Low Carbon Development Pathway for Re-Rolling Mills in Bihar

GHG Inventory and Strategy for Carbon Neutrality

BIHAR
Bihar State Pollution Control Board

Development Alternatives

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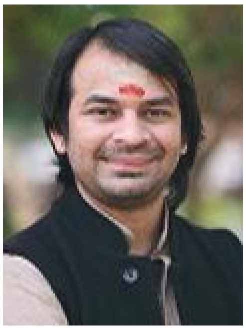
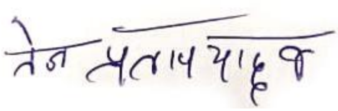
संदेश



अत्यन्त प्रसन्नता का विषय है कि बिहार राज्य प्रदूषण नियंत्रण पर्षद् द्वारा राज्य की जलवायु अनुकूल एवं न्यून कार्बन विकास कार्यनीति विकसित करने हेतु किए जा रहे अध्ययन के अंतर्गत डेवलपमेंट अल्टरनेटिव, नई दिल्ली के सहयोग से राज्य के औद्योगिक क्षेत्र द्वारा हो रहे ग्रीन हाउस गैसों के उत्सर्जन के आकलन के लिए एक अध्ययन किया गया है। इस क्रम में राज्य के रि–रोलिंग मिलों से हो रहे ग्रीन हाउस गैसों के उत्सर्जन से संबंधित एक विस्तृत प्रतिवेदन प्रकाशित किया जाना एक सराहनीय प्रयास है।

देश के अन्य क्षेत्रों के साथ–साथ बिहार राज्य भी जलवायु परिवर्त्तन के प्रभावों से अछूता नहीं है। जहाँ एक ओर राज्य के कुछ क्षेत्र बाढ़ से प्रभावित होते हैं तो दूसरी ओर कुछ अन्य क्षेत्रों में सूखा होता है। ऐसे में जलवायु परिवर्त्तन के क्षेत्र में किये जा रहे इन अध्ययनों से राज्य की जलवायु अनुकूल कार्यनीति विकसित करने में सहायता मिलेगी एवं इस क्षेत्र के सभी हितधारकों, शिक्षाविदों, विद्यार्थियों, शोधार्थियों आदि को लाभ होगा।

शुभकामनाओं सहित।



(तेज प्रताप यादव)
मंत्री,
पर्यावरण, वन एवं जलवायु परिवर्त्तन,
बिहार।

MESSAGE

I am pleased to acknowledge that the Bihar State Pollution Control Board, in association with Development Alternatives, is conducting a study to assess Greenhouse Gas (GHG) emissions in Bihar's industrial sector. This study is a part of the broader initiative to formulate a 'carbon-resilient and low carbon development pathway for the State of Bihar.'

The study focuses on quantifying GHG emissions across various industrial sectors in Bihar, particularly emphasizing Re-Rolling mills. It meticulously examines and estimates the environmental impact associated with these mills, considering their significant role in infrastructure development and economic significance in Bihar's industrial landscape. However, this economic importance is accompanied by environmental consequences, primarily in the form of GHG emissions.

Given the expanding economy and the growing demands for infrastructure, it becomes imperative to thoroughly assess and address the environmental impact of the re-rolling mill sector. This report goes beyond a surface-level examination, providing a detailed analysis of the GHG inventory of operational re-rolling mills in Bihar. Doing so sheds light on the intricate intersection of economic importance and environmental impact, recognizing the sector's integral role in the State's development.

The report analyzes the current emissions status of the operational re-rolling mills in the State. It outlines a strategic pathway for short-, medium-, and long-term goals to achieve carbon neutrality in the sector. While the steel-melting process is highly power-intensive in nature, it must constantly evolve and incorporate measures to improve efficiency while curbing the resultant emissions.

While acknowledging that there may not be quick or easy solutions, this report provides a solid foundation for initiating discussions on the issues it raises. It should serve as a catalyst for policymakers, the private sector, and industry actors to engage in collective action, working towards positive changes in the industry sector in Bihar. The ultimate goal is to implement strategies that genuinely contribute to a sustainable and low-carbon future for the State.

Bandana Preyashi, IAS
Secretary,
Department of Environment, Forest and Climate Change,
Government of Bihar

Dr. D.K Shukla, IFS (Retd.)
PhD, Econ., Wales, U.K.
Commonwealth Fellow
Chairman

बिहार सरकार

Bihar State Pollution Control Board

MESSAGE

As an integral component of the study conducted by Bihar State Pollution Control Board in association with UNEP and other partner organizations on *'Climate Resilient and Low Carbon Development Pathway for Bihar'* M/s Development Alternatives, New Delhi has contributed for the industrial sectors of the State like Brick kilns, Sugar, Re-rolling Mills, *etc.*

A Low Carbon Development Strategy is pivotal for Bihar's future, striking a balance between economic prosperity and environmental conservation. By establishing clear targets, promoting cleaner energy sources, enhancing energy efficiency, and embracing technological innovations, the State can attain sustainable growth. Fast-tracking the adoption of cleaner options for the re-rolling mill industry within the State's policy framework is essential to propel Bihar towards sustainability and carbon-neutrality. I sincerely hope that this detailed report on Green House Gas inventory and Low Carbon Development Pathway for Re-rolling Mills of the State will provide practical insights spanning short, medium and long-term strategies with policy suggestions, technical advancements and financial considerations achieving the goal of net zero.

Devendra Kumar Shukla, PhD.
Chairman,
Bihar State Pollution Control Board.

Patna,
16th November, 2023.

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Acknowledgements

Development Alternatives, in collaboration with the Bihar State Pollution Control Board (BSPCB), has conducted a pioneering study to assess the Greenhouse Gas (GHG) inventory in Bihar's industrial sector and to propose low-carbon development strategies. These collective efforts are poised to significantly contribute to Bihar's aspiration of becoming a Net-Zero State in India by 2070. This comprehensive study is integral to the ***'Climate Resilient and Low Carbon Development Pathway for Bihar'*** program initiated by the Bihar State Pollution Control Board.

Our deepest gratitude goes to Ms. Bandana Preyashi, IAS, Secretary, Department of Environment, Forest, and Climate Change, Government of Bihar; Dr. Devendra Kumar Shukla, Chairman, BSPCB; and Shri S. Chandrasekar, IFS, Member Secretary, BSPCB. Their unwavering support has been instrumental throughout the course of this study.

The success of this endeavor is attributed to the dedication of the project team at Development Alternatives and the invaluable contributions of expert individuals and organizations. We extend our gratitude to Shri Dipak Kumar Singh, IAS, Additional Chief Secretary, Cooperative Department, Government of Bihar; Shri Arvind Kumar Chaudhary, IAS, Principal Secretary, Department of Finance, Government of Bihar; Dr. Ashok Kumar Ghosh, Former Chairman, BSPCB; Dr. Naveen Kumar, Scientist, BSPCB; and members of the BSPCB. Without their unwavering support, this initiative would not have been possible. These individuals have taken a keen interest in the study, providing strategic guidance and support.

A special acknowledgment goes to the deep-dive partners and supporting agencies, including the Department of Industries, Department of Environment, Forest, and Climate Change (DoEF&CC), United Nations Environment Programme (UNEP), World Resources Institute – India (WRI India), Research Triangle Institute (RTI), Council on Energy, Environment and Water (CEEW), ECLEI South Asia, and the Programme Management Unit at BSPCB, for their invaluable support, provision of information, facilitation of workshops, and seamless coordination. The openness with which they shared information and ideas has been truly remarkable.

The team thanks industry owners and other stakeholders for their crucial role in the initiative's success. Their open collaboration, data sharing, and participation enriched the study with valuable insights and real-world perspectives. The contributors demonstrated transparency, cooperation, and a commitment to advancing sustainable practices in Bihar's industrial sector. The study gained a more comprehensive understanding of challenges and opportunities through their collective engagement.

Lastly, our gratitude extends to Mr. Koyel Kumar Mandal, Chief of Programmes; Shakti Sustainable Energy Foundation (SSEF) Mr. Shubhashis Dey, Director – Climate Policy & Climate Finance, SSEF; Dr. Sachin Kumar, Director - Industry, Building & Cooling Programs, SSEF; and Ms. Nidhi Madan, Associate Director - Climate Policy, SSEF. Their guidance, support, and critical inputs at every step were instrumental in the success of this study.

Contents

Abbreviations

BAU	Business-as-Usual
BIADA	Bihar Industrial Area Development Authority
BREDA	Bihar Renewable Energy Development Agency
BSPCB	Bihar State Pollution Control Board
CAGR	Compound Annual Growth Rate
CBG	Compressed Biogas
CNB	Carbon Neutral Building
CNG	Compressed Natural Gas
CO_2e	Carbon Dioxide Equivalent
DC	Direct Current
DG	Diesel Generator
DRI	Direct Reduced Iron
DoEF&CC	Department of Environment, Forest and Climate Change
FY	Financial Year
GDP	Gross Domestic Product
GHG	Green House Gases
GSDP	Gross State Domestic Product
GST	Goods and Service Tax
GVW	Gross Vehicle Weight
HDV	Heavy Duty Vehicle
HYSD	High Yield Strength Deformed
IBEF	India Brand Equity Foundation
IF	Induction Furnace
IPCC	Intergovernmental Panel on Climate Change
KW	Kilowatt
LDV	Light Duty Vehicle
MDV	Medium Duty Vehicle
MS	Mild Steel
MT	Metric Tonnes
MTPA	Metric Tonnes per Annum
MW	Million Watts
PIB	Press Information Bureau
PV	Photovoltaic
QST	Quenched and Self-Tempered
SME	Small and Medium Enterprise
SSRM	Secondary Steel Re-Rolling Mills
SRRM	Steel Re-Rolling Mills
tCO_2e	Tonnes of Carbon Dioxide Equivalent
TMT Bar	Thermo Mechanically Treated Bar
WHR	Waste Heat Recovery

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सारांश

आधुनिक अर्थव्यवस्था के विकास में लोहा और स्टील की महत्वपूर्ण भूमिकाएं रही हैं। विशेषकर स्टील, जिसका उपयोग-क्षेत्र, निर्माण और औद्योगिक मशीनरी से लेकर उपभोक्ता उत्पादों तक हमेशा ही विस्तारित होता रहा है। पिछली सदी में, स्टील अपनी असाधारण मजबूती, स्थायित्व और चालकता के कारण धातुओं में पहली पसंद के रूप में इस हद तक उभरा है कि स्टील की प्रति व्यक्ति खपत न केवल किसी भी देश की सामाजिक-आर्थिक प्रगति की प्रमुख निर्धारकए बल्कि देश के जीवन स्तर का एक प्रमुख संकेतक भी बन चुकी है।

चीन के बाद विश्व में दूसरा सबसे बड़ा स्टील का उत्पादक भारत है। 2022 तक, भारत का स्टील का उत्पादन लगभग 126.26 मिलियन मीट्रिक टन था, जो वैश्विक स्टील उत्पादन का लगभग 7% था। इसके बड़े हिस्से की खपत देश के भीतर होती है, जबकि कुछ स्टील उत्पादों का निर्यात भी किया जाता है। यद्यपि भारत के समग्र धातु-क्षेत्र में स्टील सर्वोच्च स्थान पर विराजमान है, समग्र स्टील-क्षेत्र के भीतर, री-रोलिंग मिलें स्टील बार, छड़ (रॉड), तार की छड़ (वायर रॉड) और अन्य संबंधित उत्पादों (जैसे माइल्ड स्टील -एमएस फ्लैट्स) का उत्पादन करती हैं।

इन उत्पादों का मुख्य उपयोग स्थावर संपदा (रियल एस्टेट) और आधारभूत संरचना के क्षेत्रों में होता है, जहां इनका उपयोग कंक्रीट संरचनाओं को सुदृढ़ बनाने के लिए किया जाता है। हालाँकि, वर्तमान निर्माण कार्यों में, एक स्वतंत्र संरचनात्मक घटक के रूप में भी स्टील का उपयोग बढ़ता जा रहा है। इस प्रकार, री-रोलिंग मिलें महत्वपूर्ण हैं और निर्माण क्षेत्र के लिए महत्वपूर्ण आदानों (इनपुट) का उत्पादन करती हैं। हालाँकि, री-रोलिंग मिलें (और बड़े पैमाने पर इस्पात उद्योग) ग्रीन हाउस गैसों (जीएचजी) के उत्सर्जन को कम करने के दृष्टिकोण से समाप्ति-के लिए- कठिन (हार्ड-टू-इबेट) उद्योगों के अंतर्गत आती हैं।

इस रिपोर्ट का उद्देश्य "बिहार में री-रोलिंग मिल क्षेत्र से ग्रीन हाउस गैस उत्सर्जन" का मूल्यांकन करना है। राज्य में सभी परिचालित री-रोलिंग मिलों का व्यापक सर्वेक्षण किया गया, प्रासंगिक डेटा एकत्र किया गया और वर्तमान आईपीसीसी दिशानिर्देशों के आधार पर विश्लेषण किया गया। सभी संगणनाएँ सबसे हालिया वर्ष, 2021-22 से प्राप्त आंकड़ों पर आधारित थीं। विश्लेषण से पता चला कि 2021-22 तक बिहार में री-रोलिंग मिलों का वार्षिक उत्पादन 11,55,426 टन धातु था। उत्पादित उत्पाद के अधिकांश भाग की खपत स्थानीय स्तर पर हुई, और केवल एक छोटे हिस्से की खपत उत्तर प्रदेश और मध्य प्रदेश के निकटवर्ती राज्यों में हुई।

वर्तमान में, बिहार में 42 री-रोलिंग मिलें हैं, जिनमें से 28 चालू स्थिति में हैं। इस रिपोर्ट के प्रयोजन हेतु, मिलों को उत्पादन प्रक्रिया के आधार पर वर्गीकृत किया गया है; री-रोलिंग मिलें मोटे तौर पर दो प्रकार की होती हैं: स्टैंडअलोन और इंटीग्रेटेड। चालू री-रोलिंग मिलों में से 13 इंटीग्रेटेड मिलें हैं, और बाकी 15 स्टैंडअलोन हैं।

स्टैंडअलोन मिलें मुख्य आदान (इनपुट) यानि, स्टील की सिल्लियाँ (इन्गोट्स) और कुंडे (बिलेट) अपस्ट्रीम इकाई से लेती है जो उसी परिसर में अवस्थित नहीं होती हैं। इन सिल्लियों/बिलेट्स को पुनः गर्म करने वाली भट्ठी में लगभग 1,100° C के तापमान पर पिघलाया जाता है, जिसमें ईंधन के रूप में कोयले का उपयोग किया जाता है। दूसरी ओर, कुछ री रोलिंग मिलों में पिछड़ा हुआ इंटीग्रेशन है, जिनमें खुद की इंडक्शन भट्टियां स्थापित हैं जिनमें पिघले हुए धातु को छड़, बार और अन्य उत्पाद बनाने वाली टर्न डिश के माध्यम से गर्म किया जाता है।

जीएचजी उत्सर्जन के विशलेषण के लिए अमल में लाया गया पद्धतिगत तंत्र जीएचजी प्रोटोकॉल में उल्लिखित स्कोप I, स्कोप II और स्कोप III जीएचजी उत्सर्जन के मूल्यांकन पर आधारित था, जो जीएचजी उत्सर्जन सूची की संगणना के लिए सबसे विश्वसनीय पद्धति के रूप में व्यापक रूप से स्वीकृत है। इस दृष्टिकोण को एक परियोजना से होने वाले उत्सर्जन की सीमा तय करने और टाले जाने वाले जीएचजी उत्सर्जन का अनुमान लगाने में पारदर्शिता और निष्पक्षता को सुरक्षित करने के लिए अपनाया गया था। उत्सर्जन की गणना, सूत्रों और विधियों के लिए, जहां भी लागू हो, जलवायु परिवर्तन पर अंतर-सरकारी पैनल (आईपीसीसी) के 'मैन्युअल ऑन कैलकुलेशन ऑफ़ जीएचजी इन्वेंटरी' का उपयोग किया गया है।

परिणामों के संदर्भ में, 2021-22 तक बिहार में चालू री-रोलिंग मिलों से कुल वार्षिक जीएचजी उत्सर्जन अनुमानतः 3,81,440 टन CO_2 उत्सर्जन है। नीचे दिए गए चित्र में स्कोप I, II, और III उत्सर्जन विस्तृत रूप में दिए गए हैं। उत्सर्जन का मुख्य कारण भट्टियों को दोबारा गर्म करने में कोयले का उपयोग और उत्पादन के लिए बिजली का उपयोग करना है। इंटीग्रेटेड मिलों में कोयले का न्यूनतम उपयोग किया जाता है, औरअधिकांश ऊर्जा उपयोग में बिजली की खपत होती है। जबकि स्कोप I उत्सर्जन प्रति वर्ष अनुमानतः लगभग 183,500 टन CO_2 उत्सर्जन (CO_2e) है, स्कोप II उत्सर्जन भी प्रति वर्ष लगभग 178,467 टन CO_2 उत्सर्जन है।

इंटीग्रेटेड और स्टैंडअलोन री-रोलिंग मिलों में प्रति मीट्रिक टन उत्पादन पर जीएचजी उत्सर्जन क्रमशः 0.290 टन सी CO_2 उत्सर्जन (CO_2e) और 0.395 टन CO_2 उत्सर्जन (CO_2e) है।

बड़े पैमाने पर क्षेत्र की बात करें, तो इनकी तुलना में स्कोप III (अप्रत्यक्ष) जीएचजी उत्सर्जन (मुख्यतः परिवहन के कारण), 2021-22 तक कुल जीएचजी उत्सर्जन के लगभग 5% के साथ काफी कम है, (जिसकी गणना 2021-22 के लिए लगभग 19,413 टन CO_2 उत्सर्जन (CO_2e) प्रति वर्ष के अनुसार की गई है).

अगले पचास वर्षों में, शहरीकरण की मांग (वर्तमान तिथि तक बिहार में शहरी घरों का स्तर 20% से कम है) और औद्योगिक व अन्य

अवसंरचनाओं के लिए मांग के चलते, बिहार में री-रोलिंग मीलों के क्षेत्र से मज़बूत व स्थिर विकास अपेक्षित है। पूर्वी भारत के लिए एक लॉजिस्टिक हब बनने के बिहार के सामर्थ्य के कारण भी टीएमटी बार और अन्य उत्पादों की मांग में वृद्धि की उम्मीद है। सामान्य व्यवसाय परिदृश्य में, 2070 तक, री-रोलिंग मिल्स क्षेत्र में लगभग 7.85 मिलियन टन तैयार माल का उत्पादन करने का अनुमान है और सालाना लगभग 2.59 मिलियन मीट्रिक टन CO_2 उत्सर्जन उत्पन्न होने की उम्मीद है।

जैसा कि यह एक समाप्ति-के लिए- कठिन (हार्ड-टू-इबेट) क्षेत्र है, बिहार में री-रोलिंग मिलों से जीएचजी उत्सर्जन को कम करने के विकल्पों में दो मुख्य महत्वपूर्ण क्षेत्र हैं: पहला, पुनः गर्म करने वाली (रीहीटिंग) भट्टियों में कोयले के उपयोग को कम करना है। इसके विपरीत, दूसरे में उत्पादन के लिए ऊर्जा-कुशल उत्पादन तकनीकों या ग्रीन इलेक्ट्रिसिटी विकल्पों को अपनाते हुए बिजली के उपयोग को कम करना शामिल है। कई हितधारक विमर्शों के आधार पर 2070 तक लगभग शुद्ध-शून्य उत्सर्जन हासिल करने की रणनीतियाँ तैयार की गई हैं। इन रणनीतियों को लघु, मध्यम और दीर्घकालिक हस्तक्षेपों में विभाजित किया गया है।

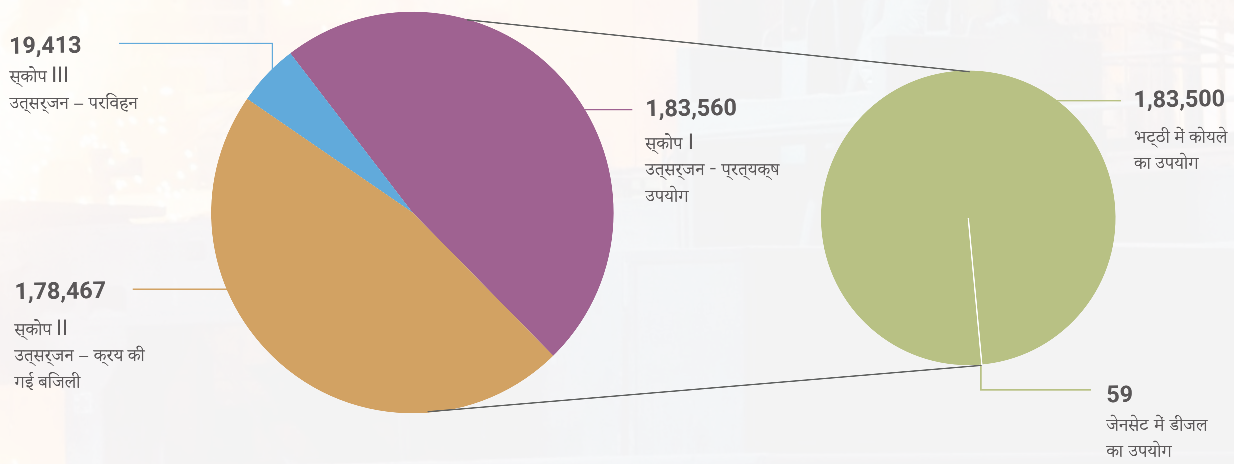
अल्पकालिक कार्यवाहियों में, कोयला आधारित पुनः गर्म करने वाली (रीहीटिंग) भट्टियों से पूर्ण इंटीग्रेटेड इकाइयों में स्विच करना शामिल है, जिससे कोयले का उपयोग कम होगा और जीएचजी उत्सर्जन में काफी कमी आएगी। मध्यम-अवधि कार्रवाइयों में, नई और ऊर्जा-कुशल प्रौद्योगिकियों की शुरूआत के साथ बिहार में री-रोलिंग मिल क्षेत्र में तकनीकी सुधार शामिल हैं। अंत में, दीर्घकालिक कार्यवाहियों में, एक स्वच्छतर राष्ट्रीय ग्रिड (भविष्य में भारतीय विद्युत् क्षेत्र द्वारा शुद्ध-शून्य उत्सर्जन स्थिति हासिल करना अपेक्षित है) और हरित उर्जा (अक्षय ऊर्जा) में मिलों के निवेश के संयोजित प्रयास के माध्यम से री रोलिंग मीलों द्वारा जीएचजी उत्सर्जन को कम करना अपेक्षित है।

उपरोक्त हस्तक्षेपों के साथ, बिहार में री-रोलिंग मिल क्षेत्र में जीएचजी उत्सर्जन फुटप्रिंट को काफी कम किया जा सकता है। सामान्य व्यवसाय परिदृश्य की तुलना में, जिसके अनुसार 2070 में 2.59 मिलियन टन CO_2 उत्सर्जन (CO_2e) अपेक्षित है, उपरोक्त हस्तक्षेपों के माध्यम से 2070 में उत्सर्जन को 0.28 मिलियन टन CO_2 उत्सर्जन (CO_2e) तक कम किया जा सकता है, जो लगभग 90% कम है।

यद्यपि, उपरोक्त हस्तक्षेपों की सफलता नीति, प्रौद्योगिकी और वित्त तक पहुंच में किये जाने वाले हस्तक्षेपों पर निर्भर करती है। री-रोलिंग मिलों को इंटीग्रेटेड मिलों में परिवर्तित करने, और प्रौद्योगिकियों और वित्त तक पहुंच प्रदान करने के लिए नियामक प्रावधानों जैसे मुख्य सोपानों को सुनिश्चित करने के लिए नीतिगत हस्तक्षेप महत्वपूर्ण हैं। उत्पादन-क्षमता को बनाए रखते हुए कम उत्सर्जन के प्रपथ पर चलने वाली बिहार की री-रोलिंग मिलों को सहारा देने में तकनीकी समर्थकों को महत्वपूर्ण भूमिका निभानी होगी। अंत में, बिहार में री-रोलिंग मिलों को कुशल प्रौद्योगिकियों और प्रक्रियाओं में निवेश संबंधी प्रोत्साहन प्रदान करने के लिए वित्तीय समर्थकों की आवश्यकता होगी।

यह अध्ययन बिहार के लिए एक मजबूत लो-कार्बन विकास रणनीति तैयार करने, और इन प्रौद्योगिकियों को व्यापक स्तर पर अपनाये जाने के लिए अनुकूल परिवेश को विकसित करने में महत्वपूर्ण भूमिका निभाएगा। यह रणनीति, बिहार में री-रोलिंग मिलों से उत्सर्जन और उनकी परिचालन लागत को काफी कम करने, उनकी संवहनीयता और प्रतिस्पर्धात्मकता को बढ़ाने और साथ-साथ राज्य में अधिक स्वच्छ और अधिक पर्यावरण-अनुकूल औद्योगिक क्षेत्र के निर्माण में योगदान देने का सामर्थ्य रखती है। यह अध्ययन दीर्घकालिक विकास और लचीलेपन को प्रात्साहित करते हुए बिहार में री-रोलिंग मिल क्षेत्र के लिए भली-भांति परिभाषित रोडमैप भी प्रदान करता है।

बिहार में चालू री-रोलिंग मिलों से उत्सर्जन के स्कोप 1, 2, और 3 (टन सीओ$_2$/प्रति वर्ष)



Executive Summary

Iron and steel play pivotal roles in the development of modern economies. Steel, in particular, finds an ever-expanding array of applications, ranging from construction and industrial machinery to consumer products. Over the last century, steel has emerged as the primary choice among metals due to its exceptional strength, stability, and conductivity to the extent that the per capita consumption of steel is not only a key determinant of any nation's socio-economic progress but also as an index of its living standards.

India is the world's second-largest producer of steel after China. As of 2022, Indian steel output was around 126.26 million metric tons, around 7% of the global steel production. The bulk of this steel is consumed internally, while some steel products are also exported.

While steel holds a place of pride in the overall metals sector in India, within overall steel sector, Re-Rolling mills are responsible for producing steel bars, rods, wire rods, and other related products (such as mild steel -MS flats). These products are mainly used in real estate and infrastructure sectors, where they are used in concrete reinforcement structures. However, in recent construction practices, steel is also being increasingly used as an independent structural element. Thus, Re-Rolling mills are important and produce a vital input for the construction sector. However, Re-Rolling mills (and the steel industry at large) rank among ***hard-to-abate*** industries from the point of view of reducing emissions of Green House Gases (GHGs)

This report aims to assess "GHG Emissions from the Re-Rolling Mills sector in Bihar." Extensive surveys of all operational Re-Rolling mills in the state were conducted, and relevant data was collected and analyzed based on the existing IPCC guidelines. All calculations were based on data from the most recent year, 2021-22. Analysis showed that Re-Rolling mills in Bihar

had an annual production output of 11,55,426 tons of metal as of 2021-22. Most of the produced output was consumed locally, while a small fraction was consumed in the adjoining states of Uttar Pradesh and Madhya Pradesh.

Currently, there are 42 Re-Rolling mills in Bihar, of which 28 are operational. For the purpose of this report, the mills have been categorized based on the production process; there are broadly two types of Re-Rolling mills: Standalone and Integrated. Among the operational Re-Rolling mills, 13 are integrated mills, and the rest 15 are standalone. The standalone mills obtain the principal input, i.e., steel ingots and billets, from upstream units not located in the same premises. These ingots/billets were then melted in a reheating furnace that used coal as fuel at temperatures of around 1,100 ^{0}C. On the other hand, few of the Re Rolling Mills have backward integration, installing their own induction furnaces and enabling hot charging of molten metal through a turn dish for making rods, bars, and other products.

For analysis of GHG emissions, the methodological framework derived was based on assessing Scope 1, Scope 2, and Scope 3 GHG emissions as outlined in the GHG Protocol[1], widely accepted as the most reliable methodology for computation of GHG emission inventories. This approach was adopted to delineate a project emissions boundary and secure transparency and objectivity in the estimation of GHG emissions avoided.

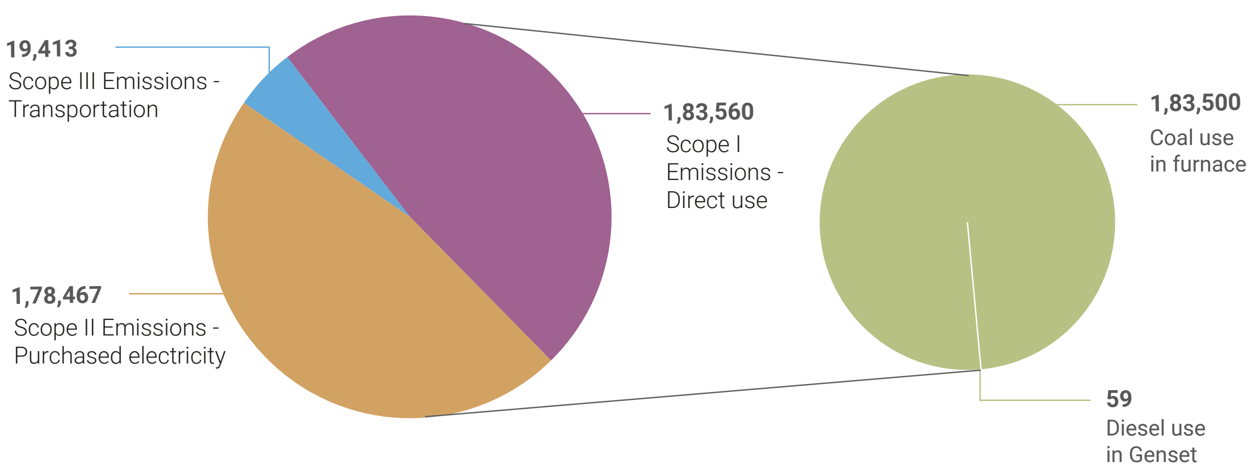
For emissions calculation, formulae, and methods, the Intergovernmental Panel on Climate Change's (IPCC) Manual on Calculation of GHG Inventories has been used wherever applicable.

In terms of results, total annual GHG emissions from operational Re-Rolling mills in Bihar are estimated at 3,81,440 tons of CO_2e as of 2021-22. The scope 1, 2, and 3 emissions are detailed in the figure below. Emissions are mainly due to the use of coal in reheating furnaces and the use of electricity for production. Coal use is minimal in integrated mills, with the bulk of energy use attributed to electricity consumed. While Scope I emissions are estimated to be around 183,500 tons of CO_2e per year, Scope II emissions are similarly around 178,467 tons of CO_2e per year.

GHG emissions per metric tonne of production in integrated and standalone Re-Rolling mills are 0.290 tons CO_2e and 0.395 tons CO_2e, respectively.

Scope 1, 2, and 3 emissions from operational Re-Rolling Mills in Bihar

Scope I, II, & III Emissions from Rolling Mills in Bihar (tCO_2/year)



1 https://ghgprotocol.org
The GHG Protocol is a comprehensive global framework for estimating GHG emissions from any activity

For the sector at large, Scope III (indirect) GHG emissions (due to transportation, primarily) are much lower in comparison, accounting for about 5% of total GHG emissions as of 2021-22 (accounting for around 19,413 tCO_2e per year as of 2021-22).

Over the next fifty years, the Re-Rolling mills' sector in Bihar is expected to record robust to steady growth, led by demand for urbanization (the level of urban households in Bihar is less than 20% as of the present date) and demand for industrial and other infrastructure. Bihar's potential as a logistical hub for eastern India is also expected to propel the demand for TMT bars and other products. In the business-as-usual scenario, by 2070, the Re-Rolling mills sector is projected to produce around 7.85 million tons of finished goods and is expected to generate around 2.59 million metric tonnes of CO_2 emissions annually.

As a hard-to-abate sector, options for reducing GHG emissions from Re-Rolling mills in Bihar comprise two main areas of influence: the first involves reducing the use of coal in reheating furnaces. In contrast, the second involves reducing electricity use in production by investing in energy-efficient production techniques or green electricity options. The strategies for achieving near-net zero by 2070 have been formulated based on several stakeholder discussions. These have been segregated into short, medium, and long-term interventions.

Short-term actions include a switchover from coal-based reheating furnaces to fully integrated units, minimizing the use of coal thereby significantly reducing the GHG footprint. Medium-term actions include technological improvements in the Re-Rolling mill sector in Bihar, with the introduction of new and energy-efficient technologies. Finally, over the long run, the Re-Rolling mill sector is expected to reduce its GHG emissions through a combination of a cleaner national grid (the Indian electricity sector is expected to seek net-zero status in the long run) and mills' investing in green energy (renewable energy).

With the above interventions, the Re-Rolling Mill Sector in Bihar can significantly reduce its GHG emission footprint. Compared with the business-as-usual scenario of 2.59 million tCO_2e in 2070, the interventions can reduce emissions to 0.28 million tCO_2e by 2070, a reduction of nearly 90%.

However, the success of the interventions mentioned above is determined by interventions in policy, technology, and access to finance. Policy interventions are crucial to ensure key steps, such as converting Re-Rolling mills into integrated mills, and regulatory provisions to catalyze access to technologies and finance. The role of technological enablers would be to support Bihar's Re-Rolling mills embarking on a low-emission trajectory while keeping up production efficiencies. Finally, financial enablers are needed to support Re-Rolling mills in Bihar to invest in efficient technologies and processes.

This study will play a pivotal role in formulating a strong low-carbon development strategy for Bihar, nurturing an environment conducive to the widespread adoption of these technologies. This strategy has the potential to significantly reduce emissions and operational costs for the Re-Rolling mills in Bihar, enhancing their sustainability and competitiveness while contributing to a cleaner and more environmentally friendly industrial sector in the state. It also provides a well-defined roadmap for the Re-Rolling Mill sector in Bihar, promoting long-term growth and resilience.

1. Introduction

1.1 Background to Steel Sector and Re-Rolling Mills

One of the key pillars of industrial growth lies in its use of metals. Within metals, steel arguably occupies the top spot. Steel also ranks among the most significant modern products and is strategically crucial for industrialized countries. It is also a diverse industry in terms of production technologies, depending on the nature of the application. From precision tools, internal combustion engines, and turbines to rods and plates for constructing houses and bridges, steel is used in a wider array of uses than ever before.

The primary raw material used in steel production is iron ore, which is occasionally melted along with throwaway steel (called steel scrap) in a furnace to generate molten metal. This metal is processed, often as steel ingots or billets, for further melting for final use or directly converted into products in an integrated operation.

Re-Rolling mills manufacture a wide range of steel products, such as wire rods, Thermo Mechanically Treated (TMT) bars, and other specialized steel products. Re-Rolling mills use cast ingots and billets as raw materials, fed into a reheating furnace to make them malleable. Following this, the billets are passed through a series of intermediate and finishing mills, which convert the hot metal into various products, most notably TMT bars and, more recently, the production of Rebars. As these mills use other rolled products (such as billets or pencil ingots), this is one reason why they are often called Re-Rolling mills.

1.2 Status of the Steel Sector in India

The steel industry contributes about 2% to India's Gross Domestic Product (GDP) and directly or indirectly employs around 25 lakh people (National Resource Efficiency Policy, 2019). In India, steel has an employment multiplier factor of 6.8X and an output multiplier effect of around 1.4X to the GDP of the country's economy[2].

Looking back to the nascent stages of this industrial development, India had a limited capacity of 22 million metric tons (MT) in 1990-91 prior to deregulation, moving up to 29.27

2 National Steel Policy 2017, Ministry of Steel, Government of India; web link: https://steel.gov.in/national-steel-policy-nsp-2017#:~:-text=The%20policy%20projects%20crude%20steel,current%20consumption%20of%2061%20Kgs.

The secondary sector is estimated to contribute nearly **57%** of the total steel production in India

million metric tons by 2000-01[3]. Today, India is the second-largest crude steel producer, the largest sponge iron producer, and the second-largest consumer of finished steel worldwide as of January 2022 (Joint Plant Committee Report, Ministry of Steel, 2022). The crude steel output is very relevant because it can be converted to make several finished and semi-finished products. Ministry of Steel's Annual Report (2021) states that the country's total finished steel consumption was 96.2 million tons, expected to rise to around 160 million tons by 2024-25 and about 250 million tons by 2030-31. As per the World Steel Association, India was the second largest consumer of finished steel in 2021 (106.23 MT), preceded by China as the largest consumer.

India's growing demand for steel is fueled by various crucial domestic sectors, where construction accounts for 35% of steel consumption, followed by infrastructure development at 20% and 12% for the automotive industry[4]. The secondary sector is estimated to contribute nearly 57% of the total steel production in India (FICCI, 2015). Furthermore, a globalized trade context gives India significant export potential. Still, current national per capita steel consumption is around 77 Kg (as of FY2022[5]); these figures are lower than the global average of 208 kg[6] due to India's large numbers and high population densities.

The National Resource Efficiency Policy estimates that steel consumption per capita will rise to 160 kg by 2030, necessitating increasing steel-making capacity from 125 million tons per annum (MTPA) to 300 MTPA by 2030-31. High-quality iron ore and non-coking coal are two critical inputs to steel production. These are abundantly available in India, giving the Indian steel industry a comparative advantage.

Steel Re-Rolling mills are India's second most important steel-making industry, and some units belong to the small and medium enterprises (SME) segment, contributing to decentralized growth. Rolling and Re-Rolling is the process of plastically deforming the metal by passing it between a set of rolls revolving in opposite direction. A wide range of products, such as TMT bars, mild steel flats, steel coils, and wires, are manufactured by Re-Rolling mills. Although smaller than steel mills that use blast furnaces to produce over 10 million tons of steel yearly (hot or cold sheets), Re-Rolling mills produce specialized steel products needed in construction and for infrastructure.

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3 https://steel.gov.in/sites/default/files/Chapter%20II%20%281%29.pdf

4 National Resource Efficiency Policy, 2019; web link: https://moef.gov.in/wp-content/uploads/2019/07/Draft-National-Resourc.pdf

5 https://www.livemint.com/economy/indias-steel-use-bucks-global-slump-to-rise-15-in-first-half-11698253634017.html#

6 https://steel.gov.in/national-steel-policy-nsp-2017#:~:text=The%20policy%20projects%20crude%20steel,current%20consumption%20of%2061%20Kgs.

As per the FICCI report "Indian Secondary Steel Industry - Opportunities and Challenges," published in 2015[7], there are over 2,000 steel Rolling/ Re-Rolling units in India. Several of these are in the small to medium-scale segments. Typically, a small or medium-sized enterprise employs about 100 – 250 individuals, with a steel production capacity of 10 to 30 tons per hour and an annual production range of 10,000 to 400,000 tons. A report by the World Steel Association (Belgium, 2019) states that the hot Re-Rolling mill segment accounts for the largest share of India's secondary steel production.

With the first steel Re-Rolling mill set up in Kanpur, Uttar Pradesh, in 1928, the sector has come a long way today. Over the past two decades, the push for urban and other infrastructure has created a strong market for Re-Rolling mills through sustained demand. On the supply side, technological improvements in steel Re-Rolling mills from process engineering and product design ends have ensured a 25-40% energy reduction over the past two decades[8].

Re-Rolling mills in India are located where the primary raw materials – Pig Iron and Direct Reduced Iron (DRI) or Sponge Iron – are available. As a result, iron ore availability governs the presence of Re-Rolling mills and the steel industry at large. Table 1 compares iron ore availability and crude steel output for five leading Indian states.

A look at **Table 1** shows that the numbers correspond with a positive correlation; however, there is an anomaly in Jharkhand's production, which is higher than its ore production. This is partly caused by higher levels of capacity utilized due to demand from neighboring states of Bihar, Uttar Pradesh, and the Northeastern states. On the other hand, Karnataka has lower capacity utilization. The same is true for West Bengal.

Table 1: Five leading Indian states based on the availability of iron ore and corresponding steel output[9]

	State	Iron-ore *(Production, 2021)*	Steel *('000 tons production, 2020-21)*
1	Odisha	51.1%	21,432
2	Chhattisgarh	18%	13,183
3	Karnataka	16.9%	11,688
4	Jharkhand	10.4%	15,549
5	West Bengal	2%	7,075

Historically, the Indian steel sector has witnessed strong growth over the past six decades (PwC, 2019), while since 2000, the average growth rate has been around 6% per annum (Statista, Annual change rate of steel production in India from financial year 2013 to 2022, 2022), which can still be considered impressive. Over this period, the Re-Rolling mills sector has undergone technological transformation while experiencing similar growth trends.

The Secondary Steel Re-Rolling Mills (SSRM) in India are small in size, manufacture various products to meet demand, and comparatively have a higher worker-output ratio. Several of these mills produce high-quality output for export or precision markets that are largely self-financed. Typically, these units are family-run and self-financed and are hesitant to upgrade their technologies, which calls for significant changes in their manufacturing process.

Several mills use outdated technologies, incurring higher operating costs, leading to high energy consumption and emission of GHGs. Over the last decade, some SRRM units have become aware of state-of-the-art technologies for steel Re-Rolling. However, access to cutting-edge technology remains limited due to insufficient information, knowledge, and cost barriers.

Though some large-scale integrated steel plants in India use the best available technologies, these energy-efficient or productivity-enhancing technologies in large-scale plants cannot be directly replicated for smaller-scale units because they require customization to make them adaptable. Also, while the SRRM industry has its associations, there is often little

7 https://beta.ficci.in/publication.asp?spid=20782

8 There is a wide range, varying from mill to mill. Fuel switching (coal to electricity), backward integration of rolling mills and change in design of rollers have contributed to energy efficiency benefits.

9 (Statista, Distribution of iron ore production in India in financial year 2021, by leading state, 2022) (PIB Delhi, 2021)

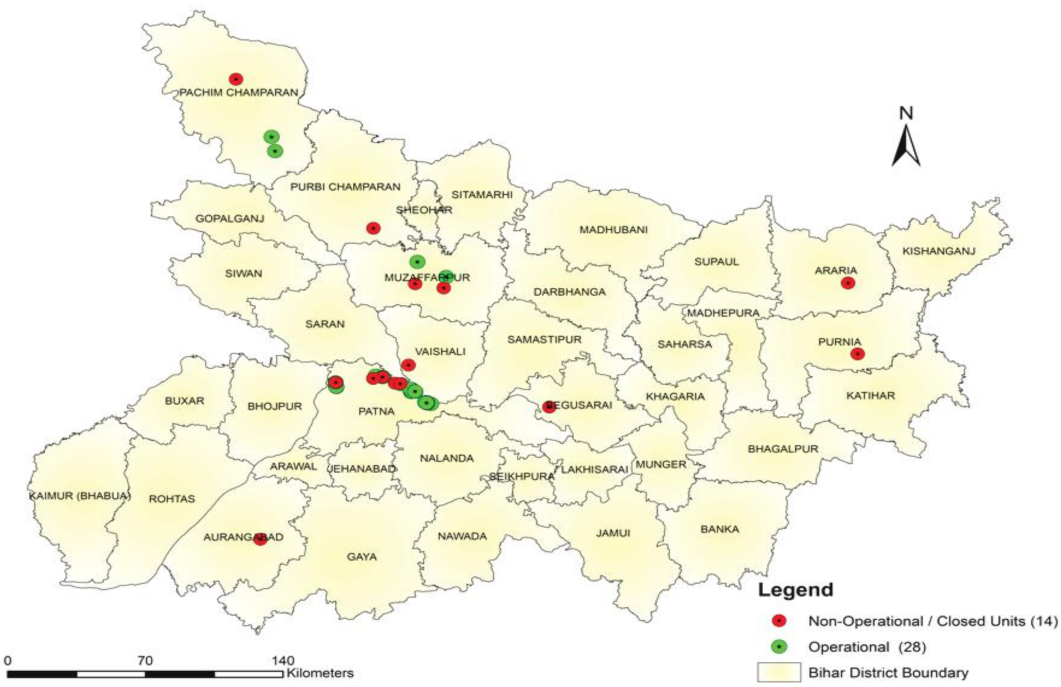
cohesion or collaboration among industry associations, and secondary steel (particularly Re-Rolling mills) remains largely disjointed as a national industry.

1.3 Status of the Re-Rolling Mills Sector in Bihar

Bihar is one of the fastest-growing state economies in India, with growth in Gross State Domestic Product (GSDP) of Bihar in 2021-22 at 11%, compared to 8.7% for India for the same period (PRS India, 2021).

With the backdrop to the Indian scenario as above, attention is now focused on the state of the Re-Rolling mills industry in Bihar. In the industrial landscape in Bihar, Re-Rolling mills constitute an important economic sector. The sector provides critical input to the real estate and infrastructure sectors in the form of steel bars, wire rods, and other steel products that are required in the erection of bridges, buildings, and civil structures.

Figure 1: Map of Bihar showing locations of Re-Rolling mills



Currently, there are 42 Re-Rolling mills in Bihar, of which 28 units are operational and the rest are non-operational. In addition to these, six units are closed as of now. Of the 28 operational units, 13 are integrated mills, and the rest 15 are standalone mills. Integrated mills have an in-house billet production process. They are made by melting sponge iron and scrap metal in an induction furnace that melts and oxidizes the iron into steel, which is then fed into casting molds to produce steel billets. **Figure 1** above represents the location of all Re-Rolling mills located in Bihar.

On average, the Re-Rolling mills operate for around 300 days a year (surveys revealed an average annual operation of 288 days; more information is provided in the following section). Importantly, some mills operate based on orders received; as a result, these are not continuous operations, while other mills have steady demand owing to strong marketing linkages. As observed, two clusters of Re-Rolling mills emerge, the first in and around Patna that caters to the market in central Bihar and the other around Muzaffarpur in the north-western part of the state. These clusters enable them to stay closer to the demand zones and locate themselves centrally to access transportation (road and rail) and logistics hubs (coal, sponge, or pig iron). This also explains the location of Re-Rolling mills in industrial clusters in Bihar (set up by Bihar Industrial Area Development Authority or BIADA) to avail of facilities such as uninterrupted electricity supply, water supply, and other benefits.

The Re-Rolling mill industry in Bihar faces a challenge because the state does not extract iron ores (although modest reserves have recently been identified in the Jamui district of Bihar[10]). The two raw materials – sponge iron and billets/ingots come

10 https://www.business-standard.com/article/economy-policy/bihar-govt-initiates-auction-process-for-iron-ore-mines-worth-rs-20-000-cr-123011400563_1.html

from the neighboring states of West Bengal, Jharkhand, and Chhattisgarh. Moreover, Re-Rolling mills also suffer due to a lack of a steady supply of coal, which is mostly imported due to the demand for low-ash coal in reheating furnaces. Finally, electricity supply is also a critical input, especially for integrated Re-Rolling mills, which only use electricity as the energy input.

Due to these relative disadvantages and hamstrung by rising expenses due to transportation, most units are situated in industrial areas near Patna and Muzaffarpur for convenient access to raw materials, energy inputs (coal and electricity), and other logistical advantages. Re-Rolling mills in other districts are mostly non-operating, as shown in **Figure 1** above.

1.4 Context: GHG Inventory in Re-Rolling Mills Sector in Bihar

The Government of Bihar, led by the Bihar State Pollution Control Board (BSPCB), has undertaken several initiatives to address Greenhouse Gas (GHG) emissions and other pollutants over the years. As of today, Bihar is one of the leading states in India in terms of action for a cleaner environment.

Bihar State Pollution Control Board has undertaken a holistic program of action to carry out detailed greenhouse gas (GHG) inventory development for major economic sectors in the state. As part of the exercise, GHG inventory of the Re-Rolling mills sector in the state has been conducted.

As the section on approach would elucidate, the Development Alternatives team carried out surveys in each Re-Rolling mill in the state. Information on the mills was collected, processed, and analyzed. The initial results were shared with the Re-Rolling mills in a stakeholder consultation, where other major stakeholders were also present. The purpose of the workshop was to solicit feedback on the findings.

The finalization of the report is based on the feedback received and further analysis involving feedback and review of key stakeholders. Chapter 3, later in this report, provides more information on the approach.

2. Steel Re-Rolling and Process Description

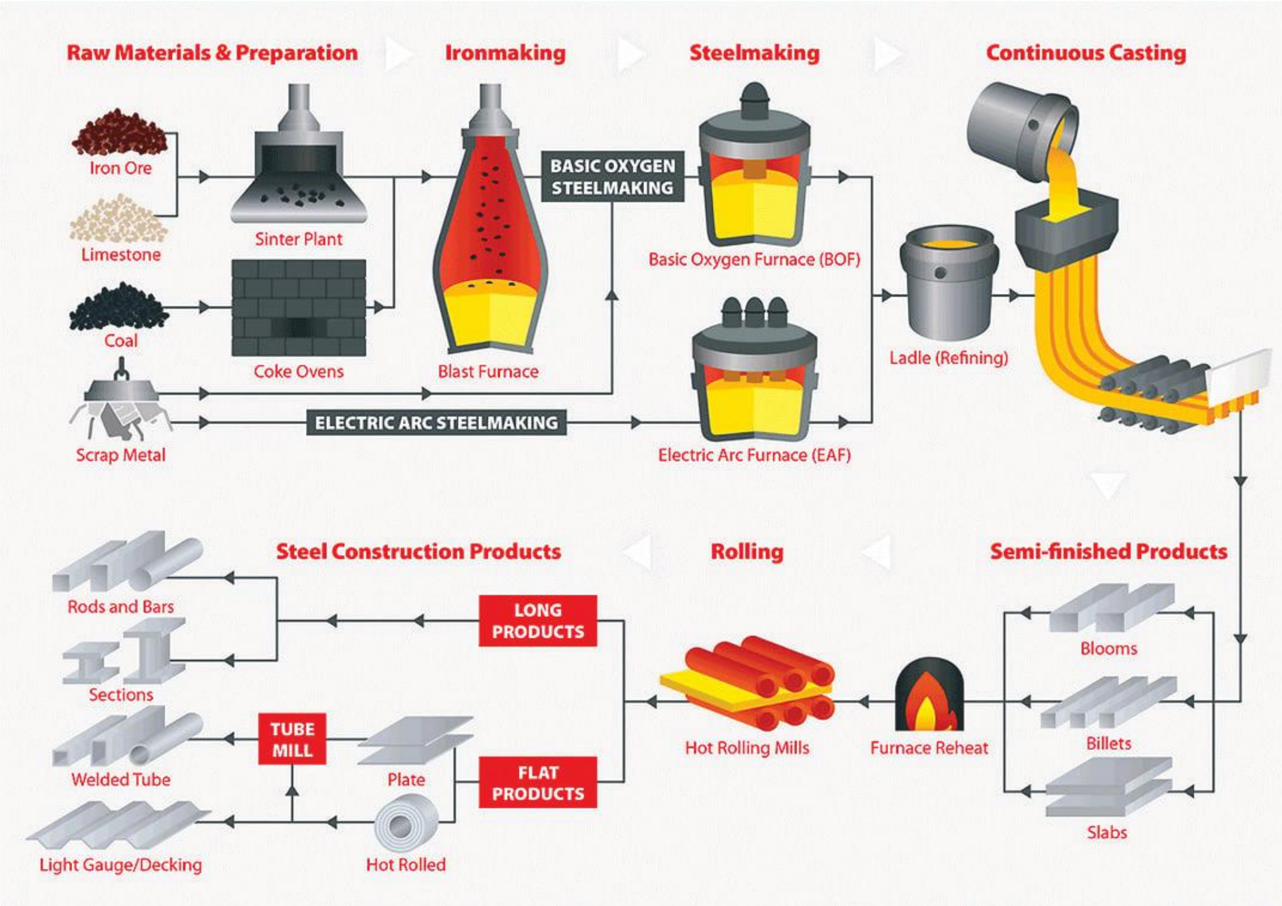
Generally, Re-Rolling involves applying mechanical forces to metal surfaces via a series of rolls to obtain precise shapes and sizes by reducing width and thickness. The two most common shaping processes are i) Hot Re-Rolling and ii) Cold Re-Rolling. The feed material is typically in the form of ingots or billets. During the hot Re-Rolling process, raw materials reheating occurs at soaring high temperatures, which range between 1150-1250°Celsius, before it is rolled into desired shapes using a series of rollers. Most furnaces use coal as a primary fuel to reach the desired temperatures ideal for Re-Rolling.

Key components of a Re-Rolling mill include a) Mill housing and b) Rolls. The mill housing is one of the most critical Re-Rolling mill structures because it holds the mill assembly in place. Housings are a Re-Rolling mill's components with chock assemblies, adjusting mechanisms, etc. As a result, their design and dimensions must account for the sizes of related elements. The housing of Re-Rolling stands must be rigid, strong enough to withstand loads, simple to design, and low in cost of production. Heavy roughing mills, such as blooming, slabbing, billet, and plate mills, use one-piece cast housings of a simple form (rectangular section).

Rolls: A Re-Rolling mill's most important component is its rolls. They are used directly to deform metal workpieces. The Re-Rolling stresses are applied on rolls and transmitted to other mill sections. As a result, the rolls had to be harder and more deformable than the metal being processed.

The following diagram illustrates the manufacturing process of steel Re-Rolling mills:Key processes shown in the figure above are discussed in brief in the sub-sections below:

Figure 2: Diagram showcasing the manufacturing process of steel making and re-rolling



2.1 Key Processes in Re-Rolling Mills

Raw material preparation and shearing: The production process begins with the raw material, such as scrap metal sheets, separated per the final product profiles. Thickness and length are the primary requirements for raw material segregation. In the cutting process, a piece of sheet metal is separated by applying force and cut to the desired size. Shearing is the most common cutting process using shearing machines and gas cutters. The sheet metal used usually is 5-6 feet long. For billet cutting, systems that use billets as the raw material also use gas-cutting machines. After cutting, the waste or unused sheet is allocated to the steel melting units.

Charging and reheating: Steel reheating is the first step in hot Re-Rolling to achieve good product mechanical and chemical properties. The material is stacked to the hearth at the charging end of the furnace during the reheating process. A mechanical pusher is used to push the material inside the furnace continuously. Almost all of the furnaces in the cluster are continuous, with manual charging and discharging.

The temperature of the soaking zone in the reheating furnace is set to around 1,250°C. The temperature determines the thickness of the sheet and the final finishing required. To prepare the sheets/billets for subsequent Re-Rolling, they are heated in the reheating furnace. If the metal is too cold, it becomes too hard, causing stress and cracking in Re-Rolling equipment. When rolled, scorching metal will develop cracks, surface melting, and blemishes. Uneven deformation may occur if the metal is not heated uniformly, resulting in poor quality and possibly derailment. As a result, the retention time of the material inside the furnace and the temperature profile of the heating and soaking zones are critical parameters in Re-Rolling mills.

Re-Rolling and finishing: Re-Rolling alters the shape of metal due to plastic deformation caused by passing between rolls, resulting in a reduction in cross-sectional area or general form. A large percentage of the Re-Rolling mills use semi-automatic heating furnaces (size 14–16 inches). During hot Re-Rolling, twin-high and three-high mills are used for intermediate and initial passes, while four-high and cluster mills are used for final passes. The primary stand / roughing stand is equipped with an 800 HP slip ring motor (the most common installation), and intermediate stands (9-inch size) are motor-capable up to 800 HP. The electric motor power installed at the final stand or finish has a capacity of 250 kilowatts (kW).

In the finishing section, the most common type of motor is a Direct Current (DC) type. The operator's ability determines the mill's speed and product quality. Finishing stands are used to give the product the desired shape and gauge. After the final section, the product is cooled and cut to the desired length.

Packaging and transportation: After the manufacturing process is completed, the finished material is packed according to the users' needs and transported to the required location in trucks or other load-carrying vehicles.

Manual loading and unloading is the norm in most facilities in India. However, electronic cranes are installed in more modern Re-Rolling mills to help expedite this process.

2.2 Technologies Used in Re-Rolling Mills

Thermal energy is primarily consumed by reheating furnaces. The operational characteristics of reheating furnaces are critical to the overall milling process. The combustion equipment in these furnaces includes coal pulverizers, burners, combustion air blowers, and waste heat recovery (WHR) systems. Charge and discharge systems, such as pushers and loaders, are also included in the associated equipment. A typical reheating furnace comprises preheating, heating, and soaking zones that gradually increase and maintain the desired temperature profiles for the milling process. Re-Rolling mills make use of cutting machines, trimming machines, and tools. The majority of Re-Rolling mills are open trains, 2-high or 3-high type. A detailed description of technologies adopted at these facilities is explained below.

Reheating furnace: The reheating furnaces are continuous-type pusher hearth furnaces. The charge or stock is introduced at one end ('feeding or charging') and moves through the boiler before being discharged at the other ('discharge doors'). Pulverized coal is used as the primary fuel in furnaces and is charged with combustion air (primary air). The furnace combustion system (coal charging mechanism) uses the temperature of the soaking zone to determine whether to increase or decrease the coal charging rate. However, the majority of units need help to bypass this system.

The temperature of the soaking zone is measured to be between 1,130^{0}C and 1,280^{0}C. This temperature, however, is not maintained continuously throughout the operation, which may be attributed primarily to a lack of automation in the combustion control system. Heat losses from surfaces and preheated air pipelines are usually high, owing primarily to inadequate insulating materials.

Pulverizer: Coal pulverization is currently the preferred method of preparing coal for combustion. By mechanically pulverizing coal into a fine powder, it can be burned as a gas, allowing for more efficient combustion. Pulverized coal can be introduced directly as air or an air/gas mixture for combustion.

Air preheater: Waste Heat Recovery (WHR) systems are commonly used in steel reheating furnaces to recover heat losses in flue gases and improve efficiencies. Because flue gas heat losses account for a significant portion of total heat inputs to furnaces, WHR systems such as air preheaters are advantageous. The majority of the units in India need more technologies, such as WHR systems, which will result in more efficient furnace operation. Most reheating boiler flue gas temperatures are quite high, ranging from 650°C to 800°C. A study done by TERI in Bhavnagar's (Sihor) cluster showcased that in the Re-Rolling mills with a WHR system installed, the system's performance was poor, which could be attributed to its poor designs and insufficient capacities (TERI, 2016).

Induction Furnace: The Induction Furnace (IF) is best suited for melting and alloying a broad array of metals with marginal melt losses while enabling limited metal refining. Small furnaces are used to produce very precise alloy compositions, while large furnaces are used to produce clean metal for a variety of applications. These furnaces are typically used as melting units with very limited refining. Therefore, the charge material being fed into the furnaces must have low impurities. Facilities with the provision of IF are said to require lesser capital and space, which enables them to reach higher energy efficiency, substantive growth in production, and reduction in CO_2 levels altogether.

2.3 Standalone and Integrated Re-Rolling mills

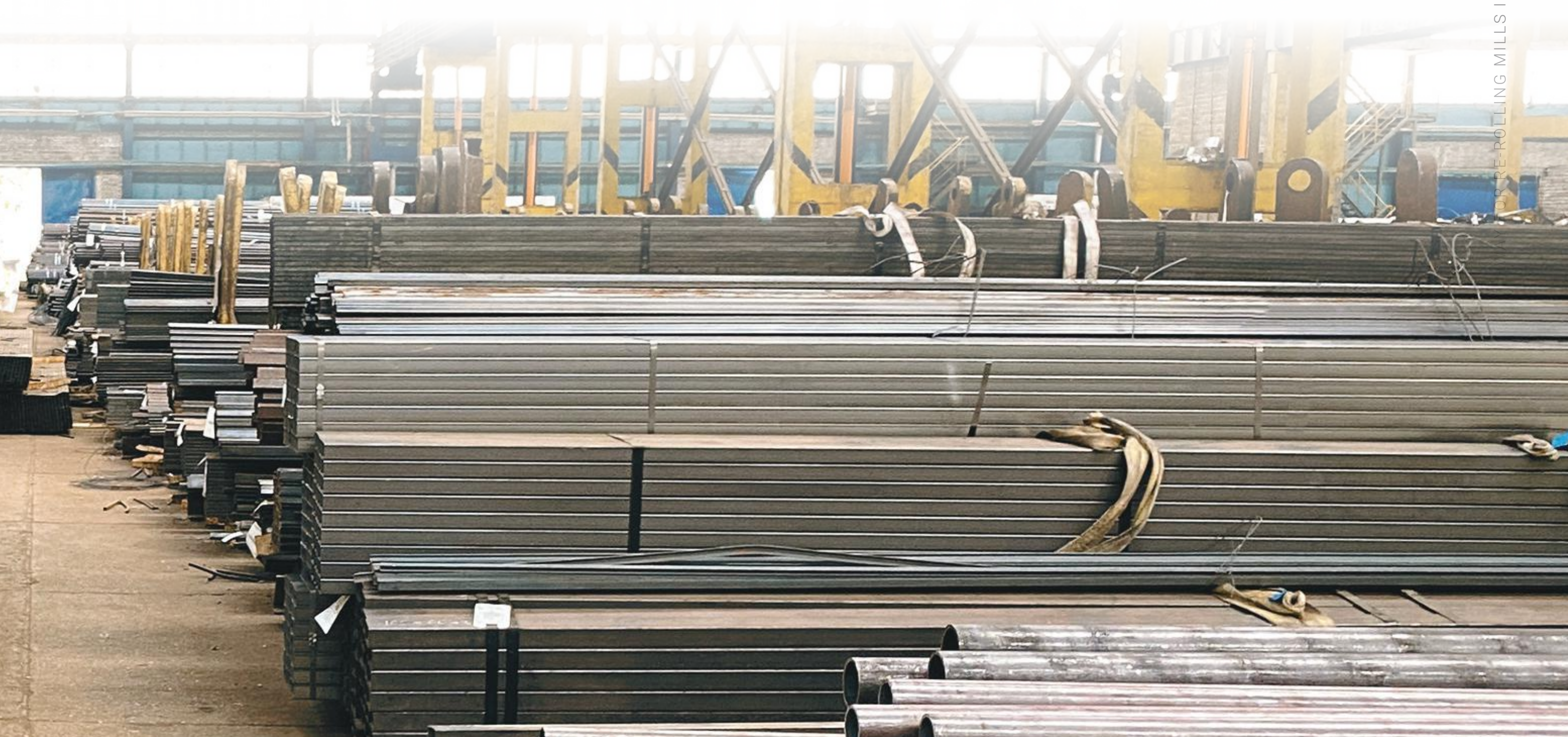
Re-Rolling mills in India can be broadly bifurcated into a) standalone mills and b) integrated mills. These are explained below.

Standalone Re-Rolling mills: Standalone Re-Rolling mills use a reheating furnace, which is usually coal-fired, to melt processed steel ingots, billets, and other inputs. The molten metal is passed through rollers from the reheating furnace to make the finished products as needed. Standalone Re-Rolling mills use coal in reheating furnaces and electricity for Re-Rolling mill operations.

Integrated Re-Rolling mills: Integrated mills also use either an induction furnace or an electric arc furnace to melt the raw materials, usually sponge iron and scrap metals. The molten iron, after processing, is directly fed into molds or rollers for making finished products. Electricity is used to operate the furnaces, thus completely reducing the use of coal as a fuel.

In the context of Bihar, most mills are the standalone type. However, as coal has to be imported from other states, this entails costs on transportation. Further, costs are associated with the rise in coal prices and capital costs to set up and operate a pulverizer unit (coal needs to be pulverized to break it down into granular form for better combustion). Finally, with growing awareness of GHG emissions, coal use in industrial processes is being phased out globally.

Thus, there has been a shift from standalone to integrated Re-Rolling mills. This report discusses this in more detail in chapters 4 and 5.



3. Survey of Re-Rolling Mills in Bihar

3.1 Approach

A detailed survey of all active Re-Rolling mills in Bihar was conducted through visits to units in association with BSPCB. The details of all Re-Rolling mills in Bihar were received from the repository of BSPCB. All the listed units were contacted and classified as closed, operational, or non-operational.

The Re-Rolling mills were analyzed regarding their operating performance and existing and future trends in the sector. Information collected was used to create future production, growth, and GHG emission scenarios for the sector, presented in Section 5.

From the inventory development point of view, key aspects of GHG emissions from Re-Rolling mills were surveyed in detail. Special focus was attributed to the estimation of emissions from the use of coal in standalone mills, given the variety in coal grades and associated GHG emissions. To support this aspect, random samples of coal used in the Re-Rolling mills were collected and analyzed, and their results were presented as part of the study. Electricity bills were collected for each unit to assess the electricity consumption in the Re-Rolling mills.

The survey also identified key parameters relevant to developing this GHG inventory, such as the type of vehicle used to transport materials to and from the mill, distance traveled, and so on.

3.2 Survey Methodology

The study has used primary data collected from site surveys in all Re-Rolling mills for all calculations.

Extensive primary surveys were conducted using a structured questionnaire to collect information on capacity, production, processes, fuel use, and transportation data. Detailed engagement with the management of Re-Rolling mills was also carried out to unearth information relevant to the Re-Rolling mills sector in the State.

Each visit was also accompanied by walk-through surveys of the mill that were carried out to check facilities for material handling and disposal on the site.

3.3 Key Findings

The key findings of the site survey, conducted in all of the twenty-eight (28) active Re-Rolling mills of Bihar, are summarised below.

- The Re-Rolling mills sector is spread across central (Patna district, especially), north (Muzaffarpur), and northwest (West Champaran) parts of the state, with some non-operational units (as of today) in the east and southern parts.
- Most Re-Rolling mills in Bihar report about 300 days of production cycle. With 28 Re-Rolling mills currently in operation, the sector in Bihar has a cumulative processing capacity of around 24,20,250 metric tons per annum (2.4 million metric tons per annum).
- There are thirteen (13) integrated Re-Rolling mills in Bihar out of a total of 28. These mills have their own induction furnace to produce billets and ingots for on-site Re-Rolling operations. Thus, these units can do hot charging, in which hot billets are fed directly into the Re-Rolling mill as they are produced. This eliminates the need for a reheating furnace, eliminating coal use in the process.

  Compared to the integrated Re-Rolling mills, fifteen (15) standalone Re-Rolling mills are in the state. These mills either procure billets or ingots from the market or have their own suppliers (and/or their subsidiaries) who produce them. These are melted in a reheating furnace, which uses coal. Thus, they have a higher carbon footprint of production.

  The previous section has discussed standalone and integrated Re-Rolling mills.
- Based on FY 2021-22 production data, the average annual production of a typical Re-Rolling mill in Bihar is around 42,794 tons. However, the annual production data varies widely across mills based on their installed and operating capacity.

  Total production data available for FY 2021-22 points to a net output of 11,55,426 tons (equivalent to 1.155 million metric tonnes) against an installed capacity of 24,20,250 tons (i.e., 2.42 million metric tonnes). One of the mills was set up recently, and there was no production in the year 2021-22.

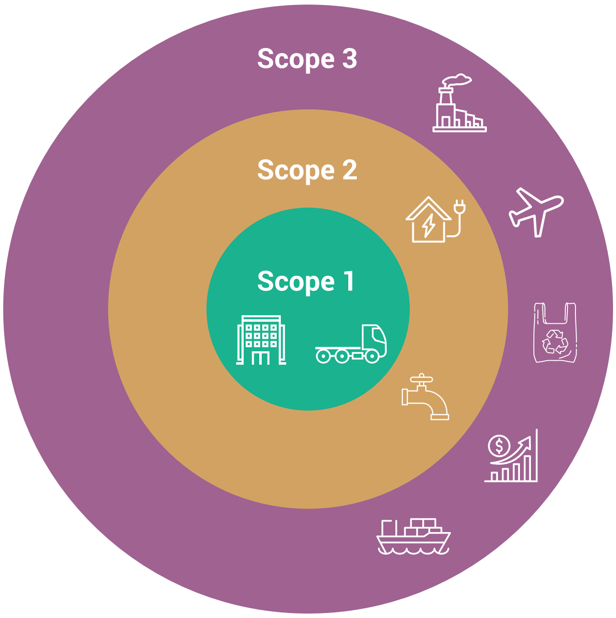
The DA team conducting on-site survey at a Re-Rolling Mill in Bihar.

4. GHG Inventory of Re-Rolling Mills Sector

The approach to developing a greenhouse gas (GHG) inventory for the Re-Rolling mills in Bihar draws upon the classification of the type of GHG emissions, as outlined in the GHG Protocol developed by the World Resources Institute (WRI) (Greenhouse Gas Protocol, 2022). As per the GHG Protocol, there are three broad classifications of emissions of GHGs from an enterprise or process. They are Scope 1, Scope 2, and Scope 3 emissions.

Scope 1 missions are defined as direct emissions that are released into the atmosphere as a direct result of a set of activities at a company or factory level. Scope 2 emissions are those that are released in the atmosphere from the consumption of purchased electricity, steam, heat, and cooling. Finally, Scope 3 emissions are all indirect emissions, not included in Scope 2, but that occur in the value chain of the reporting company, including both upstream and downstream emissions. These three GHG emission classifications are shown in **Figure 2**.

Figure 3: Scope 1, Scope 2, and Scope 3 emissions



The subsequent sections discuss the sources of Scope 1, Scope 2, and Scope 3 GHG emissions in a Re-Rolling mill, the approach for calculating them, and the results.

4.1 GHG Emission Sources

Scope 1- Direct emissions: In Re-Rolling mills of Bihar, direct emissions are generated due to (1) the combustion of coal in reheating furnaces and (2) the use of diesel fuel in generators. Re-Rolling mills employing their own vehicles for transporting raw material (i.e., steel billets or ingots), finished products, or providing commute to employees to/from work also falls under Scope 1. However, these are very rare in the case of Re-Rolling mills in Bihar.

Regarding coal use, primary reliance is upon low-ash, high calorific value coal sourced from Margherita coal fields (Assam) or imported from countries such as Indonesia. This is because reheating furnaces need a steady supply of heat at approximately 1,000 degrees C, and high-ash coal is not the best option due to its higher ash content and lower calorific values. This means high ash coal is needed in much higher numbers as compared to low ash coal to generate the same heating value. Moreover, ash handling becomes an issue for the mill.

However, market fluctuations leading to spikes in prices of imported coal sometimes lead to mill owners using high ash coal with low calorific value, sourced from coal mines in West Bengal (*Ranigang, Jharia*), Jharkhand (*Bokaro, Ghanto*), and other areas.

In addition to coal, diesel generators are used by Re-Rolling mills during outages of grid electricity to provide power to Re-Rolling mills and offices. Re-Rolling mills in Patna district have negligible use of diesel as power outages are rare. However, mills located in the outer districts use diesel gensets since power is erratic.

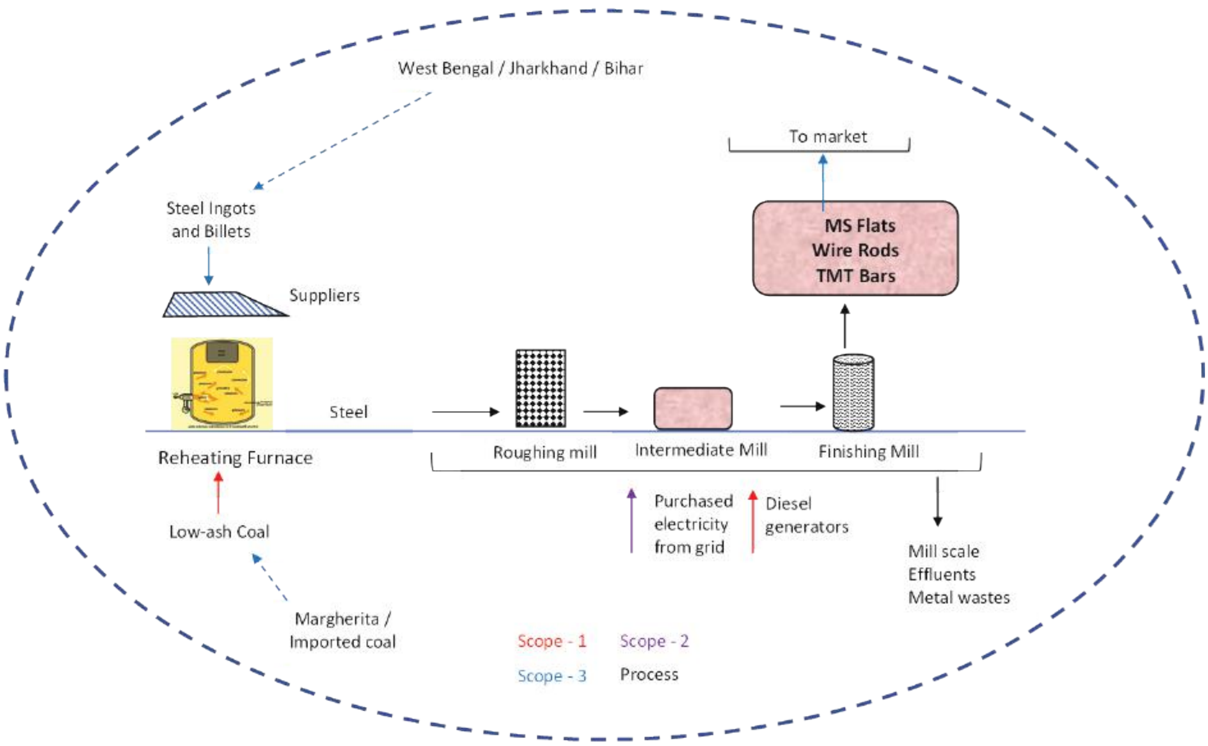
Scope 2 – Indirect emissions (owned): The Re-Rolling mills in Bihar heavily rely on purchased grid electricity for their operations, which is the primary source of energy used. As mentioned earlier, standalone Re-Rolling mills use coal and electricity, but integrated Re-Rolling mills depend on electricity as the sole energy source. As such, reliable and affordable electricity is key to the success of this sector, as well as the single most important source of GHG emissions.

Scope 3 – Indirect emissions (not owned): The Scope 3 emissions are limited to emissions from diesel use in the transportation of materials that include the following:

- Supply of coal to mills
- Supply of ingots, billets, etc., to the mills (will not apply for integrated Re-Rolling mills)
- Transport of processed wire rods, MS flats, TMT bars, etc., for sale
- Disposal of mill scale by vendors
- Supply of maintenance chemicals
- Employee movements (ignored as most employees are in-campus, or workers live nearby and commute via bicycle or two-wheeler)

The emissions constituting Scope 1, 2, and 3 are unit-dependent; as a result, these tend to be subjective. Thus, the demarcation of a boundary assumes importance in the context of estimating emissions from Re-Rolling mills in Bihar: the boundary ring fences inclusions and exclusions for GHG inventory development. **Figure 3** presents the various processes in a Re-Rolling mill and an outline of the project boundary.

Figure 4: Project Boundary delineation and outline of GHG emissions from Re-Rolling mills



4.2 Approach for Estimating GHG Emissions

Using the project boundary described above, the methodology for GHG inventory development considers *source-to-gate and Gate-to-first destination* approaches as follows:

Source to Gate: Emissions are considered from the point where the input material is ready to be delivered to the Re-Rolling mill. As a result, upstream GHG emissions involved in the process of making the inputs are not considered within the project boundary.

Gate to First Destination: Similarly, GHG emissions from the gate of the Re-Rolling mill to the sale points for delivery of the finished product are considered.

Thus, all GHG emissions are recorded between the source and the destination (unless found to be negligible in context). These are estimated and/or calculated for the purpose of GHG inventory development.

Wherever applicable, GHG emission factors indicated by the Intergovernmental Panel on Climate Change (IPCC) have been applied. India-specific information derived from IPCC methodologies has been used in certain cases as they are more reliable and widely used.

As mentioned above, there are two categories of mills operating in Bihar – one with only Re-Rolling operations (standalone type) and the other with casting and Re-Rolling operations (integrated type). Since the project scope is limited to Re-Rolling mills, the Re-Rolling mill component alone is considered for analysis for integrated mills. The electricity consumed in the induction furnace, which converts hot molten metal into billets and redirects billets to Re-Rolling mills in the same process, has been ignored since this is outside the project boundary. Based on survey data, a conservative assumption of 20% has been made to calculate the electricity consumption in the Re-Rolling mill for Integrated units[11].

A benchmarking analysis was completed to arrive at the benchmark values (average values) for a Re-Rolling mill using the survey data. Generally, the benchmark values of the number of operational days, coal, electricity, and diesel use, the quantity of metal processed, operating capacity, etc., have been calculated. Subsequently, these benchmark values have been used to estimate the Scope 1, 2, and 3 emissions for a Re-Rolling mill as discussed below and extrapolated to all operating Re-Rolling mills in Bihar.

11 For instance, monthly electricity bill for a representative unit was around INR 2,20,00,000. Of this, furnace accounts for INR 1,80,00,000 and rolling mill share was INR 40,00,000. Thus, the electricity consumption in rolling mill was around 18.2% of total

4.2.1 Scope 1 Emissions – Direct Emissions

GHG Emission due to Combustion of Coal in Reheating Furnace

The GHG emission from coal use in reheating furnaces has been calculated using the formula below. Samples of coal from a few Re-Rolling mills in Bihar were tested in the laboratory to arrive at calorific value and coal grade. Based on the test results, it was found that around 70% of coal used in a Re-Rolling mill is low-ash coal, and the remaining 30% is high-ash coal.

GHG emissions from coal use in reheating furnaces

= Average coal use by a rolling mill * emission factor

GHG Emission due to Diesel use in Generators

The GHG emission due to diesel use in the DG set has been calculated considering the benchmark value of diesel-based electricity use in a Re-Rolling mill and the emission factor for diesel fuel combustion given by IPCC using the formula below.

GHG emissions from diesel use in generators

=Average diesel based electricity use by a rolling mill * emission factor

4.2.2 Scope 2 Emissions – Purchased Electricity

Using the benchmark electricity purchased data for a Re-Rolling mill in Bihar after ignoring the electricity use in induction furnaces and the emission factor for grid electricity provided by the Central Electricity Authority (Government of India), the Scope 2 emissions have been estimated using the formula below.

Scope 2 emission for a rolling mill

=Average electricity purchased by a rolling mill * emission factor

4.3.3 Scope 3 Emissions – Transportation

The emissions from diesel use in transportation have been estimated using the information on the type of vehicle used for transportation, the average distance traveled by each means of transport, and the emission factor of freight vehicles (provided below).

Table 2: Benchmark values for a Re-Rolling mill	
Emission Factor of Freight Vehicles	
Category as per GVW	Emission Factor (kg CO_2/km)
LDV (<3.5 T)	0.307
MDV (<12 T)	0.5928
HDV (> 12 T)	0.7375

The Scope 3 emissions have thus been estimated using the formula given below.

Scope 3 emission for a rolling mill

= Average distance travelled by vehicle type (i) * emission factor for that type of vehicle

4.3 Results of GHG Inventory in Re-Rolling Mills

Based on the above approach, the benchmark (average) values for a Re-Rolling mill in Bihar have been estimated and presented in **Table 3** below. The benchmarking used data from 27 Re-Rolling mills out of 28 currently operating in Bihar.

Table 3: Benchmark values for a Re-Rolling mill

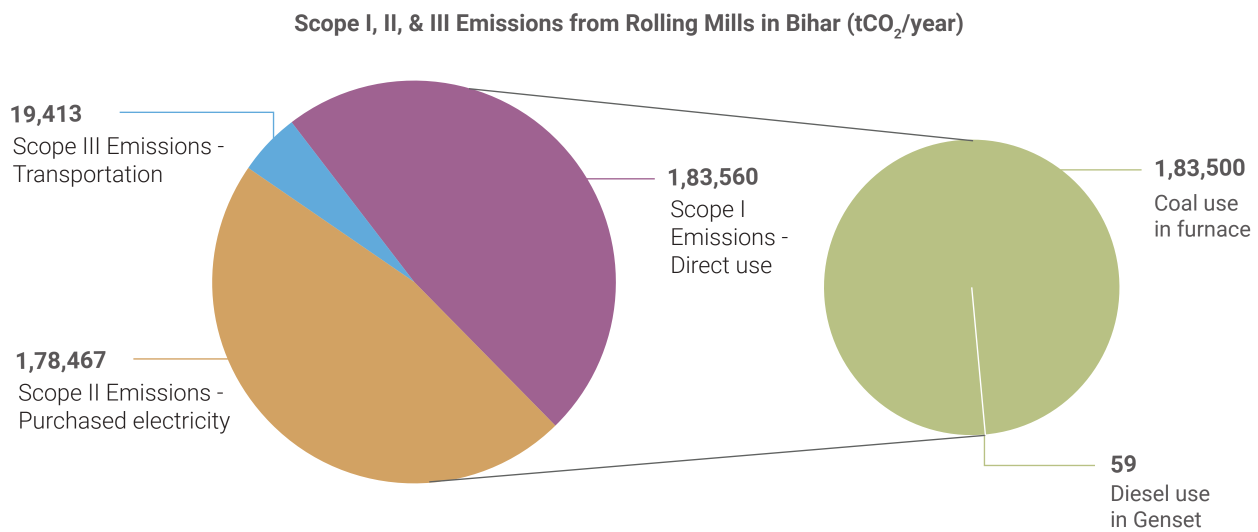
#	Parameter	Values
1.	Number of days of operation in a year	277
2.	Operating capacity (tons per day)	324
4.	Quantity of finished product produced in a year (metric tonnes)	42,794
7.	Quantity of coal used by Re-Rolling mill (Tons per year)	2,614
8.	Diesel-based electricity used by Re-Rolling mill (kWh/year)	2,740
9.	Grid electricity used by Re-Rolling mill ***(minus use in induction furnace)*** (kWh/ year)	80,60,803

Considering the benchmark values for fuel use and others, the scope 1, 2, and 3 emissions for a Re-Rolling mill and the total for all Re-Rolling mills in Bihar have been calculated based on the abovementioned approach. The estimated values have been presented below in Table 3 and Table 4 and graphically represented in Figure 4.

Table 4: Estimated values of Scope 1, 2, and 3 emissions for Re-Rolling mills in Bihar

Category of GHG emission	GHG emissions - one Re-Rolling mill (tCO_2e/year)	No. of Re-Rolling mills	GHG Emission - all Re-Rolling mills (tCO_2e/year)
Coal use	6,796.3	27	1,83,500
Diesel use	2.2		59
Scope I Emissions	**6,798.5**		**1,83,560**
Scope II Emissions	**6,609.9**		**1,78,467**
Scope III Emissions	**719.0**		**19,413**
Total GHG emissions	**14,127.4**		**3,81,440**

Figure 5: Scope 1, 2, and 3 emissions for Re-Rolling mills in Bihar



5. Approaching Net Zero and Beyond

As Section 3 has shown, the Re-Rolling mills have a per-unit footprint of 14,127 tons of CO_2e per annum. For the sector at large, corresponding annual GHG emissions are estimated at 3,81,440 tons CO_2e as of FY 2021-22. This translates to roughly 0.33 tons CO_2e produced per ton of rolled steel produced. To understand the variation between standalone and integrated plants in terms of their emissions profile, GHG emissions for standalone plants is around 0.395 tons CO_2e /ton of rolled steel, while the same figure for integrated units stands at 0.290 tons CO_2e / ton of rolled steel.

Addressing the challenge of reducing greenhouse gas (GHG) emissions amid the growing steel consumption involves comprehensive measures distributed across distinct time horizons. These measures are tailored to align with short-term, medium-term, and long-term goals, reflecting a strategic and phased approach towards sustainability in the re-rolling industry.

1. Short–term measures (2022 to 2030):

Integration of Re-rolling Mills: Swiftly transitioning to re-rolling mills with integrated billet production and rolling processes will enhance efficiency, primarily through hot charging. This optimizes resource utilization and minimizes coal dependency in the reheating stage, contributing to an immediate reduction in greenhouse gas emissions.

Replacing Coal with Cleaner Fuels: Expedited substitution of coal with cleaner alternatives such as natural gas and compressed biogas during various stages of steel production will play a pivotal role in curtailing carbon emissions within the short-term horizon. This pragmatic shift aligns with the urgency of mitigating environmental impact.

2. Medium-term measures (2030 to 2040):

Advanced Manufacturing Processes: Implementing cutting-edge manufacturing techniques in the steel industry during this phase enhances energy efficiency and reduces emissions. Innovations such as direct reduction processes and next-generation technologies significantly decrease the carbon footprint, emphasizing a commitment to sustainable practices.

Captive Renewable Energy Production: Introducing self-sustaining energy solutions within re-rolling plants by adopting captive renewable energy sources, such as solar and wind power, promotes eco-friendly operations. This medium-term strategy ensures a greener energy mix and provides resilience against fluctuations in external energy markets.

3. Long-term measures (2040 to 2070):

Decarbonizing the National Grid: In the extended timeframe towards 2070, a strategic focus on reducing the overall carbon intensity of the national grid becomes paramount. This involves a systemic shift from coal-based power generation to harnessing cleaner energy sources, with a particular emphasis on transitioning to Hydrogen as a major energy carrier. This ambitious but crucial transformation is pivotal for achieving deep decarbonization in the the re-rolling industry and aligning with broader sustainability goals.

b. Hydrogen as a Catalyst: The long-term vision involves leveraging Hydrogen as a versatile and clean energy carrier for steel production. Substituting coal with Hydrogen in grid power generation minimizes carbon emissions and positions the steel industry as a key player in the transition towards a hydrogen-based economy. This transformation is foundational for achieving carbon neutrality and sustainable steel production over the long haul.

natural gas to be roughly

60%

cleaner than coal from a GHG emissions point of view.

5.1 Road to Carbon Neutrality

As analyzed in the previous section, the major contributor of GHG emissions in the Re-Rolling mill sector is the use of coal (estimated to be 6,796 tons CO_2e per mill per annum), which is closely followed by the use of electricity (6,609 tons CO_2e per mill per annum). Due to the much higher incidence of coal used in standalone units (integrated units do not need to use reheating furnaces unless there is an inventory of cold billets that need melting), GHG emissions from standalone mills are higher than those of integrated mills.

While the use of coal has reduced over time, with more and more standalone units integrating backward into billet production and thus resorting to ***hot charging***, the road to net zero for Re-Rolling mills would be to invest in options to reduce the GHG footprint from both coal and electricity use. These are enumerated below:

a. Renewable energy-based power generation

Currently, Bihar has estimated a target of installing 2,969 MW of solar PV-based power generation distributed across ground-mounted and rooftop projects. This is outlined in the state's policy to promote renewable energy (2017) by the Bihar Renewable Energy Development Agency or BREDA (Energy Department, Govt. of Bihar, 2017). However, the potential of ground-mounted solar projects is not realized, and there is much-untapped potential to exploit. As such, setting up ground-mounted and rooftop solar PV plants could be one way to reduce GHG footprints.

However, engagement with stakeholders from the Re-Rolling mill sector (a ***Stakeholder Consultation*** was conducted in November 2022; discussions with individual mills were carried out during surveys) has indicated that Re-Rolling mills have two binding constraints in investing in solar PV or any other RE-based generation. First, the business in Bihar, as briefly mentioned in Section 1, is not earning high rewards except for a few players that are able to integrate their operations backward and forward and with scale. As a result, most units are cash-constrained and do not have free cash to invest. Others who have invested in backward integration may have debt on their books. As a result, investment in RE could be a delayed decision.

Second, most units have not carried out a full-value analysis of the RE potential: the common reaction at the time of surveys has been to inform that rooftop solar PV would not be able to support the electrical demand of a reheating furnace or induction furnace, which require significant electrical energy. Also, the export of electricity to the state grid is not popular in Bihar as yet. Thus, mill owners were also not keen to invest in solar PV, even if they had access to capital.

Given these constraints, the option for the Re-Rolling mill sector is to set up a solar PV park and sell power to the state grid as their contribution to green energy. The advantages of this would be as follows:

- First, electricity can be sold to the state grid as a separate project while the unit simultaneously consumes electricity from the state grid.
- Second, this will ensure that their own business remains unaffected while generating a second stream of revenues.
- Third, the solar PV project can be located in any state (such as Gujarat and Karnataka) where green power sold to the grid fetched more revenue per unit (kWh) sold.

b. Investment in natural gas and/or Hydrogen

Natural gas can replace coal in reheating furnaces, which would save resources due to the higher calorific value of natural gas than coal. In addition, it reduces GHG emissions, as natural gas is cleaner than coal. Available secondary literature estimates **natural gas to be roughly 60% cleaner than coal from a GHG emissions point of view. Thus, considering a total of 183,500 tons of GHG emissions from coal use, shifting to gas will roughly reduce around 110,000 tons of CO_2e annually.**

Currently, the gas pipeline connecting Barauni to Guwahati is set to be operational, which will further support access to the existing natural gas grid in a few districts of Bihar, such as Patna[12].

Alternatively, using compressed biogas[13] (referred to as CBG) would reduce GHG emissions from reheating furnaces to zero (as a renewable fuel) while providing the same efficiency benefit and resource conservation as conventional petroleum-based natural gas, thereby reducing coal-based emissions by its full measure of 183,500 tCO_2e per annum. There is potential for harnessing CBG in Bihar due to the presence of strong dairy and sugar sectors. However, the concept is in nascent stages, as covered in the following section.

5.2 Scenario 2070

Re-Rolling mills produce capital goods (or producer goods) in the form of TMT bars, MS rods, and MS flats. These are consumed in the real estate and construction sectors. Thus, the growth of the Re-Rolling mills sector is linked to the overall growth of the infrastructure sector in Bihar. To understand the future perspective of the Re-Rolling mill sector, it is therefore important to assess the growth profile of these sectors.

5.2.1 Growth of Re-Rolling Mills Sector in Bihar: Now - 2070

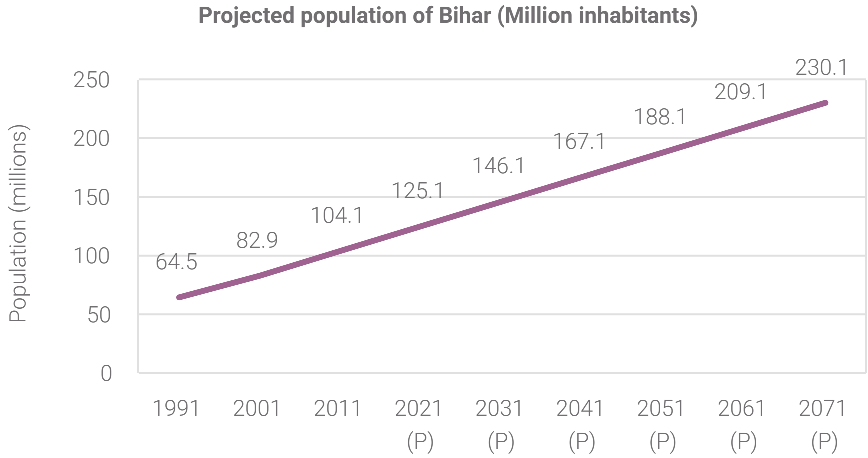
Future growth of the Re-Rolling mills' sector in Bihar will depend on key factors such as a) population growth and urbanization, which in turn governs demand for housing and other infrastructure that calls for steel products, and b) growth in Bihar's economy, which will propel steel demand. These aspects are analyzed below.

a) Population growth and urbanization: Demand for infrastructure is well correlated with population growth. Bihar's decennial population growth is over 2.5% (the growth rate for Census 2001 was 28.6%, while in Census 2011, it was found to be 25.1%), which is among the highest in India – and the highest among all mainland states, ignoring Union Territories and states in Northeastern region[14].

Looking into the future, population growth is a significant proxy for economic growth. Government of India's research report on population projections shows that Bihar's population is expected to grow by 42% between 2011 and 2036 (National Commission on Population, 2020). This gives a simple, year-on-year population growth rate of 1.7% per annum. This leads to a state population of roughly 231 million persons by 2071.

12 https://www.offshore-technology.com/marketdata/barauni-bongaigaon-guwahati-gas-pipeline-india/
13 Compressed biogas is purified biogas, which contains methane over 90% and is used to replace CNG or LPG
14 https://pib.gov.in/PressReleasePage.aspx?PRID=1602755

Figure 6: Population trends and projections, Bihar (1991 – 2071)



In Bihar's case, the population growth is also accompanied by higher urbanization rates. Bihar has a current rate of 16.2%, as estimated in the Bihar Economic Survey 2022-23[15], which is in the lower deciles compared with Indian states. Higher urbanization rates in the future translate to high demand for housing, social (houses, schools, hospitals), and economic (bridges, roads, markets, offices) infrastructure. The projected growth in housing units in Bihar is depicted in the graph above.

b) Economic growth: As State Economy Surveys and other macroeconomic planning documents point out, over the past decade, Bihar has consistently outpaced the Indian economy regarding growth rates. However, a closer look at the 2019-20 figures reveals that growth has been driven primarily by the tertiary (services) sector, while that of the secondary sector (manufacturing) has remained steady but without notable growth. There has been a deceleration in the primary (agriculture, mining) sector. Over five years, though (2016 – 2021), Bihar's primary, secondary, and tertiary sectors grew at average rates of 2.3%, 4.8%, and 8.5%, respectively (Govt. of Bihar, 2022).

Considering that the bulk of products from Re-Rolling mills is consumed in the secondary sector (infrastructure and construction), the growth of this sector shall determine demand growth for products from Re-Rolling mills. As mentioned above, the sector has been growing at about 4.8% per annum, which also explains the sustained demand for products from Re-Rolling mills over the past decade.

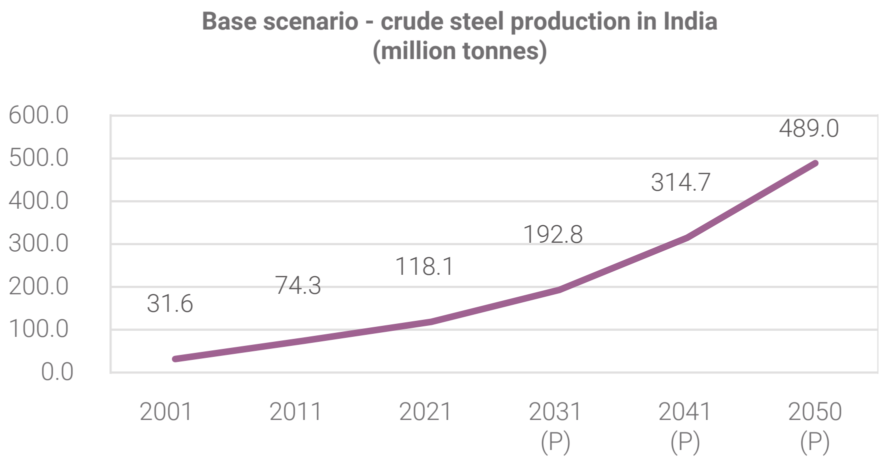
Thus, while long-term growth rate projections are often not reliable, it has been observed that Bihar's growth rates have, over the past decade, consistently outpaced that of the Indian economy[16].

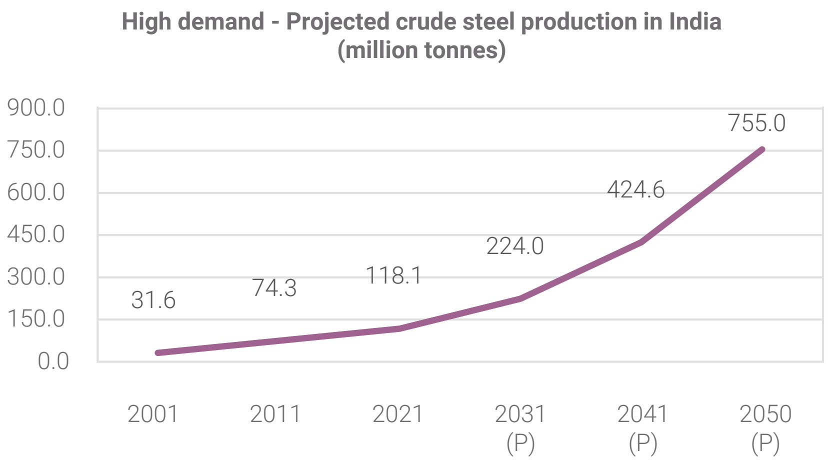
At the same time, there is an apparent push for infrastructure investment, which will likely continue well into the 2040s. The Global Investment Outlook published a report for India, which has estimated a total infrastructure investment need of US $ 4.5 trillion. It has also been estimated that infrastructure demand will remain around 3% of GDP in 2040, down from around 4.5% as estimated for the current year (2022).

Steel sector growth: Over and above these macroeconomic indicators, it is important to look at the iron and steel sectors in India and, specifically, in Bihar. In India, the steel sector produced around 118 million metric tons in FY 2021-22, while consumption was around 133 million metric tons (MT) in FY 2021-22 (IBEF, 2022). Along with domestic inventories, India is a net importer of steel, especially specialty steel products, which make up roughly 50% of the country's total steel imports[17]. Further, India's per capita steel consumption is approximately 77 kg compared to the global average of 228 kg (Ministry of Steel, 2022)[18].

15 https://indiainfrahub.com/main-featured/is-bihar-finally-urbanising-a-ground-report-from-one-of-states-newly-designated-urban-areas/#:~:text=The%20projected%20urban%20population%20of,expenditure%20of%2018%20per%20cent.
16 https://www.outlookindia.com/national/bihar-economic-survey-report-says-state-s-growth-performance-better-than-national-average-news-184047
17 https://www.india-briefing.com/news/specialty-steel-india-production-linked-incentives-program-applications-beneficiaries-22773.html/#:~:text=Specialty%20steel%20makes%20up%204,capacity%20is%20dedicated%20to%20it.
18 https://steel.gov.in/overview-steel-sector

Figure 7: Projections for crude steel in India. Sources: TERI, Ministry of Steel





In terms of projections, the report "Towards a Low Carbon Steel Sector," produced by TERI in 2020, estimates a best-case scenario of steel demand in India at 500 MT by 2050, with a ***high*** scenario where demand reaches 755 MT. The two options are further combined with actual annual steel output in India, and the resultant projections are shown in Figure 7 above.

Comparing the 2050 demand scenario of 500 MT as outlined in the TERI report with the present demand level of around 130 MT translates to a CAGR of roughly 4.8%, which is distributed across various categories of finished steel demand. From a macro perspective, this is consistent with the Indian per capita finished steel consumption that still needs to go up, as it is lower than the global average (as of the present date). Finally, findings of the Joint Plant Committee, Ministry of Steel also point to an annual growth rate of around 5% for the Indian steel sector over the past ten years.

Combining the above scenarios, the ***best-case*** projection for the Re-Rolling mills' sector in Bihar, which is largely consumed within the state, could be around 4.8% CAGR between now and 2040, the projected growth phase, before growth rates stabilize. Higher demand for steel products in the state is expected from Bihar's emergence as a logistics gateway for eastern India and Nepal, as well as higher investments in emerging areas such as food processing and preservation: these would support demand for warehousing and other logistical infrastructure.

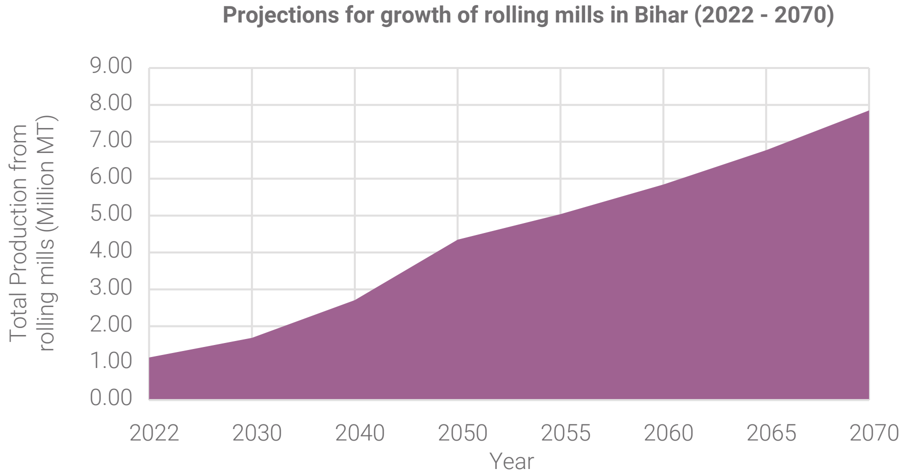
Finally, and as mentioned above, Bihar has a lower urban development rate: the urbanization effect, which has improved from around 11% in 2021 to 15.3% as of 2021-22[19] and more than 16% as of FY2022-23, is indicative of growth potential over the next two decades.

In the subsequent decades (2050 – 2070), the growth phase of the Re-Rolling mill sector in Bihar is expected to taper to around 3%. This deceleration in growth is also consistent with other reports, such as the one produced by the Council on Energy, Environment, and Water (CEEW) in Bihar, projecting growth of the industrial sector at 3% in that time period.

19 Bihar Budget and Economic Survey, March 2021-22

This could be due to saturation in the state's real estate and infrastructure sectors. Other key factors would include the growth and proliferation of new technologies/processes in real estate that could replace steel or the use of modified steel products. A good example of this can be found in TMT bars: these consume less steel but have higher tensile strength compared to ordinary steel bars and rods.

Figure 8: Projected trajectory of rolling mills in Bihar



Thus, projecting demand for Re-Rolling mills in Bihar up to 2070 (the target for achieving carbon neutrality of the Indian economy), the growth rate is expected to have two trajectories, as defined in table 5 below. Plugging sector growth rates derived in the above scenario lead to a growth trajectory of Re-Rolling mills in Bihar from the present 1.15 million tons to nearly four times, at 7.85 million tons by 2070. This is graphically represented in Figure 8 above.

Table 5: Growth trajectory of Re-Rolling mills (2022 – 2070)

#	Period	Growth trajectory (CAGR)	Rationale
1	2022 – 2050	4.8%	This is the ***growth*** phase, characterized by unmet infrastructure demand, including urban growth, logistics, and agro-processing
2	2050 – 2070	3%	This is the phase where infrastructure demand is met by alternative technologies, resulting in lower demand for steel products and also a slowing down due to the cooling of economic cycles.

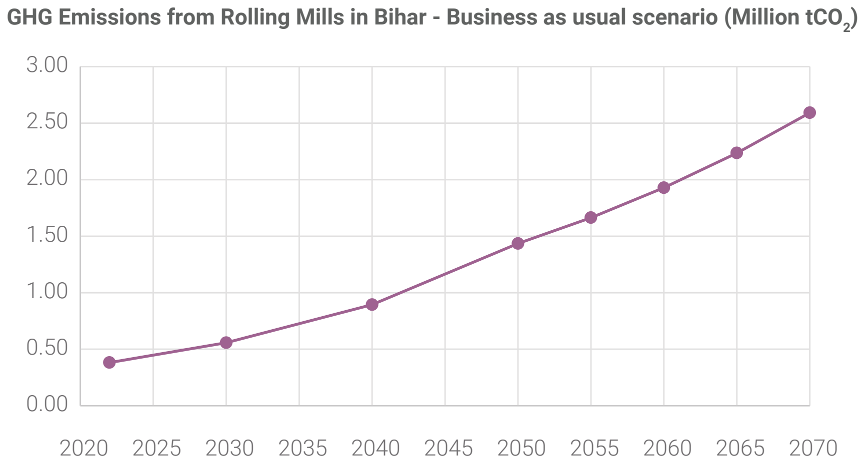
Comparing projected 2070 output with Bihar's population in 2071 of roughly 231 million inhabitants, one arrives at a per capita consumption of 33 kg (of rolled steel products), assuming all rolled steel is locally consumed. This compares well with developed country averages of today (rolled steel products are about 10% - 20% of total steel consumed per capita). In comparison, as of the present day, the per capita consumption of rolled steel products in Bihar is around 9.2 kg per capita.

5.2.2 GHG Emissions from Re-Rolling Mills in Bihar: Business as Usual Scenario

Having deduced the growth path of the Re-Rolling mills sector in Bihar till 2070, the final step is to estimate the quantum of GHG emissions from the production of steel products from Re-Rolling mills in Bihar.

The business-as-usual (BAU) scenario for the Re-Rolling mills sector in Bihar considers emissions of GHGs from the current date (2022) till 2070. In a business-as-usual scenario, the sector's GHG emissions continue exactly as it is on the present date, assuming continuity of the existing set of circumstances that are present today, as regards the Re-Rolling mills sector in Bihar.

Figure 9: GHG emissions from rolling mills in Bihar under BAU scenario



This implies that with the Re-Rolling mills sector's growth, GHG emissions will also move with the same trajectory until 2070. A graphical representation of GHG emissions is provided in **Figure 8.**

Total GHG emissions in the business-as-usual scenario are estimated to rise from around 0.38 million metric tons CO_2e as of 2021-22 to 2.59 million metric tons CO_2e by 2070.

5.2.3 GHG Emissions from Re-Rolling Mills in Bihar: Low Emission Scenario

Having derived the business-as-usual scenario, the **low-emissions scenario** considers interventions aimed at reducing the trajectory of GHG emissions from Re-Rolling mills without affecting gross output, which remains as estimated in **Figure 7** above.

The slew of measures to improve GHG emissions performance would include using new and advanced technologies and processes in production, replacing electricity with natural gas and/or investments in green electricity. These measures will likely be implemented as Bihar seeks to decarbonize its economy.

To understand the impact of interventions aimed at addressing GHG emissions performance in Re-Rolling mills, interventions are demarcated into short, medium, and long terms. These are explained below.

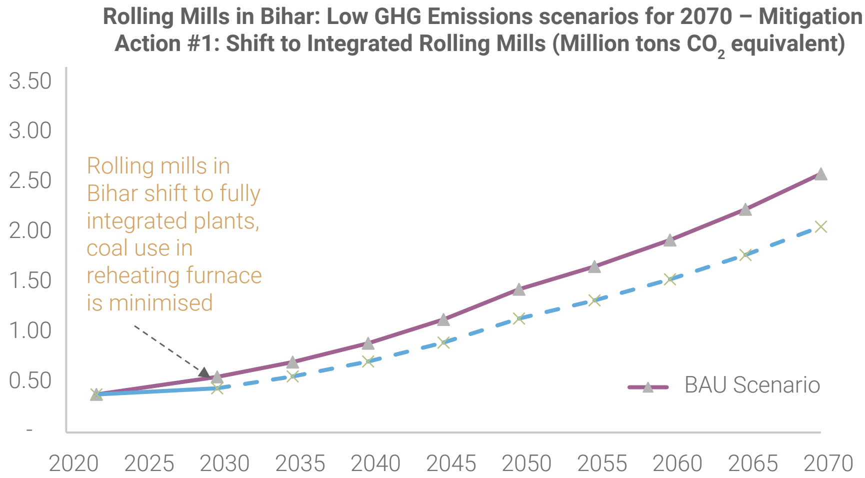
Low-emissions scenario: Intervention in short term (2022 – 2030)

The short term has been defined in the context of Re-Rolling mills as the period between 2022 and 2030.

As part of stakeholder engagement, interaction with entrepreneurs in the Re-Rolling mills sector in Bihar revealed that significant energy cost savings would be possible if standalone Re-Rolling mills were to set up their own induction furnaces to produce billets and ingots that are inputs for the mills. This would not only save costs, but replacing coal with more GHG-efficient electricity (from the grid) would positively impact the level of GHG emissions, as outlined earlier in this chapter (Section 5.1). The impact of this action is demonstrated in **Figure 10**.

The Govt. of India has committed to achieve net zero by **2070** and also reduce emissions intensity of GDP by **45%** by 2030.

Figure 10: Short-term interventions in low emissions scenario for rolling mill.



As one may observe, the red dotted line in the said figure shows the low emission scenario. While the move to shift from standalone to integrated Re-Rolling mills needs to be initiated as of the present date, there would be an expected lag time for the industry to make the process change effective. Further, some units had indicated a lack of access to investible capital to enable the process transformation. Thus, the full impact of the intervention would be felt by 2030. The necessary policy shift needed for this is analyzed in the following sections.

Low-emissions scenario: Intervention in the medium term (2030 – 2040)

In the medium term, there would be a Scope for deploying more advanced technologies in the Re-Rolling mills sector in Bihar. This would be the phase where units could move up the technology scale.

Currently, globally and in India, there are advanced technologies for producing thermo-mechanically treated (TMT) bars and other products generated in a Re-Rolling mill. One technology on the anvil of being mainstreamed in India is Direct Reduced Iron (DRI), which directly reduces iron ore using a reducing agent (gas or elemental carbon) that is produced from a fuel such as coal. While DRI reduces fuel demand while producing stronger steel, when combined with Hydrogen as the fuel, it can reduce GHG emissions by more than 50% per ton of steel produced. Research studies say switching to DRI using renewable (green) Hydrogen can even reduce GHG emissions from production by up to 90%, although these are yet to be practiced globally[20].

In terms of thermological Improvements, three key interventions include a) changes in furnace design, b) improved material use, and c) automated process control systems for efficient melting. Some of India's leading and large-scale rolled steel product producers

20 https://network.bellona.org/content/uploads/sites/3/2023/07/HYDROGEN-DRI-FOR-STEEL-IN-A-RESOURCE-CONSTRAINED-EUROPE-V3-1-1-1.pdf

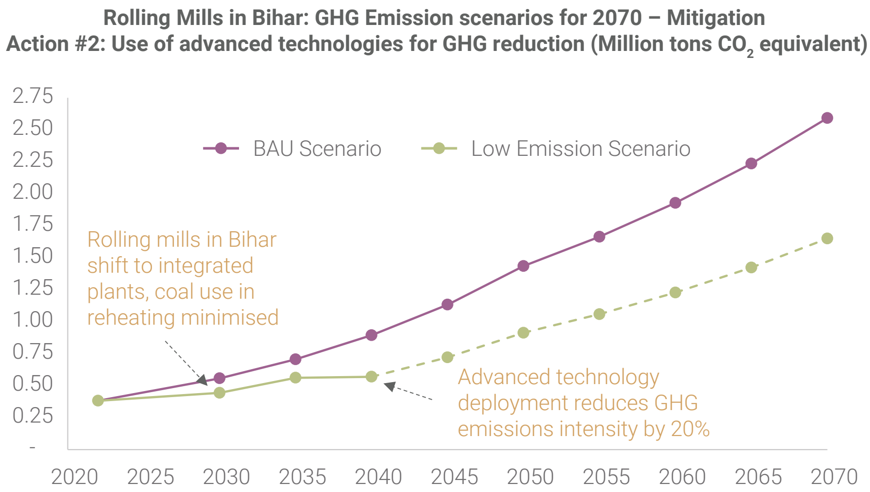
have started producing High Yield Strength Deformed (HYSD) steel bars that have enhanced capacity to absorb stress but are efficiently produced using less energy. Other technologies include Quenched and Self Tempered (QST) bars, which are already present in India. However, units in Bihar have yet to adopt such technologies and processes, and only a couple of surveyed units were operating automated systems.

The following points can be mentioned in addition:

- Globally, there are examples where energy consumption in steel Re-Rolling mills has reduced energy consumption by nearly 50%. Companies such as H2 Green Steel (Sweden) have combined the two, i.e., the DRI process and use of best-in-class machines, combined with the replacement of coal by green Hydrogen, to reduce the use of fossil fuels (and GHG emissions) by over 90% in their plant near Stockholm, which would expectedly commence production in 2025[21].
- In addition, European and Australian Re-Rolling mills are seeking to introduce upgraded designs, such as improved *laying head* designs (for wire rods), improved mechanics in hot as well as cold Re-Rolling processes, and finally, better digital technologies for better stiffness and rigidity of rolled steel.

The impacts of technological advancements in this low-emissions scenario have the potential to reduce GHG emissions significantly. However, in the context of Bihar, the impact of technological progress is expected to reduce GHG by 20% from the pre-existent scenario over an implementation scenario of ten years between 2030 and 2040, as shown in the figure alongside **(Figure 11)**. It is important to note that adopting new and advanced technologies would not be a one-time activity but would overlap with other supply-side interventions, such as cleaning the electricity grid, expected in the long run, as shown below.

Figure 11: Medium-term interventions in rolling mills sector in Bihar, low emissions scenario



Low-emissions scenario: Intervention in the long term (2040 – 2070)

In the long term, the main effect on GHG performance could be observed through a reduction in the overall carbon intensity of the national / state grid. This could be brought about by policy commitments made at the national level to reduce GHG emissions intensity. In addition, as mentioned above, the impact of newer technologies is expected to overlap with this stage, leading to a compounding effect of cleaning the electricity grid.

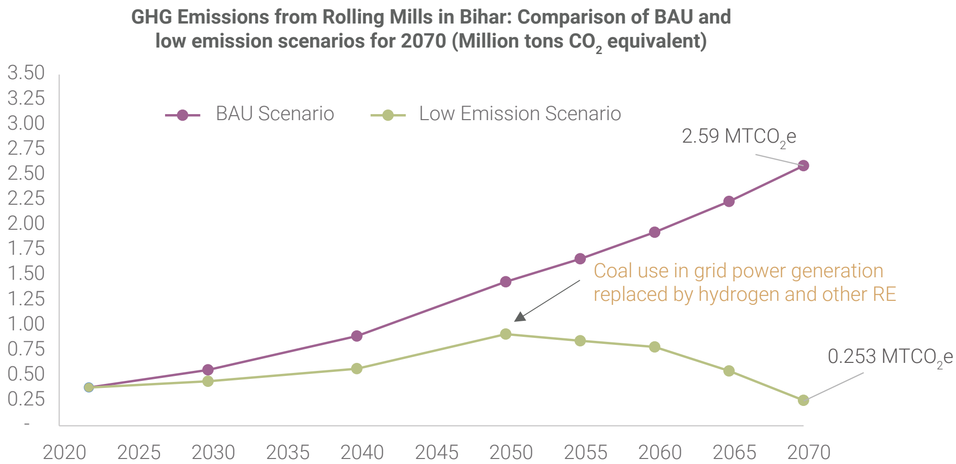
The Government of India has committed to achieve net zero by 2070 and also reduce emissions intensity of GDP by 45% by 2030[22].

To achieve this target, India's electricity grid would need to reduce GHG emissions intensity similarly: to achieve that milestone, new power generation technologies such as renewables, green Hydrogen, and other energy conservation measures would need to be introduced.

21 https://www.h2greensteel.com/articles/green-steel-production, accessed 10th Sept, 2023
22 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812

There would be a decade-on-decade reduction in GHG emissions intensity as an ongoing process. Accordingly, Re-Rolling mills in Bihar would also face lower emissions per kWh of electricity that is consumed. The resulting chart is projected in the figure below. It is worth noting that if Re-Rolling mill owners were to invest in green electricity, the net impact on the GHG emissions profile would complement and thus accentuate the reduction in GHG emission intensities. The same impact would be felt as a result of improving technological performance.

Figure 12: Long term interventions in rolling mills sector in Bihar, under low emissions scenario



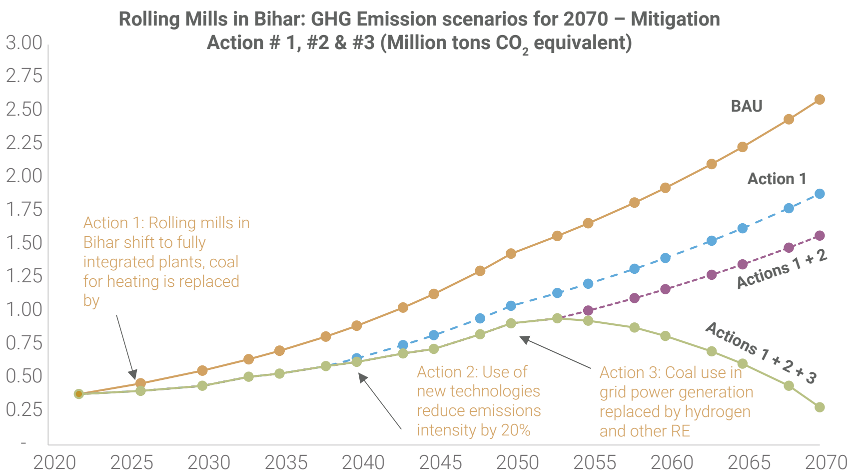
As the figure demonstrates, the net impact of short, medium, and long-term interventions would reduce GHG emissions intensity of the Re-Rolling mills industry; as a result, total emissions fall to around 0.25 million metric tons of CO_2e.

Combining the three scenarios, one can derive the following graph highlighting the low GHG emissions scenario for the Re-Rolling mills sector in Bihar:

The combination of three mitigation action bundles in short, medium, and long terms demonstrates the net impact of mitigation actions on GHG emissions from the Re-Rolling mills sector in Bihar.

The solid green line denotes the low emissions schedule. The line depicts the cumulative action of all GHG mitigation actions in the short, medium, and long terms.

Figure 13: Low emissions scenario for rolling mills sector in Bihar, 2022 - 2070



In the low emissions scenario, GHG emissions stop rising by 2050, following which there will be a reversal. This means that as the production of Re-Rolling mills increases, GHG emissions are actually lower. This is due to the decarbonization of the sector, caused by technological advancements, process shifts, and also lowering of GHG intensity of the electricity grid.

In addition to grid electricity, individual Re-Rolling mills could invest in their own green power supply options in addition to grid electricity. The recent introduction of a domestic carbon market by the Government of India[23] (June 2023) would also create potential revenue streams from an asset that replaces fossil fuels with clean energy.

The trajectory of GHG emissions under both scenarios is provided in **Table 6** below.

Table 6: GHG Emission trajectories from Re-Rolling mills: Scenario 2070					
	Scenario	Production and GHG Emissions from Re-Rolling mills in Bihar (Million tons output, Million tons CO_2e)			
		2022	**2040**	**2050**	**2070**
1	Production	1.16	2.7	4.34	7.84
2	Scenario 1: Business as usual	0.38	0.89	1.43	2.59
3	Scenario 2: Low emission	0.38	0.62	0.93	0.28

As one can observe, under the business-as-usual scenario, GHG emissions are roughly 2.59 million tons CO_2e per annum in 2070. In the low-emission scenario, however, these emissions are reduced to around 0.28 million tons CO_2e per annum.

Thus, per ton of rolled steel produced in 2070, emissions would stand at 0.035 tCO_2e/ton of rolled steel (35 kg CO_2e/ ton of rolled steel). This is a significant reduction from the current level of GHG emissions in the sector, estimated at 0.33 tons CO_2e/ ton of rolled steel (330 kg CO_2e per ton of rolled steel).

At the same time, as discussed in section 5.2 above, the per capita consumption of steel in Bihar rises from 9 kg in the base year to around 33 kg per year in 2070 (assuming all rolled steel is consumed locally).

Thus, while on the one hand, there is a near 400% rise in consumption of steel in the state, there is also a 90% fall in projected emissions, from 2.59 million tCO_2e in the baseline scenario to 0.28 million tCO_2e in the low-emissions scenario derived here.

5.3 Net Zero for the Re-Rolling Mills Sector

The preceding sections have illustrated a notable trajectory towards achieving net-zero emissions within the Re-Rolling mills sector in Bihar. This journey is characterized by a discernible decline in both the intensity of greenhouse gas (GHG) emissions and the absolute GHG emissions. This downward trend is attributed to a deliberate and phased reduction in reliance on coal, continuous technological advancements within the sector, and a concerted effort towards greening the electricity supply to Re-Rolling mills. This is due to the gradual phasing out of coal, technology advancements in the sector, and the greening of electricity supplied to Re-Rolling mills.

However, as of 2070, the sector is yet to emerge as a net zero sector. Around 282,200 metric tons of CO_2e are emitted from all units in the sector. One possible option to emerge as a net zero sector would be to invest in renewable energy, such as solar power or green Hydrogen.

For example, to avoid 280,000 metric tons of CO_2e, one may need to set up a 60 MWp solar PV-based power plant. As of the current date, the cost of such a unit would be around INR 300 crore, although over time, capital costs of setting up solar PV units are falling.

23 https://pib.gov.in/PressReleasePage.aspx?PRID=1923458

6. Creating an Enabling Environment

Steel Re-Rolling mills constitute a ***hard-to-abate*** sector dependent on fossil fuels, characteristic of most ferroalloy and other metal companies. Moreover, the processes of melting iron ores are GHG emission-intensive. As a result, the sector has a larger emissions footprint.

As some European companies have demonstrated, albeit on a pilot scale, it is possible to lower the GHG emissions footprint by investing heavily in green power. In the case of Bihar, local Re-Rolling mills face higher costs of procurement of raw material (iron ore) as well as fuel (coal), none of which are available in the state. As a result, Re-Rolling mills find it difficult (in comparison with mills in other states) to invest in green energy.

Thus, there needs to be some enablers to help support the sector. These enablers have been classified into technological, financial, and policy-related enablers. These are discussed below.

6.1 Technological Enablers

As discussed in section 5.2.3 above, the low-GHG emission scenario is built upon the premise that technologies would penetrate Bihar's Re-Rolling mills' sector to reduce the carbon footprint of steel product making.

Technologies also need upgradation and change to respond to evolving market conditions. As the global construction sector seeks to become more resource-efficient, there is more demand for ductile and strong variants of steel rods, as shown by the recent demand for TMT bar variants with lower phosphorus and sulfur content.

Costs of technology upgradation, as discussed in section 4, would vary across scale and location. Advanced technologies like green Hydrogen (in reheating processes) are still in nascency in India. However, companies such as Jindal (Rebars) have introduced state-of-the-art, European, and US-based plant technologies for production, resulting in finished TMT bars that are superior in output quality and environmental performance.

Thus, the Re-Rolling mills sector in Bihar requires capacity development to leapfrog technologies and introduce state-of-the-art processes, achieving twin objectives of cost competitiveness and better GHG performance. During stakeholder consultations, mill owners indicated weak technical

support, which could be possible through business exchange tours and tech transfer between north-south and south-south. Capacity development needs are outlined in the next sub-section.

6.2 Capacity Enablers

In the context of Bihar's Re-Rolling mill sector, there emerges a crucial imperative for enhancing the capacity of mill owners. This enhancement is essential for the widespread adoption of advanced technologies aimed at curbing greenhouse gas (GHG) emissions and optimizing resource utilization, ultimately resulting in long-term returns on investment.

The expressed sentiments of mill owners underscore a critical need for a paradigm shift in technology adoption. Many currently face challenges due to their reliance on conventional methods and the absence of automation, which, in turn, impacts profitability, product quality, and the ability to make informed decisions.

A significant hurdle lies in the limited awareness among stakeholders regarding crucial aspects such as the impacts of climate change, the potential benefits of green and clean energy investments, and the dynamics of the carbon credits market. These knowledge gaps represent substantial barriers to progress in the Re-Rolling mill sector.

A strategic focus on capacity development becomes paramount to address these challenges and bolster the prospects of the sector in Bihar. Such initiatives can serve as enablers, empowering mill owners with the knowledge and skills needed to navigate the evolving landscape of sustainable practices, advanced technologies, and the broader context of climate-conscious business operations.

6.3 Financial Enablers

As discussed in Chapters 1 and 4, Re-Rolling mills in Bihar face higher input costs on transportation, as neither the raw material (iron ore) nor the fuel (coal) is locally available in Bihar. In addition, transportation from West Bengal, Jharkhand, and Chhattisgarh involves time and cost overruns due to logistical imperfections (poor roads and weak logistics infrastructure add to cost and time overruns).

Thus, the sector remains vulnerable to shocks such as a rise in input, fuel, and transport prices because inputs are not locally available within 0the state. This constrains the entrepreneur from investing in long-term, high-capital investment technologies, even if they are more sustainable in the long run[24]. Moreover, if timely investments are not made, technological and process improvements are not implemented. In the context of Re-Rolling mills, this would lead to weaker products compared to other states where advanced technologies (such as DRI) are already operational or in an advanced state of planning.

There are opportunities for green investments, such as climate bonds and green bonds, and the industries can avail that to invest in cleaner technologies. As mentioned above, Re-Rolling mills need the capacity to access such funds and markets.

During the consultation with stakeholders from Re-rolling mills, it was suggested by mill owners that a fund should be made available in Bihar, under the able stewardship of the Bihar Government, to support green investments in the sector. The fund could be a mix of low-cost and market debt, with easy repayment norms, to assist the mills in introducing green technologies.

24 As understood during stakeholder consultations

6.4 Policy and Regulatory Enablers

Financial and technological enablers mentioned above must be ensconced in an enabling policy and regulatory environment to maximize impact and benefits to the Re-Rolling mills sector in Bihar.

Key policy and regulatory interventions for Re-Rolling mills in Bihar would be:

a) Regulatory incentives for backward integration of Re-Rolling mills in Bihar: Backward integration of Re-Rolling mills is key to reducing costs of coal use. Such a step would diversify the business by procuring sponge iron and scrap metal to produce a range of steel products and finally reduce environmental and resource footprint by replacing fossil fuels with electricity. Policy guidelines in this regard would be to issue fresh licenses.

   However, backward integration would also constitute reduced (if not eliminated) use of reheating furnaces and investing in an induction furnace. In keeping with demand, ladle refining furnaces that produce molten metal with much lower phosphorus and sulfur content would constitute state-of-the-art.

b) Policy guidelines in this regard could adopt a carrot-and-stick policy whereby Re-Rolling mills are incentivized to create an investment plan for fully integrated Re-Rolling mills. Incentive structure could include financial assistance to mill owners to invest in technology upgradation. Simultaneously, the policy discourages the establishment of new standalone mills by suggesting a restriction on issuing fresh licenses. This dual strategy aims to drive the sector towards sustainability and technological advancement while curbing the proliferation of less sophisticated mills.

   Over the long run, a similar carrot-and-stick approach may be adopted for other technological upgrades such as Direct Reduced Iron, HQST, and other energy-efficient technologies for the production of bars and investment in green energy.

c) Incentives for ***green steel*** production: A widely acknowledged fact is that the steel sector is a hard-to-abate candidate for GHG emissions. As this report has outlined, the sector would still have some GHG emissions even if all of the proposed scenarios are realized.

   Creating an incentive structure, such as tax benefits and GST waivers, shall provide entrepreneurs with incentives to invest in upgrading technology, explore cutting-edge and best-in-class opportunities, and thus ensure that the sector stays more competitive.

Photographs documenting the Stakeholders' Consultation held at the BSPCB, Patna

7. Conclusion

In conclusion, the following points are pertinent to observe:

- The Re-Rolling mills are a vital industry in Bihar, supporting industrial and all-round economic growth in the state. The sector provides much-needed steel inputs for real estate and infrastructure sectors. The mills produce TMT bars, MS flats, and other rolled products using electricity and coal as the principal energy inputs. However, the sector is hamstrung by insufficient raw materials (sponge iron, etc.) and inputs (coal). The total production of Re-Rolling mills as of the latest year (FY 2021-22) was around 1.155 million tons, representing around 48% of the total installed capacity of 2.4 million metric tons.
- The sector has evolved, with nearly 50% of units having backward integration by setting up their own induction furnaces so that they may be able to directly ***hot charge*** molten metal in the Re-Rolling process.
- GHG emissions from Re-Rolling mills are primarily due to the use of coal and the purchase of electricity. Emissions from motorized transportation and other upstream and downstream emissions (Scope 3) are less than 10% of total GHG emissions.
- Based on the latest year (FY 2021-22) data, the per-unit GHG emissions indicate 14,127 tons of CO_2-equivalent GHG emissions from a single unit per annum. As an industry as a whole, cumulative GHG emissions are 381,440 tCO_2e per annum. This translates to around 330 kg CO_2e per ton of steel the Re-Rolling mills produce. While standalone mills that use coal in reheating furnaces emit close to 400 $kgCO_2e$ per ton of rolled steel, integrated Re-Rolling mills that have an induction furnace have occasional use of the reheating furnace, and thus their emissions are lower at 290 $kgCO_2e$ per ton of output.
- As the sector seeks to become more competitive and manage its GHG emissions, options for Re-Rolling mills involve investments in green energy and replacing coal use with gas or phasing out coal through the backward integration

process. There is significant potential for natural gas (CNB or bio CNG) development in Bihar, which can be harnessed to meet energy demand from Re-Rolling mills. Integrated mills, on the other hand, have already reduced coal demand.

- Looking ahead to the 2070 scenario, it is estimated, based on several macroeconomic parameters, that output from Re-Rolling mills in Bihar could reach around 7.85 million tons, up from 1.15 million tons as of the current year. This demand is created from demand for housing (rates for urbanization in Bihar are among the lowest across India's larger states and are expected to pick up) and other infrastructure. One expects a period till 2040 that is marked by rapid growth in demand followed by a phase of slower or steady-state demand. The 2070 estimated production level translates to a per capita rolled steel consumption of around 33 kg annually.
- In the longer term, Re-Rolling mills are expected to invest in greener technologies – specifically, technologies such as DRI using green Hydrogen as fuel are slated to significantly reduce fossil fuel based energy consumption (and GHG emissions).
- From the supply side, the national grid will likely become cleaner in response to the Government of India's commitment towards net zero. Re-rolling mills are also expected to invest in green electricity, replacing power purchased from the grid.
- In terms of future GHG emissions, there are two trajectories: the first is the ***business-as-usual*** scenario, while the second is the low emissions trajectory.
- Under the b-a-u scenario, total GHG emissions are around 2.59 million tons of CO_2e per annum in 2070, while under a low emissions trajectory, GHG emissions are around 0.28 million tons of CO_2e per annum in 2070. This will translate to roughly 35 kg of CO_2e emissions per ton of rolled steel output. This is almost 90% lower than present-day baseline emissions of around 330 kg CO_2e per ton of rolled steel.
- The road to achieving the marked reduction in GHG emissions for a ***hard-to-abate*** sector such as Re-Rolling mills has its own challenges. For one, Re-Rolling mills in Bihar need capacity and knowledge enhancement on state-of-the-art technologies that are prevalent in India as well as globally. Secondly, the sector is constrained by a lack of financial wherewithal due to higher operating expenses on account of trans-state transportation of key inputs such as iron and coal. Finally, policy incentives are needed to guide Re-Rolling mills towards a lower GHG emissions pathway.

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Annexure - 1

GHG Inventory Development for Industrial Sectors in Bihar

Questionnaire for Rolling Mills

District / Block:	Site address:
Name of Rolling Mill:	Date:
Name of Respondent:	Name of the company:
Contact details: Phone: Email:	Name of surveyor:

Section 1. Process Description		
Inception year of the rolling mill		
What is the capacity of the rolling mill? (tons per day)		
Days of operation in a year		
Hourly operation per day (average)	Depends on raw material availability	
What products are rolled out in the plant? Please also ask for a percentage share	☐ MS Flat	☐ TMT Bars
	☐ MS rings	☐
	☐ Other (please specify) Pipes	
Any innovation carried out by the unit	None	

Scope 1. Direct Emissions **Includes all fuels burned directly as part of activities at the mill level, including transportation by a vehicle owned by the cement plant.**		
Given the list of fuels identified in Section 1, please identify the supply chain of each.		
What fuels are used in the plant?		
What are the fuels used in reheating furnace?	☐ Coal	☐ Natural gas
	☐ Furnace Oil	☐ Electricity (induction furnace)
	☐ Other (please specify)	
What is the annual consumption of fuel? Tons per annum		
Natural gas / FO / Coal		
Where is the fuel procured from?		

What grade of fuel is used? Coal: indicate source mine, calorific value Natural gas: indicate source field / terminal, Kcal Furnace oil:		
If using coal, are they pulverizing the coal? If yes, what is the capacity of coal pulveriser		
What other fuels are used in the plant site?		
Does the plant have its own transport?		No
If yes, please provide the number and description of vehicles in operation		
Vehicle engine capacity (displacement)		
Gross Vehicular Weight		

Scope 2, Indirect GHG emissions	
Quantity of electricity purchased for plant operation annually? A monthly electricity bill copy is needed	
Any other purchase of electricity, steam, or heat	

Scope 3, Indirect GHG Emissions			
What inputs are required by the rolling mill? Click all that apply	☐ Steel billets	☐ Steel ingots	
	☐ Furnace Oil	☐ Water	
	☐ Others (please specify) ___________________________		
What is the quantity of billets / ingots needed to produce 1 ton?			
Upstream emissions of each of the inputs Use blank sheet for additional info for each			
Coal			
Natural gas			
Furnace oil/diesel			
Billets / ingots (steel)			
Water			
Others			
Average distance travelled per vehicle, for each of the inputs, from depot (collection point) to gate	☐ Coal	☐ Natural gas	
	☐ Furnace Oil / Diesel	☐ Billets / ingots of steel	
	☐ Water	☐ Others ______________	
Vehicle for transporting materials			
Waste generation: What are the different wastes generated in the unit	☐ Mill scale	☐ Coal ash	☐ Wastewater

What is the quantity of Mill scale per ton of rolling mill output (tons)	
What is the means of disposal of mill scale	Descriptive:
What is the quantity of coal ash per ton of rolling mill output (tons)	
What is the means of disposal of mill scale	Descriptive:
What is the quantity of wastewater per ton of rolling mill output (tons)	
What is the means of disposal of wastewater	Descriptive:
What proportion of water is recycled in the unit Percentage	

Others	
Do they have a transformer at the site?	
If yes, please indicate the transformer size.	
Is there any DG set at the site?	
If yes, what is the capacity of DG sets?	

Annexure - 2

Minutes of the Stakeholder Consultation Meetings on 21st November 2022 at Parivesh Bhawan, BSPCB, Patna

Minutes of the stakeholder consultation meeting on the quantification of GHG emissions from the rolling mills in Bihar held under the chairmanship of the Chairman Dr. Ashok Kumar Ghosh, on 21st November 2022 at Parivesh Bhawan, BSPCB, Patna.

The Board organised a stakeholder consultation meeting in association with Development Alternatives (DA) with support from Shakti Sustainable Energy Foundation (SSEF) on GHG Emissions Inventory and Action Plan for the Rolling Mills in Bihar. This consultation was organized as a part of the ongoing project climate resilient and low carbon development pathways in association with UNEP. At the forum, representatives from a few of the rolling mills in the state, BIADA, SSEF, WRI, CEEW, ICLEI & other relevant stakeholders were present. The following officials were in attendance for this meeting:-

1. Sri. Ashok Kumar Ghosh, Chairman, BSPCB;
2. Sri. S. Chandrasekar, Member Secretary, BSPCB;
3. Dr. Naveen Kumar, Scientist BSPCB;
4. Dr. Soumen Maity, Vice President, DA, New Delhi;
5. Sri. Santosh Kumar Sinha, Executive Director, BIADA, New Delhi;
6. Sri. Subhendra Sanyal, Consultant (SSEF), New Delhi;
7. Sri. Abhijit Chatterjee, Consultant, DA, New Delhi;
8. Sri. Avinash Kumar, Senior Manager, DA, New Delhi;
9. Sri. Ujjawal, Program Manager, CEEW;
10. Sri. Mani Bhushan Jha, Program Associate, WRI- India;
11. Sri Shourabh Singh, Consultant, ICLEI, India

The meeting began with the Member Secretary welcoming the participants and explaining to them the objectives behind this study and how necessary it is to gather data before any form of implementation. He appreciated the efforts of DA team for going into the field and collecting primary data. He also expressed his gratitude towards SSEF for supporting this important initiative. Prior to the finalisation of any strategic policies, it is important to have such consultation meetings with the stakeholder to get a better perspective.

After this, Sri. Santosh Kumar Sinha, Executive Director, BIADA, addressed the gathering and pointed out that to reach the Carbon Neutrality goal by 2070 it is necessary to hold such stakeholder consultation. All findings have been done through detailed survey analysis and at present, suggestions from all the concerned organisations and entrepreneurs are required so that we can contribute to the society. It is crucial to not disrupt the supply chain, right from the users until the enterprises should emerge as winners.

Following this the Chairman of BSPCB, Dr. Ashok Kumar Ghosh expressed his views on how we as a society must work together for the preservation of environment. The emissions which have been generated up till now can still be reversed if we work collectively. He also made the audience aware on how essential are the rolling mills for the growth of construction sector and the economy of Bihar. The aim of this discussion is to assist the industries, and not to penalise and if a particular enterprise requires support from the Board to identify technology for the upgradation, then the support from this Board would be provided.

Post the opening remarks by the dignitaries, the presentation by DA began with analysing GHG emissions from the rolling mills. Such an analysis is a first of its kind to be done in the country. Few of the aspects considered during the study was the transportation of raw material to the mill (Sponge Iron/ Pig Iron/ Scrap/ Billets/ Ingots), the manufacturing process of these raw material to other mild steel products and its final dispatchment to the market. At present there are 42 rolling mills out of which 28 are operational and rest are non-operational. Rolling Mills manufacture a range of mild steel products such as rods, TMT bars and other specialised steel products. For the calculation of GHG emissions, IPCC guidelines have been strictly followed to derive results.

At the end of the presentation, the floor was open for discussion where various points were highlighted such as coal being the only economically viable resource for the rolling mill industry, as PNG/CNG/LPG or furnace oil are not cheaply available. Another suggestion was to look out for solar panel implementation, but this would require large areas of land. The electricity which would be harvested at these sites can then be sold back to the grid, and the entrepreneurs can earn benefits.

Member Secretary added that once the PNG/CNG pipeline reaches any industrial area of Bihar, then within six months, all industries have to shift from coal to the mentioned alternative fuels. To which an interjection was made by Mr. Sudhir Kumar Patwari, who expressed how this would not be viable and the industries will come crashing down due to the inflating prices. As suggested by MS, a detailed study needs to be done of rolling mills situated in Mandi, Gobindgarh, Punjab where the industries that adopted CNG/PNG etc, had collapsed. A study needs to be done based on the replacement of the fuels that the industries are dependent on and are the major source of GHG emissions.

At the end vote of thanks was given by Dr. Soumen Maity, Vice President, DA, who expressed his gratitude for all who attended this meeting specially to the rolling mill owner for cooperating with the team and providing them with all the necessary data. He sincerely thanked the Bihar State Pollution Control Board, especially Chairman Dr. Ashok Kumar Ghosh, Member Secretary Sri. S. Chandrasekar, Scientist Dr. Naveen Kumar for providing the space and encouragement to conduct this study. The contributions by UNEP and the PMU team were admired by him. And lastly, he acknowledged the support of Shakti Sustainable Energy Foundation.

22/11/22

(S Chandrasekar)

Member Secretary, BSPCB

Memo No. 2528

Patna -10, Dated 23-11-22

Annexure - 3

Minutes of the Stakeholder Consultation Meetings on 3rd July 2023 at Parivesh Bhawan, BSPCB, Patna

Minutes of the stakeholder consultation meeting on the quantification of GHG emissions and Action Plan for the Rolling Mills and Distilleries in Bihar held under the chairmanship of the Chairman Dr. D K Shukla, on 03rd July 2023 at Parivesh Bhawan, BSPCB, Patna.

A stakeholder consultation meeting in association with Development Alternatives with the support of Shakti Sustainable Energy Foundation GHG emissions inventory and action plan development for the Rolling Mills and Distillery sector of Bihar was organised by the Bihar State Pollution Control Board on the quantification of GHG emission and action plan for rolling mills and distilleries in Bihar on 3rd July 2023 at the Seminar Hall of the Board. The consultation was organized as a part of the 'Climate Resilient and Low Carbon Development Pathway for Bihar' project. It was attended by representatives from all Rolling Mills and Distilleries in the State, Bihar Industry Association, Shakti Sustainable Energy Foundation, Department of Industry, WRI India, and other relevant stakeholders under the chairmanship of Dr. D.K. Shukla, IFS (Retd.), Chairman, BSPCB. The following officials and representatives from various organizations attended the meeting:

1. Shri S Chandrasekar, IFS, Member Secretary, BSPCB, Patna
2. Shri Pankaj Dixit, IAS, Director, Industries, Department of Industries, Bihar
3. Shri Vivek Ranjan Maitrey, IAS, Director, Food Processing, Department of Industries, Bihar
4. Dr. Soumen Maity, Vice President, Development Alternatives, New Delhi
5. Shri Arun Kumar, Board Analyst, BSPCB
6. Shri S. N. Jayaswal, Scientific Advisor, BSPCB
7. Dr. Naveen Kumar, Scientist, BSPCB
8. Shri Shambhu Nath Jha, Regional Officer, BSPCB
9. Shri Sain Kumar, Regional Officer, BSPCB
10. Shri S. P. Roy, Regional Officer, BSPCB
11. Shri A. K. Gupta, Regional Officer, BSPCB
12. Ms. Nidhi Madan, Associate Director, Shakti Sustainable Energy Foundation, New Delhi
13. Shri Subhendra Sanyal, Consultant, Shakti Sustainable Energy Foundation, New Delhi
14. Shri Avinash Kumar, Program Officer, Development Alternatives, New Delhi
15. Shri Abhijeet Chatterjee, Consultant, Development Alternatives, New Delhi
16. Shri Mani Bhushan Jha, Program Associate, WRI India
17. Shri Shashidhar Kumar Jha, Manager, WRI India
18. Ms. Prisha Singh, Fellow, Development Alternatives, New Delhi
19. Ms. Sumedha Singh, Deputy Manager, Development Alternatives, New Delhi
20. Ms. Nilufer Sajjad, Fellow, Development Alternatives, New Delhi
21. Ms. Neha Kumari, CEEW, New Delhi
22. Representatives from Distillery and Rolling Mill Units of Bihar

Shri S. Chandrasekar, IFS, Member Secretary, BSPCB, began the session by welcoming all the representatives from Distilleries and Rolling Mills and set the stage for the discussion. He highlighted the significance of assessing carbon emissions and working together to achieve Carbon Neutrality goals in the industry sector of Bihar by 2070. He also thanked Shakti Sustainable Energy Foundation for supporting this initiative and impressed upon the importance of such stakeholder consultation meetings prior to finalizing any strategic policies to get a better perspective.

Dr. D.K. Shukla, IFS (Retd.) Chairman, BSPCB, stressed how industries could take advantage of the new carbon credits trading scheme recently notified by the Government of India. Since the State aims to be carbon neutral by 2070, the contribution of industries like Rolling Mills and Distilleries is immense. The aim of such a discussion is to assist the industries and not to penalize them.

Shri Pankaj Dikshit, IAS, Director, Department of Industries, Govt. of Bihar, began the dialogue by highlighting how environmental protection is a part of our cultural teachings and heritage. Many of the energy processes can be substituted with renewable energy sources, and thus, the dependency on fossil fuels is to be minimized to achieve sustainable growth in industries. The reduction of emissions from the sector should be a common goal of all and not just the task of the Government, he said.

A detailed presentation was made by the Development Alternatives (DA) team, highlighting the carbon emissions estimation of the Rolling Mills and Distillery units in Bihar, along with strategic recommendations for low-carbon development pathwaysin the sector. According to the study, the Distillery sector has been found to have negligible carbon emissions to the atmosphere. Since Bihar is the leading State to adopt the State Ethanol Blending Policy (EBP), it has the potential to be a leader in grain-based ethanol production in the Nation. As for the Rolling Mills, there are emissions pertaining to coal use; hence, recommendations have been made around the technology upgradation, alternative fuels, and policy changes.

During the discussion following points were suggested-

Distilleries: -

- The State government is emphasizing the utilization of biomass as an energy source, as mentioned by the Director, industries. This indicates a shift towards renewable and sustainable energy options.
- To support this initiative, a feasibility study should be conducted on carbon capturing and storage from the distillery unit. This study should explore the potential of capturing carbon dioxide emissions generated during the distillery process and storing them safely to prevent their release into the atmosphere and it can be used in the other industries where required.
- The industry department is advocating for the expansion of the types of grain/feedstock used in these units beyond broken rice. They are specifically proposing the utilization of maize as an alternative feedstock. This diversification of grain sources allows for increased flexibility and reduces dependency on a single type of grain.
- There is a need to explore 2G feedstock in bio-ethanol production.

Rolling Mill: -

- A feasibility study shouldbe conducted to assess the potential for the utilization of Compressed Natural Gas (CNG) and Piped Natural Gas (PNG) as alternative energy sources.The feasibility study on CNG/PNG utilization in Bihar will assess the viability of using these cleaner energy sources, and subsidies can be granted based on their utilization.
- The government may considerto provide incentives to various sectors to encourage the adoption of renewable energy, promoting a greener and more sustainable energy landscape in the State, wherever possible.

Shri Vivek Ranjan Maitrey, IAS, Director, Food Processing, Department of Industries, Bihar, expressed a need to mitigate carbon emissions to meet the 2070 goals while offering support to the stakeholders. He advised the industry representatives to keep informed of the current policies that may help them be more carbon-neutral while simultaneously helping them economically. It is key to find green alternatives and nature-based solutions to curb emissions. The purpose of these efforts is to leave a better tomorrow for future generations, he said.

Dr. Soumen Maity, Vice President of Development Alternatives, proposed a vote of thanks to conclude the session. He thanked the Board for taking up this initiative of conducting the study for industries in Bihar and thanked the representatives from Rolling Mills and Distilleries for their contribution and participation. He assured the participants that the discussions during the meeting would be taken into consideration by the team for the low-carbon pathway development of the sector.

Sd/-

(S Chandrasekar)

Member Secretary, BSPCB

Memo No. 1619

Patna- 10, Dated 07.7.23

Copy to: All concerned for favour of information and necessary action.

07/7/23

(S Chandrasekar)

Member Secretary, BSPCB






BIHAR STATE POLLUTION CONTROL


BIHAR STATE POLLUTION CONTROL BOARD


BIHAR STATE POLLUTION CONTROL BOARD


BIHAR STATE POLLUTION CONTROL BOARD

Development Alternatives

Development Alternatives (DA) is a premier social enterprise with a global presence in the fields of green economic development, social empowerment, and environmental management. It is credited with numerous innovations in clean technology and delivery systems that help create sustainable livelihoods in the developing world. DA focuses on empowering communities through strengthening people's institutions and facilitating their access to basic needs, enabling economic opportunities through skill development for green jobs and enterprise creation, and promoting low carbon pathways for development through natural resource management models and clean technology solutions. DA works to address three global challenges, namely-

Resource Efficiency and Circular Economy - Accelerating the transition to inclusive and circular modes of production and consumption by reducing carbon and material footprints across the lifecycle of economic activity while promoting local value and wealth creation.

Climate Resilience and Ecosystem Restoration - Regenerating lost biodiversity and degraded ecosystems and building resilience to climate change and extreme events in a manner that also generates prosperity.

Livelihood Security and Inclusive Entrepreneurship - Innovative business models and institutional ecosystems to empower local entrepreneurs to create businesses that generate jobs and deliver basic needs.

Our solutions in addressing these issues are focused on nine sectors - namely Waste Management, Human settlements, Decent work, Climate Response, Sustainable Enterprise, Empowering Communities, Water Solutions, Sustainable Agriculture, and Green Energy.

Since 1982, Development Alternatives has impacted approximately 20 million lives.

BIHAR

Bihar State Pollution Control Board

Bihar State Pollution Control Board (BSPCB) was constituted in the year 1974 under the provisions of the Water (Prevention and Control of pollution) Act, 1974. Enactment of the said Act and subsequently constitution of this Board was in pursuance of Clause-I of Article 252 of the Constitution of India. The Water Act, 1974 was made applicable in the first instance to the whole of 12 States and Union Territories, with Bihar being one of the said 12 States. Since its inception BSPCB, like other State Boards has been performing its functions of planning, monitoring, surveying, strengthening R&D, education and training activities in the domains of air, water, soil and noise pollution.

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