Energy-efficient technologies driving India's secondary steel production

0 to 34 to 321...

Australian Aid

Ministry of Steel
Government of India

UNDP
Empowered lives.
Resilient nations.

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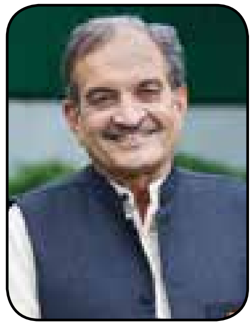

Birender Singh
Minister of Steel
Government of India

I am glad to note the remarkable progress made in the Second Phase of the project, "Upscaling energy efficient production in small scale steel industry in India", being implemented by Ministry of Steel.

The secondary steel sector in the country contributes over 50% of finished steel products, and therefore plays a major role in the development of the country. Adoption of energy efficient technologies in this sector is essential for fulfilment of Intended Nationally Determined Contributions (INDCs) submitted by Ministry of Steel. As we know, India has committed to reduce greenhouse gas (GHG) emissions per unit of Gross Domestic Product (GDP) by 33–35% by 2030 from the 2005 level.

I am told that over 350 secondary steel units volunteered to participate in the project. Maximum energy savings and reduction in emission in certain units have been upto the level of 24–25%, which is commendable. It is indeed appreciable that efforts in reducing energy consumption and GHG emissions have been impressive in both phases of the project.

I congratulate UNDP and Australian Department of Foreign Affairs and Trade, Consultants, Ministry of Steel, Secondary Steel Units and the entire Project Team for successfully implementing this project.

(Birender Singh)

MESSAGE

Aruna Sharma
Secretary, Ministry of Steel
Government of India

India is poised to shortly become the second largest steel producing country in the world soon, after China. Steel production in India has been growing at 8.4% per annum for the past 20 years, higher than the global growth rate of about 6% per annum.

Out of the total steel production in the country of about 90 million tonnes in 2014/15, the secondary steel sector contributes about 50%. As a whole, the steel sector accounts for about 2% of the country's gross domestic product (GDP) and generates employment for about 6 lakh people. In tune with India's rapid economic growth year on year, the country is likely to reach a production capacity of 300 million tonnes per year by 2030 or even earlier with a significant portion coming from small steel producers. The Government is keen to ensure that steel production by small steel producers is not only competitive, but also clean and green.

The Ministry of Steel had initiated a nation-wide project in this direction in the year 2004, with the support of the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF) to enable the same. The decade-long Steel Project (2004–2013) not only identified the barriers plaguing the steel re-rolling mill (SRRM) sector but also transformed 34 model SRRM units through energy-efficient technologies (EETs), generating awareness among mill owners, building capacities of workers and foremen, and through financial incentives/subsidies. The result from the post-implementation studies carried out in the model units revealed a 30% savings in specific energy consumption with the accompanying benefit of reduction in greenhouse gas (GHG) emissions!

Encouraged by these results, the Ministry embarked on a second phase with a more ambitious target: 300 model units in 30 months (2013–2015). The Ministry of Steel gratefully acknowledges the technical support provided by

UNDP and the Australian Department of Foreign Affairs and Trade (DFAT) in this 'Steel Upscaling Project'.

The highlight of the Steel Upscaling Project is the overwhelming participation from secondary steel unit owners from across the country. I am happy to note that the set target has been achieved by my colleagues in the Ministry and the Project Team. The energy savings reported so far ranges from 5% to 25% depending on the investment made and the technology employed by the units. It is also significant that the mill owners of the model units of both phases of the project put together have invested about 42.7 million USD in various EETs. That shows the scale of efforts the mill owners in India have been willing to put in to achieve energy efficiency. We also look forward to the industry mainstreaming energy efficiency in their procurement and production processes as well.

The Steel Project assumes even more significance from the point of view of India's commitment to the global community (Paris Agreement at 21st Conference of the Parties [COP21]) on reducing GHG emissions. As per the Intended Nationally Determined Contributions (INDCs) submitted by the Ministry of Steel, the average carbon dioxide (CO_2) emission intensity is projected to reduce from 3.1 T/tcs (tonnes/tonnes of crude steel) in 2005 to 2.4 T/tcs by 2030. I am confident that the efforts made through the Steel Project would help us get closer to fulfilling our global commitment.

This publication documents the journey of the Steel Upscaling Project in detail. I hope this publication would encourage more secondary steel unit owners to take the 'energy-efficiency' path demonstrated by over 300 model units. I thank the stakeholders of this project for making it a success.

(Aruna Sharma)

MESSAGE

Yuri Afanasiev
United Nations Resident Coordinator and
UNDP Resident Representative in India

In 2015, world leaders came together at the Conference of Parties (COP21) in Paris to agree on a historic agreement to address climate change. While use of energy produced from fossil fuels cannot be completely eliminated from the world, there is realisation that much can be done by using cleaner technologies.

UNDP is committed to promoting low carbon, climate-resilient technologies and inclusive development. The Indian steel sector is unique with a large number of small-scale steel producers, contributing to nearly 50% of India's steel production. These small-scale steel producers were using obsolete technologies resulting in inefficient use of energy, poor productivity, causing significant local pollution and global emissions. This sector did not have the wherewithal to address the issues concerning them. UNDP and the Ministry of Steel (MoS) identified energy efficiency as an entry point to address these barriers.

The interventions in phase 1 demonstrated significant reduction in energy consumption in 34 steel units. The payback on investments was just about 12 months. The interventions not only resulted in innovative methods to produce steel, but also inculcated the habit of innovation among these small-scale producers. It took over 100 months to roll out technology packages and convince potential steel mills to adopt energy efficiency measures.

Building on results from phase 1, UNDP and MoS took up scaling-up efforts and aimed to make interventions in 300 small-scale steel mills with financial assistance from Australian Department of Foreign Affairs and Trade (DFAT).

The publication, '*Energy-efficient technologies driving India's secondary steel production: 0 to 34 to 321...*', documents how the programme was rolled out to fast-track the implementation of energy efficiency measures in 300 steel units in just 30 months. The response from all stakeholders was encouraging.

The sector has further great potential to expand energy efficiency interventions to those units that are yet to adopt energy efficiency measures. In addition, there is scope to add on more energy efficiency measures in the units, which have already adopted the first set of energy efficiency measures. The sector has about 3500 small-scale steel units and has potential for an investment of half a billion dollars on energy efficiency. The units can reduce 30% of the energy cost, which can help them become more competitive. The sector can produce greener steel and has prospects to reduce over three and a half million tonnes of carbon dioxide annually.

UNDP values the collaboration with MoS in demonstrating and paving the way for scaling up energy efficiency as driver to reduce GHG emissions impacting the globe. UNDP also acknowledges the funding support from Global Environment Facility and Australian Department of Foreign Affairs and Trade (DFAT) for extending funding support. UNDP values the leadership shown by the steel units that have already adopted energy efficiency measures. UNDP stands by to support further action in accelerating energy efficiency in this sector, which has triple wins: (a) the interventions are economically remunerative to steel units, (b) saves exhaustible energy and local pollution at the national level, and (c) reduces GHG emissions thus helping the global agenda of reducing the impacts of climate change.

MESSAGE

Ryan Thew
First Secretary
Australian High Commission

Responding to the challenge of climate change is one of the key issues facing the world today and incremental action to improve the existing situation will go a long way in negating the damaging effects.

Improved industrial energy efficiency such as in India's steel sector provides one such opportunity. The Indian steel industry annually produces about 100 million tonnes of steel, with more than half of this produced by India's secondary steel sector. This includes about 3500 small and medium steel re-rolling mills (SRRMs), which have traditionally had little incentive to become more energy efficient.

The initial phase of the Steel Project (2004–2013) – 'Removal of Barriers to Energy Efficiency Improvement in the Steel Re-Rolling Mill Sector in India' – improved energy efficiency in over 30 model SRRM units, with gains in energy efficiency of over 30% of specific energy consumption.

The Australian Government is pleased to have been associated with the second phase of the project titled, 'Upscaling energy efficient production in small scale steel industry in India' which expanded the project to reaching about 350 SRRM units and introduced new technology packages in the electrical induction furnace sub-sector. As this project comes to a close, we welcome indications that energy savings to the tune of up to 25% have been maintained depending on the technology it employed.

Credit to the success of the programme goes not only to the project initiators – the Ministry of Steel (Government of India), United Nations Development Programme (UNDP) along with the Global Environment Facility (GEF) – but also to those steel units who willingly participated in the project and invested their own resources in new technologies.

The Australian Government is pleased to note this project will support India's efforts to address climate change concerns from the industry sector. Perhaps, more important is the outcome that uptake of many of the energy efficiency technologies (EETs) had payback periods of less than six months. I look forward to witnessing the independent uptake of EETs in India's steel sector, utilising the lessons learnt and strong positive business cases developed as a part of this project. May outcomes from this project also be used to demonstrate the strong business case for adopting industrial EETs more broadly.

Best wishes.

FOREWORD

Syedain Abbasi
Joint Chair, Project Steering Committee
Joint Secretary, Ministry of Steel
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Jaco Cilliers
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India's GDP (gross domestic product) has been growing at the rate of 5%–7% year on year over the past few years despite global slowdown. Every forecast predicts that this trend in economic growth is likely to continue and, perhaps, even gain momentum in the years to come. The steel industry in the country has been playing an important role in this growth story, with the steel production reported in 2016 touching about 100 million tonnes. Analysts predict that steel output by India would reach an estimated 300 million tonnes by 2030, which would take it to the position of the world's second largest steel producer after China. Out of the current production figure, it is remarkable that the secondary steel sector contributes about 50% of the overall finished steel production in the country. With a vision to produce 300 million tonnes of steel by 2030, the present share from the secondary steel sector is expected to increase from the present 45 million tonnes to 90 million tonnes by 2030.

The Ministry of Steel, Government of India, accords high importance to the secondary steel sector not only for its finished steel production capabilities and employment generation potential at the local level but also for its access to the interior markets of the country. At the same time, the Ministry is also aware of the immense challenges faced by over 3500 units in the secondary steel sectors to stay competitive in the market place.

When the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF) came up with a proposal to the Ministry in 2004 with funding support to tackle the issues faced by the SRRM sector, the Ministry lost no time in implementing the 'now-famous' 'MoS-UNDP-GEF Project Steel' (2004–2013). Led by the Ministry, the Steel Project was the first major intervention in the country in the SRRM sector to identify the major barriers facing the sector and to help them overcome those barriers. The major barriers identified by the Steel Project are listed below.

1. High energy consumption due to the use of obsolete technologies
2. Lack of awareness and knowledge on many fronts
3. Lack of proper operational procedures
4. A negative mind-set among owners of SRRM units
5. Lack of finance to effect necessary changes in the production system

The Project did manage to address all of the above, albeit in a smaller scale. For example, the eco-tech packages (energy-efficient, low carbon technologies) offered by the Project were implemented by the 34 model units, which helped them save over 30% of specific energy consumption. Several knowledge products were produced and disseminated to all the SRRM units in the country. A number of capacity building programmes were organised across the country to not only train the owners of the mills but also the shop-floor workers and foremen. Operational procedures were spruced up in the 34 model units with the implementation of standard operating procedures (SOPs), standard maintenance practices (SMPs), 5S, ISO, etc. As for finance, the subsidy offered by the Ministry for installing energy-efficient technologies helped the whole process move a bit faster. Once the mill owners started benefitting with the initial small changes they made as per the guidance provided by the Project Management Cell, investment almost became a non-issue to many of the mill owners as the payback period ranged from a mere 4 months to just 14 months. Another important achievement of this project was the introduction of 'Direct Rolling' technology into the sector. As for greenhouse gas emissions reduction, the Project's efforts have enabled these model units to avoid carbon emissions to the tune of 88,000 tonnes of carbon dioxide per year.

The success achieved by the 34 model units of the Steel Project motivated the Ministry to scale up the efforts made in the project in order to help more number of SRRM units. This time around, UNDP and Australian Department of Foreign Affairs and Trade came forward to scale up the initiative further. The Ministry took the leadership and began the 'Upscaling' Project with an ambitious target of reaching out to 300 secondary steel units in just about 30 months (2013–2015)! The thinking behind giving such a short duration for the Upscaling Project was that the first phase had already created enough awareness about energy-efficient technologies (EETs) and the benefits of using them.

As we wind up the Upscaling Project in December 2016, the results being reported are highly encouraging. More than 350 units had signed up for the project and many of them have reported 5%–25% savings in specific energy consumption!

Having been associated with this project right from the first phase, it gives me immense pleasure to see this positive turnaround in the secondary steel sector. The primary credit for this positive change must go to the participating units, both in the first and the second phases, as they came forward to buy the 'idea' floated by the project and making that crucial decision to invest in the idea. The important role played by the Secondary Steel Associations must be lauded as they kept pushing their members to adopt this sustainable path of production.

Overall, both phases of the project have done immense good to the secondary steel sector. However, concerns do remain for the Ministry as there are still many more out there yet to be touched by this energy-efficiency movement. Should there be a third phase to the project as being demanded by the sector? Well, we must wait and see as it depends on a lot of factors.

Last but not the least, we congratulate all the Project Team members and external consultants who had put in tireless efforts over the past two years or so to make it happen. Our sincere thanks to Australian Department of Foreign Affairs and Trade (DFAT) for its wholehearted technical and funding support.

PREFACE

At UNDP, we believe in documentation of activities of a project right from its planning stage. Most of such activities fall in the standard procedures, which are mandatory for most projects. If one reviews such documentation of any project at any given point, even beyond the project period, one can get a sense of what the project is all about, its goals, strategies adopted, its activities, minutes of various meetings, back-to-office reports, event summaries, and, of course, the various numbers that the project generated during its course. Such documentation caters to a particular audience who are very close to the project, for example, the funding agencies and other partners. In that sense, they serve a very important purpose.

Needless to say, such documentation is so objective-oriented that it normally keeps references to 'people' to a bare minimum; and rightly so.

Process documentation is a relatively new entrant in the field of development publishing. In process documentation, the inside stories of project activities from the perspectives of stakeholders get highlighted. In process stories, more than the numbers, the process adopted by the project to attain its goals is given more importance. Therefore, substantial part of such documents would focus on the implementation part of projects. For example, how the project was implemented, how difficult it was, how the challenges were overcome, and so on. All these will have 'people' involved in the project talking about it. The readership of such process-oriented publications ranges from policy makers to researchers to development practitioners, to even existing and potential funding agencies.

In the Steel Project, we published a process document in 2012 when the first phase was almost getting over. The feedback we received from various quarters was quite positive and overwhelming. We strongly believe the publication did play a proactive role among secondary steel mill owners in the country when the second phase of the project – Steel Upscaling Project – was rolled out towards the end of 2013.

This publication – *Energy-efficient technologies driving India's secondary steel production: 0 to 34 to 321...* – is a sequel to the first one. It captures the essence of how the Steel Upscaling Project managed to increase the number of energy-efficient small-scale steel units from 34 to 321 in the country. That too, in just about 30 months and with one-fifth of grants!

For people involved in this project, we have clearly learned that there are a lot more to learn when it comes to mastering the art and science of 'scaling up'! This documentation has helped us in learning that.

We would be very satisfied with effort of producing this publication if other development practitioners also find something or other of their liking and learn from this publication.

Hope you like reading it just as much as we loved producing it.

Editors

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This publication is the result of the efforts of several organizations and individuals. We gratefully acknowledge the contributions of all of them.

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Australian Department of Foreign Affairs and Trade

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Royal Ispat Udyog, Mandi Gobindgarh

Boparai Steel Rolling Mills, Mandi Gobindgarh

Agarwal Channel Mills Pvt. Ltd, Raipur

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ABBREVIATIONS/ACRONYMS

3S	scale, speed, and skill
AISRA	All India Steel Re-rolling Association
BEE	Bureau of Energy Efficiency
BFR	Bankable Feasibility Report
BTOR	Back-to-Office Report
CBM	coal-bed methane
CCM	continuous casting machine
CII	Confederation of Indian Industry
CLA	cluster-level agency
COP	Conference of the Parties
CO_2	carbon dioxide
CV	calorific value
DESL	Development Environergy Services Ltd
DFAT	Department of Foreign Affairs and Trade
DIM	Direct Implementation Modality
DRI	direct reduced iron
EAF	electric arc furnace
EE	energy efficiency
EETs	energy-efficient technologies
E^2 Unit	energy-efficient unit
EIF	electric induction furnace
EoI	expression of interest
FI	financial institution
FICCI	Federation of Indian Chambers of Commerce and Industry
FM	Field Manager
FRP	fibre-reinforced plastic
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GoI	Government of India
HSD	high strength deformed
IF	induction furnace
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
JPC	Joint Plant Committee
kcal/kg	kilocalories per kilogram
kg/t	kilogram per tonne
kWh	kilowatt-hour
kWh/t	kilowatt-hour/tonne
M&E	monitoring and evaluation
MITCON	MITCON Consultancy and Engineering Services Ltd
MJ/t	megajoules per tonne

MoS	Ministry of Steel
MT	million tonnes
MTPA	million tonnes per annum
MWh	megawatt-hour
NISST	National Institute of Secondary Steel Technology
NITCON	North India Technical Consultancy Organisation
Nm^3/h	normal cubic metre per hour
NPC	National Productivity Council
OFP	Operational Focal Point
PAC	Project Advisory Committee
PCRA	Petroleum Conservation Research Agency
PID	proportionate integrated derivative
PLC	programmable logic control
PMC	Project Management Cell
PMU	Project Management Unit
PSC	Project Steering Committee
PSCST	Punjab State Council for Science and Technology
PwC	PricewaterhouseCoopers
RfP	Request for Proposal
RHF	re-heating furnace
SAIL	Steel Authority of India
SEC	specific energy consumption
SFC	specific fuel consumption
SI	sponge iron
SME	small and medium enterprise
SMP	standard maintenance practice
SOP	standard operating procedure
SPC	specific power consumption
SRMA	Steel Re-rolling Mills Association
SRRM	steel re-rolling mill
tCO_2	tonnes of carbon dioxide
tCO_2/t	tonnes of carbon dioxide per tonne
tpa	tonnes per annum
tph	tonnes per hour
TJ	terajoules
TMT	thermo-mechanically treated
UNDP	United Nations Development Programme
USD	United States Dollar
VFD	variable frequency drive
VSD	variable speed drive
VVVF	variable voltage variable frequency

CHAPTER 1

The Steel Industry

An overview

STEEL: BUILDING THE MODERN WORLD

Steel is used in different and varying forms practically in every sector of the economy – be it domestic, industrial, transport, or even services. When it comes to the industrial sector, sectors such as construction, energy, automotive and transportation, infrastructure, packaging, machinery, and even in renewable energy industry, steel occupies its ubiquitous position. Of these, the housing and construction sector is the largest consumer of steel today, using about 50% of steel produced. The consumption figures place the steel industry as the second biggest industry in the world after oil and gas with an estimated global turnover of 900 billion USD. By 2050, steel use is projected to increase to 1.5 times higher than present levels in order to meet the needs of a growing population.[1]

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

STEEL IN INDIA

At the time of independence, India had only two large steel plants, together producing only about 2 million tonnes of steel annually.[2] This amounted to just about one per cent of

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[1] World Steel Association. 2015. World Steel in Figures 2015. <http://www.worldsteel.org/>, accessed on 25 November 2015.

[2] Guha R. 2007. India After Gandhi – The History of the World's Largest Democracy. pp. 211. New Delhi: Macmillan.

the global steel production in 1950, which stood at 189 million tonnes.[3] By 1960, three new steel plants were commissioned – one in Bhilai, made with Russian assistance; one in Rourkela, built with German help; and one in Durgapur, this time with the help of British technicians and engineers.

In 1980, the country produced 12.6 million tonnes of crude steel.[4] However, with the opening up of the economy in 1991, the steel production in India gained considerable momentum with the production figures in 2016 touching about 100 million tonnes. With support from the Government of India through enabling policies and regulations, India is all set to produce about 300 million tonnes by 2030. This will position India as the second largest steel producer in the world after China.

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

What is to be understood about the Indian steel story is existence of vibrant and thriving secondary steel sector, which comprises privately owned small- and medium-sized steel re-rolling mills (SRRMs). By contributing close to about 45 million tonnes of steel in 2016, and with a potential to touch 90 million tonnes by 2030, secondary steel sector hold the key to India attaining its ambitious target of producing 300 million tonnes by 2030. Therefore, it is extremely important to track the performance of this sub-sector, which comprises over 1800 units scattered all over the country. The following section gives a brief account of steel re-rolling and the SRRM sector in the country.

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3 US Geological Survey. Iron & Steel Statistics <minerals.usgs.gov/ds/2005/140/ironsteel.pdf>, accessed on 20 September 2012.

4 Bowonder B and Miyake T. 1988.Measurement of technology at industry level: a case study of the steel industry in India and Japan.Science and Public Policy 15(4): 249–269. <spp.oxfordjournals.org/content/15/4/249.full.pdf>, accessed on 20 September 2012.

THE STEEL RE-ROLLING MILL SECTOR

Steel re-rolling is the process of converting raw/unprocessed steel into finished steel products by rolling and re-rolling them in their hot state into desired shapes such as bars, thermo-mechanically treated (TMT) rods, and wires (Figures 1 and 2). A bulk of these finished products finds application in the construction sector.

Today, depending on the kind of technology used, SRRMs can be classified into 'bar mills' or 'structural rolling mills'. While bar mills exclusively produce high strength deformed (HSD) bars, structural rolling mills are equipped to produce flats, angles, and other structural steel products.

Figure 1 *Steel being rolled into a TMT bar in a re-rolling mill*

Figure 2 A finished steel product commonly used in construction activities

The production process in a typical SRRM unit begins with hot charging of raw materials, scrap or ingots or billets or blooms in an oil-, coal- or gas-fired re-heating furnace. Once the raw material achieves the desired temperature, it is manually or automatically pushed out into the rolling floor, where iron rollers (also called drums) are used to squeeze and stretch them into finished steel products.[5]

THE SRRM SECTOR IN INDIA

As mentioned earlier, the secondary steel sector comprises over 1800 SRRM units spread across the country. They are usually found in clusters, with each cluster having about 50 to 400 units closely located. Collectively, these units today produce a whopping 45 million tonnes of finished steel products, which is close to 50% of what India produces in a year (2015). It has also

[5] UNDP. 2013. *Energy Efficient Steel Re-rolling: How a pioneering project is transforming the Indian secondary steel sector*. Edited by S N Srinivas, A C R Das, and Srinivasan Iyer. New Delhi: United Nations Development Programme.

been estimated that the sector employs, directly and indirectly, about 400,000 people. These employees are a mix of skilled engineers, semi-skilled foremen and technicians, and unskilled shop-floor workers.

While the strong performance of the SRRM sector has undoubtedly added muscle to India's steel sector, the issues and challenges the sector faces have also kept on increasing over the years. Some of the general, but fundamental ones are listed below.

- Being family-run units, most of them lack a cohesive and forward-looking corporate vision.
- They struggle with obsolete and inefficient technologies/processes due to lack of awareness and motivation to upgrade and innovate for greater productivity and profitability.
- The mill owners' mindset of reluctance to change their approach to newer ways of production and lack of confidence in new solutions/vendors.

The above-mentioned issues have gradually led them to practise unsustainable means of producing steel. Over a period of time, the high levels of energy consumption and the resulting pollution have started showing telling effects on their daily production targets, machine downtimes, competitiveness in the price-sensitive market, and so on. It was evident that the SRRM sector was struggling to cope with the current market conditions and was badly in need of help and technical assistance to come out of the issues plaguing them.

The next chapter would discuss in detail the first ever major intervention made by the Government of India through the Ministry of Steel, the United Nations Development Programme, and the Global Environment Facility.

CHAPTER 2

The Steel Project

A breakthrough initiative

1 2 3 4 5 6 7

INTRODUCTION

In this chapter, an attempt has been made to summarise the first phase of the project so as to keep the contents of this book in perspective. It is also an attempt to emphasise the point that developmental projects are to be seen from a historical perspective and not to be seen in isolation. For example, the pace of 'change' was rather slow in the first phase of the Steel Project as reflected in the 34 model SRRM units. But, it was 10 times quicker in the 'second phase' of the Project! Therefore, while appreciating the second phase, one must keep in mind the roads cleared by the first phase for the second phase to succeed.

In addition, an attempt has also been made to keep this publication as independent as possible from the first publication, *Energy-Efficient Steel Re-Rolling: How a pioneering project is transforming the Indian secondary steel sector*,[1] brought out in 2013. With a brief introduction to the SRRM sector that prevailed around the year 2004, this chapter will move on to describe briefly the first phase of the Steel Project.

THE SRRM SECTOR IN INDIA: A BRIEF INTRODUCTION

Modern steel re-rolling in India began with the establishment of a small SRRM unit in the industrial town of Kanpur (Uttar Pradesh) in 1928.[2] Since then, in a span of about seven decades, several units had sprung up across the country giving them the shape of an industry. By 1996, the SRRM sector was seen to be contributing about 50% of the country's total finished steel output.[3] In other words, more than half of the steel products used in the country came not from the giant integrated steel mills but from the secondary steel sector.

[1] The publication titled, *Energy-Efficient Steel Re-Rolling: How a pioneering project is transforming the Indian secondary steel sector,* is freely available on UNDP India website.
[2] Steel Re-Rolling Mills Association of India Retrospect <http://www.srma.co.in/retrosspect.html>.
[3] Ibid.

By 2012/13, there were about 1800 working SRRM units in India, scattered across the country and producing 28 million tonnes of steel. In percentage terms, this figure worked out to about 68% of the total production of non-flat steel products in the country. The sector assumed significance not only for its contribution to the total steel production in the country, but also for the fact that the sector gave employment to about 400,000 people, directly and indirectly.

It is important to mention the geographical spread of these SRRM units in the country. They are generally found in clusters nearer to the location of giant integrated steel plants. This is because the primary source of raw material (crude steel) comes from these steel plants.

ABOUT THE STEEL PROJECT

A unique characteristic of the SRRM sector in the country is that most of them are family-run units, handed down from one generation to the next. In most cases, the *status quo* of production methodologies and processes continued for several years without questioning the efficacy of those technologies and processes in operation. This scenario led them to the stage of struggling with obsolete technologies and methods of production.

Post 1991, a time when Indian economy was thrown open to globalisation, their situation started worsening further as they had to now face tough competition for market shares from various quarters. All these were symptomatic of a lack of corporate vision, inefficient technologies and processes, and lack of awareness and motivation to upgrade and innovate for greater productivity and profitability.

Lack of technical and managerial capacity to run new technologies and processes only added to the problem. Further, the SRRM sector was heavily dependent on furnace oil, coal, or natural gas for its direct energy needs. This dependence substantially increased their production costs by a quarter. To compound the issue, fossil fuel use also increased their emission load. Being in the 'red' zone meant fresh investments into the sector were hard to come by. Overall, the SRRM sector was going through a vicious cycle of obstacles that were seriously denting India's steel output.

It was at this juncture that the Ministry of Steel (MoS), United Nations Development Programme (UNDP), and Global Evnironment Facility (GEF) decided to team up and help lift the SRRM sector up. As a first step in the process, this MoS–UNDP–GEF team designed a project to study the root causes of the downward trend seen in the sector and find remedial measures. The project titled, '**Removal of Barriers to Energy Efficiency Improvements in the Steel Re-Rolling Mill Sector in India**' or the 'Steel Project', in short, was perhaps the starting point of the 'energy-efficiency revolution' being witnessed today in the SRRM sector. In fact, this decade-long project (2004–2013) acted as the much-needed 'change agent' that the SRRM sector was badly looking for.

As for funding for this project, the MoS contributed 7.2 million USD by way of financial incentives to be directly paid to SRRM units and the GEF chipped in with 6.7 million USD for providing technical assistance to the 'willing' model units. Being a GEF implementing agency, UNDP was primarily responsible for implementing the technical assistance component of the project.

The Steel Project: Institutional set-up

With its focus on improving energy efficiency in the sector, as a first step, the Steel Project set in place an institutional structure to deal with the challenges ahead and for the smooth functioning of the project. At the apex was the Project Steering Committee (PSC), headed by the Secretary, Ministry of Steel. The primary role of this committee was to give policy direction to the project. The committee had representation from Ministry of Finance; Ministry of Power; Ministry of Coal; the then Planning Commission; Ministry of Petroleum and Natural Gas; Ministry of New and Renewable Energy; Ministry of Environment, Forests, and Climate Change; Department of Science and Technology; Department of Scientific and Industrial Research; GEF Operational Focal Point (OFP); All India Steel Re-rolling Association (AISRA); Steel Re-Rolling Mills Association (SRMA); and UNDP India.

Next in line in the implementation set-up was the Project Advisory Committee (PAC). Chaired by the National Project Director, the PAC's role was to oversee the implementation agenda of the project. Along with the National Project Coordinator, the PAC comprised experts from large steel plants, consulting firms, government officials, and development banks such as the Indian Renewable Energy Development Agency and the Small Industries Development Bank of India.

Together, the PSC and the PAC took care of the supervisory and administrative needs of the project. However, it was the Project Management Cell (PMC) that actually implemented the project. The PMC was adequately staffed with technical experts in different disciplines in addition to others to look after other routine functions such as projects and contracts, administration and finance, and human resource development. The PMC also had the freedom to hire additional experts as and when it needed.

To support PMC and propel the project forward at the ground level, the three Resident Missions – the National Institute of Secondary Steel Technology (NISST), the Petroleum

Conservation Research Agency (PCRA), and MITCON Consultancy and Engineering Services Ltd (MITCON) – were appointed. NISST undertook bulk of the tasks by taking care of four clusters –North I cluster (Punjab, Jammu and Kashmir, and Himachal Pradesh), Central cluster (Chhattisgarh, Madhya Pradesh, and Maharashtra [only Nagpur]), East cluster (West Bengal, Bihar, Odisha, and Jharkhand), and South cluster (Tamil Nadu, Kerala, Karnataka, and Andhra Pradesh). The PCRA was responsible for North II cluster, comprising the states of Delhi, Rajasthan, Uttar Pradesh, and Uttaranchal. The West cluster that comprised Gujarat, Maharashtra (except Nagpur), Goa, Daman, and Diu was under the supervision of MITCON.

Barriers and Solutions

Barriers

The prime barriers identified through various studies and other means to sustainable and efficient methods of production are listed below.

- Outdated technologies and practices
- Low information and awareness levels on the developments in the sector
- Inappropriateness of generic energy-efficient technologies (EETs) developed
- Lack of incentives to cater to small-scale energy efficiency projects
- Lack of experience in accessing external funds
- High investment costs of EETs
- Low research and engineering base and other institutional linkages
- Ill-equipped technical staff at the middle level and shop floor
- Lack of vision on the part of mill owners
- Resistance to 'change'

After having identified the main barriers, the Steel Project identified a set of solutions by way of EETs and technical training programmes that could effectively change the way steel is produced in SRRMs. However, to the dismay of the project proponents, the project found it hard to implement the solutions in the SRRM units due to various reasons. Some of the main ones are listed below.

- Lack of trust among SRRM owners towards the very intention of Steel Project.
- Baseline data was inadequate to start the implementation as unit owners never opened out with financial and operational data to the officers of the Steel Project.
- For about three to four years since the project began, not many units came forward as 'model units' for implementing the solutions developed by the project.
- From among the units that came forward, many retreated during the course of implementation.

Due to the 'trust deficit' and other reasons identified above, the going was tough for the Steel Project in the initial years to the extent that there was even talk of shelving the project altogether! The documentation in these years revealed that no unit came forward to sign up for the 'model unit' initiative of the project!

For the way the project turned around in the remaining years of the project period, a lot of credit goes to the 'never-say-die' attitude and spirit of project leaders at UNDP and some senior officers of the MoS. They persisted with their efforts by inviting the SRRM owners to various regional conferences, national seminars, and local-level workshops organised by the project to disseminate information and raise awareness on the issues at hand. This constant cajoling and coaxing over the years finally started yielding results with over 67 units signing up for the project, though rather reluctantly. It is a different matter that about half of them backed out midway through. The fact that 34 units stayed through the full course of the project period was good enough for the project team to work harder and prove the point. These champion units stayed true to being the 'model' units by implementing the EET solutions in their units offered by the project team.

Before coming to the benefits accrued to the model units, it is worthwhile to look at the technological solutions developed by the project, known as 'Eco-Tech' options, and a variety of training programmes organised by the project team targeting not only the unit owners but also the foremen and shop-floor workers.

Solutions

What all constituted as 'solutions' that helped these 34 model units to not only conserve energy but also generate profits? From the project's perspective, primarily there are four areas that played up as solutions.

1. A data-driven approach adopted by the project.
2. The 'Eco-Tech' options identified by the project and the ones customised for each independent SRRM model unit.
3. Customised training programmes not only on the technologies identified and implemented at the model units but also on the 'best practices', including modern management techniques.
4. Removal of financial barriers

The data-driven approach included collection of a set of baseline data (before the implementation of the project), collection of interim data to help fine-tune the technologies and processes midway, and the final data post-implementation.

As for eco-tech options,[4] the team developed low-cost technology options. Successful demonstration of low-cost EET packages helped the project team to gain the confidence of the mill owners. Subsequently, high-end technology packages were also developed, for which the mill owners willingly agreed to foot the bill as they saw large-scale benefits of implementing them. In all, 11 technology packages and options were developed for re-heating furnaces to reduce thermal energy consumption. These were supplemented by 19 eco-tech options for the rolling process to reduce electrical energy consumption.

Information and awareness generation campaigns and customised capacity building programmes undertaken by the project were the two main contributing factors that delivered the desired results in the end.

About 150 technical training and awareness generation programmes were organised by the Project Management Cell. These included national workshops, training on ISO 9001 and 14001, roll pass design workshops, training on conducting electrical energy audits, performance improvement training, training on standard operating practices and maintenance practices, training on 5S implementation, etc. Put together, about 3000 personnel from the SRRM sector benefitted directly from these training and awareness generation initiatives.

To aid this initiative was the development and dissemination of several knowledge products in the form of training manuals. Published in both English and Hindi, these products were developed with the help of the Management Training Institute of the Steel Authority of India Ltd. Some of the manuals are as

[4] For more details on these eco-tech options and their payback period, please refer the publication *Energy-Efficient Re-Rolling: How a pioneering project transformed the Indian secondary steel sector*, published by UNDP, India. The publication is available on the UNDP India website.

follows: (a) furnace basics and furnace advanced, (b) rolling mill basics and rolling mill advanced, (c) statistical process control, (d) financing basics, (e) energy basics, (f) electrical basics, (g) automation basics, (h) fuel storage and handling system, (i) safety and fire-fighting, (j) ISO 14001 and ISO 9000/IS references, (k) management information system, (l) operation management/ supply chain management, etc. About 70,000 copies of these publications were disseminated across SRRMs in the country.

To motivate mill owners to invest in EETs, the project launched a capital subsidy scheme. In this scheme, each model unit was eligible for a direct 25% capital subsidy upon achieving a minimum of 10% reduction in specific energy consumption (SEC) and specific CO_2 emissions. Depending on the investment made, the capital subsidy offered ranged between Rs 30 lakh maximum (for low-end eco-tech packages) and Rs 75 lakh maximum (for high-end eco-tech packages). This scheme, in fact, opened the doors to eco-tech in the model SRRM units.

Apart from subsidy schemes, the project also helped the 'reluctant' mill owners by reimbursing the consultancy fees (up to a maximum of Rs 500,000) they paid to external experts. Several bankable feasibility reports (BFRs) were also prepared by the project in an attempt to bridge the knowledge gap in financial institutions, realising that they do not possess the technical capacity to evaluate the feasibility of energy-efficiency projects in SRRM units.

Results and Impact

To state upfront, there were three technological breakthrough achievements:

1. The first-ever introduction of 'Direct Rolling' technology in the country, which has the potential to completely transform the way steel is produced in SRRM units in the country in the years to come.

2. Successful demonstration of a biomass-based SRRM unit in Puducherry.
3. Successful demonstration of coal-bed methane as an energy source in SRRM units for the first time.

On the energy and environment fronts, the following are seen as major achievements:

- The savings in specific energy consumption (SEC) in the 34 model units hovered around 36%.
- The total energy saved is 787 TJ (terajoules) per year.
- In terms of oil, the saving is 18,794 toe (tonnes of oil equivalent) per year.
- In terms of coal, the saving is 27,558 tonnes per year.
- In terms of electricity, the saving is 21,101 MWh (megawatt-hour) per year.
- The average specific fuel consumption (SFC) saving of 50% in coal-based producer-gas-based furnaces.
- In biomass-based producer-gas-based furnaces, the average SFC saving stood at 10%–15%.
- In the units that switched to direct rolling, the SFC saving was 100%.
- The units that used pulverized coal as fuel, the SFC saving was in the range of 30%–50%.
- In the units that used energy-efficient furnaces with natural gas as fuel, the SFC saving was in the range of 20%–30%.
- The specific power consumption (SPC) in the model units got reduced by 18%–30%.
- The total reduction in greenhouse gas (GHG) emissions from the 34 model units stands at 88,400 tCO_2 (tonnes of carbon dioxide) a year.

On the cost and financial fronts, the major achievements are as follows:

- For investments between Rs 7 lakh and Rs 6 crore on various EET packages, the payback period ranged from just 6 months to a maximum of mere 18 months.

- The savings in energy cost accrued to the model units stand at over Rs 50 crore a year.
- The cumulative investment made by mill owners in EETs is huge when compared to what they received as subsidies/incentives.

On the awareness generation front, the national seminars and workshops have sensitised almost all players in the SRRM sector to issues of energy and environment as well as use of EETs. The training programmes have helped develop capacities at the local and the national levels to deal with a host of technical issues faced by SRRM units. The publications developed as part of this exercise such as training manuals, case studies, process document, etc. as well as the audio-visuals helped sustain the momentum of the drive towards energy efficiency in the sector.

As for impact, the Replication Study carried out by SAIL under this project revealed that once the benefits of energy efficiency became clearer to the mill owners, the issue of funds for EETs did not matter much for a number of mill owners. The proof for this was that 166 SRRM units had implemented EET packages through their own initiatives without actually waiting for the project to reach out to them. This was a clear indication that there existed a large potential for investments in EETs in the SRRM sector as a whole.

It is also a matter of pride for the project that some of the model units got awarded by their states for their efforts towards energy conservation.

CONCLUSION

The hundred and twenty months (120) of steady interventions by the Steel Project did manage to change the negative perception that surrounded usual energy efficiency initiatives. The SRRM sector has today been made aware of the manifold

Model SRRM unit owners – the leaders of energy efficiency in the SRRM sector – being felicitated during the launch of the second phase of the Steel Project at New Delhi, 25 November 2013.

benefits of EETs, especially with the model units benefitting from them hugely. The project's activities have lowered many barriers inhibiting access to EETs by the sector, most notably the technology and capacity barriers. It has also busted many myths in the SRRM sector about the costs of energy efficiency and its monetary benefits. The Replication Study reiterates the fact that there is enough scope for more such interventions in the sector.

CHAPTER 3

The Steel Upscaling Project

1 2 3 4 5 6 7

INTRODUCTION

It was sometime during the concluding phase of the Steel Project that the idea of taking the beneficial aspects of the project to a wider group of SRRMs started doing the rounds. The thought process in the Ministry of Steel (MoS) and the United Nations Development Programme (UNDP) towards setting up a second phase gained further strength because of the strong results posted by the Steel Project. The main project achievements have been briefly covered in the previous chapter. In addition, there were demands from the steel re-rolling mill associations and SRRM owners for continuation of the project.

Therefore, from the larger perspective, it was essential to continue the good work carried out in the Steel Project (called the first phase hereafter) and expand it to more number of SRRM units in the country to have more meaningful impact. And that too, sooner enough!

Having been convinced about the need to go in for a second phase, decision-making for MoS and UNDP to proceed with the second phase was a relatively easy one, but it was one that took into consideration some assumptions in a positive manner. A few of such assumptions are listed below.

- The training programmes, awareness generation workshops/conferences, and specific capacity building initiatives undertaken by the first phase have laid a solid foundation for a smoother implementation of a second phase.
- The capacity developed in the sector by way of training over 3000 individuals in the SRRM sector across the country would help in the scale-up initiative planned for the second phase.
- Having demonstrated EETs successfully in the first phase with stunning results to showcase, it would not be a difficult task to get more units to participate in the second phase.

- The EETs that worked for the 34 model units would work for those SRRM units that enroll themselves in the second phase.
- The new SRRM unit owners would have a fairly open mind to allow the project team to inspect, investigate, measure, and analyse the data coming from their respective units.
- The enrolled units would not mind making investments in the EETs promoted by the project, without expecting much of capital subsidy from the project.
- The 'critical mass' of human resources who worked in the Project Management Cell of the first phase would be available in the second phase also.
- If the first phase has generated an estimated investment of 7.4 million USD in EETs by the private sector against the project funding of about 10 million USD (GEF 6.7 million USD towards technical assistance, MoS 3.3 million USD towards capital subsidy and others), the second phase would trigger much more investments from the private sector.

These fairly 'reasonable' assumptions were surely the confidence boosters for MoS and UNDP. However, for designing a second phase, a few critical aspects had to be settled. Some of these aspects considered by MoS and UNDP are listed below in the form of questions.

- What should be the target number of SRRM units to be enrolled in the second phase of the project?
- What should be the duration of the second phase?
- Besides scaling up the initiatives taken in the first phase to a larger number of SRRM units, should the second phase also target some of the sub-sectors of the SRRM industry for added benefits? If so, which one?
- What should be the amount to be set aside for the capital subsidy/financial incentive scheme in the second phase?

A few rounds of discussions and deliberations in the meetings of the Project Steering Committee and both within MoS and UNDP settled most of the issues cited above. In addition, consultations were held with steel mill associations and other stakeholders too. The results of such meetings eventually gave a final shape to the design of the second phase of the project, which was titled, '**Upscaling energy efficient production in small scale steel industry in India**'.

LAUNCH OF THE SECOND PHASE: THE STEEL UPSCALING PROJECT

The second phase of the Steel Project titled 'Upscaling energy efficient production in small scale steel industry in India' was eventually launched on 25 November 2013. The timing of the launch was significant as it was precisely back-to-back to the end of the first phase. There was absolutely no time lag between the end of the first phase and the beginning of the second phase! That speaks volumes about the strong commitment of MoS and UNDP towards bringing energy efficiency in the SRRM sector of the country.

Dignitaries at the launch of the Upscaling Project
(Left to Right: Mr Bernard Philip, the then Deputy High Commissioner, Australian Department of Foreign Affairs and Trade [DFAT]; Ms Lise Grande, the then UN Resident Coordinator and UNDP Resident Representative; Mr G Mohan Kumar, the then Secretary, Ministry of Steel [MoS]; Mr Syedain Abbasi, Joint Secretary[JS], MoS; Mr U P Singh, the then JS, MoS; and Mr A C R Das, Former Industrial Advisor, MoS)

Mr G Mohan Kumar, the then Secretary, Ministry of Steel, Government of India

In the launch workshop, several SRRM owners and mill association representatives were in attendance. The presence of senior officials from the Government of India such as Secretary, MoS, and Joint Secretary, MoS; UN Resident Coordinator and UNDP Resident Representative; and First Secretary, Australian Department of Foreign Affairs and Trade (DFAT) added more credibility to the second phase. During the event, the owners

Ms Lise Grande, the then UN Resident Coordinator and UNDP Resident Representative of all 34 model units who participated in the first phase were felicitated as a token of appreciation by the Government of India in recognition of their commitment and achievements towards energy efficiency.

Mr Syedain Abbasi, Joint Secretary, Ministry of Steel, Government of India

Mr U P Singh, the then Joint Secretary, Ministry of Steel, Government of India

Mr Bernard Philip, the then Deputy High Commissioner, Australian Department of Foreign Affairs and Trade (DFAT), India

Mr A C R Das, Former Industrial Advisor, Ministry of Steel, Government of India

Ms Alexandra Solovieva,
the then DCD (Programmes), UNDP

Dr S N Srinivas,
Programme Analyst, UNDP

A stakeholder raising a query on the Upscaling Project

Objectives and Targets

The broad objective of this 'Steel Upscaling Project', as it is commonly referred to, was to scale up adoption of EETs in the small-scale steel industry in India. As in the first phase, the Steel Upscaling Project also focused on bringing down end-use energy consumption levels, improving productivity and cost-competitiveness, as well as reducing associated emissions of greenhouse gases (GHGs) and related pollutant levels.

The project targets were kept quite steep compared to the first phase based on the assumptions made earlier. This project had a target of penetrating into about **300 small-scale steel units**, including SRRM units, with appropriate EET options, customised solutions, knowledge support, and financial assistance. Here, it is important to note that that 'Steel Upscaling Project' has endeavoured to cover **electric induction furnaces** and introduce **second generation technologies in rolling mills**, besides the SRRM units.

More challenging was the project completion deadline of **30 months** from the launch date. To make matters further complicated and challenging, the financial outlay sanctioned for the project was a mere **4.37 million USD**. The breakdown of this amount is as follows: 2 million USD from MoS towards providing *financial incentives* to secondary steel units for adoption of EETs; 0.67 million USD from Australian Department of Foreign Affairs and Trade (DFAT), 0.95 million USD from UNDP, and an additional fund of 0.75 million USD towards providing technical assistance to the unit owners.

To sum it up, with one-third of the grant money and one-fifth of the time allocated, the Steel Upscaling Project was handed a target that is 10 times more as compared to the MoS–UNDP–GEF Steel Project (the first pilot phase)!

As the implementing agency for this project, UNDP found these challenges overwhelming; at the same time, the steep targets did not deter the spirit and enthusiasm of the project implementing team. The excellent rapport between the officials of MoS and those of UNDP as well as the partnership between these two institutions, which stood the test of time during the decade-long first phase, undoubtedly acted as a strong support system. And, Australian Department of Foreign Affairs and Trade (DFAT) chipped in with timely monetary support towards technical assistance to complete the partnership circle.

Backed by this strong partnership, the project team moved ahead with the following objectives:

- Implement EETs in 300 SRRM units in the country, i.e. upscale EET interventions from 34 units to 300 units.
- Initiate and pilot EE interventions in other sub-sectors of steel such as the induction furnace units.
- Trial second generation technology packages in SRRM units.

Will
they
reach
the above
targets?

The subsequent chapters would reveal the story of the Steel Upscaling Project as it unfolded iteslf.

CHAPTER 4

CASTING THE NET WIDER

The Action Plan

UNFOLDING THE STRATEGY

Among the most critical factors that contribute to the success of programmes and projects in any field is the level of effort that is invested upfront in planning the implementation strategy. The planning efforts at this stage must also ensure that all facets of the intervention are taken into consideration. This was of even greater significance in the secondary steel sector in India at that given point in time as there was this risk of losing the momentum that was built towards energy efficiency through the first phase of the Steel Project. Therefore, having defined the targets and timelines for the second phase of the Steel Project, the 'Upscaling Project' had to act quickly to lay down a roadmap (strategy) for its implementation.

Emanating from the objectives of the second phase of the project, the implementation strategy based itself on the lessons learned from the first pilot phase, which, between 2004 and 2013, impacted 34 steel re-rolling mills (SRRMs) and transformed them into 'model units'. With an imposing target of making 300 units energy efficient in about 30 months, the Upscaling Project had a real task on its hand. 'Innovation' in every step of the implementation strategy was the need of the hour:

- Innovation to scale up to almost 10 times, that is, from 34 model SRRM units in the first phase to 300 SRRM units;
- Innovation to speed up energy efficiency (EE) interventions in 300 units; and
- Innovation to skill not only the trainers at the cluster levels but also the human resources in over 300 SRRM units.

The subsequent sections will deal with the nitty-gritty of the innovative means adopted by the Upscaling Project.

PROJECT MANAGEMENT GUIDED BY INNOVATIONS

It was clear to the proponents of the Upscaling Project right at the beginning that to respond to the triple challenges of 3S

'OUT OF THE BOX' THINKING TO MAKE THE UPSCALING PROJECT WORK

S N Srinivas
Programme Analyst (Energy for Development), UNDP

During the project initiation period, it was felt that developing the proposal for the Upscaling Project was in itself quite a task. But once the proposal was approved and the funds sanctioned for its implementation, the stark reality of implementation challenges literally dwarfed the intensity of the previous challenge of preparing the proposal! In short, the core team that prepared the proposal got virtually stumped by the scale, speed, and skill (3S) that were required to complete the tasks ahead!

As the saying goes, 'when the going gets tough, the tough gets going'. The team realized that they needed to get tough right at the start, both mentally and physically, in order to overcome the 3S challenges. The team was certain that only meticulous planning down to the wire would save the day for them. The brainstorming sessions held back-to-back helped the team to break down the larger goal into smaller, but seemingly achievable time-bound tasks.

An example of a calculation during the planning exercise goes like this: for each steel unit to become energy efficient, it required roughly 30 person-days of an expert. To cover 380 units, it would take almost 1140 person-days of an expert. Even with six project managers, going by the approach taken by the PMU in the first phase of the project, it would give only 2000–2500 person-days, which is grossly inadequate. The funds available for implementation did not give the luxury of hiring another 15 project managers! It was clear that the Upscaling Project demanded new ways of implementation.

With each member of the core team wearing the 'thinking hat' during meetings, ideas started pouring in. The concept of having

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cluster-level agencies and field managers emerged out of the blue. Vigorous calculations were made on assessing the time in hand for implementation, back-end work, and the post-implementation work. All this worked out to about 10 months for implementation. Accordingly, the project was designed to have about 15–20 field managers, stationed in clusters, and each field manager managing 20–25 steel units. At that stage, all tough tasks looked 'doable' enough, albeit on PPT slides and paper! The sagging confidence of the team members suddenly started looking up, with each one ready to run the distance that it takes. And fast enough too!

The overriding 'mantra' followed by the project team was:

When the scale is ten times, innovate to scale, innovate to speed, innovate to skill.

I think it was this thought process that worked for the project to succeed at the end of the day.

(scale, speed, and skill) demanded by the project, a dynamic and effective organizational structure was required. Therefore, the first master step taken by the project was to design and set up an organizational structure that could effectively meet the project challenges.

Organizational Structure

In line with the above thought, an apex body in the form of a Project Steering Committee (PSC) was created with members drawn from the Ministry of Steel (MoS), the Government of India; the Bureau of Energy Efficiency (BEE); and other independent experts on the steel sector. The PSC was jointly headed by the Joint Secretary at the MoS and the Country Director of UNDP.

The main role of this apex body was to provide strategic advice and direction to the work of a dedicated PMU (Project Management Unit), besides taking major policy-level decisions for the initiative.

The structure of the PMU was almost similar to that developed for the implementation of the first phase, except for administrative control. Due to technical reasons, the administrative control of the Upscaling Project was vested with UNDP.[1] Nevertheless, the Programme Officer in charge of the project in UNDP worked under the guidance of the PSC.

In setting up the PMU, a few strategic decisions were taken that eventually proved to be 'innovative' master strokes in tackling the challenges of 3S. Some of them are listed below.

- A lean staffing structure for the PMU.
- Clusterisation of the project implementation areas.
- Outsourcing of tasks related to selection of E^2 (Energy-Efficient) units,[2] collection of benchmark (baseline) and post-implementation data, and capacity building.

Lean staffing of PMU

Figure 1 shows the organizational chart designed for the Upscaling Project. The primary role of the PMU being that of providing technical assistance and implementation, the project laid more emphasis on having a comparatively thick middle management layer. This is reflected in the recruitment of young, qualified technical resources in the team. So, when the project took off the ground, the PMU consisted of the following human resources:

- 4 Project Managers (Technical)
- 1 Project Assistant (Technical)

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1 The Upscaling project was implemented through the Direct Implementation Modality (DIM) of UNDP.

2 E^2 stands for 'Energy-Efficient'. An E^2 unit is one that has signed up for this energy-efficiency project. In the first phase of the project, such units were called 'model units'.

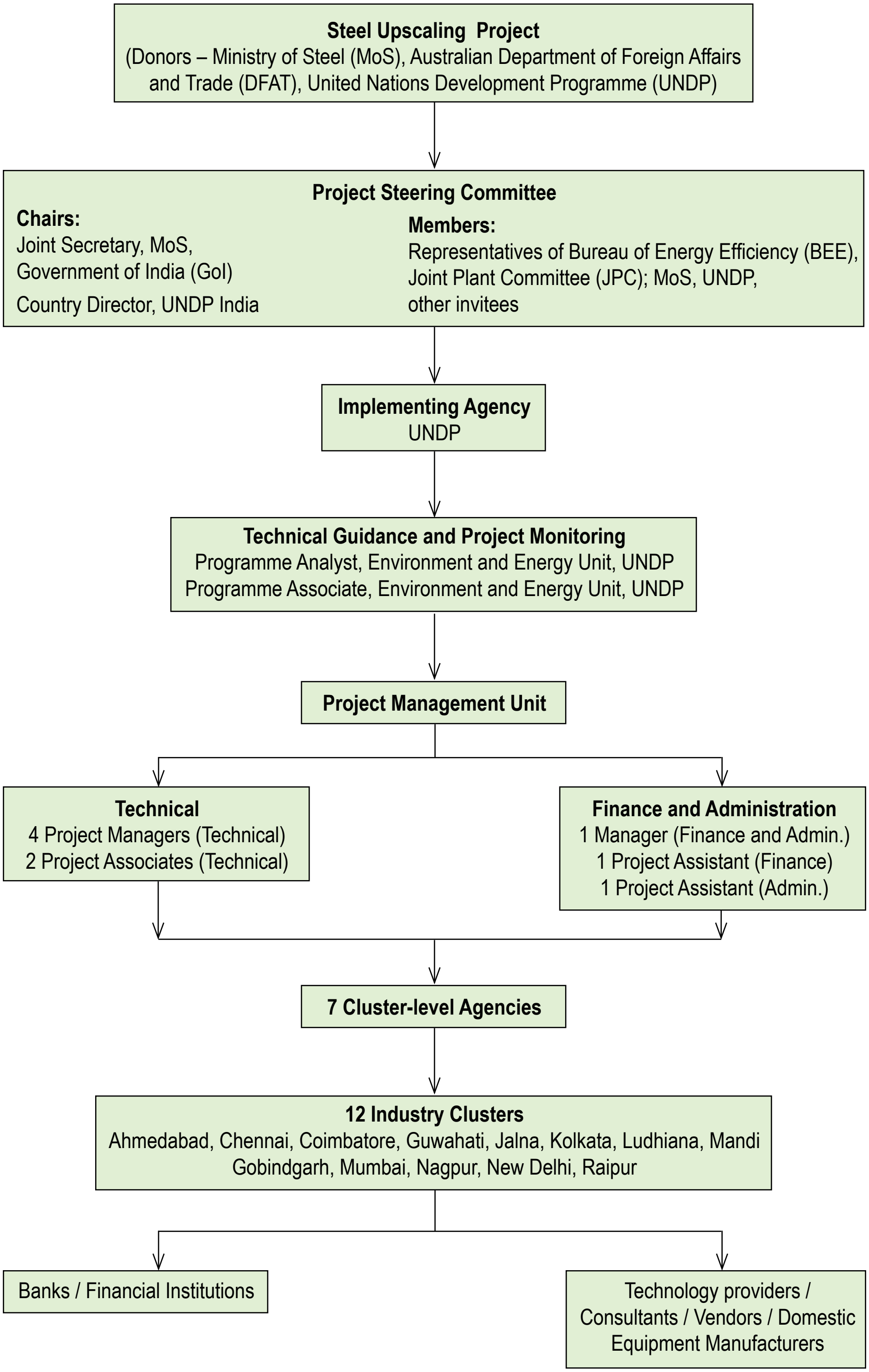

Figure 1 *Organogram of the Steel Upscaling Project*

- 1 Finance-cum-Administration Manager
- 1 Administrative Assistant
- 1 Finance Assistant

As the work started progressing through its intended path, one more Project Associate was recruited midway to strengthen the delivery of technical assistance to the various units. Although there were issues of one or two individuals leaving the PMU midway through the project, the total PMU strength was kept at nine professionals by and large from the beginning till the end.

Project implementation areas

As identified by the first phase of the project, the SRRM units are scattered all over the country, but in congregated form due to reasons of easy availability of raw materials, access to markets, etc. This has obviously posed serious challenge for the PMU to reach out to all with the project idea and select 300-odd units out of over 3100 secondary steel units, including induction furnace units.

To counter this, the strategy of 'categorise and penetrate' was adopted. Hence, the whole country was categorized into 12 clusters, with each cluster having the number of units ranging from 25 to 250. The identification of these clusters was carefully done to cover all regions of the country so as to enhance the project reach and impact. At the same time, it was also ensured that the project was proportionately spread across these clusters so that the benefits accruing to the individual units within the cluster are visible to other similar units in the respective clusters. This was done to enhance the possibilities of other units replicating the EE measures adopted by the E^2 units.

Table 1 lists the clusters selected for project implementation, which covered about 1175 units in all. The idea was to target about 380 units from these clusters, taking into account a few

TABLE 1

NUMBER OF TARGET UNITS FROM THE 12 CLUSTERS

Sl no.	*Cluster*	*No. of units in the cluster*	*No. of target units*
1	Mandi Gobindgarh	250	90
2	Ludhiana and Kalamb	120	20
3	Raipur	200	60
4	Nagpur and Indore	100	30
5	Coimbatore and Palakkad	60	20
6	Mumbai, Wada, Nashik, Goa, and Silvassa	60	20
7	Bhavnagar, Ahmedabad, Sihor, and Kutch	150	45
8	Jalna and Aurangabad	40	10
9	Kolkata, Durgapur, Giridh, Jamshedpur, and Bokaro	60	20
10	Chennai, Hosur, and Salem	60	20
11	Guwahati and Shillong	25	10
12	New Delhi, Jaipur, Bhiwadi, Ajmer, Muzaffarnagar, and Haridwar	50	35
	TOTAL	1175	380

dropouts that may happen during the course of implementation. The number 380 assumes importance as it reflects a key learning from the first phase of the project, which could not actually meet the target number of model units due to some units dropping out halfway through the project. So, this time around, even if the assumption that around 80 units would give it a slip midway, the project target of implementing energy efficiency measures in 300 units would not suffer. In retrospect, this turned out to be an important strategic decision from the point of view of project implementation. Figure 2 shows the locations of these 12 clusters. In all, the project covered 48 locations spread across 17 states.

Selection of partner agencies

Having formed the PMU, identified the 12 clusters, and decided on the number of target units from these clusters, it was time to penetrate these clusters with the project ideas through partner agencies at the cluster level. It was important to identify the

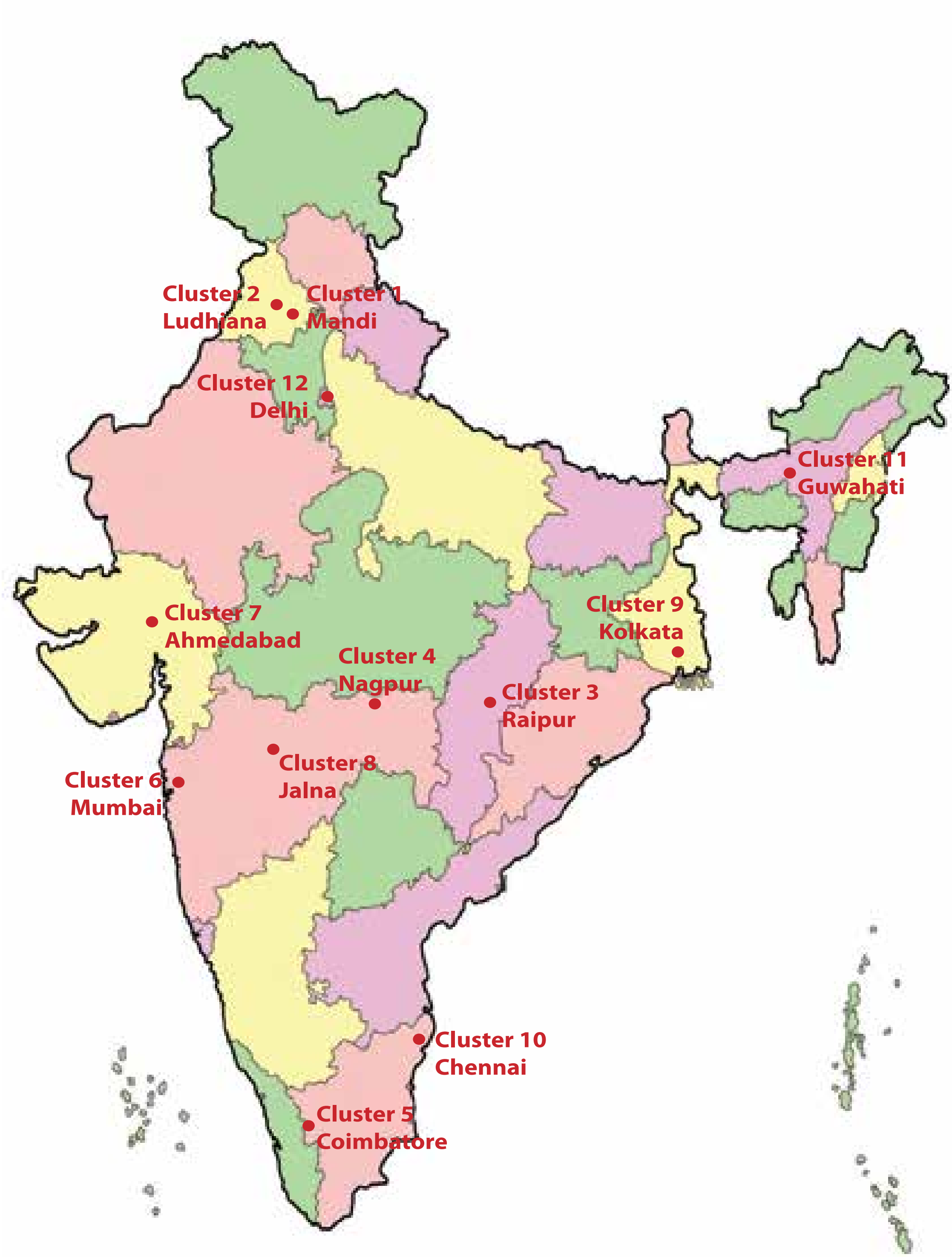

Figure 2 Locations of the 12 clusters identified for operation

cluster-level agencies (CLAs) that have not only the requisite knowledge of the SRRM sector but also adequate human resources to carry out the work at the field/unit level. Taking into account these factors, the PMU floated four Requests for Proposals (RfPs) through the procurement route of UNDP:

- RfP for 'Baseline energy measurements in steel re-rolling mill (SRRM) units' (See Box 1 for details)
- RfP for 'Exploration and description of economically viable energy efficient technology options, packages and practices for secondary steel electric induction furnace (EIF) sector' (See Box 2 for details)
- RfP for 'Technical assistance and coordination for implementation of energy efficient technologies in 50 scrap-based secondary steel re-rolling mill units in India' (See Box 3 for details)
- RfP for 'Selection of cluster-level agencies (CLAs) to support implementation of energy efficient production in small scale steel industry in India' (See Box 4 for details)
- Rfp for conducting 'post implementation studies'

Box I

Details of the RfP on 'Baseline energy measurements in 380 SRRM units'

Issued on 13 November 2013, this RfP required consultants to conduct baseline energy measurements on all the participating 380 SRRM units, which would quantify the energy performance of the units based on productivity parameters. The whole baseline data collection task was to be completed in three months.

In this activity, the consultant was to conduct the baseline study for a period of two consecutive days at each selected unit. (It is to be noted here that in the first phase, six days were allocated for baseline data collection. Experience suggested that two days would be sufficient to carry out this activity.) The consultant was required to measure the following parameters for two continuous days (8 hours/day) in the unit.

1. Productivity on mill output (hourly)
2. Specific fuel consumption (SFC) on mill output (hourly)
3. Specific power consumption (SPC) on mill output (hourly)
4. Mill Yield (two readings spread over two days)
5. Mill utilisation (hourly)
6. Burning loss (two readings spread over two days)
7. Crop loss (two readings spread over two days)
8. Mill scale loss (two readings spread over two days)
9. Power factor (hourly)

Based on the collected data for two consecutive days, the consultant was required to derive the average figures against each of the parameters. The consultant should also submit a summary of the derived baseline parameter for each individual participating unit as per a pre-designed format. The mandatory element in this format is that of verification and endorsement of the data captured by all stakeholders through their signatures: (a) the owner of the unit or his representative, (b) the person in charge of conducting the measurements from the Cluster-level agency, and (c) the representative from PMU or the field manager.

The National Institute for Secondary Steel Technology, North India Technical Consultancy Organisation, and National Productivity Council won the bids for carrying out the task of baseline data collection from different clusters.

Box 2

Details of the RfP on 'Exploration and description of economically viable energy efficient technology options, packages and practices for secondary steel electric induction furnace (EIF) sector'

An electric induction furnace is a major technology component in a secondary steel manufacturing sector. The EIF sector comprises about 1300 small and medium enterprises, scattered across different parts of the country. Electricity being the main source of energy for the functioning of an EIF, minimising its consumption is of paramount importance to the energy efficiency measures being carried out in the SRRM sector through this project. Hence, the project floated an RfP on 14 April 2014 placed the following responsibilities on the consultants.

- Conduct energy audits in 10 EIF units to generate the baseline data and identify potential areas for energy savings.
- Generate information on best practices, technology developments, and barriers to energy efficiency in the EIF sector.
- Scout nationally and internationally for appropriate energy efficiency interventions for the EIF sector.
- Identify appropriate technologies based on the outcomes of energy audits, consultation, and brainstorming meetings and technology scouting.
- Prepare a list of energy efficient technology options / packages or best practices, along with the individual techno-commercial information.

PricewaterhouseCoopers (PwC) won the UNDP bid through a transparent process.

Box 3

Details of RfP for 'Technical assistance and coordination for implementation of energy efficient technologies in 50 scrap-based secondary steel re-rolling mill units in India'

Within the SRRM sector, a substantial number of units use steel scrap from ship-building yard, rails, railway wheels, etc. as raw material. The re-heating furnace in such units heats such scrap material to the required rolling temperature. The heated scraps are then processed into final desired products in these rolling mills.

In a typical small-scale set-up, over 70% of the total energy is consumed by the re-heating furnace. Besides, about 30% of the total energy is consumed by the rolling mill and auxiliaries in the form of electrical energy.

The first phase of the project brought out the fact that such scrap-based units use obsolete technologies leading to high consumption of energy (both fuel and electricity). Therefore, it was essential for the project to bring such units under the ambit of 'energy efficiency' using technology and information and knowledge interventions so as to improve their productivity and cost-competitiveness, and reduce associated emissions of greenhouse gases (GHGs) and related pollutants.

The objective of floating this RfP was to identify suitable partner agencies, which can provide technical assistance and coordinate implementation of economically viable energy-efficient technologies (EETs) in 50 mini scrap secondary steel rolling mill units, located at the already identified clusters across the country. A separate RfP was made to focus on customised solutions to very small scale and varied capacity steel mills. The specific tasks to be carried by the selected agencies are as listed below:

- Conduct a one-day study of 50 scrap-based small-scale units (less than 5 t/h) to identify potential areas for energy saving. Also, recommend suitable EETs, implementation plans, and techno-economic feasibility for each of the units.

Contd...

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- Verify the results of the baseline studies conducted by the agency appointed earlier by UNDP.
- Provide technical assistance to these units and liaise between the units and equipment suppliers and consultants for actual implementation of the identified EETs for a particular unit.
- Coordinate with the agency selected for conducting the post-implementation studies.
- Calculate the reduction in specific energy consumption and GHG emissions in each of these 50 units.

Starting in May 2014, the assignment has to be completed in 8 months, i.e. by December 2014. Through a transparent process, Development Environergy Services Ltd (DESL) was selected as the partner agency to carry out the tasks identified in this RfP.

Box 4 Details of the RfP on 'Selection of cluster-level agencies (CLAs) to support implementation of energy efficient production in small scale steel industry in India'

Through this RfP, the project sought to appoint cluster-level agencies (CLAs) to support PMU in the implementation of project ideas in 380 units in the identified clusters. Acting as the extended arms of the PMU, the main responsibilities of a CLA included:

- Identify and depute full-time field manager/s in each cluster;
- Generate expressions of interest (EoIs) from steel units;
- Coordinate baseline measurements done by a different agency in the steel units;
- Suggest energy efficient (EE) measures and help the steel units to implement interventions for energy efficient production;
- Coordinate post-commissioning measurements (to be done by a different agency selected by UNDP);
- Coordinate the activities that are implemented at the unit/cluster level (training, workshops, etc.).

Contd...

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In terms of specific tasks, a CLA has to ensure that the target number of units from its designated cluster sign the EoIs and implement EE measures. Each CLA will be responsible for overall implementation of project activities in the designated cluster. Each CLA was expected to complete the tasks assigned to it in about 10 months, beginning April 2014.

The agencies selected as CLAs are (a) Punjab State Council for Science and Technology (PSCST), (b) Kamtech Associates Pvt. Ltd, (c) PricewaterhouseCoopers (PwC), (d) National Productivity Council (NPC), (e) National Institute of Secondary Steel Technology (NISST), (f) CTRAN Consulting Ltd, (g) MITCON Consultancy and Engineering Services Ltd, and (h) ITCOT Consultancy and Services Ltd.

Similarly, through another RfP floated for post-implementation data collection, the following agencies were selected through a UNDP bid process:

1. NISST
2. North India Technical Consultancy Organisation Ltd (NITCON)
3. NPC
4. Zenith Energy Services Pvt. Ltd
5. Federation of Indian Chambers of Commerce and Industry (FICCI)
6. Confederation of Indian Industry (CII)
7. APITCO Ltd.

GETTING TO BRASS-TACKS

While putting together the institutional arrangements in place, the core team also worked on a broad project design that laid down the steps for a unit to be become a prospective E^2 unit. All these steps were well documented and were part of the training programmes designed for field managers and partner agencies.

The project design consisted on the following elements, in a specific order:

1. Submission of expressions of interest (EoIs) and affidavits by the units through field managers appointed by the CLAs.
2. Verification and approval of the EoIs and affidavits by the committee that comprises members from both MoS and UNDP.
3. Upon approval of the unit as a potential E^2 unit by the committee, a baseline study will be conducted by the agency recruited for the same.
4. Analysis of baseline data, identification of appropriate energy-efficient technology (EET) or EET package for the concerned unit, and implementation of the same in the unit.
5. After implementation of the EET/EET package in the unit, overcome operational challenges with technical assistance from PMU/CLAs till the unit runs smoothly.
6. Conduct post-implementation study through the agency appointed for the same to collect data on specific parameters.
7. Process the request for financial incentive by the unit with MoS.
8. Award of financial incentive and for implementing energy efficiency measures.

The project design also reflected the four basic stages that the Upscaling Project entailed:

- **Stage 1:** Generation of EoIs and affidavits from units that are interested in becoming an E^2 unit.
- **Stage 2:** Provision of technical assistance to signed-up E^2 units
- **Stage 3:** Implementation of EETs
- **Stage 4:** Closure of the project.

In terms of tasks, the Stage 1 activities included (a) cluster meetings; (b) advertisements in national and local newspapers

FIELD MANAGERS AS 'GO-GETTERS'!

The role of field managers (FMs) as designed by the project was extremely critical to the success of the project. Although the FMs are not in the Project Management Unit (PMU) payrolls, they were given the charge of implementing most of the project-related activities. As representatives of PMU, and not as that of their respective cluster-level agencies (CLAs), the FMs virtually acted as the extended arms of the PMU.

The FMs deputed by the CLAs were located in the implementation areas of the project, which made accessibility of their services to the units located in that cluster much easier. They facilitated networking with all stakeholders that form part of the steel re-rolling mill/electric induction furnance (SRRM/EIF) business circle. Armed with the knowledge of EETs for the SRRM sector through the five-day orientation workshop conducted by the PMU, they were completely in sync with the specific requirements of the project. Their specific contributions to the project included:

- Generation of the required number of expressions of interest (EoIs) from the units, which involved (a) organizing cluster-level meetings, (b) meeting with associations, etc.
- Making intervention plan for implementing energy efficiency measures in selected units through field visits and then finalizing the technology package for each of the selected unit.
- Coordination between PMU and the unit for approval of the unit as an E^2 unit from PMU.
- Coordination for baseline measurement, actual implementation, post-commissioning measurements and other related activities.
- Adherence to timelines at each implementation stage in all the units, identification of the causes for delays (if any) and solving the same.
- Coordination of all training activities (for workers, plant supervisors, and other stakeholders in the units), awareness workshops, and implementation of best practices.
- Liasioning with the local statutory bodies such as state pollution control boards, departments of industries, and other government and financial institutions.
- Assistance to technical managers of PMU in the preparation of closure reports for individual units in their cluster with the help of baseline and post-implementation study data, evaluation of impacts, implementation report, and certificate of commissioning and satisfactory running of the plant.

about the project and eliciting response from interested small-scale steel units; (c) direct visits by technical experts to units, which have expressed interest in joining the project; (d) development of an E-network, a platform that connected PMU and E^2 units and also among E^2 units; and (e) arranging an exposure visit for potential E^2 units to a 'model unit' of the first phase as a confidence-building measure.

Stage 2 tasks involved the technical assistance component, which included (a) baseline data generation; (b) identification or customization of relevant EET or EET packages for each E^2 unit, and (c) helping E^2 units on making the right investment decisions.

Stage 3 was fully focused on implementation aspects. This stage involved strengthening the network of technology suppliers and vendors as they are crucial to the success of the whole project. Besides handholding the units for implementation through CLAs, this stage also provided intensive training to shop-floor workers and management staff of the units on 'best practices' related to EETs installed in their respective units as well as on making productivity improvements.

The project closure stage (Stage 4) was primarily concerned with post-implementation studies, processing of the requests for financial incentives to E^2 units, as well as issuing certificates to units for the implementation of EETs.

Like in the first phase of the Steel Project, the financial incentives provided by the MoS in the Upscaling Project has surely acted as a trigger for these small-scale steel units to take the plunge. Here is what was on offer to the units:

- Rs 2 lakh for very low cost and low to moderate cost technology interventions
- Up to Rs 5 lakh for direct rolling technology interventions

- Up to Rs 40 lakh for piloting EETs in induction furnaces
- Up to Rs 20 lakh for piloting EETs in second generation interventions.

Implementation of technologies being an important part of this project, the next chapter has been dedicated to detailing the EET options identified by the project. ◆❖◆

CHAPTER 5

ENERGY-EFFICIENT TECHNOLOGIES

The Change Agents

1 2 3 4 5 6 7

INTRODUCTION

As mentioned in Chapter 3, there are three main objectives of the project 'Upscaling energy efficient production in small scale steel industry in India'.

1. Upscaling energy efficiency (EE) interventions in about 300 steel re-rolling mills (SRRM) units.
2. Trialing second generation of technology packages in SRRM units.
3. Piloting EE measures in other steel sub-sectors such as induction furnace.

The common thread that links all the above three goals is 'energy-efficient technology (EET)'. In other words, it is the EET or EET packages that the project promoted to the secondary steel sector. To make their adoption easier in the steel units, the project also imparted the skills required to run these EETs through appropriate capacity building, technical assistance, and management programmes.

Altogether, the project identified 36 EET options or packages, categorised into five distinct groups (Table 1). Upon identifying these technologies, the project ensured that sufficient information about these technologies was made available to all the E^2 units to help them make informed decisions.

In the subsequent pages, brief descriptions of these technologies have been provided.[1]

Group 1: Technologies for SRRM Units

The technologies under Group 1 are primarily low-end technologies targeted at SRRM units. Categorised into two sub-

[1] Some of these technologies have been covered in the book *Energy-Efficient Steel Re-rolling*, published by UNDP in 2012. However, they are worth being repeated here for the sake of grouping all technologies together in one place for easier reference in the future.

TABLE 1

CATEGORISATION OF TECHNOLOGIES BASED ON THEIR APPLICABILITY AND END USERS

Technology group	*No. of technologies in each of the group*	*Nature of the technology/ies*	*End user in the secondary steel sector*
Group 1A	11	Low-end technologies	SRRM units
Group 1B	7	Low-end technologies	SRRM units
Group 2	1	Low-end technologies	Scrap-based mini SRRM units
Group 3	1	High-end technology (Direct rolling)	Composite SRRM units[2]
Group 4A	11	Induction furnace (Model)	Electric induction furnace-based units, a sub-sector of the secondary steel sector
Group 5	5	New generation technologies	SRRM units

groups, Group 1A comprises 11 technology options and Group 1B has 7 technology packages. Most of these technologies were identified during the first phase of the Steel Project and were found to be successful in terms of reducing energy consumption and greenhouse gas (GHG) emissions. The costs and benefits of these technologies have been briefly described below.

Group 1A: Low-end energy-efficient technologies

1. Shell-in-shell type recuperator for pulverized coal-firing system

This technology can be used in all pulverized coal-fired re-heating furnaces (RHFs), which are not equipped with recuperators. A shell-in-shell type recuperator consists of two concentric shells, one carrying hot flue gas and the other combustion air. Heat transfer takes place from the hot flue gas

[2] A composite unit is one which has both an induction furnace and a rolling mill in the same premise.

to the combustion air, thereby pre-heating the combustion air. Due to its simple design consisting of concentric shells of large diameter, coal dusts do not get deposited in such designs of recuperator. However, the efficiency of such a recuperator is low due to the lower heat-exchange area. The efficiency of a shell-in shell design recuperator can be enhanced by having one half of the recuperator as shell-in-shell type and the other half as a tube-type recuperator. It can recover waste heat up to 350 °C from flue gas of temperature 700 °C.

- Estimated investment: Rs 3–6 lakh
- Potential savings in specific fuel consumption (SFC): 5%–15%
- Estimated payback period: 6 months
- Installation period: 2–3 months

2. *Modified pulverized coal-firing system*

The modified pulverized coal system provides a solution towards better combustion of coal, avoiding formation of residual or unburnt coal, thus leading to reduced specific fuel consumption. In this system, coal and combustion air are separately carried and mixed in the burner tip, providing a turbulent atmosphere for uniform and proper mixture of air and coal. The burners are specially designed to provide swirling effect in the air–fuel mixture, which leads to almost complete combustion.

- Estimated investment: Rs 5–15 lakh (excluding the cost of the recuperator)
- Potential savings in SFC: 10%–15%
- Technology installation period: 2–3 months
- Estimated payback period: 6 months

3. *Energy-efficient pulverizer*

A coal pulverizer is an equipment to grind coal to the required fineness suitable for combustion in an RHF. The modified, energy-efficient pulverizer can produce fines of –200 mesh coal size, which can maximize combustion efficiency. Improvements in the efficiency of a pulverizer can be done by improving the material of hammer and liner and maintaining a proper gap between classifiers.

- Estimated investment: Rs 5–10 lakh
- Potential savings in SFC: 5%–10%
- Potential reduction in GHG emissions: 5%–10%
- Technology installation period: 2–3 months
- Estimated payback period: 6–9 months

4. *Automation and control system*

Use of a microprocessor-based proportionate integrated derivative (PID) controller in RHF can control and regulate the air–fuel flow, in addition to maintaining desired temperature regimes. The system consists of thermos-couple installed in different zones of the furnace. The feedback from thermocouples is given to PID controllers, which control the coal flow (by controlling the speed of the DC motor) and the air flow (using solenoid valve), thereby maintaining a proper air–fuel ratio for combustion.

- Estimated investment: Rs 5–10 lakh
- Potential savings in SFC: 5%–10%
- Potential reduction in GHG emissions: 5%–10%
- Technology installation period: 2–3 months
- Estimated payback period: 6 months

5. *Highly efficient U-tube cross-flow-type metallic recuperator*

A recuperator is a heat exchanger that is used to recover waste heat from the flue gas to pre-heat the combustion design. Recuperator comes in different designs and specification. Compared to a shell-in-shell type recuperator, a U-tube cross-flow type metallic recuperator is of higher efficiency. Waste heat recovery of up to 80% can be achieved with this technology. However, using this technology in pulverized coal-fired furnaces can lead to issues like depositing of coal dust in recuperator pipes leading to blockage in the air flow. Such issues can be sorted out with certain design modifications on conventional U-tube cross-flow type recuperators. This technology can be best used in RHFs that are based on furnace oil or natural gas.

- Estimated investment: Rs 5–15 lakh
- Potential savings in SFC: 5%–10%
- Potential reduction in GHG emissions: 5%–10%
- Technology installation period: 2–3 months
- Estimated payback period: 6 months

6. *Variable voltage variable frequency (VVVF) drive*

A VVVF drive is an adjustable speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying the motor input frequency and voltage. The benefits of a VVVF drive can be best utilized in variable speed application of an AC motor. Energy is stored during low speed running, which is re-utilized during the high speed operation of the motor, thus leading to significant savings in specific power consumption.

- Estimated investment: Rs 5 lakh
- Potential savings in SPC: 2%–3%
- Potential reduction in GHG emissions: 2%–3%
- Technology installation period: 2–3 months
- Estimated payback period: 6 months

7. *Universal spindles and couplings*

As a replacement to conventional wobler coupling and spindles, universal spindles and couplings are suggested; this provides better transmission efficiency of power from the motor to the rotating rolls. These couplings and spindles consist of universal joints, which lead to lesser jumps during operation. Due to lesser jumps, they operate at a high torque carrying capacity with negligible backlash and radial clearance.

- Estimated investment: Rs 10–15 lakh
- Potential savings in SPC: 5%–8%

- Potential reduction in GHG emissions: 5%–8%
- Technology installation period: 2–3 months
- Estimated payback period: 12 months

8. *Anti-friction roller bearings*

Like any other rotating parts, journals of the roll are fitted with bearings. Different varieties of bearings are used for rolling mill operation such as brass cotter, fibre, and roller bearings. Anti-friction roller bearings are considered superior among the bearing varieties, as there is only one point of contact between the rolls and the bearing balls. These bearings have higher transmission efficiency, minimize the torque on spindles, and lead to higher mill speed.

- Estimated investment: Rs 3–6 lakh
- Estimated increase in mill utilization: 5%
- Potential savings in SPC: 3%–5%
- Potential reduction in GHG emissions: 3%–5%
- Technology installation period: 2–3 months
- Estimated payback period: 6 months

9. *Y-roller table in 3-Hi mill stands of rolling mills*

Installation of a Y-roller table improves bar handling in a 3-Hi mill (single mill stand with three rolls), reduces the drop in temperature for the next pass, and enhances human safety. A reduction of three or four skilled manpower per shift can also be expected, in addition to significant increase in mill utilization.

- Estimated investment: Rs 5–10 lakh
- Estimated increase in mill utilization: 10%
- Potential savings in SPC: 4%–7%
- Potential reduction in GHG emissions: 4%–7%
- Technology installation period: 2–3 months
- Estimated payback period: 12 months

10. Installation of tilting table for 3-Hi mill stand

A tilting table ensures smooth guided entry of metal to the passes and also eliminates manual lifting and feeding of the rolling stock. It also eliminates temperature variation in bars and ensures uniform feeding to the passes. A reduction of three or four skilled manpower per shift can also be expected.

- Estimated investment: Rs 10–12 lakh
- Estimated increase in mill utilization: 5%–10%
- Potential savings in SPC: 6%–8%
- Technology installation period: 2–3 months
- Estimated payback period: 12 months

11. Energy-efficient drives for rolling mills

Installation of energy-efficient and properly sized motors in rolling mills leads to such benefits as (a) higher efficiency of up to 92%, (b) lower running cost, (c) lesser noise and vibrations, and (d) more tolerant to overload conditions.

- Estimated investment: Rs 8–10 lakh
- Potential savings in SPC: 4%–6%
- Potential reduction in GHG emissions: 4%–6%
- Technology installation period: 2–3 months
- Estimated payback period: 12 months

Group 1B: Low-end energy-efficient technology packages

1. Replacement of existing RHF with new energy-efficient RHF

An energy-efficient RHF is designed to offer uniform heating of the stock, optimum hearth utilization, proper combustion, controlled air–fuel ratio, and optimum waste heat recovery with optimum specific energy consumption (SEC) and higher efficiency of the furnace.

- Estimated investment: Rs 1.5–2.0 crore for a 15–20 tph furnace
- Potential savings in SFC: 25%–30% (furnace oil); 35%–40% (pulverized coal)
- Estimated reduction in GHG emissions: 20%–40%
- EET package installation period: 4–6 months
- Estimated payback period: 12 months

2. Conversion of fossil-fuel-based RHF to CBM-based RHF

Large depositories or mines of coal consist of naturally formed methane gas above the coal bed. This coal-bed methane (CBM), when extracted from the coal bed, is a cleaner, safer, more environmentally friendly fuel than many other energy sources. Using CBM would require certain design modifications including safety parameters in the furnace, apart from other design features associated with a switch-over of fuel. One of the limitations is that a CBM-based RHF can be used only where CBM is available through pipelines.

- Estimated investment: Rs 1.5–2.0 crore for a 15–20 tph furnace.
- Potential savings in SFC: 20%–25%
- Estimated reduction in GHG emissions: Net zero emissions
- EET package installation period: 4–6 months
- Estimated payback period: 12 months

3. Conversion of fossil-fuel-based RHF to biomass-based RHF

Unlike fossil fuels, biomass generated from agricultural cultivation does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon while cultivation. These extracts, when used in the form of briquettes, are the cheapest, eco-friendly, renewable source of energy. It has been tried and tested that biomass briquettes can be used in existing coal-based plants with certain design modifications.

- Estimated investment: Rs 1.5–2.0 crore
- Potential savings in SFC: 20%–25%
- Estimated reduction in GHG emissions: Net zero emissions
- EET package installation period: 6–8 months
- Estimated payback period: 12 months

4. Revamping/modernization of pulverized coal-fired RHF

An energy-efficient pulverized coal-fired RHF is designed with the modified pulverized coal feeding system in addition to the general design of the RHF. The system will ensure uniform stock temperature, higher furnace productivity, optimum furnace refractories and insulation, optimum waste heat recovery and better mixing and combustion of pulverized coal.

- Estimated investment: Rs 1.5–2.0 crore
- Potential savings in SFC: 20%–25%
- Estimated reduction in GHG emissions: 20%–25%
- EET package installation period: 3–6 months
- Estimated payback period: 12 months

5. Revamping existing furnace with energy-efficient top-fired RHF

In addition to the installation of a new energy-efficient furnace, an existing furnace can also be revamped to ensure optimum hearth utilization, proper temperature regime, optimum refractory and insulation, desired control of temperature, and air–fuel ratio, and optimum recovery of waste heat. This will result in lower SFC and higher efficiency.

- Estimated investment: Rs 1.5–2.0 crore
- Potential savings in SFC: 20%–25% (furnace oil); 30%–35% (pulverized coal)
- Estimated reduction in GHG emissions: 20%–30%
- EET package installation period: 3–6 months
- Estimated payback period: 3–6 months

6. Revamping of rolling mill

There are several technologies in this EET package such as installation of anti-friction roller bearing stands, installation of universal couplings and spindles, installation of Y-table/tilting table, installation of roller guides, installation of repeaters, and adoption of optimum roll pass design. Adoption of these technologies can be done either in isolation or in groups based on its application as per layout considerations.

There are several technological and other advantages in adopting this EET package such as (a) reduction in transmission losses and improvements in transmission efficiency; (b) reduced miss rolls, increased utilization, and improved mill efficiency;

(c) higher mill speed; (d) elimination of temperature variation and uniform feeding to passes; etc.

- Estimated investment: Rs 0.5 to 1.5 crore (depending on the level of interventions made)
- Estimated increase in mill utilization: 5%–10%
- Potential savings in SPC: 10%–15%
- Estimated reduction in GHG emissions: 10%–15%
- EET package installation period: 6 months
- Estimated payback period: 6 months

7. Revamping furnace with new insulation and refractory lining

A siginificant portion of the heat generated in an RHF is lost through the walls in the form of radiation losses. Conventionally, the thickness and quality of the refractory are not taken care of, while installing a furnace. The furnace wall in the soaking zone usually consists of alumina bricks of only 40%–50% aluminium content, leading to dissemination of heat to the surface. In conventional furnace, the wall temperature is maintained at 100–120 °C.

A good refractory and insulation lining pattern can save significant heat losses from the furnace side walls and roof, in addition to other advantages. Optimum refractory and insulation linings consist of high alumina bricks (with 80% aluminium content) backed by insulation bricks of hot face and cold face, backed by ceramic fibre linings/calcium silicate linings and asbestos sheet. Use of ceramic fibre should be optimally used. Usually the furnace wall temperature should be maintained close to 60 °C.

- Estimated investment: Rs 10–50 lakh
- Potential savings in SFC: 5%–10%
- Estimated reduction in GHG emissions: 5%–10%
- EET package installation period: 6 months
- Estimated payback period: 12 months

Group 2: Technology for SRRM Units

1. Revamping of mini scrap-based rolling mill

A few technologies such as installation of roller bearing mill stands, modification of RHF, installation of waste heat recovery system, installation of temperature-based furnace automation, and installation of optimum refractories and insulation have been identified in this EET package for revamping of mini scrap-based rolling mills. Adoption of these technologies can be done either in isolation or in groups based on its application as per layout considerations.

- Estimated investment: Rs 5–10 lakh
- Estimated increase in mill utilization: 5%–10%
- Potential savings in SEC: 5%–15%
- Estimated reduction in GHG emissions: 5%–15%
- EET package installation period: 6 months
- Estimated payback period: 6 months

Group 3: High-end Technology for SRRM Units

1. Direct rolling

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

- Estimated investment: Rs 1.5–6.0 crore
- Potential savings in SFC: 80%–100%
- Estimated reduction in GHG emissions: 80%–100%
- EET package installation period: 6–8 months
- Estimated payback period: 12 months

Group 4: Technologies for Induction Furnaces

For electric induction furnace (EIF) units, six technology packages and five EE practices/options have been identified by the project. These EETs/EE practices are listed below.

Technology packages for EIF units

1. Installation of shredding machine and shredded scrap charging through bucket or vibro-feeder[3]

Applicable to scrap-based EIF units, a shredder machine can be used to cut large scrap pieces into smaller pieces with higher bulk density. The shredder removes rust and dust from the scrap. Due to its higher bulk density, shredded scrap increases the charging rate and also helps in better power coupling (means maximum power input which increases the melt rate), thus reducing the heat/cycle time. The other advantages of using shredded scrap in an IF are (a) less slag generation as shredded scrap is free from dust and rust, (b) more lining life, (c) better productivity, and (d) lesser air pollution.

- Estimated investment: Rs 75 lakh) (approximate cost for shredder machine for 250 hp motor) and about Rs 15.50 lakh for bucket and vibro feeder
- Expected benefits: (a) Reduction in electricity consumption by 5%–10% per heat; (b) Reduction in GHG emissions for the shredding machine in a scrap-based EIF unit (8 tonnes/heat) by approximately 850 tCO_2/year; (c) Reduction in GHG emissions for the shredding machine in a DRI-based EIF unit by approximately 880 tCO_2/year.
- EET package installation period: 15–20 days
- Estimated payback period: (a) 12 months for scrap-based unit as they are dependent on grid power, which is costly; (b) 23 months for DRI-based unit as they normally use their captive power, which is cheaper in comparison to grid power.

[3] The estimations are made based on real-time case studies on both a scrap-based induction furnace unit having a furnace capacity of 8 tonnes/heat and a DRI-based EIF unit of furnace capacity 12 tonnes/heat.

2. *Replacement of coil cradle of old furnace*[4]

In IFs that are of 8–10 years old, the energy losses due to old coil cradle assembly are high. By replacing the old coil cradle assembly with an energy-efficient one, energy consumption can be reduced in the melting zone. It maintains uniform temperature gradient throughout the refractory, prevents overheating, and enhances refractory life.

- Estimated investment: (a) Rs 25 lakh for 8-tonne IF; (b) Rs 28 lakh for 12-tonne IF
- Expected benefits: (a) Savings in electricity consumption by 15–20 kWh per tonne; (b) Reduction in GHG emissions by approximately 300 tCO_2/year for an 8 tonnes/heat scrap-based IF unit; (c) Reduction in GHG emissions saving potential by approximately 350 tCO_2/year for a 12 tonnes/heat DRI-based IF unit
- EET package installation period: 2–4 days
- Estimated payback period: (a) 11 months for scrap-based units (8 tonnes/heat); (b) 21 months for DRI-based units (12 tonnes/heat).

3. *Installation of continuous casting machine (CCM) for billet making*[5]

Most IF units use moulds to cast the molten metal into ingots, using the traditional runner and gate system. This operational practice results in increased SEC due to energy losses during the melting process. Installing a CCM removes the traditional 'mould filling using the runner and gate system' and saves the energy loss of melting 500–600 kg of steel per heat thereby reducing the SEC at the final output. The productivity also increases, besides other benefits.

- Estimated investment: (a) Rs 1.2 crore (the price of CCM equipment) + Rs 1.5 crore (expenses in civil and other work) = Rs 2.7 crore (total investment) with two stands provision
- Expected benefits: (a) Additional realisation of Rs 1 crore per annum for the same production quantity; (b) Savings in electricity by 10–12 kWh per heat; (c) GHG emission reduction by approximately 28 tCO_2/year

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[4] The estimations are made based on real-time case studies on both a scrap-based induction furnace unit having a furnace capacity of 8 tonnes/heat and a DRI-based EIF unit of furnace capacity 12 tonnes/heat.

[5] The estimations are made based on a real-time case study done on a scrap-based induction furnace unit having a furnace capacity of 8 tonnes/heat.

- EET package installation period: 3–4 months
- Estimated payback period: 2–3 years.

4. *Installation of sintering panel for sintering heat*[6]

Refractory or ramming mass plays the role of refractory/insulation material in an IF. The thickness of refractory lining keeps on reducing with furnace operation. After every 15–20 heats, the ramming mass needs resetting or replacement to avoid furnace breakdown. The first heat after ramming mass resetting is called sintering heat, which takes almost double heat time compared to normal heat time (as it requires slow heating from ambient temperature to approximately 1660 °C). The sintering heat consumes more energy, ultimately reducing the overall SEC.

Installation of a sintering panel helps overcome the limitations associated with sintering heat. The panel reduces the heat time of sintering heat to normal heat time and will increase productivity without consuming any extra power. The end results are reduced SEC, enhanced production, and better power quality and utilisation during the sintering heat.

- Estimated investment: Rs 25 lakh
- Expected benefits: (a) Approximately 100–200 extra heats per year; (b) Approximately 25%–30% increase in kVA utilisation index
- EET package installation period: 2–3 days
- Estimated payback period: (a) 18 months for a scrap-based unit of furnace capacity 8 tonnes/heat; (b) 23 months for a DRI-based unit of furnace capacity 12 tonnes/heat.

5. *Scrap pre-heating*[7]

Pre-heating of scrap material saves energy. By using a pre-heater, scrap can be heated from ambient temperature to 400 °C

[6] The estimations are made based on real-time case studies on both a scrap-based induction furnace unit having a furnace capacity of 8 tonnes/heat and a DRI-based EIF unit of furnace capacity 12 tonnes/heat.

[7] Ibid.

to 450 °C. The pre-heating system consists of a high velocity burner, blower, scrap basket, swivelling and temperature control mechanism. The installation of a scrap pre-heater reduces the work of an IF as the power requirement is considerably lower.

- Estimated investment: Rs 18 lakh
- Expected benefits: Net saving in running cost up to Rs 800 per heat if electricity tariff is more than Rs 7 per kWh.
- EET package installation period: 1 month
- Estimated payback period: (a) 9–10 months for scrap-based IF plants with tariff rate more than Rs 7 per kWh; (b) Normally not viable in DRI-based IF plants even with tariff.

6. Ladle pre-heating[8]

A ladle pre-heater can raise the temperature of the molten metal by 300 °C to 350 °C, thus reducing the tapping temperature by 15 °C to 20 °C. Some of the other advantages of using a ladle pre-heating system are reduction in cycle/heat time and reduction in heat losses during the transfer of ladle.

- Estimated investment: Rs 8 lakh
- Expected benefits: (a) Net saving in running cost up to Rs 300–350 per heat if electricity tariff is more than Rs 7 per kWh; (b) Net saving in running cost is negative if electricity tariff is less than Rs 4 per kWh
- EET package installation period: 1 month
- Estimated payback period: (a) 9 months for scrap-based unit as they are dependent on costly grid power; (b) Normally not viable in DRI-based induction plants if the tariff is less than Rs 4 per kWh.

Energy-efficient operational practices

The 'best practices' identified for EIF units that can lead to substantial energy savings are listed below:

[8] The estimations are made based on real-time case studies on both a scrap-based induction furnace unit having a furnace capacity of 8 tonnes/heat and a DRI-based EIF unit of furnace capacity 12 tonnes/heat.

7. Avoid superheating of the metals

All units with CCM go for super heating of the metal/melt to ensure optimum temperature at the CCM. When the CCM is engaged, super heating is conducted considering the waiting and travel time. The operator working on the furnace may not be confident about the temperature shown by the transducer, so he keeps providing extra heat to the melt till the CCM is ready to take up the melt for billet making. This super heating has to be avoided.

As this is an operational issue, the operator working on the induction furnace needs to be trained, so that he/she effectively utilises the power for melting the metal. A case study carried out on a DRI-based IF unit shows that with effective training, about 1700 kWh of electricity can be saved in a day. The GHG emission reduction estimated through this best practice is about 390 tCO_2/y.

8. Avoid overfilling (metal above the coil level) of furnace during the melting

Overfilling of the induction furnace during the melting process has to be avoided at all costs. With appropriate training to the worker operating on the IF, filling up the furnace up to the desired coil height can be achieved. This ensures effective and faster heat transfer. This best practice will result in reduced heat time thus allowing more heats per day to ultimately resulting in more production. Apart from more production, it will also reduce the SEC of the operation as compared to the SEC during the overfilling.

It is estimated that this best practice can save over half a million units of electricity in a year (kWh/y), resulting in monetary savings of about Rs 36 lakh a year. Besides, the GHG emission reduction potential is estimated at about 425 tCO_2/y.

9. Installation of energy-efficient pumps

The pumping system is an integral part of auxiliaries in an IF operation. Overall, the pumping system contributes to about 5%–6% of the total energy consumption for per tonne of production. The Upscaling Project recommends replacement of the existing pumps with energy-efficient pumps that match the designed head and flow. Installation is easy.

- Estimated investment: Rs 3.2 lakh for 22 kW energy-efficient pump and Rs 3 lakh for 18.5 kW energy-efficient pump
- Expected benefits: Reduction in electricity consumption by 30%–35% and the resultant monetary savings
- EET package installation period: 2 days
- Estimated payback period: 6 months

10. FRP blades in cooling tower

The use of fibre-reinforced plastic (FRP) blades, instead of metallic/aluminium blades, will save energy and improve the performance of the cooling towers. FRP blades are light in weight and have better aerodynamic shape. They can be easily installed.

- Estimated investment: Rs 50,000/-
- Expected benefits: Consumes 25%–30% less power compared to metallic blades
- Estimated payback period: 10 months

11. Installation of variable frequency drive on the air compressor

A variable frequency drive (VFD) is a method of compressor control that provides efficient operation over a wide range by closely matching the output with the demand. It is advisable to use VFD on air compressors if they have variable loading character as it offers better control of operation and lower the operating pressure. It also reduces energy consumption during no load or unloading of the compressor.

- Estimated investment: Rs 3 lakh for a 30-kW VFD
- Expected benefits: Reduction in electricity consumption by 15%–20%
- Estimated payback period: 39 months

Group 5: Second Generation Technologies for SRRM Units

Second generation technologies are basically advanced technologies that are yet to find their places in SRRM units in the country. Five such technologies were identified during a stakeholder workshop organized exclusively for the purpose by the Project. Brief descriptions of these five technologies are given below.

1. High performing insulation for RHF

Use of ceramic fibre modules as lining material in side walls and the roof of the RHF in place of conventional high alumina bricks offers very low thermal conductivity, thereby reducing the heat losses significantly. In ceramic fibre lining, the fuel consumption for restart will also be less due to the lower density of the ceramic fibre blanket.

- Estimated investment: Rs 70 lakh (approximate cost of lining per cubic metre is Rs 142,857/-)
- Expected benefits: (a) Saving in fuel consumption by 18%; (b) Reduction in CO_2 emission by 18%
- Implementation period: 10 days
- Estimated payback period: 19 months

2. Effective furnace atmosphere (temperature, pressure, and oxygen) control through automation

To maintain the required pressure in the furnace flue gas for its ease of travel through the chimney and also to maintain an optimum air–fuel ratio, various parameters need to be measured, monitored, and regulated instantaneously. Such instantaneous and continuous regulation is practically impossible through manual intervention and hence, automation needs to be incorporated in the operation of an RHF. The automation system monitors and controls furnace pressure, excess air (by measuring and controlling free oxygen in the flue gas), and temperature in an RHF.

- Estimated investment: Rs 18 lakh
- Expected benefits: (a) Savings in fuel consumption by 13%; (b) Savings in power consumption by 10%; (c) Reduction in burning loss by 1%; (d) Reduction in CO_2 emissions by 12%
- Implementation period: 5 days
- Estimated payback period: 9 months

3. *Coal drying using waste heat in flue gas*

The coal drying system proposed here works on a principle of removing the moisture content by using the waste heat available in flue gas. The flue gas that comes out of the RHF is generally at a temperature of 600 °C–700 °C. Partial heat recovery is achieved in a recuperator for pre-heating combustion air. The temperature of flue gas is still around 300 °C–350 °C at the outlet of the recuperator. Such untapped heat in flue gas can be used for drying coal. The proposed system consists of a dedicated recuperator, which will use the flue gas coming out of the main recuperator to pre-heat the air. This hot air is then mixed with coal for the drying of coal.

- Estimated investment: Rs 10 lakh
- Expected benefits: (a) Savings in fuel consumption by 11%; (b) Reduction in CO_2 emission by 11%
- Implementation period: 14 days
- Estimated payback period: 8 months

4. *Power generation using waste heat in flue gas*

The proposed system is a waste heat recovery power plant operating on organic Rankine cycle. The refrigerant circulating in a closed loop absorbs the heat available in flue gas and converts into high-pressure vapour. This high-pressure vapour is expanded in an expander coupled to an alternator for power generation. For a typical RHF of 10 tph capacity, the volume of flue gas flow would be around 10,000 Nm^3/h and it is estimated that a net power of 100 kWh can be generated by using the waste heat available in such quantum of flue gas.

- Estimated investment: Rs 120–150 lakh
- Expected benefits: (a) Savings in fuel consumption by 10%; (b) Reduction in CO_2 emission by 10%
- Implementation period: 2 months
- Estimated payback period: 5.7 years

5. *Effective energy management in motion control for SRRM*

Effective energy management includes (a) installation of variable speed drives (VSDs) for larger mill motors, (b) reduction in speed of mill motors during non-utilization period, (c) use of servo motors with integrated measurement and control mechanism for hydraulics, and (d) use of accumulator charged systems as main drives for induction furnace. Such measures with improved energy management will lead to efficiency improvement of motion controls.

- Estimated investment: Rs 5–20 lakh (installation specific)
- Expected benefits: (a) Reduction in power consumption by 20%–70%; (b) Reduction in CO_2 emissions by 20%–40%.
- Implementation period: 15 days
- Estimated payback period: 6–18 months (installation specific)

CONCLUSION

Armed with an array of 36 EETs/EET packages/practices, the project team is now fully equipped to enter the field. The strategy was to promote these technology options and best practices aggressively to the secondary steel units in the clusters already identified. As there was no compulsion on the part of SRRM units to join in the project, the challenge for the Project team was to get them in 'voluntarily'. And that too, as quickly as possible and as many of them as possible, because 'time' was at a premium for the project team! The next chapter will dwell on how over 300 units got 'rolled' in to the project.

CHAPTER 6

ON THE GROUND

Rolling in 300 Units

INTRODUCTION

The proof of the pudding is in the eating.

No second thoughts on this! It simply means until you eat the pudding, you can never judge how good or bad it is. This age-old proverb perfectly fits in with the context of the second phase of the Steel Project at this stage.

The strategies have been made, several meetings have been held and many decisions have been taken, various consultants have been appointed for carrying out the tasks identified, 12 clusters have been identified as target operational areas, about 36 technologies/technology packages have been identified for rolling out, the Project Management Unit (PMU) has been set up with adequate staff, specific responsibilities have been assigned to the PMU staff, and what not. In short, the recipe for making this project a success has been put in place.

All these have been done to rope in 380 steel re-rolling mills (SRRMs) and guide them on to becoming E^2 (energy-efficient) units. More importantly, out of the total allocated time of 30 months for the completion of this project, about 6 months have elapsed in the preparation of a fool-proof plan of action, including recruitment of cluster-level agencies (CLAs). It is literally the 'testing' time for the project team and its extended arms to ensure that all the deskwork carried out in the past 6 months is all worth it!

The overall implementation plan has to work; for which each of its components has to work. By components, one can count the promotional strategy for getting 300 units to sign up for the project, the management systems that were put in place, the investments to be made by the units on energy-efficient technologies (EETs), timely delivery of customised EETs by technology vendors and training programmes on these by technical experts at PMU and elsewhere, arrangements to conduct baseline and post-implementation measurements, etc. Above all, the people involved in the implementation of the project must deliver on their commitments! The search for 'proof' begins now!

MAKING IT WORK

For the Upscaling project to deliver the desired results, it is vital to bring in 'synergy' among the various working arms of the project. Because, the result expected from the effort is to the tune of 1 + 1 = 11! Internally, there was this understanding that even if the project achieves 50% of the final target at the end of the day, it would serve as a 'proof' of effectiveness of the overall project strategy. However, for all practical purposes, this internal target was not revealed to the rank and file of the project team, but kept under wraps within the senior decision makers of the project.

Realising the role of synergy in the project, the project team gave primacy to four broad basic functions: (a) the promotional strategy, (b) implementation of EETs, including capacity building, (c) monitoring and evaluation, and (d) the coordination part to ensure that there is seamless integration of the first two functions. The subsequent sections would deal with these functions in detail, although role of coordination would cut across all the functions.

Promote, promote, promote: getting the message across

A sound promotional strategy was critical in getting the message across to all unit owners in the 12 clusters. In the development of such a promotional strategy, the first phase did provide a number of pointers. Documentary evidence from the first phase of the project suggested that the initial experience with implementation was not very encouraging. Even the units that showed interest in the beginning were seen to be backing out giving some reason or the other. It took almost four years for the first phase to identify the model units and then start moving with the actual implementation of EETs/EET packages in those selected model units. Therefore, the promotional strategy for the Upscaling Project tried to leverage the lessons learnt from the first phase of the Steel Project.

Accordingly, unambiguous targets were set for the second phase.

- Raise expressions of interest (EoIs) from about 380 SRRM units from the 12 clusters that have been identified
- Ensure that over 300 SRRM units sign up for the Upscaling Project
- Further ensure that at least 300 SRRM units commit to making the necessary investments on EETs or EET packages and implement them.

As stated in Chapter 4, the decision to have about 380 EoIs, which is about 25% more than the stated target of 300 units, was a clear hint that an important lesson of the first phase has been fully imbibed in the second phase.

There were other learnings too from the first phase. Table 1 shows some of the positives of the first phase that were readily lapped up by the Upscaling Project, improved upon, and then put to good use.

One additional effort made by this project this time around was to issue advertisements in the mainstream media such as newspapers, including the popular ones in vernacular languages. There were concerns when the response to these

TABLE 1

OVERALL PROMOTIONAL STRATEGY

Sl no.	*Positives of the first phase*	*How the positives from the first phase could be effectively used for the Upscaling project*
1	Gained the confidence of the steel re-rolling mill associations towards the intentions of the project	Continue and strengthen the relationship with steel re-rolling mill associations. Involve them more intently to rope in more units.
2	Innumerable awareness building and training workshops, training manuals, etc. helped in softening the rigid stand of unit owners.	Build on the awareness already generated in the sector and reach out to more units through a cluster approach. Use the knowledge products such as training manuals, case studies, other publications, and video films of units that successfully implemented energy-efficient technologies (EETs) and reaped the benefits.
3	Established communication platforms	Strengthen the existing communication platforms and build on them. Develop vibrant two-way information exchange platforms such as cluster meetings, one-on-one meeting where required, and e-networks through WhatsApp and e-mail groups.
4	Instilled confidence among unit owners on providing end-to-end solutions	Use the model units for exposure visits. Get the unit owners of the model units to interact with the fence sitters (potential unit owners) and convince them of the benefits of using EETs. Showcase the energy savings and monetary savings in numbers. Assure potential E^2 units of complete handholding through technical assistance offered by the project.

advertisements was not to the expected levels. Before 'self-doubts' started raising their ugly heads, the project team got its act together and approached the clusters with all its strength and promotional resources at their disposal. The follow-up actions post-newspaper advertisements worked well and started producing the desired results.

The coordination system led by the PMU and UNDP and supported by the Ministry of Steel functioned seamlessly like a 'well-oiled machine'. All combined, it is to the credit of the larger project team that at the end of the promotional exercise, there were 383 SRRM units ready to take the plunge, of which the project approved 373 of them! Further screening by the project team eliminated five of these units as they were 'greenfield' (new) units; and another five due to duplication of the technology choices they had made. And 24 units, as anticipated, dropped out before the baseline studies could be conducted. Table 2 lists out the number of units from different clusters that were finally selected for conducting the baseline studies.

Thus, the first 'proof' came by way of these 350 units, which opened their gates for the collection of baseline data!

Implementation of EETs

The crux of the project was in the implementation of EETs. The main tasks associated with implementation are as listed below.

- Conduct baseline studies in all 350 units.
- Analyse baseline reports and identify appropriate technologies or technology packages for each of these units.
- Provide technical assistance to each unit depending on the EET/s chosen by it.
- Ensure the technology vendor delivers and installs the customised EET/s, wherever applicable, in each unit.

TABLE 2

NUMBER OF SRRM UNITS ENROLLED FOR THE UPSCALING PROJECT

Sl no.	*Cluster*	*No. of units in the cluster*	*No. of units targeted*	*No. of units submitted EoIs*	*No. of units approved by the project*	*No. of approved units for baseline studies after 24 dropouts and rejection*
1	Mandi Gobindgarh	250	90	87	87	84
2	Ludhiana (Ludhiana and Kalamb)	120	20	21	20	18
3	Raipur	200	60	50	49	46
4	Nagpur (Nagpur and Indore)	100	30	33	32	31
5	Coimbatore (Coimbatore and Palakkad)	60	20	24	22	19
6	Mumbai (Wada, Nashik, Goa, and Silvassa)	60	20	21	20	18
7	Ahmedabad (Bhavnagar, Ahmedabad, Sihor, and Kutch)	150	45	44	44	42
8	Jalna (Jalna and Aurangabad)	40	10	14	13	11
9	Kolkata (Kolkata, Durgapur, Giridh, Jamshedpur, and Bokaro)	60	20	20	20	18
10	Chennai (Chennai, Hosur, and Salem)	60	20	20	19	19
11	Guwahati (Guwahati and Shillong)	25	10	10	10	10
12	New Delhi (New Delhi, Jaipur, Bhiwadi, Ajmer, Muzaffarnagar, and Haridwar)	50	35	39	37	34
	TOTAL	**1175**	**380**	**383**	**373**	**350**

ENROLLING 300 UNITS: A FIRST PERSON ACCOUNT

Manisha Sanghani
Programme Associate, UNDP

The challenges that we faced in the second phase of the Steel Project were more or less the same. The first and foremost was to convince the decision makers (SRRM unit owners) for investing in energy efficiency. Being an unorganised sector filled with family-owned units running for generations, it was extremely difficult to change the mindset of the owners.

The needs of each of these unit owners were different due to difference in the size of units, raw material used, product, technology being used, etc. For UNDP, it was important to understand all of them and we had to come up with something that was acceptable to all so that these unit owners accept us as someone who is there only to help them out and there are no other hidden interests.

In this phase, however, we were in a slightly advantageous position because of the assets we created in the first phase. Our main assets from the first phase were (a) the 34 model units located in different clusters, (b) the level of credibility that we established with SRRM associations and through them, (c) proven technologies and technology packages, and (d) the knowledge products in the form of technical manuals, books, and video films.

Despite being in possession of all the above, the team had to really work hard to convince 380 individual unit owners to sign up for the project. Though found in clusters, these units were not well connected with each other in terms of sharing knowledge and good practices, etc. As a first step, we organised one or two cluster-level meetings where potential new unit owners got opportunities to interact with model unit owners, SRRM association members, and our technical experts. During these meetings, our technical experts made presentations, distributed the knowledge products, and were also shown the video films of the model units. The model unit owners played the advocacy role to perfection, due to which there were many new takers from these clusters. The presence of members from SRRM associations helped in dispelling the doubts of many newcomers, including that of UNDP's role in the project.

In addition, in each cluster, we roped in local agencies working on energy efficiency issues to help promote this project. For example, the awareness programmes conducted by the National Institute of Secondary Steel technology (NISST) and Punjab State Council for Science and Technology (PSCST) helped in building the confidence of potential newcomers into the project in Mandi Gobindgarh cluster.

In some cases, our technical experts visited individual units and suggested solutions for improving their productivity and reducing their energy consumption. These efforts did help in gaining their trust.

Seeing is believing! True to this saying, we organised several exposure visits for potential unit owners. They were taken to some of the model units where EETs have been installed and running.

Once they found merit in joining this project, things started falling in their places. And it reflected in 380 unit owners from across the country wanting to sign up for the Upscaling project.

Stills from the 'Awareness Programme on Lean Manufacturing Competitiveness Scheme of DC-MSME, Government of India, held at Khanna, Punjab, for Secondary Steel Re-Rolling Mills. The programme was organised by the National Productivity Council, Chandigarh, in association with MSME-Di, Ludhiana. Technical experts from UNDP and Punjab State Council for Science and Technology used this opportunity to interact with SRRM unit owners and foremen through presentations and other means.

SRRM unit owners from Ludhiana and nearby places participating in the programme

Mr Pritpal Singh, PSCST, interacting with the participants

Foremen of SRRM units participating in the programme

Ms Neelima Jerath, Executive Director, Punjab State Council for Science and Technology addressing the participants

Mr Arindam Mukherjee, Former Project Manager (Technical), PMU, addressing the concerns of mill owners and explaining the benefits of joining the project

- Build capacity of workers, including foremen, in these units with respect to use and management of the EETs.
- Conduct post-implementation studies.
- Analyse the project impact in each unit.

Baseline studies, analysis, and the waiting game!

Soon after the approval of 350 units, the cluster-level agencies (CLAs) entrusted with the task of carrying out the baseline studies in their respective clusters got into the act. The National Institute of Secondary Steel Technology (NISST), the North India Technical Consultancy Organisation Ltd (NITCON), and the National Productivity Council (NPC) did the baseline studies for all 350 SRRM units; PricewaterhouseCoopers (PwC) carried out detailed energy audits in 10 induction furnace-based units for baseline data collection; DESL did the diagnostic study in 50 scrap based SRRM units.

The calculations for arriving at the calorific value of fuels used by the units were done using the guidelines of the Intergovernmental Panel on Climate Change (IPCC). Tables 3 and 4 show examples of benchmark data captured during the baseline studies and energy audits carried out in an SRRM unit and a second generation unit, respectively. In the case of IF units, only the specific power consumption (SPC) figures were captured.

In the energy audit carried out by PwC at one of the associated induction furnace units, the SPC was found to be 684.82 kWh/t.

Detailed analyses of such baseline data of all 350 SRRM units, 4 second generation units, and 10 IF units carried out by the respective CLAs revealed not only the existing energy consumption patterns but also a broad scope for potential energy savings and GHG emissions reduction through effective intervention of EETs and best practices. In the entire exercise

TABLE 3

BASELINE DATA OF AASHIANA ROLLING MILLS LTD, AHMEDABAD (SRRM UNIT), CAPTURED BY NPC

Parameter	*Baseline data*
Productivity (Mill output)	15.99 tph (tonnes per hour)
Annual production	57,564 tpa (tonnes per annum)
Type of fuel used	Pulverized coal
Calorific value (CV) of fuel	6166.35 kcal/kg (kilocalories per kilogram)*
Specific fuel consumption (SFC)	46.21 kg/t (kilogram per tonne)
Specific energy consumption (SEC)	1487.93 MJ/t (mega joules per tonne)
Specific greenhouse gas (GHG) emission (thermal)	0.11 tCO_2/t (tonnes of carbon dioxide per tonne of steel)
Specific GHG emission (electrical)	0.7 tCO_2/t of steel
Specific GHG emission (total)	0.19 tCO_2/t of steel
*IPCC value	

TABLE 4

BASELINE DATA OF T K STEEL ROLLING MILLS, LUDHIANA (SECOND GENERATION UNIT), CARRIED OUT BY NISST

Parameter	*Baseline data*
Productivity (Mill output)	7.08 tph
Annual production	25,488 tpa (tonnes per annum)
Type of fuel used	Pulverized coal
Calorific value (CV) of fuel	6166.35 kcal/kg (kilocalories per kilogram)*
Specific fuel consumption (SFC)	65.82 kg/t (kilogram per tonne)
Specific power consumption (SPC) (electrical)	65.77 kWh/t (kilowatt-hour/tonne)
Specific energy consumption (SEC) (total)	1936 MJ/t (mega joules per tonne)
Specific GHG emission (thermal)	0.161 tCO_2/t of steel
Specific GHG emission (electrical)	0.059 tCO_2/t of steel
Specific GHG emission (total)	0.220 tCO_2/t of steel
*IPCC value	

spanning over 8–9 months, the lead-linking task that would take the Upscaling Project to its logical next step was that of identifying the EETs for each of the units. The importance and uniqueness of this task was the understanding among the CLAs and the core project team that a 'one-size-fits-all' approach

Baseline audit in progress at Shree Prithvi Steel Re-rolling Mills, Jaipur

would not work in most cases. Although certain commonalities do exist among units within a cluster, the operation of each unit was different in several ways even among units within the same cluster. Hence, the CLAs, in consultation with UNDP and the PMU, suggested appropriate technology solutions to each of the units separately.

Also, through various communication means, the unit owners were made aware of the cost implications of each of the technology interventions, the estimated payback period for each of the technologies, and other benefits such as energy and cost savings. It was also made clear to them that there was no compulsion to implement the solution package in toto; they were free to implement either all or some of the EETs suggested to them, depending on their financial strengths and their confidence.

As the ball now was in the court of unit owners to invest money and implement the recommended technology/ies in their respective units, the general mood among officials of PMU and UNDP wore veils of both optimism and tension. The feeling of optimism stemmed from the hard work that had gone in thus far and the positive feedback received from scores of individual unit owners during the various interactive sessions. Because there was no way of knowing the thought processes of unit owners that lead to the stand they would eventually take added to the tension. What added to the negative feelings further was the unviable external environment for making fresh investments in the steel industry in general. The demand for steel products was at an all-time low and the steel industry, including the SRRM sector, was going through recession. This was an extremely critical period in the timeline of this project.

At the same time, the only silver lining in this dark phase was that if ever there was a period to experiment with new technologies, it must be during the lean production period. The current period serves well from that angle.

'Hope' is always a great game-changer during most crisis situations. It was no different this time too and the great expectations from the project played well for both parties here. For unit owners, it was the hope of doing better (better productivity, better final products, etc.) eventually when the market recovers from recession. For the project team, it was the hope of converting more small-scale steel re-rolling units in the country into energy-efficient ones and reducing the overall GHG emissions from the SRRM sector.

One good thing done by the project team this time around was to keep the communication channels open. The project team and its extended arms upped the ante and engaged themselves with individual unit owners constantly, clearing their apprehensions and giving them the confidence to invest and go for it. The WhatsApp platform provided by the project aided in the sharing of information among all stakeholders. The result of this constant engagement with unit owners is covered in the next sub-section on investments and deployment of EETs.

Investments on EETs

As stated in the previous section, baseline studies were carried out in 350 SRRM units; and energy audits in 10 IF units and 4 second generation units. Altogether, there were 364 units in the fray, ready of implementing the EETs suggested to them. All the same, it was also the time for unit owners to loosen their purse strings and make those investments in technologies. The promised incentives by the Ministry of Steel would come only later after the technologies have been duly implemented. The central idea of the Ministry of Steel to provide financial incentives was only to trigger the investment decisions of these unit owners and to help them stand on their own. To that extent, the Ministry of Steel succeeded in getting the units to make the initial investments! Table 5 gives details of financial assistance offered by the Ministry of Steel.

The information exchange and knowledge sharing that happened during this period between and among unit owners, and between unit owners and the project team, and between unit owners and the technology vendors were quite interesting and very encouraging from all points. Never before has this happened in any sector of the economy: competitors in the marketplace discussing with each other the merits and demerits of each of the technologies that they want to invest in! The communication platforms initiated by the project such as WhatsApp group, e-mail groups, cluster meetings, and one-on-one meetings were abuzz with hectic parleys and activities! Moderated well by the project team with the support of resource persons and CLAs, conventional wisdom of many of the unit

TABLE 5

DETAILS OF FINANCIAL ASSISTANCE OFFERED BY THE MINISTRY OF STEEL

Technology group	*Applicability*	*Target area*	*Financial assistance*	*Maximum amount per unit*
Group 1A	SRRM – low end technology	Pan India	20% of capital cost or consultancy fee or both	*Rs 2 lakh*
Group 1B	SRRM – low end technology	Pan India	20% of capital cost or consultancy fee or both	*Rs 2 lakh*
Group 2	SRRM – low end technology (Mini scrap-based mills)	Bhavnagar/ Indore/Mandi Gobindgarh/ Bhiwadi/ Lucknow/Raipur/ Kolkata/Nagpur	20% of capital cost or consultancy fee or both	*Rs 2 lakh*
Group 3	SRRM – high end technology (Direct rolling)	Pan India	20% of capital cost or consultancy fee or both	*Rs 5 lakh*
Group 4A	Induction furnace (Model)	To be selected	20% of capital cost	*Rs 40 lakh*
Group 4B	Induction furnace (Pipeline)	To be selected	20% of capital cost or consultancy fee or both	*Rs 5 lakh*
Group 5	SRRM - New generation technologies	Pan India	20% of capital cost	*Rs 20 lakh*

owners that dominated the SRRM industry for ages gradually paved the way for collective wisdom and action!

The 'proof' of this was that out of 364 units that underwent baseline studies, 287 units decided to invest and go for the 'change'. The break-up of this number is as follows:

- SRRM units - 280 (out of 350 units)
- Induction furnace units - 4 (out of 10 units)
- Second generation units - 3 (out of 4 units)

That is, 70 SRRM units, 6 IF units, and 1 second generation unit backed out due to various reasons. The prominent reason among those was lack of funds. The project team did make efforts off and on to bring them back, but lack of time prevented the project team from pushing them beyond a point.

The previous chapter gave a detailed account of the different groups of technologies that were being promoted through this project. When it came to adoption of these technological options, a clear choice was made by a large number of units, as can be seen from Table 6.

It was quite understandable as to why 255 SRRM units out of 280 units had opted for low-end technological options provided under Groups 1 and 2. However, the number that stunned the project team was the remaining 25! These 25 unit owners had opted for the state-of-the-art direct rolling technology, offered under Group 3! It also meant investments to the tune of a few crores of rupees from each unit! Credit to the unit owners, the total investments put together in EETs touched close to Rs 85 crore!

TABLE 6

TECHNOLOGY GROUPS ADOPTED FOR IMPLEMENTATION BY UNIT OWNERS

Technology group	*Applicability*	*Adopted for implementation by units*
Group 1A	SRRM – low-end technology	215 (both 1A & 1B)
Group 1B	SRRM – low-end technology	
Group 2	SRRM – low-end technology (Mini scrap-based mills)	40
Group 3	SRRM – high-end technology (Direct rolling)	25
Group 4A	Induction furnace (Model)	4
Group 5	SRRM – New generation technologies	3
Total		**287**

That is a remarkable achievement in the investment history of any small-scale industry sector in the country, that too in such a short period of time!

Deployment of EETs and capacity building

Once investments started flowing in from unit owners, the technology vendors and the capacity building team of PMU swung into action in no time. Some of the technologies, which were available off the shelf, were installed in the first go. Others, which needed customisation based on each individual unit's requirement took some time. Throughout this phase till the complete installation of EETs in all the units, the PMU played an active role of pushing the technology vendors for timely delivery and installation. It was an act very much appreciated by the unit owners and also the one that showed the commitment of the project team towards the project.

Equally appreciated was the numerous capacity building programmes organised by the project team to facilitate quicker operationalisation of the EETs deployed. The technology vendors also played their part well in imparting training at the unit level on the functioning of the technologies installed. The technical expertise available at PMU came out in full force to ensure that the EETs worked well within the specified parameters. They also ensured that the foremen and other workers were fully equipped to handle, manage, and operate the technologies deployed at each of the units.

Post-implementation study and project impact

Beginning July 2015, the post-implementation studies in each of the units were carried out by designated CLAs in about 6 months. Over a period of two days in each unit, the agencies selected for post-implementation measurements collected the same data as collected during baseline studies on each of the days and the average of the two-day observations was taken as the final data for the unit. The numbers thus collected from each unit were corroborated and endorsed by the field managers (FMs) of CLAs, project staff of PMU, and the unit owners too, as was the case during baseline studies.

At this stage also, 14 SRRM units backed out from doing the post-implementation study due to reasons best known to them. That reduced the total number of SRRM units to 264. Four IF units and 3 second generation units stayed true till the end. So the final tally stood at 271 units, still a respectable number. In terms of percentage, it is over 90% of the initial target of 300 units.

In terms of impact, the post-implementation study results and analysis showed some incredible numbers:

- About 15%–20% average reduction in specific energy consumption from the baseline data in individual SRRM units.
- Emissions reduction to the tune of 500 tCO_2 a year (average) in individual SRRM units.
- About 40% reduction in SEC in second generation units from the baseline data.
- About 40% reduction in GHG emissions in second generation units with respect to baseline figure.
- Energy savings of about 70 TJ a year in IF units from the baseline figure.
- Savings in specific power consumption (SPC) of about 93 kWh/t, that is, about 13% in an IF unit.

There are several soft impacts as well. All that will be discussed in the last chapter.

The six case studies presented at the end of this chapter give credibility to the numbers stated above. Table 7 gives the list of units whose case studies feature in this chapter. One unit from each of the technology groups has been chosen for these studies.

TABLE 7

LIST OF CASE STUDY UNITS BASED ON THE TECHNOLOGY ADOPTED BY THEM

Sl no.	*Name of the unit chosen for the case study*	*Technology group adopted by the chosen unit*
1.	Steel Rolling Mill of Maharashtra, Thane	Group 1A (SRRM – Low-end technology)
2.	Royal Ispat Udyog, Mandi Gobindgarh	Group 1B (SRRM – Low-end technology)
3.	Boparai Steel Rolling Mills, Mandi Gobindgarh	Group 2 (SRRM – Low-end technology for mini scrap-based units
4.	Agarwal Channel Mills Pvt. Ltd, Raipur	Group 3 (SRRM – High-end technology – Direct rolling
5.	Durgapur Iron and Steel Co. Pvt. Ltd, Burdwan	Group 4A (Induction furnace)
6.	T K Steel Rolling Mills Pvt. Ltd, Ludhiana	Group 5 (SRRM (Second generation technologies)

PEER PRESSURE LEADING TO INVESTMENTS IN ENERGY-EFFICIENT TECHNOLOGIES

Manisha Sanghani, Programme Associate, UNDP

Once 380 SRRM units expressed their interest in joining the project, the challenge that followed was of conducting baseline studies in all. That too, in a span of about 6–8 months as per the implementation plan that was charted out in the beginning!

Going forward, a cluster-level agency (CLA) was appointed in each cluster to coordinate with each of the units in that cluster. These CLAs, in turn, appointed a field manager (FM) for each cluster. Stationed in the respective clusters, FMs were given the task of coordinating the baseline studies for the units in those clusters with the unit owner, their respective CLA, and the concerned project manager at UNDP.

The base line studies were duly completed and as a parallel exercise, analyses were also carried out by UNDP and the FMs. Based on the results of the analysis, the project identified and suggested different technologies or technology packages for each of the 380 units. Thereupon, it was left to each unit to make the necessary investments in the EETs or EET packages prescribed for them. As anticipated by the Project Team, a few of them backed out at this stage due to financial burden.

An extraneous challenge was that India's economy was not doing well overall at that time and the steel sector, in particular, was in the red. So, convincing the unit owners to invest in EETs was tougher. The response to this was that for the units to stay competitive in the industry, investing in EETs was the only option for them.

Organising exposure visits to units that have implemented some of these EETs helped in clinching the deal with some of the units. But what seemed to have worked really was the strategy of connecting the units through electronic networks such as WhatsApp and email group. Prompted by the project's technical experts, unit owners started discussing issues related to technologies, benefits of implementing a particular technology, the cost involved, the payback period, etc.

The news of a unit implementing a particular technology was shared by none other than the unit owner himself. This kind of sharing of information was unheard of in the SRRM sector till a few years ago! Here, information is being exchanged not only within the cluster, but beyond the cluster as well! Many units followed suit thereafter and the chain reaction gathered momentum sooner than later.

Now these mill owners are connected to each other and are sharing information and knowledge with each other without our involvement! The awareness has dawned on these mill owners that to survive in this competitive world, their units have to be energy-efficient and they have to stay united.

The propeller of the project: coordination

The seemingly impossible objectives of the project could not have made possible without the invisible and visible roles played by the heads of the project. A strong coordination part was played by the PMU, which acted as the centre point. Like the 'eye of a storm', the core of PMU and UNDP staff appeared stationary, but it was responsible for all the actions around it. Always available when needed on the ground, UNDP guided the PMU efficiently and effectively too. The invisible hand of the Ministry of Steel in taking the project forward was gratefully appreciated by all stakeholders. The Ministry kept track of the project at regular intervals and gave adequate support at all times to UNDP for the smooth implementation of the project.

Being at the fore front of implementation, the PMU was always in the thick of things. Some of the specific tasks carried out by them with respect to coordination are as listed below:

- Coordination with unit owners at three levels: (a) with potential SRRM unit owners in various clusters in the beginning, (b) with those unit owners who have given their expressions of interest (EoIs) to join the project, and (c) with those who have finally signed up for the project.
- Coordination with cluster-level agencies that were recruited for conducting baseline and post-implementation audits in the various clusters.
- Coordination with technology vendors to ensure timely delivery of EETs and customised solutions designed for each unit.
- Coordination with the promotional strategy adopted for the project.

To achieve all this, PMU adopted a 'systems-based' approach. This includes putting in effective checks and balances in the monitoring and evaluation (M&E) system, reporting system, communication system, delivery of technical assistance, etc.

To begin with, each unit was given a specific code, which made communication faster not only within the project team, but also between the project team and FMs/CLAs and between CLAs and FMs. For example, SG06 represented Premium Bars Pvt. Ltd in Jaipur, which is a second generation unit. Similarly, IF03 represented the induction furnace unit, Durgapur Iron and Steel Co. Pvt. Ltd, in Durgapur. And AH06 represented Vinayak TMT Bars Pvt. Ltd, an SRRM unit in the Ahmedabad cluster.

Within the PMU, project managers were assigned the responsibilities of different clusters and coordinating with both unit owners and the respective CLA appointed solely for executing the plans. For instance, one project manager was assigned the responsibility of overseeing the operations of a few clusters in northern India, another project manager for a few clusters in the southern region, etc. The FMs stationed in the various clusters would report to the respective CLA, which, in turn, would report to the project manager.

As for the M&E system, there were regular field visits to various clusters by either project managers or technical managers to take stock of the situation on the ground. Meetings at regular intervals took place not only within the PMU, but also with FMs, cluster managers, unit owners, technology vendors, etc.

The reporting system kept track of the progress of the project. The FMs in each cluster, who are basically the front face of the project, did most of the 'running around' tasks within the cluster allocated to them. Organising meetings at the cluster level to encourage unit owners to join the project, convincing the unit owners from that cluster to participate in those meetings, reporting on the outcomes of those meetings, etc. were all diligently carried out by the FMs. They filed weekly reports to the concerned project manager in PMU and to the CLA, which he is part of. The issues faced by the FMs during the course of his daily tasks were flagged in these weekly reports. This system helped the project managers and the CLAs to address the issues immediately and remove the bottlenecks for the project to move forward.

In all the cluster meetings organized by the FMs, representation from the PMU through project managers or technical assistants, UNDP, and officials from the CLAs was ensured. The vendors of EETs were also invited to these meetings to talk about their technologies and customisation. The reporting system had ensured that whatever transpired in those meetings were recorded and filed through the 'back-to-office reports' or BTORs. A typical BTOR as to how it looks like and what all information it carries is given in Annexure 1. The issues that needed the intervention of senior officials of the project, UNDP or Ministry of Steel were quickly attended to and resolved.

The records in PMU show that in the initial months, scores of cluster meetings were organized in different parts of the country. Each of these meetings had participation of potential unit owners, foremen, technology vendors, members of SRRM associations, local agencies, and other stakeholders. In some cases, there were more than two cluster-level meetings held to convince the unit owners to be a part of this project.

Combined with the promotional strategy, these efforts ensured that 369 SRRM units took the plunge and signed up showing their expressions of interest, within the first six months itself.

The photo feature in the subsequent pages gives a glimpse of interactions that have happened at various levels during the course of the project period.

Mr S Abbasi, Joint Secretary, Ministry of Steel, addressing the gathering at the National Conference on Cost Optimisation in Secondary Steel Sector, held on 10 March 2014, New Delhi, and organised by All India Induction Furnaces Association and UNDP.

Induction furnace unit owners from across the country in rapt attention during the National Conference.

Mr Srinivasan Iyer, the then Assistant Country Director, UNDP India, delivering his address at the National Conference

Mr A C R Das, Former Industrial Advisor, MoS addressing the gathering

Dr S N Srinivas, Programme Analyst, UNDP, and In-Charge of the Steel Upscaling Project

Mr Arindam Mukherjee, Former Project Manager (Technical), PMU on the dais with other speakers

Leading induction furnace unit owners of the country engaged in a brainstorming session

A technology vendors' meet in progress in Bhavnagar

A project review meeting being addressed by Mr A C R Das and Dr S N Srinivas

A briefing meeting on financial incentives offered by the project through the Ministry of Steel, Government of India

A cluster meeting at Bhiwadi, Rajasthan

A cluster meeting at Bhiwadi, Rajasthan

A cluster meeting at Bhiwadi, Rajasthan

A cluster meeting in Ludhiana, Punjab

Mr S K Jain, Former Additional Director, Punjab State Council for Science and Technology, at the cluster meeting in Ludhiana, Punjab

Participation of unit owners in the Ludhiana cluster

A cluster meeting in Mandi Gobindgarh, Punjab

A cluster meeting in Muzzaffarnagar, Uttar Pradesh

Training programme for field managers organised by NISST at Mandi Gobindgarh

Meeting of domestic equipment manufacturers and consultants of steel re-rolling mill sector, New Delhi

Stakeholders at the meeting of domestic equipment manufacturers and consultants of steel re-rolling mill sector, New Delhi

Field managers of the project after their training programme

Mr Sathis, Former Project Manager (Technical), PMU, addressing the field managers

Mr Surva Majumdar, Former Field Manager, addressing the field managers

Mr Haoliang Xu, Assistant Administrator & Director, Regional Bureau for Asia and the Pacific visiting M P K Steels (I) Pvt. Ltd, Jaipur, on 14 December 2013.

The PMU and UNDP teams at the first stakeholder meeting for induction furnace unit owners

THE STORY OF SMALL-SCALE STEEL RE-ROLLING MILLS IN BHAVNAGAR, GUJARAT

The steel re-rolling mills cluster in Bhavnagar (Gujarat, India) finds its roots in the ship upcycling industry, which functions as the primary source of raw material – the 'scrap' steel plates. In recent times, a segment of the industry has evolved to more modern and process-oriented practices with use of ingot, billets, and continuous casting machines. However, small-scale (less than 5 tonnes per hour) units continue to dominate the SRRM scenario in Bhavnagar. Majority of these units are located in clusters like Sihor, Tansa, Mamsa, Vartej, and so on.

Bhavnagar provides an outstanding example of the need for handholding of small-scale steel units, and how this eventually leads to building trust and transformation to sustainable production practices. Bhavnagar cluster, for multitude of reasons, lagged behind in the adoption of energy saving technologies like recuperator, anti-friction roller bearings, and use of sensors.

With the support of the Steel Upscaling Project, a group of 10 mill owners was taken for an exposure visit to units of similar scale of operations where such technologies were already running successfully. Organizing vendor meets ensured door-step availability of energy saving solutions for an otherwise unexplored cluster. The cluster now boasts of implementation of some of the finest technological installations in recuperators, high efficiency burners, energy efficient pulverizers and coal firing systems, advanced rolling technologies, and so on, collectively leading to a self-sustained drive and enthusiasm in the cluster towards efficient and cleaner production practices.

TURNAROUND IN SALUJA STEEL, KOLKATA

Saluja Steel in Giridh, Kolkata, which was operating on coal gasifier, was critically hit due to increasing production cost and low market demand. The unit had to restrict its production to single shift from continuous operation, which impacted the livelihoods of contract labourers.

After the baseline study and analyses of the data, the Upscaling Project decided to integrate technological innovation into the existing manufacturing value chain as a low carbon inclusive and sustainable growth strategy. Accordingly, the project team advised Saluja Steel to shift to an efficient pulverized coal-based firing system and also to revamp its recuperator. After the implementation of these suggestions, the unit was able to (a) arrest its thermal loss, (b) reduce its burning loss, and (c) lower the production cost drastically, thus ensuring sustainability of the mill operation.

Suvra Majumdar
Former Field Manager, Kolkata Cluster

ASHOK STEEL INDUSTRY MANDI GOBINDGARH

Gourav Jain
Owner, Ashok Steel Industry
Mandi Gobindgarh

We have two rolling mills: one makes strip and the other makes flat. We became aware of energy efficiency issues through the initiatives of the Punjab State Council for Science and Technology (PSCST). One of our mills participated in the first phase of the MoS–UNDP–GEF Steel Project and we have actually benefitted from the energy efficiency interventions made there. In the first mill, our fuel consumption got reduced by about 10%, which led to lesser pollution from our mill. So, when the second phase of the project began, we were quite excited to be a part of it and our second unit got enrolled in it.

In terms of technologies implemented in the second phase, we have modified the re-heating furnace with proper insulation, installed variable frequency drives (VFDs), etc. Our fuel consumption has considerably reduced after modifying the furnace and installing the VFDs. The training programmes organised by the project on various aspects of operating a mill have really helped us. Today, even floor-level workers are aware of ISO 9000 operational practices, 5S, etc.!

Overall, this initiative of the Ministry of Steel and UNDP needs to be appreciated. Because of the seminars and outreach efforts by the project, the awareness level on the benefits of using new technologies and operational practices has considerably increased within the SRRM sector. This has helped many units in our cluster to adopt new technologies and processes. A few years back, the pace of implementation of such reforms taking place in rolling mills was slow, but now it has picked up. We get to know of the new technologies pretty fast and then it is up to us whether to go for it or not. At least, information on such technologies reaches us well in time. And we also learnt about the consequences of greenhouse gas (GHG) emissions and the role we need to play to cut down on emissions.

Within the cluster, many neighbouring units have asked me about the new things we are implementing in our unit. I shared with them the knowledge I have gained and directed them to the project coordinator from UNDP in our cluster. Some of them have taken up energy-efficiency initiatives voluntarily too, not waiting for the project to reach out to them.

As far as GHG emissions are concerned, as we use less fuel now, there will be lesser emissions of carbon dioxide from our unit. If you look at our cluster, there has been considerable reduction in emissions in the past two years. On a lighter note, I would say that the life expectancy of the people of Mandi Gobindgarh may have increased by two years because of lesser pollution!

ROYAL ISPAT UDYOG MANDI GOBINGARH

Sanjiv Sood
Royal Ispat Udyog, Mandi Gobingarh

We were a bit reluctant to join the first phase of the Steel Project (MoS–UNDP–GEF) as things were not clear on certain aspects such as subsidy. Misinformation was also spread by some people in the industry who were part of this project that there was nothing new in it! Information regarding meetings organised by the first project never got to us too.

But later we came to know through our sources that the technologies and the capacity building programmes promoted by the first project were actually producing results for those participated in it! Therefore, we did not want to miss out on the second phase. We started participating in all the meetings organised by the Upscaling Project to gather more information about what all were on offer in terms of technologies and others.

After learning and understanding more about the technologies on offer, we went in for variable frequency drive (VFD), control panel, tilting table, and two-stand roller bearing. As for benefits, our burning loss and the use of coal per tonne of steel production have come down. By using the tilting table, we have been able to save time by about 35%. This has resulted in the reduction of electricity consumption. For example, in my unit, where the average consumption is less than 60 units of electricity for one tonne of production, other units in the cluster consume about 70–75 units. Moreover, the training given by the project to our foreman and other workers has really helped. Because of all these, there is no denying the fact that saving energy has led to increased profits for us.

Going forward, as suggested by UNDP, we would like implement 5S in our units sooner than later. We have also heard of Direct Rolling technology in one of the awareness generation workshops. We will understand more about it in terms of the chemical properties of the final product coming out of this technology and see if the technology would of beneficial to us.

We are able to survive in the highly competitive market due to the savings in fuel and better operational practices implemented with the help of the information and knowledge shared by the project team. We wholeheartedly thank UNDP, Ministry of Steel, Punjab State Council for Science and Technology, and others involved in these projects.

JITENDRA ENGINEERING CORPORATION, DELHI

Gurjeet Singh, Delhi

We have been manufacturing rolling mills for the past 40 years. We have supplied rolling mills to over 200 different types of rolling mill units so far.

To stay alive and keep competing in this tough market, it is important that we stay 'energy-smart'. Therefore, we make our machines keeping in mind the 'energy consumption' factor. The machines we supply to the industry help them to stay competitive in the market. The technologies that we supply today will not only meet the current demands of energy efficiency, but also will sustain for the next 10 years.

I am glad to see that a lot of efforts are being made by the industry to modernize their rolling mills. Today, the industry's requirement is changing: everyone wants modern energy-efficient technologies (EETs). It is a challenge for manufacturers like us...we have no option today, but to change ourselves and deliver high-quality EETs to today's mill owners.

For the change that we see today, we must appreciate the decade-long MoS–UNDP–GEF Steel Project. The awareness levels among the mill owners on the energy front have gone up tremendously. From just 34 units that participated in the first project, the second phase (UNDP–DFAT–MoS Upscaling Project), saw about 300 units willingly participating in the programme. That too in just two years' time! I would say that the industry opting for energy-efficient means of production is gaining momentum in the country.

For the steel re-rolling mill sector, this phase of development should not stop at this time when there is a positive response from the industry to change and innovate. This is the time to further spread the efforts to other rolling mills in the country. The efforts of the Ministry of Steel and development agencies should go on and quickly cover the whole sector. We must understand that it took almost 15 long years for the government and development agencies to bring the SRRM sector industry on the path of modernization. The momentum that has been built over the years should be allowed to continue.

PEARL STEEL ROLLING MILL MANDI GOBINDGARH

Tara Singh, Foreman

I have over 25 years of experience as a foreman in a rolling mill. Today, I am witnessing a lot of changes in the operational procedures. New technologies have been introduced in our unit. A lot of things that we used to do manually earlier are being done by machines today. Safety aspects of our workers have improved tremendously. Today we save a lot of time too in many of our production activities. Due to automation, I need not run around the mill all the time! Managing the workers has become a lot more easier.

I have been attending the training programmes organised by this project and I have learned a lot from these training sessions. Also, my interactions with foremen from other units who participated in these programmes have helped me in gaining new knowledge and good practices. Because of all these, our maintenance practices have improved considerably.

For me, any improvement in technologies or processes should result in increased productivity. That I have seen today: a unit that used to produce 4–5 tonnes of finished product a day, today produces 20–25 tonnes a day!

CASE STUDY 1

STEEL ROLLING MILL OF MAHARASHTRA, WADA, MAHARASHTRA

Situated in Thane district with its head office in Mumbai, the Steel Rolling Mill of Maharashtra is owned by Mr Vikas K Gupta. The unit produces mild steel (MS) plates, angles, bars, and rods.

The National Productivity Council (NPC) was engaged by UNDP/PMU to carry out the baseline study for this unit. The baseline study was conducted over two days, 19 and 20 August 2014. The average of these two days' observation was taken as the baseline data for the unit.

Upon analysing the baseline data, the PMU suggested to the unit a range of technology options. Among those, the unit opted for oxygen-based automation and control system. Costing in the range of Rs 5–10 lakh, this control system can be easily installed in about two to three months. The cost can be recovered in less than 6 months as well.

After duly implementing the same, another study was conducted over two days (11 and 12 August 2015) by the Confederation of Indian Industry (CII). The CII collected the data on the same baseline parameters. The average of the two days' of data collected was taken as the final post-implementation data. The baseline, post-implementation, and the project impact figures are captured in the table below.

Parameter	*Baseline data captured by NPC (based on mill output)*	*Post-implementation data captured by CII (based on mill output)*	*Project impact*
Fuel type	Pulverized coal	Pulverized coal	-
Productivity	7.09 t/h (tonnes per hour)	6.33 t/h	-
Annual production[1]	25,524 t/y (tonnes per year)	22,788 t/y	-
Calorific value (CV)[2] of fuel	6166 kcal/kg (kilocalories per kilogram)	6166 kcal/kg (kilocalories/kilogram)	-
Specific fuel consumption (thermal)	91.85 kg/t (kilogram per tonne) [2371 MJ/t (million joules per tonne)]	75.49 kg/t [1949 MJ/t]	-

Parameter	*Baseline data captured by NPC (based on mill output)*	*Post-implementation data captured by CII (based on mill output)*	*Project impact*
Specific power consumption (SPC) (electrical)	129.96 kWh/t (kilowatt-hour per tonne) [468 MJ/t]	129.72 kWh/t [467 MJ/t]	-
Specific energy consumption (SEC) (Total)	**2839 MJ/t**	**2416 MJ/t**	**Reduction of SEC (total) by 423 MJ/t (*14.91% SEC reduction*)**
Specific carbon dioxide (CO_2) emissions (thermal)	0.224 tCO_2/t (tonnes of carbon dioxide per tonne)	0.184 tCO_2/t	-
Specific CO_2 emissions (electrical)	0.117 tCO_2/t	0.117 tCO_2/t	-
Specific CO_2 emissions (Total)	**0.341 tCO_2/t**	**0.301 tCO_2/t**	**Reduction of GHG emissions by 0.040 tCO_2/t (*Emission reduction by 11.77%*)**

[1] Assuming 12 hours per day and 300 days per year of operation.
[2] The CV of fuel is calculated based on IPCC Volume 2, Chapter 1, Page 1.18, Table 1.2, NCV = 25.8 TJ/Gg.

With respect to baseline annual production, the unit is expected to experience energy savings of about **10.5 TJ/y** and emission reduction to the tune of **1025 tCO_2/t a year**.

Vikas Gupta, Director
Steel Rolling Mill of Maharashtra

It gives us immense joy and pleasure to announce that sustained use of oxygen-based automation and control system at our unit has ushered in substantial energy savings by lowering of our carbon dioxide emissions, ultimately resulting in reduction of our carbon footprint. We are open to and enthusiastic about more such environment-friendly initiatives for a cleaner and better future.

CASE STUDY 2

ROYAL ISPAT UDYOG, MANDI GOBINDGARH

Royal Ispat Udyog is located in Mandi Gobindgarh, Punjab. Owned by Mr Sanjiv Sood, Mr, Jayant Data, and Mr Sanjay Gupta, Royal Ispat produces MS flats.

The National Productivity Council (NPC) carried out the baseline study for this unit on 25 and 26 June 2014. The average of these two days' observation was taken as the baseline data for the unit.

Among the technology options offered by the project upon analysing the baseline data, the unit chose to install (a) tilting table, (b) energy-efficient pulverizer, and (c) a revamped furnace. All put together, the investment ranged from Rs 1.6 crore to 2.2 crore, with an installation period of about six months and payback period of one year.

After duly implementing the same, the North India Technology Consultancy Organisation Ltd (NITCON) conducted a study on 19 and 20 June 2016. The average of the two days' of data collected was taken as the final post-implementation data. The baseline, post-implementation, and the project impact figures are captured in the table below.

Parameter	*Baseline data captured by NPC (based on mill output)*	*Post-implementation data captured by NITCON (based on mill output)*	*Project impact*
Fuel type	Pulverized coal	Pulverized coal	-
Productivity	10.2 t/h	12.31 t/h	-
Annual production[1]	36,720 t/y	44,316 t/y	-
Calorific value (CV)[2] of fuel	6166 kcal/kg	6166 kcal/kg	-
Specific fuel consumption (SFC) (thermal)	63.14 kg/t [1630 MJ/t]	55.35 kg/t [1429 MJ/t]	-
Specific power consumption (SPC) (electrical)	57.22 kWh/t OR [206 MJ/t]	51.27 kWh/t [185 MJ/t]	-
Specific energy consumption (SEC) (Total)	**1836 MJ/t**	**1614 MJ/t**	**Reduction of SEC (total) by 223 MJ/t (*12.12% SEC reduction*)**

Parameter	*Baseline data captured by NPC (based on mill output)*	*Post-implementation data captured by NITCON (based on mill output)*	*Project impact*
Specific carbon dioxide (CO_2) emissions (thermal)	0.154 tCO_2/t	0.135 tCO_2/t	-
Specific CO_2 emissions (electrical)	0.051 tCO_2/t	0.046 tCO_2/t	-
Specific CO_2 emissions (Total)	**0.206 tCO_2/t**	**0.181 tCO_2/t**	Reduction of GHG emissions by 0.024 tCO_2/t (*Emission reduction by 11.85%*)

[1] Assuming 12 hours per day and 300 days per year of operation.

[2] The CV of fuel is calculated based on IPCC Volume 2, Chapter 1, Page 1.18, Table 1.2, NCV = 25.8 TJ/Gg.

With respect to baseline annual production, Royal Ispat Udyog has acquired energy savings of about **8.17 TJ/y** and emission reduction to the tune of **895 tCO_2/t a year**.

Sanjeev Sood, Royal Ispat Udyog

We would like to thank the Ministry of Steel and the United Nations Development Programme for providing an opportunity to make our mills energy efficient.

Technical guidance extended by the project has helped us in understanding the importance of energy efficiency and its associated cost-benefits. Under the project, we have implemented energy-efficient pulverizer, tilting table, and revamped the furnace with effective insulation. This has resulted in significant reduction in fuel consumption and pollution level. The shop-floor training programmes organised by the project helped our workers understand the basic operational practices and 5S concept.

We request Ministry of Steel and UNDP to continue such initiatives for the benefit of the secondary steel sector.

CASE STUDY 3

BOPARAI STEEL ROLLING MILLS MANDI GOBINDGARH

Boparai Steel Rolling Mills functions from its unit in Mandi Gobindgarh, Punjab. Owned by Mr Jitender Singh, Parminder Singh, and Sukhdeve Singh, Boparai Mills is a scrap-based unit producing TMT bars of MS and LC grade.

The National Productivity Council (NPC) carried out the baseline study for this unit on 23 and 24 June 2014 and the average of these two days' observation was submitted as final baseline data for the unit in its report.

Among the technology options offered by the project upon analysing the baseline data, the unit chose to implement anti-friction roller-bearing stand and PID-based (proportionate integrated derivative-based) temperature control system. Costing altogether Rs 8–15 lakh for the technologies, their installation can be completed in just about two to three months. The payback period estimated is about six months.

After duly implementing the same, NITCON conducted its study on 19 and 20 June 2015. The average of the two days' of data collected was taken as the final post-implementation data. The baseline, post-implementation, and the project impact figures are captured in the table below.

Parameter	*Baseline data captured by NPC (based on mill output)*	*Post-implementation data captured by NITCON (based on mill output)*	*Project impact*
Fuel type	Pulverized coal	Pulverized coal	-
Productivity	2.48 t/h	2.12 t/h	-
Annual production[1]	8928 t/y	7632 t/y	-
Calorific value (CV)[2] of fuel	6166 kcal/kg	6166 kcal/kg	-
Specific fuel consumption (SFC) (thermal)	47.75 kg/t [1233 MJ/t]	39.88 kg/t [1030 MJ/t]	-
Specific power consumption (SPC) (electrical)	84.36 kWh/t [304 MJ/t]	81.45 kWh/t [293 MJ/t]	-

Parameter	*Baseline data captured by NPC (based on mill output)*	*Post-implementation data captured by NITCON (based on mill output)*	*Project impact*
Specific energy consumption (SEC) (Total)	1536 MJ/t	1323 MJ/t	Reduction of SEC (total) by 214 MJ/t (*13.9% SEC reduction*)
Specific carbon dioxide (CO_2) emissions (thermal)	0.117 tCO_2/t	0.097 tCO_2/t	-
Specific CO_2 emissions (electrical)	0.076 tCO_2/t	0.073 tCO_2/t	-
Specific CO_2 emissions (Total)	0.193 tCO_2/t	0.171 tCO_2/t	Reduction of GHG emissions by 0.022 tCO_2/t (*Emission reduction by 11.30%*)

1 Assuming 12 hours per day and 300 days per year of operation.
2 The CV of fuel is calculated based on IPCC Volume 2, Chapter 1, Page 1.18, Table 1.2, NCV = 25.8 TJ/Gg.

With respect to baseline annual production, Boparai Steel Rolling Mills is expected to save energy to the tune of **1.91 TJ/y** and reduce emissions by **195 tCO_2/t a year**.

Mr Jitendra Singh
Boparai Steel Rolling Mills

We installed anti-friction roller bearing stand and PID-based temperature control system through this project. We achieved tremendous amount of savings in thermal and electrical energy during our operation. Carbon emission was cut down by implementing the new furnace design suggested by Punjab State Council for Science and Technology (PSCST), the cluster-level agency appointed by the project. PSCST also provided us technical assistance in implementing these technologies. We would like to thank PSCST, UNDP, and the Ministry of Steel for selecting our unit for this project.

CASE STUDY 4
AGRAWAL CHANNEL MILLS PVT. LTD, RAIPUR

Owned and run by Mr Pradeep Goyal, Agrawal Channel Mills Pvt. Ltd is located in Sitara Industrial Growth Centre in Raipur, Chhattisgarh. The unit produces angles and channels of MS grade.

The National Institute of Secondary Steel Technology (NISST) carried out the baseline study for this unit on 8 and 9 June 2014. The average of these two days' observation was taken as the baseline data for the unit.

The unit chose to install state-of-the-art direct rolling technology. Implementing this high-end technology would involve an investment of Rs 1.5 crore to Rs 6 crore and installation period of about six to eight months. The estimated payback period is less than a year.

After duly implementing direct rolling technology, APITCO Ltd conducted a post-commissioning study on 28 and 29 May 2015. The average of the two days' of data collected was taken as the final post-implementation data. The baseline, post-implementation, and the project impact figures are captured in the table below.

Parameter	*Baseline data captured by NISST (based on mill output)*	*Post-implementation data captured by APITCO (based on mill output)*	*Project impact*
Fuel type	Pulverized coal	Pulverized coal	-
Productivity	7.81 t/h	11.09 t/h	-
Annual production[1]	28,116 t/y	39,924 t/y	-
Calorific value (CV)[2] of fuel	6166 kcal/kg	6166 kcal/kg	-
Specific fuel consumption (SFC) (thermal)	79.18 kg/t [2044 MJ/t]	- -	-
Specific power consumption (SPC) (electrical)	73.35 kWh/t [264 MJ/t]	62.02 kWh/t [223 MJ/t]	-
Specific energy consumption (SEC) (Total)	**2308 MJ/t**	**223 MJ/t**	**Reduction of SEC (total) by 2085 MJ/t (*90.33% SEC reduction*)**
Specific carbon dioxide (CO_2) emissions (thermal)	0.193 tCO_2/t	-	-

Parameter	*Baseline data captured by NISST (based on mill output)*	*Post-implementation data captured by APITCO (based on mill output)*	*Project impact*
Specific CO_2 emissions (electrical)	0.066 tCO_2/t	0.056 tCO_2/t	-
Specific CO_2 emissions (Total)	**0.259 tCO_2/t**	**0.056 tCO_2/t**	**Reduction of GHG emissions by 0.204 tCO_2/t (*Emission reduction by 78.48%*)**

[1] Assuming 12 hours per day and 300 days per year of operation.

[2] The CV of fuel is calculated based on IPCC Volume 2, Chapter 1, Page 1.18, Table 1.2, NCV = 25.8 TJ/Gg.

With respect to baseline annual production, Agrawal Channel Mills has acquired huge energy savings of about **58.62 TJ/y** and emission reduction to the tune of **5724 tCO_2/t a year**.

Pradeep Goyal, Agrawal Channel Mill Pvt. Ltd.

When the baseline study was conducted, we came to know that we could adopt direct rolling technology, which will help us save energy and lower our cost of production. When we were informed that the investment of about Rs 6 crore (with an installation period of 8 months) would be paid back in less than a year, we were immediately ready for the same. Many seminars were conducted by UNDP during this period, which helped us in implementation and manpower training. Every type of help was provided, both pre-implementation and post-implementation. Finally, in May 2015, we started the direct rolling facility at our plant and we did shut down the re-heating furnace forever. So far, we are very happy with the same and we are also getting a very smooth production.

I would like to thank the complete team of UNDP; the Ministry of Steel, Government of India; and Australian Department of Foreign Affairs and Trade (DFAT) for supporting us in this journey of making our plant an energy efficient unit.

CASE STUDY 5

DURGAPUR IRON AND STEEL CO. PVT. LTD, BURDWAN

Durgapur Iron and Steel Co. Pvt. Ltd is an induction furnace-based (IF-based) unit located in Burdwan district of West Bengal. With two induction furnaces (IFs) of 7 MT capacities each, the unit produces an average of 40,000 MT of MS ingots annually. The unit uses sponge iron (60%) predominantly as raw material, while scrap (30%) and pig iron (10%) form the next options.

PricewaterhouseCoopers (PwC) carried out the energy audit over a period of three days, from 1 August to 3 August 2014. Mr Sanjiv Kumar Ganeriwala, Managing Director of the unit, facilitated PwC in carrying out the energy audit.

Based on the results of energy audit, the unit implemented the following technologies suggested by the project: (a) Continuous casting machine for billet making, (b) Replacement of coil cradle of the old furnace, (c) Energy-efficient pumps, and (d) FRP blades in cooling tower.

Thereafter, Zenith Energy Services Pvt. Ltd conducted a post-commissioning monitoring study on 28 and 29 December 2015. The baseline, post-implementation, and the project impact figures are captured in the table.

Sanjiv Kumar Ganeriwala, Managing Director

We cannot thank UNDP enough for the flawless technical support that they have given us over the last couple of years. The awareness generation done by UNDP/PwC on new technologies and measures for the electric induction furnace (EIF) sector was indeed helpful. We were updated about all the important information regarding the product, including its features, payback time, and electricity consumption. We feel much better knowing that we have such an energy-efficient and less polluting induction furnace unit.

Parameter	*Baseline data captured by PwC through energy audits*			*Post-implementation data captured by Zenith Energy Services*			*Project impact*
	Furnace 1 (7 MT)	*Furnace 2 (7 MT)*	*Total*	*Furnace 1 (7 MT)*	*Furnace 2 (7 MT)*	*Total*	
Power consumption of induction furnaces	12029.95 kWh	23821.25 kWh	35851.20 kWh*	20449.00 kWh	20501.00 kWh	40950.00 kWh	
Power consumption of induction furnaces	43307.82 MJ	85756.50 MJ	129064 MJ	73616.40 MJ	73803.60 MJ	147420.00 MJ	
Production	16.76 MT	31.16 MT	47.92^	31.21 MT	31.37 MT	62.58 MT	
Average SPC of furnace	717.78 kWh/MT	764.48 kWh/MT	748.15 kWh/MT	655.21 kWh/MT	653.52 kWh/t	654.36 kWh/t	
SPC			**748.15 kWh/t**			**654.36 kWh/t**	SPC reduced by 93.78 kWh/t (*12.54% savings in SPC*)
SEC			**2693.33 MJ/t**			**2355.70 MJ/t**	SEC reduced by 337.62 MJ/t (*12.54% savings in SEC*)
GHG emissions			0.6733 tCO_2/t			0.5889 tCO_2/t	GHG emissions reduced by 12.54%.

*The number is derived by adding the power consumption figures of Furnace 1 and Furnace 2.

^Arrived at by adding the production figures of Furnace 1 and Furnace 2.

With the adoption of energy-efficient means of production that delivered substantial energy savings, the unit has carved for itself a sustainable future.

CASE STUDY 6

T K STEEL ROLLING MILLS PVT. LTD LUDHIANA

Owned and managed by Mr Lokesh Jain, T K Steel Rolling Mills Pvt. Ltd is an ideal role model for SRRM units in many aspects. Using ingots and billets, T K Steel produces rounds and hex.

Having implemented the TOPs system for effective furnace atmosphere control through automation after the baseline study, the unit opened its gates for other unit owners during exposure visits organized by the project team and facilitated sharing of information and knowledge on the technologies implemented by the unit.

The National Institute of Secondary Steel Technology (NISST) did the baseline study for this unit on 16 and 17 December 2014. The average of these two days' observation was taken as the baseline data for the unit.

The TOPs system implemented by the unit costs about Rs 18 lakh, with just about five days for its installation. The payback period estimated for this automation system is about 9 months.

After duly implementing the same, the North India Technical Consultancy Organization Ltd (NITCON) conducted a post-commissioning monitoring study on 4 and 5 December 2015. The average of the two days' of data collected was taken as the final post-implementation data. The baseline, post-implementation, and the project impact figures are captured in the table below.

Parameter	*Baseline data captured by NISST (based on mill output)*	*Post-implementation data captured by NITCON (based on mill output)*	*Project impact*
Fuel type	Pulverized coal	Pulverized coal	-
Productivity	7.08 t/h	7.03 t/h	-
Annual production[1]	25,488 t/y	25,308 t/y	-
Calorific value (CV)[2] of fuel	6166 kcal/kg	6166 kcal/kg	-

Parameter	*Baseline data captured by NISST (based on mill output)*	*Post-implementation data captured by NITCON (based on mill output)*	*Project impact*
Specific fuel consumption (thermal)	65.82 kg/t (1699 MJ/t)	58.03 kg/t (1498 MJ/t)	-
Specific power consumption (SPC) (electrical)	65.77 kWh/t (237 MJ/t)	60.43 kWh/t (218 MJ/t)	-
Specific energy consumption (SEC) (Total)	**1936 MJ/t**	**1716 MJ/t**	**Reduction of SEC (total) by 220 MJ/t (*11.38% SEC reduction*)**
Specific carbon dioxide (CO_2) emissions (thermal)	0.161 tCO_2/t	0.142 tCO_2/t	-
Specific CO_2 emissions (electrical)	0.059 tCO_2/t	0.054 tCO_2/t	-
Specific CO_2 emissions (Total)	0.220 tCO_2/t	0.196 tCO_2/t	**Reduction of GHG emissions by 0.024 tCO_2/t (*Emission reduction by 10.84%*)**

[1] Assuming 12 hours per day and 300 days per year of operation.

[2] The CV of fuel is calculated based on IPCC Volume 2, Chapter 1, Page 1.18, Table 1.2, NCV = 25.8 TJ/Gg.

With respect to baseline annual production, the unit is expected to experience energy savings of about **5.62 TJ/y** and emission reduction to the tune of **607 tCO_2/t a year**.

Lokesh Jain, Owner

I am happy to see the positive results of the Steel Upscaling Project in our unit. The projects initiated by UNDP and the Ministry of Steel have indeed opened up new technological platforms. New breakthroughs have been achieved, thanks to the interactive platforms being created at the national level. Like-minded individuals got a chance to interact with each other and many new possibilities emerged in an industry that was being run by age-old practices and beliefs. I am very happy to be a part of the platform and am keen on participating in the next project. Wish you all the best!

CHAPTER 7

RESULTS, IMPACTS, AND THE WAY FORWARD

All's Well That Ends Well.

All's Well That Ends Well is a common phrase in English language, used frequently for anything that ends well.

The phrase had its origins in 1546 when John Heywood included it in *A dialogue conteinyng the nomber in effect of all the prouerbes in the Englishe tongue*.[1] But it was William Shakespeare who immortalised it through his play titled, *All's Well That Ends Well* in 1601. Classified as a comedy in English literature, the play has 'conquering', 'seducing', 'betrayal', etc. as its recurring themes but ends on a happy note.

One might wonder what on earth has this play got to do with the Steel Upscaling Project!

Now bring the Project into the scene. And see the similarities between the project and the play!

- The protagonist of the play 'conquers' new territories in war; the project 'conquers' new areas of operation as in new clusters, induction furnace, and new technologies.
- The protagonist of the play 'attracts or tries to attract women'; the project campaigns aggressively, showcases the benefits of joining the project, and offers financial incentives to 'attract' potential unit owners.
- The protagonist was 'betrayed' by his close confidante, yet he moved on; in the project, several units backed out midway during the course of its execution, yet the project moved on.
- Despite all the tricky moments in the play, eventually it ends on a happy note; the project too has a successful completion in spite of all the challenges while running its course.

[1] http://www.phrases.org.uk/meanings/29800.html

The last similarity is reserved for the end of this chapter.

A comparison mandates to state the differences between the two as well. Here are the fundamental ones.

1. The project is 'real' in every sense of the term while the play is a piece of literature.
2. Unlike in the play, there are several 'winners' and 'heroes' in the project – steel mill owners, technology vendors, cluster-level agencies, consultants, steel mill associations, developmental agencies such as UNDP and Australian Department of Foreign Affairs and Trade (DFAT), the project management unit, and last but the most important, the Ministry of Steel, Government of India.

The following sections on results and impacts would justify as to why the Upscaling Project is considered successful.

RESULTS AND IMPACTS

'Results' define 'success'. Success is a 'relative' term and thus can be weighed only in relation to various challenges that one went through to attain it. Therefore, the results of the Upscaling Project have to be seen in that overall context. At the same time, impacts are tied to the results.

As mentioned in the beginning of this publication, the Upscaling Project had set rather 'ambitious' goals to achieve. Given below is a recap of the specific goals of the Upscaling Project.

- Drive 300 small-scale steel mills on to the path of energy efficiency.
- Rope in induction furnace-based units within the ambit of energy efficiency.
- Introduce second generation technologies in SRRM units.

The above goals were indeed ambitious if seen in the context of goals achieved in the first phase. The numbers shown below would reflect that.

- The target for the second phase was raised by almost 10 times. That is, from 34 mills in the first phase to 300 mills in the second phase.
- The second phase got just about 30 months to attain the target, while the first phase had a clean run of almost 120 months to achieve its target.
- In terms of funding, while the first phase received funding to the tune of 13.9 million USD, the funding support for the second phase shrunk to 4.37 million USD.

The other challenges faced by the Upscaling Project pertain to the then prevailing condition of the SRRM sector. These include the following:

- Poor market demand and raw material scarcity, which led many units to cut down production by almost 50%; some units had to even shut down temporarily.
- Low vendor base and lack of competitive energy efficient supply chain market, leading to decline in adaptation despite units being convinced about technology.
- Lack of skilled manpower, acting as hurdles for advance technology implementation such as furnace automation.
- Low-rate imports of semi-finished/finished products from neighbouring countries eating into the market share of domestic players.
- Low priority for energy efficiency.
- No analysis of energy consumption and absence of adequate information.
- Absence of technology database.
- Lack of supplier approach to customize technology to mill-specific design and operating practices.
- Reluctance of financial institutions (FIs) to finance energy-efficient projects of the SME sector due to lack of investment portfolio.

- Lack of exposure of the SME sector to prepare credit documents and business plans.
- Use of internal funds for backward integration or diversifying into other business.

Most importantly, the units had to implement the energy-efficient technologies (EETs) voluntarily as there was no mandatory rule to adopt EETs from the Ministry of Steel. Therefore, the outstanding achievements of the Upscaling Project, shown below, must be viewed in this overall scenario.

Specific results and impacts of the Upscaling Project

- Against a target of 300 units, the project achieved implementation of EETs in 287 units. That is about 96% of the target!
- While 255 units opted for low-end technologies or technology packages, what surprised many was the fact that 25 units went in for direct rolling technology, a high-end, state-of-the-art technology.
- Energy-efficient measures successfully piloted in four electric induction furnace units.
- Second generation technologies have been successfully tried out in three SRRM units.
- The interventions in these 287 units led to 24% reduction in specific energy consumption (SEC) from the baseline data. This would translate into an annual saving of 2274 TJ of energy for the country, which is equivalent to saving 631 million units of electricity. A back-of-the-envelope calculation says that about 3000 villages can be electrified with this kind of energy savings! In monetary terms, there is an overall saving of about 20 million USD a year if 24% energy saving is taken into account. This is a major impact.
- Each unit reduces 907 tCO_2 annually on an average. Extrapolating this figure to 287 units, the environment is benefitted by a reduction in GHG emissions by a whopping

260,309 tCO_2 annually! Another major impact desired by the project!

- While the final reports are still trickling in, it is reliably learnt that several units in the 12 clusters have adopted energy efficiency measures in their units on their own. As these units were not part of the project, one can safely attribute it to the impact of cluster-level awareness programmes and training programmes organised by the project.

There are numerous intangible benefits too, a few of them are listed below.

- The number of skilled manpower in the SRRM sector has increased considerably due to the various training and capacity building programmes organised by the project.
- The vendor network in the country has been consolidated.
- Through the development and sharing of the technology database among SRRM units, many in the sector are aware of the benefits of using them.
- The technical expertise available in the country has increased and spread out across the country.
- More importantly, unit owners today proudly talk about not only energy efficiency in their units but also GHG reduction from their units! A change in mindset among unit owners that the project very much desired!

WAY FORWARD

Steel production in India has been steadily increasing and it has doubled in the last 10 years – from 43.44 million tonnes (MT) in 2004/05 to 86.5 MT in 2014/15. As shown in Figure 1, the installed capacity has grown approximately at eight per cent from 2009/10 to 2014/15. This is higher than the world average.

Although the per capita consumption of finished steel products is still lower at 60 kg (2013/14) compared to the world average at 203 kg in the same year, there is no denying the fact it is growing

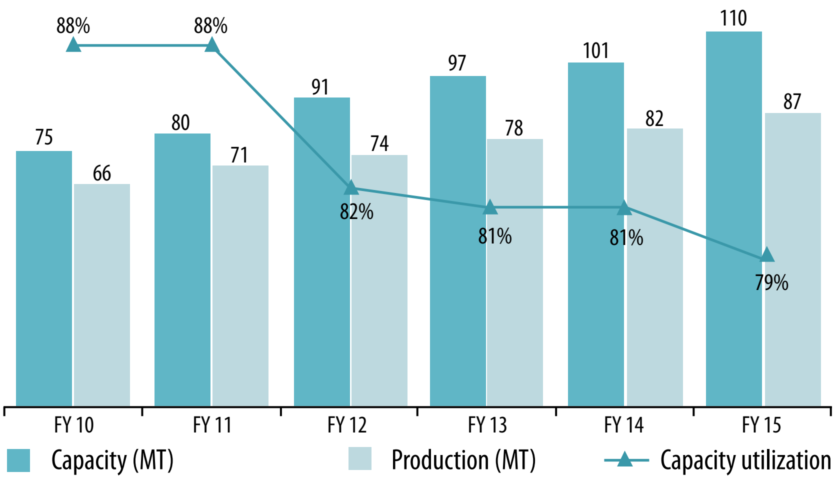

Figure 1 *Yearly capacity to produce, actual production of steel in million tonnes per year for years 2009 till 2015*

in the country if compared with the per capita figure of 51 kg in 2009/10. In all these, the secondary steel sector has contributed over 50% to the overall steel production (2015). Besides SRRM units, the broader secondary steel sector includes electric induction furnace (EIF)/electric arc furnace (EAF), direct reduced iron (DRI), cold rolling mills, galvanizing units, etc. Put together, there are about 3500 such units in the country. Table 1 gives a break-up of these units.

TABLE 1

DETAILS OF THE SUB-SECTORS OF THE SECONDARY STEEL SECTOR

Industry	*No. of units*	*Capacity (MTPA*)*	*Production (MTPA)*	*Capacity utilization (%)*
Steel re-rolling mills (SRRMs)	1773	48.6	35.31	73
Electric induction furnace (EIF)	1269	36.49	27.58	75
Sponge iron (SI) or DRI	378	45.34	22.87	50
Electric arc furnace (EAF)	48	28.87	18.46	64
Total	3468			

** million per tonnes annum*
***Source:** A C R Das, Ministry of Steel. Presentation made at an awareness programme for CEA on Energy Efficiency in SRRM, 21 March 2015, Punjab*

As per the road map developed by the Government of India, the secondary steel sector is expected to contribute 90 million tonnes per annum (MTPA) by 2030 to the overall steel production target of 300 MTPA by the same year. This would mean doubling the production from the existing secondary steel units or a significant increase in the number of such units or a combination of both. From the perspective of overall steel production target of 300 MTPA by 2030 from the current levels of 100 MTPA, the energy consumption and GHG emissions from this sector are also bound to increase by three times by 2030 in a business-as-usual scenario!

In the wake of COP21 (21st Conference of Parties) resolution and India's INDC (intended nationally determined commitment) position, the Government of India would surely want to steer clear of such high energy-intensive mode of production in the steel industry. As it is, the SEC for steel production is at least 30% more in India compared to global standards.[2] Being a net importer of energy, India would be keen to chart out a sustainable path for steel production in the country.

The Steel Project: Has It Done Enough Or Is There More to Do?

The Steel Project, inclusive of both phases, initiated by the Ministry of Steel and UNDP, has indeed made telling contributions to improving energy efficiency and reducing GHG emissions from the secondary steel sector. It has directly benefitted 321 (287 + 34) secondary steel units over a period of 12 years (2004–2015). In this context, a few observations stand out, perhaps, as 'unfinished' agenda.

- 317 units of the total 321 units belong to the SRRM sector. That is only about 18% of the total number of units in the SRRM sector.

[2] MoSPI (Ministry of Statistics and Programme Implementation). 2015. *Energy Statistics 2014*. New Delhi: MoSPI, Government of India

- So far, only about 20% units in the SRRM sector have been covered by EE initiatives. The remaining 80% is a huge number to grapple with and prompts further action from the Ministry of Steel and developmental agencies.
- Even among the 317 units directly benefitted by the project, only 28 units have adopted the direct rolling technology, thus saving energy consumption substantially or virtually nil. That leaves tremendous scope for promoting direct rolling technology in the sector even further.
- As the implementation of EETs is a voluntary exercise, 289 units adopted low-end EETs or EET packages. Also the fact that these units did not adopt all of the EETs or EET packages that were on offer due to cost considerations leaves a vacuum, which needs filling.
- Opportunities for energy efficiency still exist in SRRMs and need to be exploited to the fullest extent. For example, heat recovery at cooling bed and using waste heat to generate electricity are areas yet to be explored.
- In the pilot done through the Upscaling Project in four induction furnace units, there was visible reduction in power consumption. It just shows that there exists tremendous potential for energy savings in the other sub-sectors of the secondary steel sector such as electric induction furnace, electric arc furnace, and sponge iron (Table 1).
- Establishing R&D facilities at least at the regional level to support the EE initiatives of the secondary steel sector would go a long way in upgrading their existing technologies and adopting best practices in the sector.
- Non-availability of vendors at the cluster level and lack of standardization of designs are still issues to be tacked.
- Making use of renewable energy sources in the secondary steel sector is yet to be explored.
- Working with financial institutions on providing subsidized loans for implementing EETs in the secondary steel sector is an important area to be looked into.

The motivation for the Ministry of Steel and UNDP to initiate a third phase of the Steel Project could come from this simple projection:

> *If EE interventions are scaled up further to cover the entire sector (3500 units), it will reduce approximately 9 million tonnes of GHG emissions per year for an investment of about Rs 3000 crore. This is equivalent to GHG emissions from all vehicles in Delhi in a year. This would also lead to monetary savings of approximately Rs 4200 crore every year through energy savings!*

The two phases of the Steel Project have indeed raised the expectations of secondary steel mill owners from the Ministry of Steel, UNDP, and other stakeholders. It looks like the there are several units in the sector ready for the third phase of interventions from the government and developmental agencies. The MoS and developmental agencies must take note of this big change in the mindset of unit owners, and, perhaps, could act in that direction to keep the momentum going.

And here comes the last similarity between Shakespeare's play *All's Well That Ends Well* and the Steel Project:

> *The play has stood the test of time and still retains an iconic stature in English literature. The Steel Project of the Ministry of Steel and UNDP has already become a benchmark project on energy efficiency in the small and medium enterprise (SME) sector. It is bound to create history and build an iconic status for itself if it transcends the boundary of covering all units in the secondary steel sector.*

A NOTE ON REFERENCES AND BIBLIOGRAPHY

The publication draws all its data, figures, and statistics from documents made available by Project Management Unit of the Steel Upscaling Project. The full list of documents referred to in this book are given below. References external to these sources are marked with footnotes.

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

4. Project Document – Removal of Barriers to Energy Efficiency in the Steel Re-Rolling Mill Sector in India
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5. Monitoring & Evaluation Manual
   2007; Ernst & Young, PMC UNDP-GEF-STEEL

6. Mid Term Review – Energy Efficiency in Steel Re-rolling Mills
   2007;Akker, Jan van dan and Singh, Rajesh Kumar; UNDP India

7. Cluster Mapping Report
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   2010; PMC (UNDP-GEF-STEEL)

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11. Excel sheets that carries information n GHG emissions and unit details.

12. RfPs issued by UNDP.

13. Compendium of technology packages

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

Annexure 1: Back to Office Report (BTOR)

	UNITED NATIONS DEVELOPMENT PROGRAMME, NEW DELHI, INDIA Mission Dates: 19 October 2013
Name (s) of Traveller(s):	Sathis Kumar, Consultant-UNDP
Unit:	EEU
Project No. & Title:	Upscaling energy efficient production in small scale steel industry in India
Purpose of the Mission	Participate in a brainstorming session to explore the opportunities for energy efficiency improvement in electric induction furnace (EIF) units

Background:

UNDP in partnership with Ministry of Steel, is implementing a project titled "Upscaling energy efficient production in small scale steel industry in India". The project objective is to promote energy efficient interventions in 300 steel re-rolling mills (SRRM) across India. The project also plans to initiate EE intervention in other sub sector of secondary steel such as electric induction furnace (EIF) sector.

In order to initiate energy efficiency intervention in EIF sector, it is necessary to

- Explore the various energy efficient technology options available for induction furnace units
- Find out the various barriers which impede the implementation of energy efficiency measures in industries
- Find out the best intervention the project can make to minimize or remove the barriers for successful implementation of energy efficiency measures in Induction Furnace units

Hence a brainstorming meeting was organised with various stakeholders to EIF sector at Ahmedabad in which induction furnace equipment manufacturers, consultants, induction furnace association representative, unit owners, and government representatives participated to deliberate on the above issues.

About the meeting:

The meeting was conducted at Hotel Fortune Select, Ahmedabad between 11.00 AM – 3 PM

Shri A C R Das acted as the Chair for the meeting and Dr. S.N.Srinivas as Co-ordinator. The complete list of participants in the meeting is given below.

1. Mr. A.C.R. Das – National Project Coordinator, UNDP GEF Steel, Ministry of Steel, GOI
2. Dr. S.N. Srinivas – Programme Analyst, UNDP
3. Ms. Manisha Sanghani – Programme Associate, UNDP
4. Mr. Arindham Mukherjee – Project Manager (Tech), PMC, UNDP/GEF Steel Project
5. Mr. Sathis Kumar- Consultant, UNDP Steel upscale project
6. Mr. Kamal Aggarwal, Sr. Vice President, AIIFA
7. Mr. A.K. Aggarwal, Honorary Secretary, AIIFA
8. Mr. Bharat Tank, Asst. Vice President-Marketing (E&P Division), M/s Electrotherm (India) Ltd, Ahmedabad
9. Mr. Naishadh Parekh, Director, Inductothem India Pvt Ltd, Ahmedabad
10. Mr. Tarun Sangal,Sr. Manager, Inductothem India Pvt Ltd, Ahmedabad
11. Mr. Phillip Ittyerah, Chief Consultant, SEVAT, Kochi

12. Mr. Shailesh Kumar Bhatt, COO, 4E Technologies Pvt Ltd, Pune
13. Mr. Vijay Goyal, Proprietor, Goyal Steel Technologies, Visakhapatnam
14. Mr. Deepak Gupta, Director, M/s Stead Fast Engineers Pvt. Ltd, Faridabad.

Dr. Srinivas then explained in detail about the project and the various outputs that are planned under the project. He then informed the participants about the three major objectives of the meeting is to explore the

- Technology packs in induction furnace units that are already available in the industry
- Technology packs that are available but not able to be implemented due to various barriers
- The best intervention the project can make to minimise the barriers for implementation of energy efficiency measures in IF units

Mr. A C R Das then explained about the steps taken by Ministry of Steel for penetration of energy efficient technologies among the secondary steel units in India. He also explained that the Ministry of Steel has been pushing hard with Planning Commission to get funds to promote energy efficiency among secondary steel units. But due to several constraints, the ministry was not able to get the funds sanctioned. Hence he requested the participants to utilise the little funds that will be made available under this UNDP project. He requested the participants to share the details of options which can contribute to an overall savings of minimum of 10% in IF units.

Then each of the participants explained about the options available for energy efficiency improvement in the induction furnace sector.

Mr. Bharat Tank, Asst. Vice President-Marketing (E&P Division), M/s Electrotherm (India) Ltd, Ahmedabad

He explained about the using of tunnel kiln which are much superior to the widely prevalent rotary kiln as tunnel kilns can produce superior grade sponge iron. He also explained about the importance of processing and pre-heating of scraps before being used in the induction furnace which can give good energy savings.

Mr. Deepak Gupta, Director, M/s Stead Fast Engineers Pvt. Ltd, Faridabad.

He explained about the analog system which is widely prevalent in the industry and the need to convert them to integrated digital systems. The advantage of converting to digital systems is that melting can be controlled with greater accuracy in the furnace and hence wastage can be reduced to minimum. This helps in reduction of power consumption. He said about 50 units/tonne of electricity can be saved by changing over to integrated digital system from the analog system.

Mr. Naishadh Parekh, Director and Mr. Tarun Sangal,Sr. Manager, Inductothem India Pvt Ltd, Ahmedabad

Inductotherm gave a brief presentation about their company and the various services offered by their company. They informed that their company is a world leader when it comes to induction technology. They also explained about the range of product offerings like power supply units ranging from 15 kW to 25000 kW, furnaces from 2 kg to 50000 kg capacity. They also explained in detail about the various losses in the furnace and the importance of the quality of the copper coil tubing which is the heart of the furnace. The various losses in the furnace includes transmission losses (2-3%), radiation loss (3-4%), coil losses (15-16%), lining conduction loss (3-4%) and the useful energy is only 71 – 73%. He also explained about the 6, 12 and 24 pulse systems. He said that beyond 8000 kW it is better to opt for 24 pulse systems. He said that 550 units per tonne is the best SEC that can be achieved but due to various constraints around 700 units per ton is the normal consumption among the Indian industry. He expressed concern that the two major factors which are worrying the industry now are (1) continuous availability of good quality power supply and (2) availability of good quality scrap. He also stressed the fact that the majority of furnaces installed in the sector is between 8 to 15 Tonnes. So it is better to concentrate on this capacity of furnaces and also those that are installed before year 2010 since most of them follow old inefficient technologies.

Mr. Phillip Ittyerah, Chief Consultant, SEVAT, Kochi and Mr. Vijay Goyal, Proprietor, Goyal Steel Technologies, Visakhapatnam

They explained that they have developed a indigenous technology named as SEVAT Energy Optimiser (SEO) for scrap/sponge iron pre-heating and charging system for induction furnace units. They are in the process of applying for a patent for this SEO technology. By this technology they claimed that an increase of 25% to 30% in production and 25%-30% in energy saving can be achieved. By using this technology the scrap/sponge iron can be pre-heated upto 780 ^{o}C without affecting the properties of the charge and hence the load on the induction furnace can be reduced a lot. Apart from the energy savings, the number of heats can also be increased because of the reduction of work in the induction furnace due to shorter tap-to-tap time and this will increase the overall productivity of the unit. They also provided an illustrative example of energy savings and monetary savings that can be achieved with the help of this SEO technology using a 6 tonne capacity furnace.

Mr. Shailesh Kumar Bhatt, COO, 4E Technologies Pvt Ltd, Pune

He explained briefly about the energy conversion process that takes place starting from the input to power generation in a fossil fuel fired power plant to finally to heat the charge in an induction furnace. He stressed the fact that only 8 units are used in the induction furnace for heating of metal out of the 100 units that are utilized for power generation in a power plant after accounting for all the losses and the conversions that takes place in the intermediate process. Hence instead of using electrical energy and then converting that into heat energy for melting in the induction furnace it will be rather beneficial if heat energy is generated on site itself and use the same for melting the metal and thereby avoiding all the conversion and transmission losses. He provided some theoretical calculation that by using gasification system and generating heat energy on the site and using it for melting the SEC can be reduced to below 300 units/tonne. He said that he is in the process of developing a model unit for 2 tonne capacity using the biomass based gasification system for scrap melting and he is expecting that to be commissioned before the end of December 2014.

Mr. Kamal Aggarwal, Sr. Vice President and Mr. A.K. Aggarwal, Honorary Secretary, AIIFA

They explained that the SEC for scrap melting among the industry varies a lot ranging from 550 to 1000 units per tonne. Among the various suggestions put out by other members he said that scrap pre-heating, flue gas temperature recovery, direct rolling can be considered. They also expressed their support of the industry for all the initiatives taken which will help to improve the health of the industry. They also expressed their appreciation to the UNDP-GEF project and the impact it was able to create among the industry. They committed their support to this new project and requested that one of the focus areas should be to train the shop floor level workers in the plants who are mostly unskilled. They said that association will fully support any initiative taken in this regard.

Then open discussion was conducted and the below points emerged during the open discussion

- There is a definite scope for energy efficiency improvement in the induction furnace sector and everybody agreed that it is better to start with a target of 10% reduction as it is both practical and good step to start with

- Explore the possibilities for setting up of scrap processing units as one of the main draw back in present circumstances is the availability of good quality scraps.
- Promote the scrap pre-heating process among the units. This can be done by setting up of model units in all zones of the country like North, South, East and West.
- Promoting integrated digital system in place of analog systems to have better control on the melting process.
- Study the gasification system once the model unit is commissioned and take up a detailed study to explore further options

Conclusion:

Based on the deliberations it was decided that the following list of options can be considered

Short term options

1. Conversion to integrated digital systems from analog systems in panels
2. Direct Rolling
3. Pre-heating of scraps
4. Setting up of scrap processing units
5. Capacity building of shop floor level workers

Long term options

6. Biomass gasification

Mr. A C R Das and Dr. S.N. Srinivas thanked all the participants for devoting their time to attend the meeting and share their feedback and input to improve the energy efficiency in IF units. All the participants were asked to send a detailed write up of their suggestions along with techno economic feasibility analysis in order to take the recommendation forward.

Follow up:

- To get one page write up from the participants about their energy efficiency improvement suggestions in EIF sector along with techno economic feasibility analysis in order to take the recommendation forward.

Personnel met (if applicable)	All participants
Distribution of mission report	S N Srinivas, Manisha Sanghani

Mission report uploaded on ATLAS?	Yes
Endorsement of supervisor	Yes

India is the third largest steel producer in the world. The secondary steel sector, comprising about 3500 small-scale steel units, accounts for about 50% (45 million tonnes in 2014) of the total production of steel in the country.

To align with the overall economic growth planned for the country, the Government of India has set an ambitious target of producing 300 million tonnes of steel by 2030. In this, the contribution of the secondary steel sector has been pegged at 90 million tonnes a year.

Allowing the steel mills in the secondary sector to go on the energy-intensive path being currently followed would be damaging not only for India's energy economy but also for the environment as a whole. Aware of the situation at hand, the Ministry of Steel, along with the United Nations Development Programme, the Global Environment Facility, and the Australian Department of Foreign Affairs and Trade, embarked on an intervention programme, called the Steel Project, in two phases (2004–2013 and 2013–2016) to change the way steel is produced in the secondary steel sector.

The first phase of the Steel Project identified the various barriers, and sought to remove them through awareness generation activities, identifying and implementing energy-efficient technologies (EETs) in a few model units (34), etc. The second phase (Upscaling Steel Project) focussed on replicating the success achieved in the model units of the first phase. In the second phase, EETs were implemented in 287 secondary steel units in the country in just about 30 months. Post-implementation studies carried out in these units have revealed reduction in energy consumption to the tune of about 30% and mitigation of 2.6 lakh tonnes of carbon dioxide emissions annually!

This publication captures the implementation story of the second phase of the Steel Project. It has lessons for everyone: researchers, development practitioners, policy makers, steel mill owners, EET manufacturers and suppliers, foremen and workers in steel units, and so on.

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