMME
GLOBAL ENVIRONMENT FACILITY
PROJECT BRIEF
INDIA

Project Title:	Removal of Barriers to Energy Efficiency Improvement in the Steel Rerolling Mill Sector
Requesting Country:	India
Project Type:	Full Project
Duration:	5 years
Implementing Agency:	UNDP
Executing Agency:	Ministry of Steel, Government of India
Local Implementing Agency:	Office of Development Commissioner for Iron and Steel, New Delhi
Eligibility:	India ratified the UNFCCC on 1st November 1993
Focal Area:	Climate Change
Operational Program:	OP5 Removal of Barriers to Energy Efficiency and Energy Conservation

Summary: This project seeks to reduce greenhouse gas (GHG) emissions by providing technical assistance to the small and medium-sized steel-rerolling mills in India to enable them to adopt more energy efficient and environmentally friendly technologies. To date, these cleaner and more efficient practices have not been widely adopted in India due to information and knowledge barriers, combined with inertia and uncertainty on the part of a conservative, but competitive business sector. The project strategy seeks to involve the initial penetration of "low-risk", high efficiency technology packaged in selected small and medium-scale mills. It will thereby allow industry's confidence in and access to these technologies to grow. As a result, not only will information and assistance in adopting the identified packages be provided, but the industry will be driven to adopt these new packages through the need to maintain competitive edge. The Ministry of Steel will establish a centre for providing training, information and capacity strengthening on a sustained basis. It will develop institutional linkages with energy-service companies for providing off-the-shelf technologies from international equipment vendors. These actions, together with investment support provided by the Banking Sector are expected to result in an innovating, transforming, and efficient steel re-rolling sector.

COSTS AND FINANCING (in **US $ million**):

GEF		
	Project	**6.75**
	PDF B	0.28
	GEF Subtotal	**7.03**
Parallel financing:		
	India Government (Steel Development Fund)	7.28
	FIs/IREDA/Others	12.29
	India Government (for PDF B)	0.06
	Industry (SRRMs, equipment manufacturers and suppliers)	5.54
	Co-financing Subtotal	**25.17**
	Total Project Cost (excluding PDF)	**31.86**

OPERATIONAL FOCAL POINT ENDORSEMENT:
Name: Mr. S K Joshi, Organization: Ministry of Environment and Forests, Date: 7 March 2003

IMPLEMENTING AGENCY CONTACTS:
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ACRONYMS

A&FM	Administration and Finance Manager
ASD	Adjustable Speed Drive
BEE	Bureau of Energy Efficiency
CADD	Computer Aided Design and Development
CCE	Cost of Conserved Energy
CFD	Computational Fluid Dynamics
CII	Confederation of Indian Industry
CTA	Chief Technical Adviser
DCI&S	Office of Development Commissioner for Iron and Steel, New Delhi
DCS	Distributed Control Workstation
DEA	Department of Economic Affairs
DEMs	Domestic Equipment Manufacturers
DPRs	Detailed Project Reports
DSIR	Department of Scientific and Industrial Research
DSM	Demand Side Management
DST	Department of Science and Technology
E-E-Net	EE Information Network
EMC	Energy Management Center
ESCOs	Energy Service Companies
EWS	Engineering Workstation
FIs	Financial Institutions
GHG	Greenhouse Gas
ICICI	Industrial Credit & Investment Corporation of India Ltd.
IDBI	Industrial Development Bank of India
IMWG	Inter-Ministerial Working Group on Energy Conservation
IREDA	Indian Renewable Energy Development Agency
IRP	Integrated Resource Planning
ITP	Integrated Technology Package
LP	Long Product
MNES	Ministry of Non Conventional Energy Sources
MoEF	Ministry of Environment & Forests
MOS	Ministry of Steel
NPC	National Productivity Council
NPD	National Project Director
PAC	Project Advisory Committee
PATSER	Program Aimed at Technological Self Reliance
PCRA	Petroleum Conservation Research Association
PDAs	Project Development Agreements
PMC	Project Management Cell
PSC	Project Steering Committee
RHF	Reheat Furnace
RPD	Roll Pass Design
SIDBI	Small Industries Development Bank of India Ltd.
SMEs	Small and Medium Enterprises
SMP	Standard Maintenance Practices
SOP	Standard Operating Practices
SRRM	Steel Rerolling Mill
TERI	Tata Energy Research Institute
TIRFAC	Technology Information Research Facilitation Centre
VA	Voluntary Agreements
VR	Virtual Rolling
VVVf	Variable Voltage Variable Frequency (Drives)

GLOSSARY

Ceramic Fiber Veneering: A low-density insulating material used for conserving heat in reheat furnaces.

Crop Length Optimization: The front and back end of a rolled piece is generally defective and requires trimming. This trimming is called cropping and it affects overall yield. Minimizing crop length saves useful material and thus helps reduce indirect energy

EcoTech Options: The technologies that are energy efficient and economically viable are termed EcoTech options. This is in contrast to AllTech technologies that are the best as far as energy efficiency is concerned, but are not necessarily economically feasible.

Integrated Technology Packages (ITPs): The technology packages developed by incorporating various EcoTech options to meet the EE improvement requirements of industry. These also include some associated changes desirable to maximize the gains of EcoTech options.

Long Product (LP): Steel products are normally categorized as long and flat. The long products cover bars, rods and structural sections like angle, channels, beams, etc.

Mill Stand: A rigid structure that holds a pair of rolls at a desired gap. This is important equipment for rolling/ rerolling mill.

Recuperator: A device used for waste heat recovery from the outgoing hot flue gases in a combustion system.

Refractory: The heat resistant and insulating materials used in construction of Reheat Furnaces are called refractory material.

Reheat Furnace (RHF): The facility for raising temperature of the input steel stock from ambient to the rolling temperature (1100 to 1225^{0} C).

Repeaters: A device that facilitates transfer of material in-process from one mill stand to the next stand eliminating manual operation.

Rerolling: Rolling operations carried out starting from semi-finished rolled product as input stock or alternately using small ingots produced by recycling scrap through electric furnace based secondary steel route.

Roll Pass Design (RPD): The shaping of steel at elevated temperatures in the process of rolling requires grooved rolls. The design of grooves and sequencing along with step wise reduction in cross-section has a significant impact on energy consumption / conservation in the process. The design and sequencing of grooves on mill rolls is called Roll Pass Design.

Roller Guides: A device that directs entry of material into the roll pass or the target groove.

Rolling: A manufacturing process that converts cast metals into desired shapes under hot conditions.

Scale Loss or Burning Loss: In the process of reheating steel from ambient temperature to rolling temperature in the range of 1050-1200 degrees Kelvin, the surface layer gets oxidized and leads to material loss. This loss is targeted to be minimized, which contributes to both material and energy saving.

Small and Medium Enterprises: A small steel rerolling mill has an annual capacity in the order of 30,000 tonnes per annum, the medium segment has capacity of the order of 75,000 and the larger segment is 1,00,000 tonnes and above per annum.

Stationary and Moving Grate: The Reheat Furnace (RHF) has number of fuel options depending upon availability and cost, such as coal, furnace oil, natural gas, liquefied petroleum gas etc. A grate is a metallic grid to support the combustion of a lump coal.

Steel rerolling mill (SRRM) sector: Rerolling mills are stand alone units that take semi-finished stock from integrated plants or billets / ingots from the secondary steel sector through electric furnace route (EAF/IF).

Tilting Tables, Drop Tilters: These are material handing devices that save on the rolling cycle time of a piece. Adoption of these lead to increased productivity of mill and reduced energy use.

Variable Voltage Variable Frequency (VVVf) Drives: This is an application of electronics to pumps and motors, where the system has varying loads. At lower loads, the VVVf facility helps in saving electrical energy as well as thermal energy. These are also referred to as adjustable speed drives (ASDs).

1. BACKGROUND AND CONTEXT

1.1 Review of Energy Sector and End-use Energy Efficiency in Industrial Sector

India is currently the world's seventh-largest consumer of energy, sixth-largest source of greenhouse gas (GHG) emissions and second-fastest growing source of GHG emissions. The emissions are expected to grow at a rate of 5% between 1990 and 2010. However, the per capita energy consumption and emissions have remained relatively low at 0.3 tonnes of carbon per person due to the large population. The share of emissions from the industrial sector would be 50% of the total emissions from the energy sector, which is likely to grow five-fold by 2020[1].

The industrial sector constitutes roughly 40% of the total energy consumption in India and approximately 65% of this consumption is attributed to the most energy intensive industries, namely, fertilizer, iron and steel, aluminum, cement and paper and pulp. The end-use energy efficiency levels in these industrial sectors again are comparatively low[2]**.** Consequently, with the growing energy demand, rising shortages and spiraling upward costs of energy, the energy efficiency improvements of the industrial sector gained national priority. Since 1980s, the government has been introducing various policies and institutional measures with active participation of the industry. The Approach Paper to the Tenth Five-year Plan[3] stresses the efficient use of energy resources to achieve sustainable development. Some of the major efforts are summarized below:

- Inter-Ministerial Working Group (IMWG) on Energy Conservation constituted for directing national energy efficiency efforts;
- Petroleum Conservation Research Association (PCRA) funded by the Oil Industry Development Board set up for ensuring efficient use of petroleum products;
- Energy Management Center (EMC) established for planning and developing energy efficiency programs;
- Institutions set up for promoting energy efficiency services. These included industry associations such as Confederation of Indian Industry (CII), financial institutions (IREDA, IDBI, ICICI) the National Productivity Council (NPC), TERI;
- Regulatory reforms initiated for rationale pricing, which have brought average retail energy prices to levels that are at par or above the cost of supply. Coal and petroleum prices have been largely deregulated and average electricity prices paid by the end-users now approximate long-run marginal costs[4]; and,
- The Energy Conservation Act, 2000 enacted (on August 18, 2001) for using energy efficiently, energy conservation and for related matters. The Act mandates setting up of the Bureau of Energy Efficiency (BEE). It has the broad objectives to provide policy framework and direction to EE efforts, and coordinate energy conservation policies and programs

[1] India consumed 13.2 EJ of energy in 1998 (coal, 55%; petroleum fuels, 38%; and natural gas, 7%) and released 926 million tons of CO_2 (coal, 67.75%; petroleum fuels, 26.75%; and natural gas, 5.5%).

[2] The consumption of energy in industrial sector increased from 1.91 EJ in FY 1984 to 4.93 EJ in FY 1996 at a compound annual growth rate of over 8%. The intensity of energy use in steel, cement, and paper and pulp industries in India are relatively high (Source: World Energy Assessment-Energy and the Challenge of Sustainability, 2000).

a) Steel: 39.7 GJ/Te as compared to 17.5 in Japan, 25.4 in US and 27.5 –35.0 in China.

b) Cement: 8.4 GJ/Te as compared to 4 in US, 5 in Japan and 5.9 in China.

c) Pulp and paper: 46.6 GJ/Te as compared to 40.6 in US and 31.6 in Sweden.

[3] Five Year Plan Document of Planning Commission, 2001-02.

[4] Economic Survey, 2001.

amongst various stakeholders. BEE would further establish systems and procedures to monitor and verify EE results in key sectors of the industry, leverage multilateral and bilateral donors, support private sector, and administer the delivery of energy services to both private and public sectors.

The above efforts have increased end-use efficiency in the industry. The measure of gross energy intensity of economy, as the energy elasticity of GDP had declined from 1.26 in 1980 to 1.06 in the 1990s. In addition to the national efforts, a large number of programs are supported by multilateral, bilateral and international organizations. The World Bank, USAID and the Asian Development Bank have established credit lines with the financial institutions (IREDA, ICICI, IDBI and SIDBI). However, these efforts have been limited to larger and organized sectors including the steel sector. In the case of steel, the secondary steel production constitutes approximately 57% of the total steel production in India, which is mainly in the small and medium scale sector. Since the intensity of energy use in Indian steel industry is high, the Ministry of Steel intervened with policies and measures for energy efficiency improvement, pollution abatement and cost reduction measures. However, these interventions were limited to the large-scale integrated steel plants. Various reform processes have neglected the small and medium scale sectors, which are seen to be major consumers of energy and contributors to GHGs.

1.2 Steel Rerolling Sector –A Profile

The sector largely comprises small and medium scale mills. Small and medium scales are characterized by the hourly capacity of the mills. The small scale mills are covered in 3 to 14 tonnes per hour (tph) mills, whereas the medium scale mills are covered between 15 and 49 tph. The large-scale mills are 50 tph and above. The specific investment levels expressed in US $ per annual tonne of capacity are found to be more or less the same. The investment advantage, in the case of medium and large scale mills in general, are offset by the extent of mechanization required in the higher capacity mills. The category wise structure of the steel rerolling mill (SRRM) sector along with the investment is given in Table 1, and Table 2 provides the distribution of the SRRMs by product over the past three years.

Table 1: Category-wise Classification of SRRM Sector and Investment Levels

Category	Hourly capacity (Tonnes per hour)	**Number of Mills**		Aggregate Capacity (Million tonnes per annum)	Investment (US $ million)
		Continuous Mills	Composite Mills		
Small Scale Mills	3 – 9	753	-	7.60	655
	10 – 14	142	5	3.25	305
Medium Scale Mills	15 – 49	270	30	10.85	950
Total		1165	35	21.70	1910

Table 2: Geographical distribution of SRRM by Types of Products

Region		**Re bars**			**Medium Structural**	**Heavy Structural**
		8-10 mm	12-22 mm	22-40 mm		
North	(%)	4.0 – 8.0	10.5 –12.5	6.3 – 8.4	10.4 – 12.5	4.0 – 6.3
South	(%)	2.0 - 4.0	4.5 – 5.5	2.7 – 3.6	4.6 – 5.5	2.0 – 2.7
East	(%)	1.5 – 3.0	4.0 – 5.0	2.3 – 3.0	3.9 – 4.7	1.5 – 2.3
West	(%)	2.5 – 5.0	6.0 – 7.0	3.7 – 5.0	6.1 – 7.3	2.5 – 3.7
Total	(%)	10 – 20	25 – 30	15 – 20	25 – 30	10 - 15

Depending upon the location and the proximity to the main steel plants, North and West regions constitute the largest concentration of SRRMs in India. The percentage of units and the capacity in the stand-alone category of mills having continuous oil / natural gas fired reheating furnaces (RHFs) is the greatest, followed by mills having coal fired RHFs and mills with batch type of oil / natural gas fired RHFs. In addition, 60 – 65% of the product-mix comprises rebars (mainly 12-22 mm category), followed by medium structurals (25 – 30%) and heavy structurals (10 – 15%). Most products meet the BIS specifications (national standards for quality). Some long products conform to international specifications such as German standards (DIN), Russian (GOST), American Society of Testing Materials (ASTM) and Japanese (JIS).

The SRRMs currently meet 70 % of the long product steel requirement of the country. This share was 65 % in 1991. In spite of RINL, which is a 3 million tonne LP steel producer in the country, the share of SRRM sector has continued to expand at 0.6 % per year following macroeconomic policy reforms initiated by the Government of India in mid-1991. Going by the present trend, where large numbers of new mid-sized mills are being set up in the country and relatively little expansion is envisaged in the large mills, one can safely expect a further growth in share of the SRRM sector between 0.8 and 1.0 % per year. This is expected to result in growth of share of the SRRM sector at least to a level of 85 % in the next 20 years.

1.3 Energy and Environment Concerns of the Small and Medium Scale Steel Rerolling Mills

As noted above, the SRRMs constitute an unavoidable link in the overall supply chain of steel in the country. It largely consists of small and medium enterprises (SMEs) with 75% of units in the small scale. The mills grew haphazardly with outdated, low-investment high-cost technologies and practices largely financed with their own funds. According to the "Comprehensive Survey of Steel Rerolling Industry"[5] the sector comprises 1200 (working) SRRM units of various sizes. Some mills are composite (with electric arc furnace and/or induction furnaces to produce ingots for rolling). The cumulative average annual growth rate of the SRRM sector from 1966 to 1996 was approximately 4.7%. Correspondingly, the capacity grew from 4.7 million tons up to 19.4 million tons during that timeframe. In spite of global and domestic recession in the steel industry, the sector has recorded an annual average growth of about 6% during 1997 to 2001.[6] Also, during the same period, the share of secondary steel producers has increased to about 57%. With no major steel plant contemplated in the future, the present share of secondary steel would be

[5] DCI&S Survey Report, 1997, Ministry of Steel.

[6] Overall growth of steel was 3.8%.

expected to continue or likely to grow in future. The sector thus has a large aggregate capacity and enjoys a competitive edge over the major producers due to their flexibility in production for meeting low tonnage requirements in various grades, shapes and sizes to serve *niche* markets. The direct energy-use in this sector includes heating fuels (furnace oil, natural gas, and coal), and electrical energy. Indirect energy use is accounted by the use of energy intensive raw materials. The energy losses would thus comprise direct losses and indirect losses through scale loss and low yields. The direct energy cost in the SRRMs is estimated at 25 – 30% of overall production cost.

The steel rerolling sector is further characterized by the following:

- Outdated technologies and practices;
- Low information and awareness levels;
- Inappropriateness of generic energy efficiency technologies developed;
- Lack of incentives to cater to small scale energy efficiency projects;
- Lack of experience in accessing external funds;
- High investment costs of energy efficiency technologies; and,
- Low research and engineering base and other institutional linkages.

Tables 3 and 4 detail the high energy-use patterns and the scope for reducing energy consumption in the secondary SRRMs.

Table 3. Energy Use Pattern in the SRRM Sector in India

Region	**Furnace oil/Natural Gas**			**Coal**	**Total**	**Specific Energy Use**		
	Batch	**Continuous**				**F.Oil**	**Coal**	**Electrici**
		Stand Alone	**Composite**			**(L)**	**(kg)**	**(kWh)**
North								
‘000 tonnes	890	5960	1000	1250	9100	56	226	165
No of mills	67	211	15	167	460			
South								
‘000 tonnes	140	2496	400	930	3966	66	269	192
No of mills	15	85	6	124	230			
East								
‘000 tonnes	95	1936	350	960	3341	60	264	190
No of mills	7	37	5	128	177			
West								
‘000 tonnes	250	3458	550	1025	5283	65	264	186
No of mills	28	160	8	137	333			
Total (All India)								
‘000 tonnes	1375	13850	2300	4165	21690	61	253	180
No of mills	117	493	34	556	1200			
Distribution								
Tonnes (%)	6.3	64.0	10.5	19.2	100			
Mills (%)	10.0	41.0	3.0	46.0	100			

Table 4. Energy Use in SRRMs: India vs. Europe and Japan

Energy Emission Factors	India		Europe				Japan	
	All Sections		Medium Sections		Light Sections		Hot Charge	Cold Charge
	Obsolete Technologies		Eco Tech	All Tech	Eco Tech	All Tech		
	F.Oil	Coal	Mixed Gas		Mixed Gas		Fuel oil	
Fuel, MJ/tonne	2440	5060	1500	1310	1600	1350	540	1040
Power, J/tonne	1518	1860	736	598	966	782	828	874
kWh/tonne	165	202	80	65	105	85	90	95
Energy, MJ/tonne	3958	6920	2236	1908	2566	2178	1368	1914
CO_2, Kg/tonne	515	900	270	230	310	260	180	250
Yield,% *	90	90	97.5	97.5	96	96	94-95	94-95

Source: DCI&S Survey Report, 1997.

* Best yields obtained elsewhere in the world: Sections-97.5%, Wire rod-98.5%, Bar-97.3%. Energy consumption in the SRRMs in India is 1.8 times in the case of fuel oil based mills and 3.0 times in the case of coal based mills, when compared to energy consumption in similar mills abroad.

Note 1 kg of oil = 41 MJ; 1 normal cu.m.= 34.5 MJ;1 kg Coal = 27.8 MJ;1 kWh = 12 MJ.

A study of 90 units, selected from 5 geographical clusters during the PDF phase, revealed that the sector has tremendous potential for energy efficiency improvements. The sector primarily caters to the growing niche markets, and meets customized low volume requirements in various steel grades and shapes. Since the markets for these products are likely to grow further, there is a potential opportunity for improving energy efficiency levels by promoting profitable investments in the low GHG emission technologies suitable for SRRMs.

1.4 Energy Efficient Packages for Steel Rerolling Mills

Various established energy efficiency measures have been prescribed for the SRRM sector. A comprehensive survey of these measures was carried out to identify "EcoTech options" available to the SRRM sector. EcoTech refers to a set of technologies that are energy efficient, and economically viable under local conditions. The packages evolved from a basket of EcoTech options available to the SRRM sector, and 13 EcoTech options were considered in the area of combustion and 19 in the area of rolling mill and electrics. A detailed energy, environment and technology audit of the 20 front-rank SRRMs undertaken during the PDF phase has established a clear opportunity to reduce unit energy consumption levels in the sector, and thereby achieve national and global environmental benefits[7]. This study has quantified the gap between the investment opportunities in energy efficiency improvement and the actual practice. The PDF phase has examined various investments; technology interface issues and developed energy supply curves (cost of conserved energy - CCE) at 30% discount factor. Table 5 summarizes the packages that could be used along with EcoTech options, energy saving potential cost of conserved energy (CCE), and payback periods for investments. The five technology packages (according to mill size, configuration and type of fuel used) and two customized packages

[7] With an average EE production of 12.9 million tons in 20 years' project cycle, the following energy and environment benefits would be expected to accrue:

- Energy Conservation Benefits: Energy Saving = 21.1 PJ Valued at US $ 118.7 million, equivalent to $ 9.2/ton or 35% of the energy bill paid by mill owners at an average investment cost of $ 9.2/ton.
- National Environment Benefits: Annual average $ 18.0 million measured directly as a function of reduced soiling, increase in urban estate values, increased tree and crop growth and reduced water pollution resulting from low level of particulate emissions, low PM-10 and PM-2.5 emissions, low SOx and NOx `emissions.

integrate EcoTech options in the areas of combustion, rolling mill and electrics. In addition, customized packages that are common to all the packages and 'pre-requisites' to their adoption were evolved. Four technology packages, which are low-cost integrated types, fall under the oil/NG fuel category and one in the coal category. The latter is in two parts, (a) and (b). The adoption of the technical packages is expected to result about 30% saving in the primary energy use with nearly same amount of CO_2 reduction.

Table 5. Techno-Economic Analysis of Technology Packages

No	Packages	EcoTech Options	Energy Saved (GJ/T)	Cost of Conserved Energy ($/GJ)	Pay Back (years)
Technology Packages					
1	High Efficiency Recuperator in conventional Pusher Hearth Continuous Oil Fired Furnaces with customized packages	High Eff. Recuperator Automation & Control VVVf Drives PF Correction Energy Efficient Drives Energy Efficient Lighting	0.712	(-) 3.95	1.78
2	Change of Oil fired pusher hearth to oil fired walking beam furnace with high efficiency recuperator and customized packages	Walking Beam Furnace High Eff. Recuperator Automation & control VVVf Drives PF Correction EE Drives EE Lighting	0.949	(-) 3.89	2.04
3	Change of Oil fired pusher hearth to gas fired walking beam furnace with REGEN burners	Walking Beam Furnace REGEN Burners PF Correction EE Drives EE Lighting	1.033	(-) 6.92	1.54
4 (a)	Lump Coal Pulverized Coal Firing with Recuperator & Customized Package	High Eff. Recuperator Automation & Control VVVf Drives Lump to Pulverized Coal Firing PF Correction EE Drives EE Lighting	2.887	(+) 0.25	4.10
4 (b)	Lump Coal to Producer gas fired with HE Recuperator & Customized Package	Producer Gas Firing HE Recuperator Automation & Control VVVf Drives PF Correction EE Drives & Lighting	2.178	(+) 0.26	4.18
5	Hot Charging in Composite Mills (Both oil & gas fired)	Hot/Warm Charging HE Recuperator REGEN Burners EE Drives & Lighting PF Correction	1.05	(-) 4.71	1.5

No	Packages	EcoTech Options	Energy Saved (GJ/T)	Cost of Conserved Energy ($/GJ)	Pay Back (years)
Customized Packages					
1	Combustion (Furnace)	Improved Refractory Lining Ceramic Fiber Veneering High Emissivity Coating High Velocity/Oil Film Burners	0.28	(-) 1.5	0.8
2	Rolling Mill & Electric	Crop Length Optimization Roller Guides Roller Bearing Spindle & Couplings Tilting Tables Drop Tilters Repeaters	0.166	(-) 17.8	0.5

The energy saving potential and economic indicators of the EcoTech options and the packages have been assessed taking into account the industry and other stakeholders priorities such as profitability and willingness to invest, which are reflected as the internal hurdle rate or the discount factor, benefits in non-energy applications and competitive aspects. Some options have relatively low energy saving potential but have high negative values of CCE and high IRR indicating high cost recovery. Also, in some options energy saving potential is high, but there is a relatively low negative CCE, low IRR and low cost recovery. Each package is optimally designed with a suitable combination of range of options so that industry has sufficient willingness to pay and at the same time it serves global and national objectives. There is a significant market potential of the technical packages, which has been estimated along with EE options at US$ 120 million. However, in order to realize this potential, the identified barriers have to be removed.

2. BARRIERS TO ENERGY EFFICIENCY PACKAGES IN STEEL REROLLING MILLS

In consultation with stakeholders at all levels, seven key barriers to the adoption of technical packages have been identified and are outlined in the section below.

2.1 Lack of Need-based Financing Approaches and Mechanisms

Financing of technology projects in the SME sectors is still underdeveloped in India. The leading banks and financial institutions (FIs) are reluctant to lend for individual EE projects due to lack of understanding of technical and financial aspects of new technologies and also, at times, due to lack of sizeable investment portfolio. There is a lack of domestic venture capital institutions and/or instruments that finance new technologies. Other funds, namely, Science and Technology funds, technology fund of ICICI, bilateral and multilateral funds are not easily accessible to the sector due to different lending norms, and lengthy and cumbersome procedures. The small and medium mills, which usually have a low equity base or little exposure to equity and credit financing, lack capability to prepare application forms, credit documents and business plans to comply with standard procedures and lending norms of FIs and other lending agencies. In general, internal funds (surplus funds) are invested in backward integration, setting up new units or diversifying into other businesses.

2.2 Absence of Effective Market Transformation Strategies Specific to the SME Sector

While some state-of-the-art technologies have been introduced in the SRRM sector, they have not been widely distributed and penetration has remained low. The reasons identified are the lack of institutional capabilities to provide design and demonstration support, lack of capacities to manufacture standard EE equipment/facilities suitable for the smaller mills, and lack of experience and expertise to operate high-end technologies. Production of energy-efficient equipment, based on technologies developed in other countries, has just begun in India. However, the scale of operation of these technologies is relatively high and has not yet significantly penetrated the domestic market for SRRM sector in India. Due to a lack of in-house engineering and technical manpower, design, and engineering skills, research and development support, absorption of EE technologies within the sector has remained low. The barriers external to this sector such as poor infrastructure and lack of institutional channels/capacity for technology transfer further limits the commercialization potential of new technologies. The factors that have accentuated the present situation include low availability of energy services (design and development, technology application at user-centered interface, implementation, etc.), low market size, low scales of operation, and non-availability of standard designs and EE solutions. Although there is a potential for ESCOs in the small and medium scale sectors, these barriers have to be addressed independently.

2.3 Lack of Information

Due to lack of information and institutional mechanisms for ensuring information flow, there has been a virtual absence of technology databases. The information on EE technologies, configurations, techno-economic parameters, operating experience and type of risks associated, is marginal in nature and highly asymmetric. The suppliers of technologies have generally ignored the need for customizing information packages to suit mill-specific design and operating practices, interface and managerial issues and performance norms. Technologies supplied in a situation like this have under-performed when compared with their performance elsewhere.

2.4 Limited Institutional and Industrial Capacity

There is insufficient capacity of stakeholders at all levels, operating institutions and lack of business support network at national, regional and local levels to implement energy efficiency projects. Due to weak human resources and institutional capabilities (design, engineering and implementation support), the perceived technical and financial risks are high. Further, the cyclic nature of steel industry has forced the SMEs in the sector to look for short-term objectives rather than long-term EE solutions.

2.5 Low Priority and Bounded Rationality

The share of direct energy costs is in the range of 15 to 25% of the total operating costs in the SRRM sector. Since the sector experiences acute shortage of energy intense raw materials used as feed stock known as semis (ingot/billets) for rerolling from time to time, EE investments tend to be a low low priority[8]. The steel mills, typically in the unorganized sector, are traditionally managed by individuals who, usually due to limitations of time, attention and ability to analyze the information, have neglected EE investments/projects. Inertia is another dimension of the problem, where industry tends to be committed to the status quo. This situation leads to deferring EE investments with (supposedly) uncertain outcomes until such options/technologies could be commercially proven on extended trials.

2.6 High Transaction and Hidden Costs

Due to the SME nature of the sector, energy efficiency potential of this sector can only be achieved through implementation of a large number of small projects. Advanced technologies carry high transaction costs. The proportion of this cost relative to thebasic investment costs of technology is relatively high in SMEs as compared to large enterprises. The market has continued to remain biased against smaller EE projects, especially in cases when it takes more than two years to recover initial investments on annualized basis. Technology providers have very often ignored additional costs invariably associated with the implementation of new technologies at the operating plants. These costs include re-engineering, replacement or modification of existing plant and facilities, shifting of location, loss of production, ‘add-on’ fuel and power consumption, etc. The uncertainties in the ‘projected’ and ‘actual’ costs act a barrier in the development of the EE market.

2.7 Limited Commercial Experience

The commercial viability of EcoTech options and energy efficient technical packages is yet to be tried and proved in the sector on a visible scale to improve the confidence levels of investors. This is a ‘critical’ factor in widespread adoption of EE technologies especially when some technologies proposed under the project are new to the investor in the sector or first time in the country. This has resulted in the low confidence level of the small-scale investors.

[8] The SRRM sector is using all kinds of semis viz. Induction furnace ingots, billets, rerollable scrap, blooms and slabs from main producers etc. The price difference varies between Rs.2000 – 3000. If industry reduces the average price by Rs.700-800, this works out to more than the energy savings expected after making considerable amount of investment.

3. PROJECT RATIONALE

The proposed project is consistent with the national programs, policies and priorities of Government of India towards adoption of EE technologies for reducing pollution and related impacts. A major thrust of this goal is promotion and dissemination of sustainable viable technologies in a market-driven manner. Removal of barriers would help to reduce transaction costs of EE technologies, open up channels for obtaining sustainable financing, develop human resources at local, regional and national levels, remove difficulties in communication among and within institutions and help SMEs of the sector to develop market-based bankable energy efficiency projects. Further, through intervention in the SRRM sector, the GEF focuses on various energy intensive SME sectors in India, which are large consumers of energy and contributors to the GHG emissions and face similar complex issues and environment enforcement actions.

This project is also consistent with the UNDP's priorities to support sustainable energy use and build capacities to achieve global environmental and developmental goals. The project proposes to demonstrate best practices, including traditional technologies and innovative approaches. As a GEF implementing agency, UNDP facilitates the Government of India's commitments to demonstration of sustainable technological interventions such as those proposed under this project. The project would help to bring down both direct and indirect consumption of fossil fuels and to reduce GHG emissions. Finally, the objectives of the proposed project are consistent with the objectives of the GEF Operational Program No.5 on "Removal of Barriers to Energy Efficiency and Energy Conservation".

4. PROJECT STRATEGY

The project has been conceived based on extensive consultations held with stakeholders during the PDF phase and the pre-PDF initiative of the Ministry of Steel since 1998[9]. Alternative strategies to achieve the energy efficiency goals were evaluated on a set of criteria that included time frame, institutional capacity to implement the program, financial and economic viability, industry acceptance, social and political acceptance, replicability and sustainability, and resource availability to implement the program. Accordingly, the project intends to encompass seven integral components, namely: (i) benchmarking EcoTech options and technology packages; (ii) strengthening institutional arrangements; (iii) effective information dissemination; (iv) capacity building of stakeholders; (v) establishing technical and financial feasibility of EcoTech options and packages; (vi) introduction of ESCO and third party financing mechanism; and (vii) establishing technology information resource and facilitation center. These components would facilitate removal of barriers to developing energy efficient markets and approaches in the five major geographic clusters of mills. Annex B gives the Logframe developed for the project.

[9] Massive efforts were initiated by Ministry of Steel throughout the country to create awareness, availability and application of available EcoTech/AllTech solutions, best energy efficient practices in India and abroad, scope and potential of technological interventions in the industry, etc. with an objective to secure whole-hearted participation of the industry in the project.

4.1 Implementation Approach

By creating an enabling environment through institutional, financing and market mechanisms for accelerated spread of best practices and technologies, the project proposes to establish "EcoTech corridors" for the identified EcoTech options in the areas of combustion (13) and rolling mill and electrics (19), which combine to form technical packages. The participation of the national banks and financial institutions would be steered for ensuring suitable financing products and innovative financial mechanisms for enhanced credit facilities leading to expanded private sector investments in EcoTech options and widespread replication of the proven packages. Clusters' specific innovative institutional mechanisms for developing business and commercial networks through ESCOs would be another key area of focus. Finally, activities would be undertaken to sustain the project interventions through benchmarking, validation, setting up of technology development and information resources center, and implementation support to the industry and other stakeholders. Infusing greater confidence in the industry and securing their fullest participation are envisaged by implementing the technical packages. These packages have been designed keeping in mind the industry's willingness to pay and the potential for meeting the global and national objectives. The implementation of 5 technical packages in 30 mills would result in 30% energy savings and corresponding carbon emission reduction. These model sample mills would be linked to developing ESCOs for monitoring and guaranteeing performance. A five-step integrated model for embedding the programme in the existing industrial clusters has been proposed.

- *Step 1:* Redefine five geographical clusters with model units behaving as centers of excellence. Each zone is studied with regard to number of units in various categories, technologies employed, aggregate energy use and pattern, scope of energy conservation, institutional settings, and awareness and competence levels. The data is used to develop investment portfolios by clustering of the units in each zone.
- *Step 2:* Strengthen legal, policy, and administrative support to energy efficiency initiatives and secure commitment at local, state and central levels.
- *Step 3:* Develop zone level leadership and energy and technology management skills as a two-pronged strategy. First within the zone and secondly through proposed Technology Information Research Facilitation Center (TIRFAC) under the project. A competent group of entrepreneurs (core group) would be developed, which aims at cooperative procurement of services for hedging the transaction costs, post-installation assistance and after-sales-services. TIRFAC provides an organizational base to the private sector units and act as a focal point for dissemination of information, documentation of activities in the zone, monitoring of energy consumption profile/patterns, assimilation and absorption of technologies and measuring development through progress indicators. In addition, it acts as a technology resource center. The center develops energy managers who provide leadership in development of energy efficiency projects and programs in the zones.
- *Step 4:* Develop a culture of willingness to finance amongst local FIs/banks by demonstrating cost recovery of EE projects and facilitating mainstream financial support, including from those having links to foreign and multilateral development banks.
- *Step 5:* Develop strategically energy plans and targets for the zones linked to the national strategy for energy efficiency improvement and mitigation of local, regional, national and global environmental impacts.

4.2 Financing Plan

The Ministry of Steel through the Steel Development Fund, UNDP/GEF, Financial Institutions, and the private sector would share the total costs of project implementation: 1) Programme related costs; and 2) Investment costs. The GEF funds will not pay for any investment costs. The amount of co-financing committed by different agencies has been linked to the GEF contribution, making GEF a strategic partner leveraging co-funding for the investment component while GEF funds pay for Programme costs along with the Ministry of Steel.

The estimated total project cost is US $ 31.86 million. This covers incremental investment costs of US $ 20.96, which includes investment in 30 sample mills (17.01 million), establishment of TIRFAC (US $1.95 million) and strengthening manufacturing base of energy efficient systems (US $ 2 million). The investment component would be financed entirely by non-GEF resources. The investment requirements in the sample mills would be met out of the Steel Development Fund for mitigating financial risks and the upfront high capital cost barrier arising out of the complex, diverse and unregulated nature and low equity base of the industry.

The Programme costs associated with barrier removal activities have been estimated at US$10.9 million. Out of this requirement, GEF resources are sought for US $ 6.75 million. Given the nature of the project benefits that would be both domestic and global, the GEF would therefore partly finance barrier removal costs with contribution from the SDF as a co-financing partner. The balance financing support to mills will be mainstreamed with the existing financial schemes of FIs/Banks.

5. PROJECT DEVELOPMENT GOALS, OBJECTIVES, OUTPUTS AND ACTIVITIES

5.1 Project Development Goal (Outcome) and Objectives

The proposed project aims to increase the end-use energy efficiency of the secondary steel rerolling sector and thereby, reduce the associated GHG emissions. This would be achieved by strengthening institutional and industrial capacity for enhanced private sector investments in the proposed energy efficiency technical packages and measures. The immediate objectives of this project are removal of various key technical, financial, institutional and market barriers identified to the spread of these environmentally sustainable, and energy efficient technical packages and measures, and thereby supporting their large-scale commercialisation.

5.1.1 Output 1: Benchmarks for EcoTech Options and Technical Packages Established and Validated

Objectives

The objectives are to bridge technical gaps in the existing institutional and financial networks for adoption of technical packages by the mills; and to stimulate development of cost effective EE technologies in the marketplace along with design, engineering and implementation support.

Description of Activities

Develop energy and environment labels, standards, and benchmarks including investment norms (techno-economic viability and cost recovery norms) of EE options and technology packages. The capabilities of Indian technology and equipment providers will be assessed to ensure long-term performance parameters and efficiencies in comparison with international standards. These standards will be duly adjusted to input/output and other related conditions of operations (e.g., scale of operation) to develop prescriptive standards, minimum energy performance standards and average standards of all energy efficiency equipment/devices that are manufactured in India. The specific improvements will be identified and an action plan will be recommended/implemented. The action plan includes that industry complies with standards and validation of the same in actual performance of the model units after one year of their stabilization. Experts would be engaged to carry out studies for developing appropriate standards, validation and large-scale adoption of the EcoTech options and technical packages suggested in the areas of combustion, rolling mill and electrics. The scope of these studies and evaluations would include standard specifications, inputs and outputs, capital and operating costs, minimum viable project sizes and configurations and ranges of economic viability indicators.

Design standardized methods and tools for design, engineering and implementation of EcoTech solutions. Upon validation of technical packages, standard designs, re-engineering of the plant facilities and implementation manuals for technology packages and EcoTech options would be prepared by engaging experts. These would be disseminated to the existing manufacturers and the industry for strengthening the manufacturing base of production of proposed EcoTech options and its successful application.

Develop information modules for financing institutions, government and policy makers, and industry partners. As the existing institutions and policies influence the sector, their relevance and roles would be reviewed for effecting the technology upgrades in the sector. This would involve consultations for linking the best practices evolved through the above activities and disseminating them through facilitating effective networking among the various stakeholders.

Expected Impact on Barriers

The activities in this component will primarily address the absence of EE market transformation strategy and partly the lack of need based financing approvals and mechanisms related barriers identified under sections 2.1 and 2.2.

5.1.2 Output 2: Strengthened Institutional Arrangements

Objective

To set up self-financed long-term business support networks, at central, regional and local levels, which are both dynamic and self-sustaining for meeting the energy efficiency goals.

Description of Activities

Develop networks of associations of private and public institutions and companies, both domestic and international, bilateral and multilateral organizations, banks and financial institutions aimed at providing technical, financial and market inputs to the sector and securing policy and administrative support within legal framework of the country. Building upon the PDF findings, intensive consultations and reviews would be carried out with respect to the deficiencies and strengths identified in the existing institutions and networks; HRD institutions; S&T institutions; and policy, regulatory and administrative framework. A master plan for the sector would be prepared. The plan would facilitate active participation of the “lead” (sample or pilot mills) SRRM, in the institutional strengthening activities. In addition to “lead” units, it would involve technology providers, financial institutions, local banks, key design and engineering firms/institutions and independent experts who would analyze and propose market opportunities for investments in EE projects.

Establish business networks through self-financed association of multi-disciplinary experts, both domestic and international, including successful entrepreneurs aimed at dissemination of experience and providing support in problem diagnosis and solution design at local costs. Developing zone/cluster level entrepreneurial leadership would be initiated with focuses on the integrated resource planning (IRP) and demand side management (DSM) options, voluntary agreements (VA) with state/local administration to formulate 'Best Practice Program' and a separate plan for clustering of small-scale units to develop investment portfolios and thereby, reduce the transaction costs. An effective business support network with branches in major clusters shall be created to provide consultancy services to SMEs in the steel sector to develop and implement EE plans. Workshops and training programmes will be organized to develop industrial capacity linked to institutional requirements such as standard project development agreements, pre-qualification tenders for identifying technology suppliers and consultants/contractors, technology specifications and operational norms, performance guarantees and procurement procedure and vice versa, which means simultaneously development of institutional capacity to meet the industry requirements. Establishing project development and appraisal guidelines for market based “Bankable” EE projects and render services in lay out, design, engineering and installation, environment and safety validation of ‘new’ technologies and in the area of technology transfer, license fees, royalties, etc. E-E-Net (EE Information Network) will be created to provide industry with access to international practices and technology databases.

Develop internationally linked institutional capacity (joint ventures, technical cooperation, etc.) aimed at globalization of technology, concurrent developments and facilitating technology transfers. Mechanisms to ensure institutional networking for continuous technology upgrades and implementation of new technologies such as Calderon coal gasification, scale-free reheating, high efficiency recuperation, and flat flame burners. This would facilitate development of research and technology development alliances, joint ventures and cooperation both within India and outside leading to technology transfer. This activity would provide extended technological network and 'show-case' EE innovations. The project would support strengthening of communication channels within the proposed institutional framework for providing timely information on funding schemes and new technological developments to the enterprises.

Expected Impact on Barriers

The activities in the component will establish a long-term institutional framework, improve utilization of exiting institutions, facilities and resource personnel, build institutional capacity/expertise to provide energy services at local costs and provide improved connectivity within and outside to mitigate technical and financial risks (primarily the barriers identified in sections 2.4, 2.5 and 2.6).

5.1.3 Output 3: Effective Information Dissemination Program Developed

Objective

To develop effective information channels for facilitating continuous absorption of technological changes by the industry and other stakeholders.

Description of Activities

Develop comprehensive databases on current and emerging EE technologies including sources of supply and investment costs, expert analysis, projects, markets, opportunities, and related stakeholders through an efficient and effective system of data acquisition, storage and retrieval, updating and analysis. A report identifying information needs of stakeholders, sources of information, dissemination channels and MIS shall be prepared for implementation. A National Information Center housed in TIRFAC will be established with complete system design for data collection, storage, analysis, retrieval and continuous update. TIRFAC would support industry in acquiring ISO 9000 and 14000 Certification. TIRFAC would network with various certifying agencies operating in India such as BVQI, BIS, DNV, KPMG, RWTUV and STOC; consultants, and related government agencies and banks providing financial assistance/incentives to introduce ISO series of standards on a wider scale in this SME sector.

The activity will establish information dissemination channels and set up easy access procedures as suggested in the report. The activity will complement the efforts of the nodal Ministry and other agencies, and will be additional to what has been generally a part of generic information dissemination on the EE or technology front. Information dissemination activities would be undertaken in conjunction with the ongoing initiatives of the Government of India and related agencies, banks and financial institutions and bilateral and multilateral development agencies.

Disseminate comprehensive databases/information modules on baselines and EcoTech performance levels of industry to all stakeholders. An outreach plan would be developed for disseminating the information and continuous feedback mechanisms will be established in consultation with the key partners and stakeholders. Newsletters, technical bulletins, web site and expert presentation, including regular briefs to industry on markets, new funding schemes and new technological developments would be some of the components of the dissemination approaches proposed.

Design effective communication strategy to meet specific needs of the SRRM sector. Dissemination of best practices, lessons learned from implementation of technical packages and facilitating replication would be integral to the proposed communication strategy. In particular, the differences among the clusters and within the clusters will be recognized.

Expected Impact on Barriers

The establishment of an effective information system and communication channels will help to remove the barriers pertaining to lack of information and information asymmetry which has limited the growth of the technology market primarily the barriers identified in Section 2.3.

5.1.4 Output 4: Enhanced Stakeholders' Capacity

Objectives

To create adequate institutional and industrial capacity to develop and implement energy efficiency projects and facilitate their replication in future.

Description of Activities

Prepare and implement a time-bound action plan for capacity building of the industry. The capacity building activities will start with the technology and resource mapping in 5 geographical clusters, energy and emission pattern studies, and a SWOT analysis. This activity will identify capacity building needs of different clusters. Time-bound capacity building programs will be prepared. According to the varying needs of the mills, capacity-building activities would be undertaken at various levels. Standard Operating Practices (SOP) and Standard Maintenance Practices (SMP) will be developed for facilitating absorption and assimilation of 'Best Practices' by the mills.

Conduct training programs/workshops for cooperative procurement of EE technologies in clusters, engineering and implementation. The activity will conduct different training courses at various stakeholders' levels involving hands on experience, distance and electronic courses including training courses for the trainers. "Training of trainers" programme for developing industrial and institutional in-house capacity such as development of Energy-cum-Investment managers will be organized. Training of local, state and central level banks, state financial institutions, manufacturers, and suppliers of services and local/regional consultant, through special pilot programs will be undertaken to increase access to market information and financing of EE technologies.

Develop a national strategy for energy planning in the sector. Scaling up best practices based on lessons learnt from the implementation of the technical packages will be proposed through state-of-the-art learning and capacity building products such as customized capacity building modules, print and electronic publications and website courses. Best lessons learnt will be documented and disseminated for wider circulation. Institutional collaboration/tie-ups will be made to provide know-how to the industry, equipment manufacturers, and consultants, academic and R&D institutions, banks and financial institutions, local, state and central government agencies, technology providers and state and central pollution control boards.

Expected Impact on Barriers
The capacity building activity will result in improved institutional capabilities, increased confidence level of stakeholders, low perceived technical and financial risks and reduction in transaction costs associated with implementation of advanced EE technologies in the sector primarily the barriers identified in sections 2.1, 2.4, 2.5 and 2.6.

5.1.5 Output 5: Technical and Financial Feasibility of EcoTech Options and Technical Packages Established

Objective
To demonstrate the viability of technical packages for improving the investor's confidence and promote "learning by doing" for large-scale commercialization of the EcoTech options and technical packages.

Description of Activities

Pilot test packages in sample mills. The proposed 5 technology packages in 30 sample mills – 23 on one-to-one basis and 7 through ESCOs - will be implemented. The consultants and contractors will be identified along with the sources and selection of technologies. Based on the baselines already established, and projected energy efficiency and environment norms, linkages with special purpose funds along with adequate safeguards and mechanism to monitor technical performance and recovery of investments will be established. The detailed project reports (DPRs) detailing the design, engineering and construction of technical packages would be prepared including project development agreements (PDAs).

Verify techno-economic viability of the packages including cost recovery, performance and the impacts. The performance of the technical packages will be validated through an agreed monitoring plan developed in consultation with ESCOs, technology providers, experts and the industry. The project envisages deployment of SDF for providing financial support to sample mills by establishing separate credit line through the identified financial institutions primarily for two reasons: (1) to provide incentive to the first time investors through reduced transaction costs;

and (2) leverage funds for implementation of the technology packages. The schemes will be designed to ensure participation of the industry for sharing the performance of technical packages for its subsequent replication in other units. The schemes proposed would further address the reluctance for investments in technologies with high upfront costs and limited access to commercial financing of new technologies from FIs.

Access to commercial financing will be achieved with the technical support from TIRFAC. TIRFAC will validate the technology packages and cost recoveries in the sample mills and thereby facilitate access to commercial financing through limited recourse debt or project financing. This would allow financing of EE projects on their merits with repayments to be effected from the project cash accruals. In order to achieve sustainable financing for energy efficiency projects in the SRRM sector, the packages would be implemented in "innovative financing frameworks" based on the experience of existing leasing or vendor financing and guarantee schemes that would be necessary to mitigate the financial risks and high transaction costs including the security requirements such as bank guarantees by the FIs / banks. To this effect, a financing model has been proposed along with FIs and industry for developing and putting into place an "ESCROW" account, in which additional profits, accruing through energy savings would be secured to provide for additional collateral and / or guarantee or comfort level of both industry and FIs/Banks.

Improved access to financing will be achieved through linking ESCOs to the proposed funds for investment in sample units. ESCOs will execute Model Performance Contracts such as Guaranteed Energy Saving Contract between ESCO and SRRM units and Loan Contract between ESCO and financial institutions. For this purpose, the project would associate with the ongoing USAID's Energy Management Consulting and Training Program, National Association of Energy Service Companies (NAESCO), International Institute for Energy Conservation, etc.

The lessons learned will be compiled for development of replication plan for widespread adoption of technological packages. In addition, the model implementation process will be documented for wider dissemination.

Expected Impact on Barriers

Demonstration of advanced technology packages in sample mills would facilitate the removal of barriers associated with limited commercial model experience in minds of the sector, local consultants and FIs/Banks.

5.1.6 Output 6: Innovative Institutional Mechanisms Established

Objective

To establish market-based mechanisms to promote energy efficiency and ESCO businesses.

Description of Activities

Develop mechanisms of performance contracting involving identified ESCOs and technology providers. The concept of performance contracting for adoption of technical packages by the industry will be introduced with the support of the identified ESCOs. The project would facilitate involvement of select ESCOs in the implementation of technical packages in at least 7 mills identified during the PDF phase. M/s. Thermax EPS, INTESCO ASEA, ELPRO ENERGY CENTER, SEETECH INDIA, DCM, and 3EC have already indicated their interest in the project. The energy savings cash flows would be developed in a participatory manner. The ESCOs would operate ESCROW mechanisms or any other specific mechanism as agreed with the FIs and industry. The activity will establish model performance contracts for demonstration in 7 sample units.

Strengthen capacity of the ESCOs for implementing identified technical packages for the mills. Training programmes will be organized on technical packages for strengthening capacity of ESCOs in the areas of design and engineering requirements for technical packages, and related services to the industry. In addition, technical support would be provided for implementation of technical packages. Technical assistance in carrying out energy audits and monitoring of savings would also be provided. Since energy efficiency aspects through ESCO business vary considerably from one cluster to another, the activity will identify and select ESCOs specific to the clusters' needs.

Develop institutional linkages among existing ESCOs, technology providers and industry. Industry specific 'Best ESCO practice' norms, performance guarantees and contracting procedures would be developed and disseminated through the Confederation of Indian Industry, and the Bureau of Energy Efficiency. Improved access to financing will be achieved through linking ESCOs to the proposed funds for investment in sample units. ESCOs will execute Model Performance Contracts such as Guaranteed Energy Saving Contract between ESCO and SRRM units and Loan Contract between ESCO and financial institutions. For this purpose, the project would associate with the ongoing USAID's Energy Management Consulting and Training Program, National Association of Energy Service Companies (NAESCO), International Institute for Energy Conservation, etc.

Evaluate the market potential through demonstrating ESCO concept in 7 mills. A detailed assessment of the market potential for ESCO implementation of the technical packages will be carried out.

Expected Impact on Barriers

With adoption of market-based mechanisms and third party financing, the perceptive risks (technical, financial and commercial) and uncertainties associated with limited exposure to EE projects are greatly reduced. Bounded rationality is reduced/eliminated as a byproduct.

5.1.7 Output 7: Technology Information Resource and Facilitation Centre Established

Objectives

- Develop sustained linkages between the industry and technology developments through continuous flow and exchange of information, research and experience among mills.
- Initiate a process for phasing out technological obsolescence by promoting innovation, demonstration and indigenization of 'new' technologies.
- Set up modern engineering, modeling and software facilities aimed at developing and implementing energy efficient solutions.
- Develop master plan with institutional linkages to support introduction and implementation of EE technologies.

Description of Activities

- Set-up a project management and coordination unit for implementing project activities.
- Develop a comprehensive work-cum-implementation and monitoring plan.
- Report to funding agencies as per the pre-determined progress indicators for various activities in the project.
- Document lessons learnt for all project activities and their objective vis-à-vis outputs.
- Establish a technology information and facilitation centre.

The Project Management Cell (PMC), established for the PDF phase, will initiate this activity. This Cell would be strengthened to develop adequate project management structure and systems to ensure successful implementation of all the project activities. The Project Management Cell would assume all the functions of the centre (referred to as Technology Information Research Facilitation Centre –TIRFAC by the Ministry of Steel) until such time as it is fully operational. The PMC would subsequently merge with this centre at the end of the project to provide services to the sector on a sustained basis. It is proposed that the centre would house its hardware facilities in the National Institute of Secondary Steel Technology (located at Mandi Gobindgarh) and Thermax, Pune or any other existing institutions, and the software or computer design, modeling and business development center services would be centrally coordinated from Delhi but networked with a number institutions providing services. The Center will have modern prototype facilities like a continuous pusher hearth/walking beam furnace with distributed control and engineering workstations (DCS and EWS), various measurement and calibration facilities. These facilities are expected to provide the sector with a research, technology development and demonstration platform. The 'software' component would have modern design and software facilities such as computer aided design and development (CADD), 3-D combustion modeling of furnaces and heat exchangers using computational fluid dynamics (CFD), roll pass design (RPD) and virtual rolling (VR) software, and modern training facilities. The Centre shall function under the direction and administrative control of the PMC during the project period.

Expected Impact on the Barriers

With establishment of TIRFAC and subsequently partnering with industry the barriers related to technology absorption and transfer; design, development and implementation; customized EE solutions, and innovation support, high transaction and hidden costs as described in sections 2.2 and 2.6 are effectively addressed.

6.0 INCREMENTAL COSTS AND PROJECT FINANCING

6.1 Incremental Costs

Extensive consultations were held with the industry and other stakeholders for arriving at the incremental costs. A consensus was reached on the following:

- The potential for investments in the energy efficiency improvement of rerolling mills is not realized due to the existence of technical, information and other market barriers.
- The proposed energy efficient technical packages besides having GHG reduction potential are cost effective on a life cycle basis.
- The up-front capital costs associated with the proposed technology packages are higher than the respective baseline projects of equivalent capacities.
- The industry would be paying for the estimated costs of achieving baselines as defined in the project.
- The cost-benefit analysis of each of the five technology packages on the basis of cost of conserved energy (CCE) would consider 30% discount rate, which was specified as the internal hurdle rate of industry.
- The life of the proposed energy efficiency investments would be assumed at 10 years.

Keeping the above in mind, the project with a total cost of US $ 31.86 million, proposes two types of cost components that are associated with the removal of the identified barriers to cost effective energy efficiency improvements in the SRRMs. One component deals with the technical assistance for adoption of the proposed technical packages and the second deals with the investment support to the demonstration of the technical packages in select rerolling mills. The project however, seeks partial support from the GEF only for the technical assistance component. The other component dealing with investment support to demonstrate technical packages would be financed out of purely non-GEF resources. GEF will not be covering any costs related to investment component of the project.

The estimated costs of technical assistance for addressing the barriers in five major clusters (out of 15) are estimated at US $ 10.9 million, with GEF contributions up to US $6.75 million.

For estimating the direct investment support in 30 sample mills, the project has defined the baseline as the minimum energy efficiency levels that industry should achieve on its own. This is basically the industry's current best performance level and the cost of achieving this level has been taken as baseline costs. However, the baseline investments estimated at US $ 60.2 million being notional, the cost of implementing the technical packages (GEF scenario) in sample mills represents incremental investment costs, which has been estimated at US $17.01 million after accounting for productive gains in the alternative GEF scenario. In addition, investment support is US $3.95 million for establishing TIRFAC and strengthening manufacturing base of the energy efficient equipment suppliers. The estimated direct GHG emission reduction through this project would be 2 million tonnes of CO_2 per year. The summary of the economic and financial feasibility of the proposed technical packages and the details of incremental cost benefit analysis and incremental cost matrix are presented in Annex A.

6.2 Project Financing

The proposed project seeks contributions from the GEF along with parallel financing by the Steel Development Fund, FIs, industry and others towards meeting the total project costs. GEF contributions of US $ 6.75 million are expected only for technical assistance activities that relate to the Programme Component of the project The Ministry of Steel through the SDF has sanctioned additional technical assistance along with investment support to the tune of US $7.28 million in equivalent Rupees. The industry and other financial institutions would share the balance US $17.83 million. In principle financial commitments for cofinancing and the letter of intents for participating in the project has been received from the Indian Renewable Energy Development Agency, Program Aimed at Technological Self Reliance (PATSER) and Technology Development Board of the Department of Science and Technology, ICICI (EcoFund), Small Industries Development Bank of India as well as promoters of sample units (all letters are on file). Table 6 gives total budget by activity, source and year.

Table 6. Program and Investment Components of Project

A. PROGRAM	Funding Source	Year 1	2	3	4	5	Total
Benchmarks for EcoTech Options & Packages	GEF	0.07	0.14	0.21	0.21	0.07	0.7
	SDF	0.015	0.03	0.045	0.045	0.015	0.15
Strengthening Institutional Arrangements	GEF	0.095	0.19	0.285	0.285	0.095	0.95
	SDF	0.015	0.03	0.045	0.045	0.015	0.15
Effective Information Dissemination Program Developed	GEF	0.04	0.08	0.12	0.12	0.04	0.4
	SDF	0.01	0.02	0.03	0.03	0.01	0.1
Enhanced Stakeholders Capacity	GEF	0.155	0.31	0.465	0.465	0.155	1.55
	SDF	0.145	0.29	0.435	0.435	0.145	1.45
Feasibility of EcoTech Options & Technical Packages estd.	GEF	0.095	0.19	0.285	0.285	0.095	0.95
	Industry	0.25	0.25	0.25	0.25	0.25	1.25
Innovative Institutional mechanisms established	GEF	0.085	0.17	0.255	0.255	0.085	0.85
	SDF	0.03	0.06	0.09	0.09	0.03	0.30
TIRFAC Established	GEF	0.185	0.270	0.355	0.355	0.185	1.350
	SDF	0.15	0.15	0.15	0.15	0.15	0.75
Sub-total A		**1.34**	**2.18**	**3.02**	**3.02**	**1.34**	**10.90**
B. INVESTMENT							
Feasibility of EcoTech Options & Technical Packages estd.	**SDF**	0.282	0.34	0.679	0.634	0.495	2.43
	Industry	0.385	0.46	0.92	0.855	0.67	3.29
	FIs/Others	1.312	1.578	3.155	2.945	2.300	11.29
TIRFAC Established	SDF	0.195	0.39	0.585	0.585	0.195	1.95
Strengthening manufacturing base of EE equipment	FIs/Others	0.2	0.2	0.2	0.2	0.2	1.00
	Industry	0.2	0.2	0.2	0.2	0.2	1.00
Sub-total B		**2.574**	**3.168**	**5.739**	**5.419**	**4.060**	**20.960**
Budget by Funding Source	GEF	0.73	1.35	1.98	1.98	0.73	6.75
	SDF	0.842	1.31	2.059	2.014	1.055	7.28
	FIs/Others	1.51	1.78	3.35	3.15	2.50	12.29
	Industry	0.835	0.91	1.37	1.305	1.12	5.54
Total		**3.91**	**5.35**	**8.76**	**8.44**	**5.40**	**31.86**

7. STAKEHOLDERS' PARTICIPATION

The involvement of stakeholders was an integral component of PDF implementation. Several consultative meetings and stakeholders' workshops were organized to seek inputs in identifying the barriers, defining baselines and incremental costs, designing technical packages and barrier removal activities, and developing institutional linkages for the project during and beyond the GEF funding phase.

A day long PDF project inception workshop on August 27, 2001, to brainstorm the sector issues, followed by the first national stakeholders' workshop on August 28, 2001, received an overwhelming response from 75 participants representing front-rank SRRM units, private small and medium enterprises and industry associations, technology providers and domestic equipment manufacturers, consulting firms, government bodies – Ministry of Steel, Ministry of Environment and Forests, Department of Science and Technology, Indian Renewable Energy Development Agency, State and Central Pollution Control Boards, academic and research institutions, multilateral and bilateral agencies, Development Banks – USAID, SIDBI, ICICI, TDB/PATSER, IREDA, EXIM Bank, and UNDP. Based on the inputs received, the PDF activities were planned to systematically feed the stakeholders expectations into every component of the project.

The detailed energy audits conducted in the sample mills followed participatory approaches. Various study reports prepared during the PDF were shared with the stakeholders for their assessments and recommendations. The second stakeholders' meeting at the national level was held on April 11 and 12, 2002, which included one-to-one interactions with units on recommended technology packages and investments, and parallel technical sessions to facilitate the industry user-technology provider interface.

Besides consultations through six regional meetings held in all the geographic clusters, the stakeholders participated in a major workshop held on April 13, 2002 for barrier analysis and mitigation strategies and contributed effectively towards developing alternative project strategies. The involvement of international experts in design of technical packages and incremental costs further intensified the consultations. These approaches ensured the needed inputs resulting in greater enthusiasm among participating units for meeting energy efficiency objectives.

Simultaneously, support and commitment from the state governments and local administration were sought, as aspects such as local air pollution standards, infrastructure, energy pricing, etc., play an important role in the diffusion of proposed technologies. A study was commissioned in partnership with the stakeholders to assess the adverse impacts of emissions associated with various fuels and method of burning.

The continued consultative process ensured consensus among the stakeholders' on various project design components. This has led to project ownership at key levels – the government, industry and various institutional partners. The stakeholder participation will be intensified further during the project implementation to ensure wider participation for adopting energy efficient packages on a sustained basis.

8. RISKS AND SUSTAINABILITY

8.1 Project Risks and Mitigation Strategy

The project faces potential risks emanating from the nature of the proposed interventions, and the involvement of various stakeholders. These risks would potentially be induced by technical, commercial, financial, and management factors as outlined below.

Technical Risks

The proposed technical packages have been designed for a particular level of plant operation. Further, it assumes that adequate capacity would be available in the industry for implementing the technical packages.

Mitigation of the above risks has been proposed through training of the industry personnel as part of technical assistance support and involvement of ESCOs. The performance levels have been based on current operational levels.

Management Risks

Lack of continuity of the project team and delays in constitution of the project management cell are practical risks associated with this project. In addition, lack of effective coordination by the team with the key stakeholders may further cause delays.

Mitigation of the above risks is addressed through continuation of the existing team that implemented the PDF, which will also assume the responsibility of setting up of the project management cell. The difficulties in coordination of stakeholders would be minimized by direct involvement of Government of India. The Ministry of Steel, being the executing agency for the project, would constitute the project steering committee (PSC) with representatives from other Ministries and stakeholders, including industry through their associations to ensure streamlined project coordination, consultation and feedbacks.

Commercial Risks

The project envisages partnerships with ESCOs and financial institutions that have limited experience in this sector.

Mitigation of the above risk will be attempted by investment support to the sample mills. In addition, technical assistance will build the capacity of ESCOs and financial institutions. Already, industry has shown acceptance of this project and a number of units have already started implementing the recommendations. Since the energy efficiency related measures have a direct bearing on the operating margin, industry is keen to adopt the EE technologies to improve their bottom lines. This is reflected in changing energy consumption profile of industry during the last five years. These factors have also contributed to the lowering of risk perception. Table 7 summarizes specific potential risks and mitigation measures proposed in the project design.

Table 7. Potential Risks and Mitigation Measures

Description	Rating	Mitigation Strategy
Non Optimal Scale of operation	Low	EE norms based on plant working hours taking due consideration of past market behavior.
Conformance to technical package specifications	High	Incorporation of certified training component related to technology packages and strategy to achieve high interoperability levels.
Low Performance and reliability experienced	Low	Commercially established technical packages recommended and their feasibility would be demonstrated in the select sample mills involving ESCOs.
High Transaction Cost	Low	Reduction in cost through support activities in TA component.
Perceived risks for SME borrowers by FIs.	Medium	Techno-economic viability and cost recovery demonstrated through sample units.
Low collateral value risks associated with EE projects	Medium	TA support to build capacity of FIs to value security features of EE projects, cost saving and end-use application of EE equipment, etc.
High Costs of Appraisal and financing	Low	Technical appraisal and financial returns ensured through analysis of techno-economic models.
Slow progress	Medium	Delays overcome through better coordination.
Change in Government Policy, Programs and Commitments	Low	The sector tends to cater to niche markets, and this risk is not expected to have much impact in the present circumstances.
Impact of recession/downturn in economy	Low	The project design takes into account that paybacks and energy saving potentials of the packages are based on the average market situation.
Fall in retail energy prices	Low	Fall not anticipated, an upward trend would give better viability.

8.2 Sustainability

The project has been primarily driven by the industry and focuses on industry requirements. From the government's perspective, the project provides an effective framework for integrating environment and development involving the private sector. The institutional mechanisms proposed are sensitive to the roles of different stakeholders such as the financial institutions, small and medium scale rerolling mills, and other partners. Specific elements that influence the sustainability of the project are listed below:

- The technology packages have been tailored to suit typical units taking into the technical and financial strengths of the industry and to improve the cost competitiveness of the sector and thereby sustain the energy efficiency projects;
- Networking among industry associations, technology providers, domestic and international consultants, and domestic energy and environment agencies for undertaking collective mitigation of perceived risks;
- Targeting, developing and expanding market of ESCOs as part of sustainability strategy in the project design;
- Clustering of small sized mills to develop sizeable portfolios for investments by Banks/FIs, bilateral and multilateral agencies;

- Establishing a center supported through subscription and service charges from the industry for long-term support to technology innovation, development and diffusion for the sector;
- Involvement of research, design and development institutions both within India and outside for securing transnational co-operation to develop advanced international designs and raising industry standards to expand the energy efficiency markets;
- The policy environment resulting from Energy Conservation Act, 2001 would be gainfully utilized to support the project through Bureau of Energy Efficiency; and,
- An incentive structure comprising of monetary/non-monetary schemes and mechanisms proposed under the project would contribute to EE reforms.

8.3 Replication Potential

The secondary steel rerolling sector has been steadily growing at approximately 6%[10] annually with a corresponding increase in the annual production from a current level of around 10.0 million tonnes to 16.5 million tonnes by 2012 and to 29.0 million tonnes by 2022. The assumed growth scenario (until 2022) has factored in the cyclic nature of the steel industry, the type and behavior of the market, and the technologies deployed. The small scale mills (between 3 and 9 tph range) mainly target agriculture, rural and semi-urban markets, where cost rather than quality of the long product is the main criteria. These mills are mainly coal based units, where technical limitations are placed with regard to capacity (workable not beyond 10 tph furnaces). Since the price of coal energy is the lowest, these mills enjoy some competitive advantage over other mills such as oil and natural gas based mills. However, higher growth rates are unlikely for this segment as this market is dominated by flat steel products, iron and steel foundry products. This segment has always had low capacity operation in the past as compared to the two larger segments and is most vulnerable to closure. Survival would depend how the units upgrade themselves with respect to size and therefore introduce energy efficiency and other cost effective measures. According to a market forecast, this segment is expected to have a maximum growth rate of 4% in comparison to larger mills between 10 and 14 tph and medium capacity mills between 15 and 49 tph (5 and 6.6% growth rate respectively), as observed in the recent past.

The other two segments, namely small mills between 10 and 14 tph and medium capacity mills between 15 and 49 tph, constitute high growth segments of the SRRM sector. The majority of these mills are both innovative and progressive in nature. As the current indicators suggest, a large number of integrated composite mills are being planned in the medium category. A great number of mills in the larger of the two categories have undertaken capital modification of their existing facilities to up-scale their operation including diversification of their product range towards the high value end of the chain. It is known that steel consumption in India mainly centers around 15% of its population, where quality is the main stay. These mills cater to this niche demand of steel and are, therefore, likely to grow.

Assuming the similar pattern of growth of capacity of SRRM sector as has been indicated in the past, the project envisages reorientation of capacity of the SRRM sector in the next 20-year project cycle. Various factors have been analyzed, as indicated above, and discussed with the industry. Table 8 gives the reorientation / restructuring of capacity of the SRRM sector over the next 20 years. It may be seen that larger capacity mills will progressively move towards higher

[10] Annual Performance Review, JPC, 2001

sizes, and achieve higher capacity operation in comparison to smaller capacity mills. The smaller capacity mills will eventually be marginalized and/or closed. The overall size of the sector would move up from 10 tph to over 16.5 tph and capacity operation will go up from 46% to over 80% by the end of the 20th year.

Table 8: Reorientation of SRRM Capacity under 20-year Program

Year & Category of mills	Number of units	Avg. size of mill	Capacity (mtpa)	Production (mtpa)	Capacity utilization (%)	Number of units		
						Up-graded	New	Closed
2003								
1. Small								
Bet 3&9 tph	753	5.60	7.60	2.25	29.6	Nil	Nil	Nil
Bet10&14tph	147	12.28	3.25	1.90	58.5	Nil	Nil	Nil
2. Medium								
Bet15&49tph	300	20.09	10.85	5.85	53.9	Nil	Nil	Nil
Total	1200	10.05	21.70	10.00	46.0	Nil	Nil	Nil
2008								
1. Small								
Bet 3&9 tph	753	6.00	8.13	2.74	33.7	753	Nil	Nil
Bet10&14tph	162	12.50	3.65	2.42	66.3	147	15	Nil
2. Medium								
Bet15&49tph	304	24.00	13.15	8.06	62.3	300	5	Nil
Total	1220	11.36	24.90	13.23	53.1	1200	20	Nil
2013								
1. Small								
Bet 3&9 tph	721	6.70	8.70	3.33	38.3	721	Nil	32
Bet10&14tph	175	13.00	4.09	3.09	75.5	162	13	Nil
2. Medium								
Bet15&49tph	322	27.50	15.93	11.11	69.7	304	18	Nil
Total	1218	13.10	28.7	17.49	60.9	1187	31	32
2018								
1. Small								
Bet 3&9 tph	708	7.30	9.30	4.05	43.5	708	Nil	13
Bet10&14tph	189	13.50	4.59	3.95	86.0	175	14	Nil
2. Medium								
Bet15&49tph	335	32.00	19.30	15.32	79.4	322	13	Nil
Total	1232	14.97	33.2	23.13	69.7	1205	27	13
2022								
1. Small								
Bet 3&9 tph	664	8.00	9.57	4.74	49.5	664	Nil	44
Bet10&14tph	195	14.00	4.91	4.80	97.7	189	6	Nil
2. Medium								
Bet15&49tph	341	35.00	21.48	19.39	90.3	335	6	Nil
Total	1200	16.65	36.00	28.93	80.4	1188	12	44

The existence of the mills in clusters allows for faster penetration of any industry best practice, as has been the experience in the past. The proposed project would sensitize these clusters through effective technical assistance and implementation of technical packages in the sample mills. Further, reorienting the industry for greater acceptance of energy efficiency measures by addressing the existing barriers is likely to lead to 36.1 million tons of production by 2012 using EcoTech options. Correspondingly, this would represent 53.1 PJ energy savings and 4.2 million tonnes CO_2 emissions reduction. Table 9 gives replication potential of 5 technology packages identified for the mills for the period between 2008 and 2012.

Table 9 - Estimated Replication Potential in Post-Project Period (2008 – 2012)

Description	Unit	2008	2009	2010	2011	2012	Cumulative
Replication Parameters							
Total Likely Production	million tonnes	13.2	14.0	14.8	15.6	16.5	74.1
Energy Efficient Prod. Replicated	million tonnes	4.5	5.9	7.2	8.6	9.9	36.1
Energy Saving							
Energy Saved	PJ	6.5	8.6	10.6	12.7	14.7	53.1
Fuels, Power and Material saved							
Furnace Oil	‘000 tonnes	58.8	77.0	95.5	114.1	132.7	478.1
Thermal Coal	‘000 tonnes	103.9	137.8	171.0	204.0	237.0	853.7
Power Coal	‘000 tonnes	65.9	86.9	108.2	129.6	151.0	541.6
Material	‘000 tonnes	59.0	77.3	95.6	114.0	132.4	478.3
Emissions Avoided							
CO_2	million tonnes	0.63	0.83	1.03	1.22	1.41	5.12
N_2O	tonnes	12.6	16.5	20.5	24.5	28.5	102.6
SO_2	tonnes	7036	9234	11439	13662	15885	57256
TSP	tonnes	888.6	1177.4	1463.9	1750.8	2037.7	7318.4
PM-10	tonnes	284.4	376.8	468.4	560.2	652.1	2341.9

8.4 Assessment of Impacts

An assessment of the long-term direct and indirect impact of the proposed program has been carried out. Table 10 summarizes environmental impact of the project based on energy use, GHG emission reduction, local air pollution and air quality.

Table 10 - Direct and Indirect Environmental Impact

Impacts	Saved Energy	Emissions Avoided			
	(PJ)	CO_2 (‘000 tonnes)	N_2O (tonnes)	SO2 (tonnes)	TSP (tonnes)
Direct	387	36759	749	418231	53709
Indirect	35	3050	50	1209	6930
Total per annum	422	39809	799	419440	60637

The reduction in Total Suspended Particulate (TSP) emissions envisaged is associated with corresponding reduction of PM 10 emissions as the latter makes up around 30-35% of TSP. This TSP reduction at average annual production rate of SRRM sector translates to reduction in dust concentration between 0.2 and 0.5 micro-gm/m3 in various geographical clusters. Although the amount is little but keeping in view that these regions are relatively thickly populated (~ 0.25 million inhabitants and higher), the benefits on account of reduced soiling (roughly 1.0 $ / person / micro gm-TSP); reduced morbidity, asthmatic cases, (roughly 3.5 $/person/micro gm-PM10), etc. The corresponding local environmental benefit is estimated at US$ 1.3 million.

Although SO_2 and NOx emissions have transboundary character as they are airborne over long distances, but for this project their environmental impacts are restricted to national boundaries. Energy saving achieved through adoption of 5 technology packages by SRRM sector has been estimated to be 31.5% lower than the baseline energy consumption. At an annual average production of 12.9 million tons in 20 Years (2003-2022), the project would result in lowering SO_2 emissions by 20972 tonnes/year and N_2O by 39.95 tonnes/year. The various international studies have estimated the benefits of reduction of SO_2 and NOx emissions. Sulphur emissions cause morbidity, material damage, retard tree growth and result in water pollution whereas NOx emissions mainly impact crop production and retard tree growth. On a conservative basis, these losses have been estimated as 0.56 $ per Kg. of SO_2 and 0.69 $/Kg. of NOx emitted. The project by avoiding the estimated emissions would provide annual benefit of about $ 10.5 million.

The annual benefits of the order of $ 58.2 million would accrue to the mill owners through adoption of technology packages (at $ 4.51/tonne of production). This corresponds to annual production of 12.9 million tonnes per annum. Taking into account the same level of production in baseline and GEF alternative scenario, higher productivity and reduced energy and material bills further add to the economic benefits to the industry

9. IMPLEMENTATION ARRANGEMENTS

The Ministry of Steel (MOS) will take overall responsibility for the execution and implementation of the project. It will appoint a senior official of the MOS as National Project Director (NPD), who will be responsible for the coordination and monitoring of project activities on behalf of the MOS. The Office of Development Commissioner of Iron and Steel will be the local implementing agency and a Project Management Cell (PMC) will be set up under the control of the NPD. This NPD will be assisted by the PMC in implementation of the project, which will be headed by a full-time National Project Manager or National Project Coordinator.

A Project Steering Committee (PSC) will be composed of a Secretary (Steel) as chairman and members from various cross sectoral ministries such as - DEA (Ministry of Finance), Ministry of Power, Bureau of Energy Efficiency (BEE), Ministry of Coal, Planning Commission, Ministry of Petroleum and Natural Gas, Ministry of Non Conventional Energy Sources (MNES), Ministry of Environment & Forests (MoEF), Department of Science and Technology (DST), Department of Scientific and Industrial Research (DSIR), and UNDP. The National Project Director will be the member secretary. PSC will oversee the implementation of the project and will meet at least once in six months to review progress of the project. The main functions of the PSC will be to:

- provide guidelines to the PMC for policy decisions;
- review and monitor project activities with reference to the work plan;
- ensure fulfillment of project goals and objectives in a defined time frame;
- provide co-ordination support to PMC from various Government departments and agencies.

A Project Advisory Committee (PAC) will be constituted with the NPD as the Chairman and National Project Manager or Coordinator as the Convenor. It will have members from the Ministry of Steel, technical experts from Consultancy organizations, large public and private sector steel plants, R&D institutions, Technology Development Board, Programme for Aimed at Technological Self Reliance, IREDA, SIDBI, ICICI, representatives of industry associations, and state government officials. This Committee will meet once every quarter during the tenure of the project and will constitute a formal vehicle for on-going stakeholder consultations and interaction of the project participants. In addition, PAC will ensure institutional interaction and cooperation and undertake periodic reviews and discussion of issues requiring mid-term changes/corrections during the course of implementation. The PAC will have a flexible structure and will continuously change as the project progress. Specialized Task Force Cells will be created in the PAC to ensure successful delivery of the project components.

The PMC headed by the National Project Manager or Coordinator will comprise a Chief Technical Adviser (CTA), Project Administration and Finance Manager (A&FM) and an Accountant/Disbursement Officer familiar with disbursement procedures of the donor funding agencies, accounting and internal audit will be appointed on full time basis. It will be supported by an Expert Panel consisting of international, legal, financial, and project management experts to provide necessary support in respective areas.

10. MONITORING AND EVALUATION

Monitoring of project inputs, outputs and evaluation of impact in relation to the objectives is an important element of the project design. An integrated monitoring and evaluation cell with professional staff and up-to-date communication tools will be housed in the PMC and networked with 5 geographical clusters through regional offices of DCI&S/JPC. The PMC would ensure that information is quickly accessible to stakeholders, is transparent, shared, has necessary feedback and is acted upon as necessary. A systematic and objective evaluation program comprising of mid-term, terminal and ex-post evaluations shall be carried out by a team consisting of NPC, CTA and field officers. These reports will be presented to the PAC for constant reviews of the progress made and midcourse corrections or changes, if necessary. These evaluations will generate a databank and shall form the basis of "lessons learned"-a cumulative learning tool to effectively design the project, improve management and address the problems associated with project planning and implementation.

The primary focus of the M&E program will be on measuring and documenting the direct impacts of the project in terms of concrete success indicators including the following:

- Utilization of funds as planned;
- Performance of technical packages;
- Extent of stakeholder participation;
- Replicability;
- Innovation institutional mechanisms - number of ESCOs, enterprises providing service to the sector;
- Actual investments (including equity), number of sample units and DEMs covered under the project;
- Productivity gains and energy saved in sample units covered under the project;
- GHG emissions avoided due to projects covered under the project; and
- Local pollution reduction and health impacts.

In case of sample units, output or outcome indicators would be regularly measured and monitored for each of the technology packages and would comprise of the following:

- Thermal and electrical consumption pattern as a measure of end-use energy intensity;
- Scale loss and yield improvement as a measure of material use efficiency;
- GHG emissions (CO_2) as a measure of impact on global environment;
- SO_2, N_2O and NO_x, SPM and RSPM emissions as a measure of impact on national environment.

The field managers will conduct on-site verifications. They would confirm the successful completion of EE projects financed by participating FIs/Banks and other donor agencies and certify the right application of designated funds. They will also review the Detail Project Reports prepared by project developers/consultants, baselines and estimate the energy savings and reductions in GHG emissions produced through the earmarked investments. The Technical Assistance component of the project design leading to indirect benefits, such as establishment of sustained institutional, market and ESCOs capacities and capabilities to implement EE projects, expand market for EE finance and replicate the proposed technology packages will be monitored for the desired development impacts.

Objective	**Indicator**
Reduction in CO_2 emission	Aggregate energy consumption pattern in a zone/cluster, number of units adopting technology packages, Reduction in CO_2 emission (CO_2 emissions will be measured regularly but full impact will be observed after two years of implementation, when sample units are expected to achieve 80% capacity operation)
Replication of technology packages	The level of penetration of technology packages would be expressed as a ratio of GEF capacity in operation to total capacity in operation in a particular zone/cluster.
Information Dissemination, energy and investment studies, prototype technology testing and development, problem diagnosis and solution design and spread of best practice program	Half-yearly progress reports of technology information resource and facilitation center

A four-level (project inputs, outputs, effects and impact) MIS will be set up with two types of indicators given as above. Empirical progress of each of the five technological developments in SRRM sector will be quantitatively measured by 'Progress Ratio'[11] over various ranges of their production/market volumes. This would serve the objective to determine the replication potential of each of the technologies deployed in the sector and to develop future strategies.

Based on the criteria given above, PMC with in-country partner, UNDP and IA will prepare a comprehensive M&E plan at outset of the project. This will form an M&E manual by clearly defining the activities and setting up credible baselines for measuring the project impacts.

[11] "Progress Ratio" is a quantitative tool, which measures the progress of any technological development on a long-term basis by plotting 'experience' curves. It relies on the assumption (from empirical studies) that cost per unit of EE equipment/technology declines exponentially with increased production of the same item. PR is defined as slope of the experience line plotted on logarithmic axis to show unit cost versus cumulative production, as the percentage of cost remaining after each doubling in production volume.

LIST OF ANNEXES