Indonesia Steel Industry and Decarbonization Strategy: Navigating Rapid Growth and Climate Transition

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Abstract

This document examines Indonesia's steel industry within the context of Southeast Asia's largest economy and the world's fourth-most populous nation. With current production capacity of approximately 16 million tonnes annually and ambitious expansion plans targeting 45+ million tonnes, Indonesia presents a complex case of simultaneous industrial growth and decarbonization imperatives. The country faces the challenge of meeting rapidly rising domestic steel demand while responding to international climate pressures, particularly the EU's Carbon Border Adjustment Mechanism (CBAM). This analysis explores Indonesia's current steel landscape dominated by blast furnace-basic oxygen furnace (BF-BOF) technology, the nascent decarbonization initiatives driven by private sector leaders, and the critical policy gaps that must be addressed to align industrial expansion with net-zero commitments. The Indonesian case exemplifies the tensions faced by rapidly developing economies between immediate industrial capacity needs and long-term climate sustainability.

Contents

1 Strategic Context: Indonesia in Global Steel Landscape

1.1 Production Landscape and Industrial Structure

Indonesia's steel industry has experienced significant growth over the past decade, establishing itself as a major regional producer: **Current Production Capacity (2024):**

- Crude steel production: 15.9–16.0 million tonnes
- Global ranking: 14th–15th largest producer worldwide
- Southeast Asian context: Second largest after Vietnam
- Capacity utilization: 62% (2023), significantly below optimal 80%

Technology Distribution:

- BF-BOF integrated mills: ∼80% of capacity
- Electric arc furnace (EAF): ∼20% of capacity
- Direct reduced iron (DRI): Limited operational capacity
- Technology profile: Predominantly high-emission routes

Major Producers:

- PT Krakatau Steel (state-owned): Largest integrated producer, 2.45–3 MT capacity
- PT Gunung Raja Paksi (GRP): Leading EAF producer, expanding capacity
- PT Krakatau Posco: Joint venture (Krakatau Steel–POSCO), 3 MT capacity
- PT Gunawan Dianjaya Steel: Major private sector player
- Dexin Steel: Recent expansion to 7 MT capacity

1.2 Economic and Strategic Significance

Domestic Market Dynamics:

- Apparent steel consumption (2024): 18.3 million tonnes
- Import dependency: Historically 40–50% of domestic consumption
- Trade transformation: From net importer to 4th-largest steel exporter by value (2024)
- Export growth: $8 billion (2019) to $28.5 billion (2024)

End-Use Sectors:

- Construction and infrastructure: 78% of domestic consumption
- Transportation (primarily automotive): 8%
- Oil and gas: 7%
- Machinery and equipment: 4%
- Other sectors: 3%

Strategic Industrial Role:

- Contribution to GDP: Part of 16.48% industrial sector share (2022)
- Employment: Direct and indirect jobs across value chain
- National development: Critical to infrastructure expansion under National Strategic Projects
- Resource sovereignty: Reducing import dependency, enhancing self-sufficiency

1.3 Emissions Profile and Climate Challenge

Current Emissions:

- GHG intensity: EAF producers achieving 0.86 tonnes CO_2/tonne crude steel (GRP benchmark)

- BF-BOF emissions: Estimated 2.0+ tonnes CO_2/tonne crude steel
- Industrial sector emissions: Steel among top 5 emitting industries (70% combined with cement, ammonia, pulp, textile)
- Technology gap: 80% of capacity using high-emission BF-BOF technology

National Climate Commitments:

- Enhanced NDC target: 31.9% emissions reduction by 2030 (unconditional)
- Conditional target: 43.2% reduction with international support
- Net-zero target: 2060 or sooner (recently announced acceleration toward pre-2050)
- Presidential pledge (November 2024): Retire all fossil fuel plants within 15 years

International Pressures:

- EU CBAM: Full implementation 2026, requiring carbon accounting for steel exports
- Climate Action Tracker rating: "Critically insufficient" for 1.5°C pathway
- Trade implications: Risk to export competitiveness without decarbonization
- Green steel standards: Emerging international requirements for market access

2 Expansion Plans and Capacity Development

2.1 National Industry Development Master Plan (RIPIN)

Indonesia's steel capacity targets under RIPIN (2015–2035):

- 2019 target: 12 million tonnes (achieved)
- 2024 target: 17 million tonnes (largely achieved at 16 MT)
- 2030 projection: 33–35 million tonnes
- 2035 target: 25 million tonnes (original plan)

Current Pipeline Reality:

- Total operational and planned capacity: 45+ million tonnes
- Far exceeding 2035 targets, creating overcapacity risks
- Capacity expansion in construction: 24.5 million tonnes
- Ironmaking expansion: 5.8 million tonnes (all BF technology)

2.2 Technology Distribution in Expansion

Alarming Technology Profile:

- BF-BOF expansion: 22.8 million tonnes (93% of pipeline)
- EAF expansion: Only 1.7 million tonnes (7% of pipeline)
- DRI capacity: Zero operational or planned facilities
- Regional comparison deficit: Vietnam (17.2 MT EAF planned), Philippines (12.8 MT EAF planned)

Investment Dynamics:

- Basic metals investment surge: \$14.8 billion (2020) to \$37.7 billion (2023)
- Private sector led: Major expansions by Gunung Steel Group, Chinese investors
- State sector: Krakatau Steel seeking partnerships for BF reactivation
- Technology lock-in risk: \$17–26 billion in potential stranded assets (BF-BOF under construction)

2.3 Geographic Distribution and Industrial Clusters

Major Steel Production Hubs:

- Cilegon, Banten (Java): Krakatau Steel integrated complex, largest concentration
- Surabaya, East Java: Significant steel processing and fabrication
- Other Java locations: Distributed EAF and specialty steel producers
- Emerging locations: Expansion into less densely populated regions

Port Infrastructure:

- Cigading Port (Cilegon): Dedicated steel industry logistics
- Strategic coastal positioning: Facilitating iron ore imports, product exports
- Integration with industrial estates: Co-located utilities and services

3 Policy and Regulatory Framework

3.1 Institutional Architecture

Key Government Ministries:

- **Ministry of Industry:** Industrial policy, capacity planning, local content requirements
- **Ministry of Energy and Mineral Resources (MEMR):** Energy policy, renewable energy development
- **Ministry of Environment and Forestry:** Climate commitments, emissions monitoring
- **Investment Coordinating Board (BKPM):** Investment approval and facilitation
- **Ministry of Trade:** Trade policy, import/export regulation, anti-dumping measures

Industry Associations:

- Indonesian Iron & Steel Industry Association (IISIA): Industry advocacy, data collection
- Indonesian Chamber of Commerce (KADIN): Business representation, Net Zero Hub

3.2 Current Policy Instruments

Industrial Policy:

- Local content requirements (TKDN): 40–65% for steel products, target 85% for metal products
- Indonesian National Standard (SNI) compliance: Quality and specification mandates
- National Strategic Projects: Prioritizing domestic steel use in infrastructure
- Investment incentives: Tax holidays, import duty reductions for capacity expansion

Trade Protection Measures:

- Anti-dumping duties: Multiple measures against Chinese steel imports
- Import tariffs: Selective tariff adjustments to protect domestic producers
- Safeguard mechanisms: Responding to import surges
- Export promotion: Government support for increasing steel exports

Energy and Climate Policy:

- National Energy Policy (KEN): Under development, targeting renewable energy expansion
- National Energy General Plan (RUEN): Framework for energy transition
- Just Energy Transition Partnership (JETP): $20 billion international support package (2022)
- Renewable energy targets: Insufficient progress; barriers to grid access and pricing

3.3 Critical Policy Gaps

Absence of Steel-Specific Decarbonization Roadmap:

- No binding emissions reduction targets for steel sector
- Lack of technology pathway guidance (BF-BOF vs. DRI-EAF)
- No carbon pricing mechanism or emissions trading system
- Missing regulatory signals for low-carbon investment

Research and Innovation Funding:

- Limited public R&D support for steel decarbonization technologies
- No equivalent to EU Clean Steel Partnership or Innovation Fund
- Private sector initiatives (e.g., GRP Net Zero Roadmap) proceeding without coordinated support
- Knowledge transfer mechanisms underdeveloped

Power Sector Constraints:

- Grid dominated by coal-fired generation (60%+)
- Renewable energy: Only 13% of generation (2023)
- High renewable energy costs: Auction prices double those in comparable economies
- Regulatory barriers: Contract inflexibility, grid access limitations
- Critical bottleneck: Steel decarbonization requires clean electricity for EAF and green hydrogen

4 Decarbonization Pathways and Technology Options

4.1 Electric Arc Furnace (EAF) Expansion

Current Status and Potential:

- Existing EAF capacity: $\sim$3 million tonnes operational
- Advantages: Lower capital cost, faster deployment, 70–80% emission reduction vs. BF-BOF
- Scrap availability: Potential feedstock constraint with rising demand
- Technology leader: PT Gunung Raja Paksi (GRP) demonstrating viability

GRP Case Study – Private Sector Leadership:

- Current emissions: 0.86 tonnes CO_2/tonne crude steel (2021 baseline)
- Net Zero Roadmap target: Carbon neutrality by 2050
- International support: IFC \$60 million loan (September 2024) for low-carbon flat steel expansion
- ESG strategy pillars: (1) Low Carbon Solutions, (2) Eco-friendly Operations, (3) Circular Economy, (4) Social Development, (5) Nurturing Talent
- Specific initiatives: Renewable energy procurement, energy efficiency, carbon offsetting

Barriers to EAF Scale-Up:

- Grid electricity emissions: Coal-dominant grid limits decarbonization potential
- Scrap quality and quantity: Tramp elements, collection infrastructure, export competition
- Market segmentation: Limitations for certain high-grade steel applications
- Investment bias: Current expansion heavily favoring BF-BOF route

4.2 Hydrogen-Based Direct Reduction (H2-DRI)

Technology Assessment:

- Global pathway: Primary route for decarbonizing integrated steel production
- Indonesia status: No operational or planned DRI facilities (BF or H_2-based)
- Regional gap: Behind Vietnam, Philippines in DRI-EAF investment
- Technology readiness: Proven internationally; requires green hydrogen supply

Hydrogen Supply Challenges:

- Green hydrogen production: Requires large-scale renewable electricity
- Electrolyzer capacity: No significant domestic manufacturing or deployment
- Cost competitiveness: Green hydrogen currently 3–5× cost of natural gas
- Infrastructure requirements: Production, storage, transport systems needed
- Renewable energy prerequisite: Power sector reform essential foundation

Potential and Opportunities:

- Renewable energy resources: Abundant solar, geothermal, hydropower potential
- Geographic advantage: Island geography suitable for distributed generation
- JETP support: $20 billion package includes renewable energy deployment
- Technology transfer: Potential partnerships with leading steel producers (Japan, Korea, EU)

4.3 Carbon Capture, Utilization and Storage (CCUS)

Applicability to Indonesian Context:

- Bridge technology: For existing BF-BOF facilities during transition
- Geological storage potential: Indonesia has suitable geological formations
- Cost considerations: High capital and operating expenses
- Technology maturity: Limited large-scale demonstrations in steel sector globally

Research and Development Needs:

- Pilot projects: No steel-specific CCUS initiatives currently
- Utilization pathways: CO_2 conversion to chemicals, building materials
- Regional collaboration: Potential for shared infrastructure with other industries
- Regulatory framework: Carbon storage liability, monitoring, verification systems needed

4.4 Circular Economy and Material Efficiency

Scrap-Based Steelmaking Enhancement:

- Collection systems: Improving scrap collection rates and quality
- Urban mining: Recovering steel from end-of-life products, construction demolition
- Import/export balance: Currently net scrap exporter; reversing flows could support EAF expansion
- Quality upgrading: Advanced sorting, impurity removal technologies

Material Efficiency in End-Use Sectors:

- Construction sector: Optimized structural design reducing steel intensity
- Automotive sector: Lightweighting, material substitution
- Design for recyclability: Product standards facilitating future scrap recovery
- Life cycle thinking: Extended producer responsibility for steel-containing products

5 International Dimensions and Trade Dynamics

5.1 Export Transformation and Competitiveness

Export Growth Trajectory:

- 2019: $8 billion steel exports (17th globally by value)
- 2024: $28.5 billion steel exports (4th globally by value)
- Export share of production: 35–40% of domestic output
- Strategic pivot: From import substitution to export-oriented growth

CBAM Exposure and Response:

- EU exports: Significant share of Indonesian steel exports directed to European markets
- CBAM implementation: Transitional phase 2023–2025; financial obligations from 2026
- Embedded emissions reporting: Requiring carbon accounting for steel exports
- Competitiveness risk: High-emission BF-BOF steel facing carbon costs
- Industry awareness: Growing recognition of need for decarbonization to maintain market access

5.2 Regional Competition and Collaboration

Southeast Asian Context:

- Vietnam: Aggressive EAF expansion (17.2 MT planned), strong scrap-based strategy
- Thailand: 100% EAF capacity, lowest emissions profile in region
- Philippines: 12.8 MT EAF expansion planned
- Indonesia lag: Technology profile increasingly divergent from regional peers

ASEAN Initiatives:

- ASEAN Net Zero Hub: Established post-2023 Summit, supporting regional decarbonization
- Regional standards: Potential harmonization of green steel definitions, carbon accounting
- Technology cooperation: Knowledge sharing, joint research initiatives
- Trade integration: ASEAN Economic Community facilitating steel trade flows

5.3 Chinese Investment and Trade Relations

Investment Inflows:

- Major investors: Chinese steel companies significant contributors to capacity expansion
- Technology transfer: Predominantly BF-BOF technology
- Strategic concerns: Dependency on Chinese technology, equipment, expertise
- Bilateral relations: Balancing investment benefits with strategic autonomy

Trade Tensions:

- Import competition: Chinese steel overcapacity creating pricing pressures
- Anti-dumping measures: Multiple product categories under protection
- Circumvention: Third-country routing of Chinese steel
- Market access: Indonesian steel seeking to expand exports to China

5.4 Technology Partnerships and Development Cooperation

Potential International Collaborations:

- Japan: Longstanding steel industry cooperation; advanced technology providers
- South Korea: POSCO joint venture (Krakatau Posco); potential for green steel initiatives
- European Union: Technology transfer, standards harmonization, CBAM coordination
- IFC and MDBs: Development finance for low-carbon steel projects (GRP example)

JETP Implementation:

- $20 billion commitment: Supporting Indonesia's energy transition
- Steel sector relevance: Clean electricity essential for steel decarbonization
- Policy conditionality: Renewable energy acceleration, fossil fuel phase-out
- Coordination challenges: Aligning industrial and energy policy objectives

6 Implementation Challenges and Barriers

6.1 Structural and Economic Challenges

Capacity Utilization Paradox:

- Current utilization: 62% (2023), well below healthy 80% threshold
- Expansion pressure: Capacity additions far exceeding demand growth
- Stranded asset risk: BF-BOF investments vulnerable to policy shifts, CBAM impacts
- Financial viability: Low utilization undermining economics of decarbonization investment

Cost and Competitiveness:

- Capital intensity: Decarbonization technologies requiring major investment
- Operating cost increases: Green steel production more expensive than conventional
- Pricing power: Limited ability to pass costs to domestic market
- Export markets: Price-sensitive buyers may shift to lower-cost suppliers

Access to Finance:

- Public funding constraints: Limited domestic budgets for industrial transformation
- Private sector investment: Risk aversion given technology and policy uncertainties
- Development finance: MDBs supporting specific projects but insufficient scale
- Green finance mechanisms: Carbon credits, green bonds underdeveloped for steel sector

6.2 Technical and Operational Barriers

Skills and Workforce:

- Technical expertise: Limited domestic experience with DRI, hydrogen, CCUS technologies
- Training infrastructure: Need for workforce development programs
- Brain drain: Competition for talent from other industries, countries
- Management capabilities: Integrating sustainability into corporate strategy

Supply Chain Limitations:

- Green hydrogen: No domestic production infrastructure
- Renewable electricity: Grid access barriers, inadequate capacity
- Scrap processing: Quality upgrading technologies, collection systems
- Equipment and services: Dependency on imports for decarbonization technologies

6.3 Policy and Governance Challenges

Inter-Ministerial Coordination:

- Fragmented responsibilities: Industry, Energy, Environment ministries with different priorities
- Policy coherence: Industrial growth objectives vs. climate commitments
- Implementation gaps: National commitments not translated to sectoral targets
- Bureaucratic barriers: Permitting, regulatory approval delays

State-Owned Enterprise Governance:

- Krakatau Steel: Financial challenges, competing objectives (profitability vs. strategic goals)
- Political economy: SOE reforms sensitive to employment, regional development concerns
- Investment decisions: Balancing commercial viability with national industrial policy
- Private sector interface: Ensuring level playing field, avoiding market distortions

Regulatory Uncertainty:

- Carbon pricing: No clear timeline or design for emissions trading, carbon tax
- Green standards: Evolving definitions, certification schemes
- Trade policy: CBAM response strategy unclear
- Incentive structures: Ad hoc measures rather than comprehensive framework

7 Opportunities and Strategic Pathways

7.1 Leveraging Natural Resource Advantages

Renewable Energy Endowment:

- Geothermal: World's largest potential (29 GW), significant untapped capacity
- Solar: Strong irradiation across archipelago, declining technology costs
- Hydropower: Substantial undeveloped capacity, particularly in outer islands
- Bioenergy: Agricultural residues, forestry biomass as fuel sources
- Strategic opportunity: Low-cost clean electricity foundation for green steel

Nickel and Critical Minerals:

- Nickel reserves: World's largest, critical for stainless steel, batteries
- Downstream integration: Adding value through processing, alloy production
- Stainless steel niche: Leveraging nickel advantage for specialty steel leadership
- Export restrictions: Forcing domestic processing, beneficiation

7.2 Learning from Regional Leaders

Thailand EAF Model:

- 100% EAF capacity: Lowest emissions intensity in ASEAN
- Scrap-based production: Efficient circular economy model
- Applicability: Indonesia EAF expansion could follow similar pathway
- Technology transfer: Thai companies potential partners for Indonesian producers

Vietnam's Rapid Transition:

- Aggressive EAF investment: 17.2 MT planned capacity
- Foreign direct investment: Attracting international steel majors
- Policy framework: Clearer decarbonization signals than Indonesia
- Competition pressure: Vietnam's progress highlighting Indonesia's lag

7.3 Private Sector Innovation and Leadership

GRP and Other Champions:

- Corporate net zero commitments: Leading companies setting ambitious targets
- ESG integration: Sustainability as business strategy, not compliance
- International partnerships: Leveraging development finance, technology providers
- Demonstration effect: Successful projects creating replication pathways

Industry Association Initiatives:

- KADIN Net Zero Hub: Business-led platform for climate action
- IISIA advocacy: Industry association pushing for supportive policies
- Knowledge platforms: WRI Indonesia, CDP providing tools, frameworks
- Peer learning: Companies sharing best practices, lessons learned

7.4 International Partnership Opportunities

Bilateral Technology Cooperation:

- Japan: JBIC finance, JFE/Nippon Steel technology for H_2-DRI
- South Korea: POSCO expanding partnership beyond Krakatau Posco
- European Union: Clean Steel Partnership collaboration, standards harmonization
- Green Steel Hubs: Potential participation in international initiatives

Multilateral Support Mechanisms:

- JETP implementation: Prioritizing steel-relevant energy infrastructure
- ADB and World Bank: Green industry finance facilities
- Climate finance: GCF, GEF support for transformational projects
- Technical assistance: IEA, UNIDO capacity building programs

8 Recommendations and Policy Priorities

8.1 Immediate Actions (2025–2027)

Develop National Steel Decarbonization Roadmap:

- Binding sectoral targets: Align with national NDC, net-zero commitments
- Technology pathway guidance: Clear signals on DRI-EAF, hydrogen priorities
- Capacity rationalization: Addressing overcapacity, technology lock-in risks
- Stakeholder engagement: Industry, government, civil society co-creation

Power Sector Reform Acceleration:

- Grid access: Streamlined processes for renewable energy projects
- Contract flexibility: Allowing dispatchability, reducing curtailment
- Pricing mechanisms: Cost-reflective tariffs, green electricity premiums
- Clean electricity availability: Essential precondition for steel decarbonization

Green Steel Standards and Certification:

- National standards: Defining low-carbon, green steel thresholds
- Certification scheme: Transparent, verifiable carbon accounting
- Harmonization: Aligning with international standards (EU, ISO)
- Market creation: Public procurement preferences for low-carbon steel

8.2 Medium-Term Priorities (2027–2035)

Technology Deployment Support:

- R&D funding: Public support for pilot, demonstration projects
- Investment incentives: Tax credits, accelerated depreciation for green steel technologies
- Risk mitigation: Guarantees, insurance for first-mover projects
- Technology parks: Dedicated zones for green steel innovation, testing

Hydrogen Economy Development:

- National hydrogen strategy: Prioritizing steel sector applications
- Electrolyzer manufacturing: Domestic production capacity development
- Pilot projects: H_2-DRI demonstrations at scale
- Infrastructure investment: Production, storage, distribution networks

Circular Economy and Scrap Systems:

- Scrap management: Improved collection, sorting, quality control
- Trade policy adjustment: Restricting scrap exports to support domestic EAF
- Design standards: Product requirements facilitating future recycling
- Material traceability: Digital systems tracking steel throughout lifecycle

CBAM Preparedness:

- Emissions data infrastructure: Establishing MRV systems for steel sector
- Producer support: Assistance with CBAM reporting, compliance
- Bilateral negotiations: EU dialogue on implementation, transition support
- Competitiveness measures: Addressing cost impacts on export-oriented producers

8.3 Long-Term Vision (2035–2060)

Net-Zero Steel Sector:

- Technology transformation: Majority of capacity using DRI-EAF, hydrogen routes
- Residual emissions: CCUS for unavoidable process emissions
- Circular economy maturity: High recycling rates, minimal virgin material consumption
- Energy integration: Steel plants as flexible grid resources, hydrogen users

Regional Green Steel Hub:

- Export competitiveness: Low-carbon steel premium products
- Technology leadership: Tropical/equatorial green steel expertise
- Regional integration: ASEAN-wide supply chains, standards
- Knowledge center: Training, research for developing countries

Just Transition Outcomes:

- Workforce transformation: Skilled labor for green steel technologies
- Regional development: Steel-dependent areas successfully diversified
- Social equity: Economic benefits broadly shared
- Demonstration model: Indonesia transition inspiring other developing countries

9 Conclusions

Indonesia's steel industry stands at a critical inflection point. The country faces the simultaneous challenges of meeting rapidly growing domestic steel demand, expanding export capacity, and responding to mounting international climate pressures. The current trajectory—dominated by high-emission BF-BOF technology expansion—is fundamentally misaligned with both global decarbonization imperatives and Indonesia's own net-zero commitments. **Key Findings:**

- **Capacity-emissions disconnect:** Planned expansion to 45+ million tonnes far exceeds 2035 targets and locks in decades of high emissions through BF-BOF technology dominance.