Steel Decarbonization in Argentina: Latin America's Emerging Green Steel Opportunity

MIFUS: A Global Journey Through Steel Decarbonization

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Abstract

Argentina, South America's second-largest steel producer with approximately 4–5 million tonnes annual production, stands at a unique crossroads of economic transformation and decarbonization opportunity. This paper analyzes Argentina's steel sector within the MIFUS (A Global Journey Through Steel Decarbonization) framework, examining a landscape dominated by multinational corporations—Ternium (Techint Group), ArcelorMittal Acindar, and Gerdau—alongside emerging domestic players like Sidersa. Unlike Germany's hydrogen-focused strategy or China's massive capacity replacement approach, Argentina's decarbonization pathway is shaped by exceptional renewable energy endowments (Patagonian wind with capacity factors exceeding 50%, northwestern solar irradiation up to 2,000 kWh/kWp), the National Hydrogen Strategy targeting 5 million tonnes H_2 production by 2050, and recent policy developments including the RIGI (Régimen de Incentivo para Grandes Inversiones) framework. The paper contextualizes Argentina's steel transition against its NDC commitments (349 $MtCO_2e$ by 2030), chronic macroeconomic volatility, and the strategic opportunity presented by the Sidersa greenfield EAF project—the first integrated steel mill investment in 50 years. With steel value chains representing approximately 60% of Argentine industrial activity and the sector contributing 3.5% of national GHG emissions, Argentina's path offers critical lessons for emerging economies balancing industrial development with climate imperatives.

Keywords: Steel decarbonization, Argentina, green hydrogen, renewable energy, Patagonia, Ternium, EAF, RIGI, Latin America, MIFUS

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1 Introduction: Argentina's Steel Sector in Global Context

1.1 The MIFUS Framework

This paper is part of the MIFUS initiative (A Global Journey Through Steel Decarbonization), a comprehensive comparative study examining steel decarbonization strategies across major producing nations including China, India, Japan, United States, Russia, South Korea, Brazil, Germany, and other European countries. The analysis draws upon:

- Global overview documents (A_Global.pdf, B_GlobalAppendix.pdf)
- China's transformative October 2024 policies and provincial analysis
- European Union framework analysis (J_EuropeanUnion.pdf)
- Germany's hydrogen-based transformation strategy (H_Germany.pdf)
- Brazil country study (M_Brasil_ClaudeAndreFabio.pdf)

1.2 Argentina's Strategic Position

Argentina occupies a distinctive position in the global steel landscape:

- **Regional Significance:** Second-largest steel producer in South America (after Brazil)
- **Production Scale:** 4–5 million tonnes annually (pre-pandemic peak)
- **Global Ranking:** Approximately 30th worldwide (<0.3% global market share)
- **Industrial Weight:** Steel value chains account for approximately 60% of Argentine industrial activity; steel industry alone contributes nearly 8% of manufacturing
- **Emissions Profile:** Steel and iron sector represents roughly 3.5% of national GHG emissions
- **Domestic Focus:** 90% of Argentine steel consumption supplied via domestic production
- **Renewable Potential:** Third-highest technical Power-to-X potential globally

1.3 The Transformation Opportunity

Unlike Germany or China, Argentina faces a fundamentally different transformation context:

1. **Scale Advantage:** Smaller production volumes enable more agile transformation
2. **Renewable Endowment:** World-class wind and solar resources position Argentina as potential green steel leader
3. **Export Opportunity:** Green hydrogen and derivatives could transform economic positioning
4. **Economic Constraints:** Chronic macroeconomic instability affects investment capacity
5. **Policy Evolution:** New RIGI framework creating unprecedented investment incentives

2 Production Landscape and Technology Mix

2.1 Current Production Overview (2023–2024)

Table 1: Argentina Steel Production Statistics

Metric	2023	2024 (Est.)
Crude Steel Production	4.2–4.5 Mt	3.8–4.2 Mt
Hot-Rolled Steel	2.8–3.2 Mt	2.5–2.9 Mt
Cold-Rolled Steel	1.0–1.2 Mt	0.9–1.1 Mt
Long Products	1.4–1.6 Mt	1.2–1.5 Mt

2024 Production Context: The Argentine steel sector experienced significant disruption in 2024:

- ArcelorMittal Acindar suspended production at all four plants (March–April 2024) due to 35–40% demand collapse
- Economic recession under Milei administration's structural adjustment program
- July 2024 showed recovery signs: crude steel up 14.2% month-on-month to 314,000 tonnes
- Year-on-year comparisons remained negative (2–30% declines across product categories)

2.2 Technology Mix

Argentina's steel production employs a mixed technology profile:

Table 2: Argentine Steel Production by Technology Route

Technology	Capacity (Mt)	Share (%)	CO_2 Intensity
Integrated BF-BOF	3.0–3.5	60–65%	1.9–2.2 t CO_2/t steel
Electric Arc Furnace (EAF)	1.5–2.0	35–40%	0.3–0.5 t CO_2/t steel
Total	**4.5–5.5**	**100%**	**1.3–1.5 t CO_2/t steel**

Key Observation: Argentina's relatively high EAF share (35–40%) compared to global average (28–30%) provides a favorable starting point for decarbonization, as EAF routes can be readily decarbonized through renewable electricity and scrap recycling.

2.3 Major Steel Producers

2.3.1 Ternium Argentina (Techint Group)

- **Headquarters:** San Nicolás de los Arroyos, Buenos Aires Province
- **Ownership:** Part of Ternium S.A. (Luxembourg), controlled by Techint Group
- **Production:** Largest integrated steelmaker in Argentina
- **Facilities:** General Savio Industrial Center (San Nicolás)—BF-BOF route
- **Products:** Flat steel products (sheets, coils, profiles, tubes)
- **Markets:** Construction, mining, energy, automotive, agribusiness

- **Workforce:** Part of 35,000 employees across Ternium/Usiminas operations

Decarbonization Initiatives:

- 99 MW wind farm under construction in Olavarría (expected completion late 2024)
- Will provide 90% of purchased electricity requirements for Argentine operations
- Named Sustainability Champion 2024 by World Steel Association (sixth consecutive year)
- Revised target: 15% reduction in emissions intensity by 2030 (vs. 2023 baseline)
- Target scope includes Scope 1, 2, and Scope 3 (Categories 1 and 10)
- 2.9 million tonnes of steel scrap recycled in 2023
- 99.5% material efficiency rate in steel operations
- Environmental Product Declarations (EPDs) for eight product families

2.3.2 ArcelorMittal Acindar

- **Headquarters:** Villa Constitución, Santa Fe Province
- **Ownership:** Subsidiary of ArcelorMittal (global)
- **History:** Founded 1942 as Industria Argentina de Aceros S.A.
- **Production:** Major long products producer
- **Facilities:** Four plants—Villa Constitución (Santa Fe), San Nicolás (Buenos Aires), La Tablada (Rosario), Villa Mercedes (San Luis)
- **Technology:** Primarily EAF-based production
- **Products:** Construction steel, rebars, wire rod

2024 Challenges:

- Production suspension March 18–April 15, 2024
- 35–40% sales collapse in preceding months
- Workforce placed on leave (no layoffs announced)
- "In 20 years working at the company, there has never been a similar collapse"—Facundo Velasco, Director of Institutional Relations

2.3.3 Gerdau Argentina

- **Ownership:** Subsidiary of Gerdau S.A. (Brazil)
- **Operations:** Argentina and Uruguay
- **Focus:** Long steel products, specialty steels
- **Technology:** EAF-based mini-mill operations
- **Leadership:** Guillermo Maglieri, Executive Director

2.3.4 Sidersa—Emerging Domestic Champion

- **Headquarters:** San Nicolás, Buenos Aires Province
- **Ownership:** 100% Argentine capital (Spoto, Settimini, Coletto families from Rosario)
- **History:** 68 years in steel distribution and services
- **Current Operations:** Steel distribution, service center, processing
- **Employment:** 650 direct workers, 7,000+ indirect jobs
- **Customers:** 2,000+ clients

Transformative Investment (RIGI Project):

- **Investment:** USD 300 million (first integrated steel mill in 50 years)
- **Technology:** State-of-the-art EAF using scrap as feedstock
- **Capacity:** 360,000 tonnes/year of construction rebars
- **Location:** San Nicolás, Buenos Aires Province
- **Timeline:** Commissioning Q4 2027–2028
- **Financing:** BID Invest (USD 100 million SLL), IFC (USD 50 million)
- **Status:** First industrial project approved under RIGI regime (December 2024)
- **Employment:** 300 direct jobs, 3,500–4,000 indirect jobs
- **Exports:** 30% of production (USD 100 million/year)
- **Environmental:** 50% lower CO_2 emissions vs. conventional technology

2.3.5 Other Producers

- **Tenaris:** Seamless steel tubes (part of Techint Group)
- **Acerbrag:** Locally owned specialty steel producer
- **Techint:** Engineering and construction services to steel sector

3 Decarbonization Strategy and Policy Framework

3.1 National Climate Commitments

3.1.1 Nationally Determined Contribution (NDC)

Argentina's climate framework under the Paris Agreement:

- **2030 Target:** Not to exceed 349 $MtCO_2e$ net emissions (economy-wide, unconditional)
- **Improvement:** 27.7% reduction vs. first NDC (2016)
- **2050 Goal:** Carbon neutrality (Long-Term Strategy submitted 2022)
- **Methane:** Committed to 30% reduction by 2030 (from 2020 levels)
- **Deforestation:** Commitment to end and reverse by 2030

Climate Action Tracker Assessment: "Highly Insufficient"—policies and targets need substantial improvements for 1.5°C consistency.

3.1.2 Steel Sector Implications

With steel contributing approximately 3.5% of national emissions:

- Estimated sector emissions: 6–8 $MtCO_2$/year
- Sector decarbonization pathway not explicitly defined in NDC
- Hydrogen strategy allocates domestic H_2 to steel decarbonization
- Industry sector broadly targeted for green hydrogen deployment

3.2 National Hydrogen Strategy (2023)

Argentina launched its National Strategy for the Development of the Hydrogen Economy in September 2023:

Key Targets by 2050:

- **Production:** Minimum 5 million tonnes low-emission hydrogen/year
- **Domestic Use:** 20% (1 million tonnes) for local decarbonization
- **Exports:** 80% (4 million tonnes) for international markets
- **Infrastructure:** 30 GW electrolyzer capacity, 55 GW renewable energy capacity
- **Hubs:** 5 hydrogen production hubs, 2–5 adapted export ports
- **Cost Target:** USD 1.40/kg green hydrogen (competitive for export)

Steel Sector Priority: The strategy explicitly identifies steel as a priority sector for domestic hydrogen allocation, alongside petrochemicals and refining. One million tonnes H_2/year is designated for decarbonizing:

- Existing hydrogen applications (steel, petrochemical, refining)
- New value chains (primarily synthetic fuels)

3.2.1 Industry Commitments

In 2021, several members of the Argentine Chamber of Steel expressed commitment to emission reductions, with green hydrogen in steel reduction processes identified as a long-term strategy.

3.3 RIGI—Large Investment Incentive Regime

The Milei administration's Decree 749/2024 established the Régimen de Incentivo para Grandes Inversiones (RIGI):

Eligible Sectors: Steel, petrochemicals, infrastructure, electric/hybrid vehicles, biotechnology, nanotechnology, defense manufacturing

Investment Threshold: Projects exceeding USD 200 million

Benefits:

- 30-year tax and regulatory stability guarantees
- Reduced income tax payments
- Reduced taxes on dividends
- Preferential customs treatment

- Foreign currency benefits
- Streamlined environmental approvals

Steel Sector Application:

- Sidersa project: First industrial approval under RIGI (December 2024)
- Signals government priority for steel sector modernization
- Creates framework for future green steel investments

3.4 Renewable Energy Framework

3.4.1 Law 27,191 (Renewable Energy Law)

- **2025 Target:** 20% of electricity from renewable sources
- **2030 Target:** 30% renewable energy in national matrix
- **Current Status (2024):** Approximately 16–19% of demand from renewables

3.4.2 RenovAr Program

Government auction program for renewable energy development:

- Long-term PPAs (20-year contracts)
- World Bank guarantees
- Multiple rounds since 2016
- 6.5 GW contracts signed to date

3.4.3 MATER (Renewable Energy Term Market)

Private corporate PPA mechanism allowing direct renewable procurement:

- Enables industrial users to contract renewable electricity directly
- Ternium utilizing for wind farm development
- Critical for steel sector electrification

4 Infrastructure and Resource Endowments

4.1 Renewable Energy Resources

Argentina possesses exceptional renewable energy resources that position it uniquely for green steel production:

4.1.1 Wind Energy—Patagonian Advantage

- **Capacity Factors:** >50% in Patagonia (vs. 25–35% global average)
- **Wind Speeds:** 9+ m/s in Patagonia; 6+ m/s across 70% of territory
- **Theoretical Potential:** 500 GW in Chubut Province alone (CREE estimate)
- **Installed Capacity (2025):** 4,342 MW
- **Market Share:** 58.8% of renewable generation (2024)
- **Growth:** From 227 MW (2017) to 4,342 MW (2025)

4.1.2 Solar Energy—Northwestern Potential

- **Irradiation:** Up to 2,000 kWh/kWp in northwestern provinces
- **Installed Capacity (2025):** 1,933 MW
- **Growth Rate:** 8.0% CAGR projected (2025–2030)
- **Key Projects:** Cauchari complex (312 MW), San Rafael (200 MW)
- **Regional Distribution:** Northwest (850 MW), Cuyo (655 MW), Northeast (270 MW)

4.1.3 Hydroelectric Power

- **Large Hydro (>50 MW):** 9,639 MW installed
- **Small Hydro (<50 MW):** 524 MW installed
- **Major Projects:** Kirchner-Cepernic dams (1.3 GW under development)

4.1.4 Total Renewable Capacity

Table 3: Argentina Renewable Energy Capacity (2025)

Source	**Capacity (MW)**	**Share (%)**
Large Hydroelectric (>50 MW)	9,639	58.0%
Wind	4,342	26.1%
Solar PV	1,933	11.6%
Small Hydroelectric (<50 MW)	524	3.2%
Biogas/Biomass	192	1.2%
Total Renewable	**16,631**	**100%**
Total Installed Capacity	*43,613*	—
Renewable Share	—	*38%*

4.2 Green Hydrogen Infrastructure

4.2.1 Current Hydrogen Demand

- **2019 Demand:** 350,000 tonnes H_2/year (IEA estimate)
- **Current Supply:** 100% grey hydrogen (natural gas-based)
- **Primary Uses:** Refineries, ammonia/fertilizer production, industrial processes

4.2.2 Demonstration Projects

- **Hychico (Capex S.A.):** Operational since 2008, wind-powered electrolysis since 2011
- **Location:** Chubut Province (Patagonia)
- **Significance:** Demonstrates technical feasibility in Argentine conditions

4.2.3 Planned Major Projects

- **Fortescue Future Industries (FFI):** Large-scale green hydrogen project in Río Negro Province
- **Air Liquide Argentina:** Electrolysis expansion for steel mills and refineries
- **H2ar Consortium:** 30+ companies (YPF/Y-TEC initiative) developing hydrogen value chain

4.2.4 Cost Projections

Table 4: Green Hydrogen Cost Trajectory for Argentina

Timeframe	Cost (USD/kg)	Competitiveness
Current (Grey H_2)	1.50–2.50	Baseline
2025 (Green H_2)	3.00–6.00	Not competitive
2030 (Green H_2)	2.00–3.00	Approaching parity
2050 Target	1.40	Export competitive

4.3 Grid and Transmission Infrastructure

4.3.1 Current System

- **SADI:** Sistema Argentino de Interconexión (main national grid)
- **SIP:** Sistema de Interconexión Patagónico (integrated since 2006)
- **Management:** CAMMESA (Wholesale Electricity Market Administration)
- **Coverage:** Near 100% of population

4.3.2 Transmission Constraints

The primary bottleneck for renewable energy deployment:

- Patagonian wind resources distant from demand centers (Buenos Aires)
- High-voltage transmission expansion required
- Climate finance being mobilized for grid development
- Plan Federal de Transporte de Energía Eléctrica addressing constraints

4.4 Raw Materials and Scrap Availability

4.4.1 Iron Ore

- **Primary Source:** Imports from Brazil (Vale) for integrated producers
- **Ternium Dependency:** Reliance on Vale for iron ore supply
- **Strategic Risk:** Supply concentration; DRI-grade ore availability uncertain

4.4.2 Scrap Steel

- **Domestic Generation:** Significant but underdeveloped collection infrastructure
- **Quality:** Variable; automotive-grade scrap limited
- **Sidersa Strategy:** Scrap-based EAF production (360,000 t/year)
- **Employment Potential:** 3,500 indirect jobs in scrap collection/processing

5 Economic and Competitive Analysis

5.1 Macroeconomic Context

Argentina's steel sector operates within chronic macroeconomic volatility:

- **Inflation:** Triple-digit inflation (2023–2024)
- **Currency:** Significant devaluation under Milei administration
- **GDP Growth:** Recession in early 2024; projected 5.2% growth in 2025
- **Foreign Exchange:** Historical restrictions on FX access affecting inputs
- **Investment Climate:** High country risk historically; RIGI designed to address

5.2 Steel Demand Drivers

5.2.1 Primary Consuming Sectors

- **Construction:** 40–50% of consumption (severely affected in 2024)
- **Automotive:** 15–20% (Toyota, Mercedes-Benz investments ongoing)
- **Agricultural Equipment:** 10–15% (700+ companies, 47,000 workers)
- **Energy Infrastructure:** 10–15% (pipelines, renewable energy)
- **Mining:** 5–10% (lithium projects driving demand)

5.2.2 2024 Demand Crisis

- 35–40% demand collapse (first months of 2024)
- Construction activity sharply reduced
- Structural adjustment program suppressing consumption
- Recovery expected in second half 2024/2025

5.3 Cost Structure Analysis

Table 5: Estimated Steel Production Costs in Argentina (2024)

Cost Component	BF-BOF (USD/t)	EAF (USD/t)
Raw Materials (ore/scrap)	150–200	180–220
Energy (electricity, gas)	80–120	100–140
Labor	40–60	30–50
Other Materials	30–50	25–40
Depreciation	25–40	20–35
Total	**325–470**	**355–485**

Competitive Position:

- Labor costs lower than Europe/US but higher than China
- Energy costs favorable with renewable integration
- Raw material import dependency adds currency risk
- Transportation costs significant for exports

5.4 Trade and Market Access

5.4.1 Domestic Market

- 90% of consumption supplied domestically
- Import competition: Chinese steel pressure across Latin America
- Ternium reports Chinese flat steel imports to Brazil exceeding 80% of imports

5.4.2 Export Potential

- Sidersa targeting 30% exports (USD 100 million/year)
- Regional markets: Bolivia, Chile, Paraguay, Uruguay
- Potential green steel premium markets: Europe, Japan

5.4.3 CBAM Implications

EU Carbon Border Adjustment Mechanism (from 2026):

- Argentine exports to EU face carbon intensity scrutiny
- Green steel certification could enable premium access
- EPDs already developed by Ternium for eight product families
- Opportunity to position as low-carbon regional supplier

6 Environmental Impact and Decarbonization Pathways

6.1 Current Emissions Profile

Table 6: Argentina Steel Sector Emissions Estimate (2024)

Source	Mt CO_2/year	Share (%)	Intensity
BF-BOF Production	5.0–6.5	75–80%	1.9–2.2 t/t
EAF Production	0.6–0.9	10–15%	0.3–0.5 t/t
Indirect (electricity)	0.5–0.8	8–12%	—
Total	**6.1–8.2**	**100%**	**1.3–1.8 t/t**

National Context:

- Steel sector: approximately 3.5% of national GHG emissions
- National total: approximately 350 $MtCO_2e$/year
- Industry sector total: approximately 30 $MtCO_2e$/year

6.2 Technology Pathways for Decarbonization

6.2.1 Pathway 1: EAF Expansion with Renewable Electricity

Current Status:

- 35–40% EAF share (favorable starting position)
- Sidersa project adding 360,000 t/year EAF capacity
- Renewable electricity increasingly available via MATER

Potential:

- Increase EAF share to 60–70% by 2035
- Transition existing EAF to 100% renewable electricity
- Emissions reduction: 70–80% for EAF operations

Requirements:

- Scrap collection infrastructure development
- Grid reinforcement for industrial loads
- Corporate PPAs for renewable electricity
- Investment: USD 500 million–1 billion

6.2.2 Pathway 2: Hydrogen Direct Reduction Iron (H_2-DRI)

Opportunity:

- Argentina's renewable endowment enables ultra-low-cost green H_2
- National Hydrogen Strategy targets USD 1.40/kg by 2050
- Steel sector designated priority for domestic H_2 allocation

Timeline:

- 2025–2030: Pilot demonstrations (10,000–50,000 t)
- 2030–2035: Commercial-scale deployment (0.5–1 Mt)
- 2035–2050: Full transformation of integrated production

Requirements:

- Green hydrogen production infrastructure
- DRI plant investment (brownfield or greenfield)
- Grid connections to renewable zones
- Investment: USD 2–4 billion (long-term)

6.2.3 Pathway 3: Hybrid DRI-Scrap EAF Routes

Concept:

- Combine H_2-DRI with scrap in EAF operations
- Optimal mix: 60% DRI + 40% scrap
- Reduces hydrogen requirements while maintaining quality

Advantages for Argentina:

- Leverages both hydrogen and scrap resources
- Flexibility in feedstock mix based on availability
- Lower capital intensity than pure H_2-DRI route
- Applicable to existing EAF capacity

6.2.4 Pathway 4: Carbon Capture (CCUS) for Residual BF

Applicability:

- Bridge technology for Ternium's integrated operations
- Extends asset life while reducing emissions 50–90%
- Requires CO_2 storage or utilization pathway

Argentina Context:

- Limited geological storage assessment to date
- Potential for EOR (Enhanced Oil Recovery) in Neuquén Basin
- Not primary pathway given renewable advantages

6.3 Decarbonization Scenarios

Table 7: Argentina Steel Sector Decarbonization Scenarios

Scenario	2030	2040	2050
Conservative			
EAF Share	50%	60%	70%
Renewable Electricity	50%	70%	90%
H_2-DRI Share	0%	10%	20%
Emissions Reduction	20%	45%	65%
Moderate			
EAF Share	55%	70%	80%
Renewable Electricity	70%	90%	100%
H_2-DRI Share	5%	25%	40%
Emissions Reduction	35%	65%	85%
Ambitious			
EAF Share	60%	80%	90%
Renewable Electricity	90%	100%	100%
H_2-DRI Share	10%	40%	60%
Emissions Reduction	50%	80%	95%

7 Social and Employment Dimensions

7.1 Current Employment Profile

Table 8: Argentine Steel Sector Employment

Category	Employment	Notes
Direct Steel Production	15,000–20,000	Primary steel mills
Steel Value Chain	180,000–220,000	60% of industrial activity
Agricultural Equipment	47,000	700+ companies
Automotive Steel Users	35,000–50,000	Toyota, Mercedes operations
Mining Equipment	10,000–15,000	Growing lithium sector
Total Steel-Dependent	**300,000+**	—

7.2 Just Transition Considerations

7.2.1 Regional Concentration

Steel employment concentrated in specific regions:

- **San Nicolás (Buenos Aires):** Ternium, Sidersa—major employment hub
- **Villa Constitución (Santa Fe):** ArcelorMittal Acindar headquarters
- **Rosario Region:** Gerdau, steel distribution, services
- **Campana-Zárate:** Tenaris seamless tube production

7.2.2 Technology Transition Employment Effects

- **EAF Operations:** 30–50% fewer workers than BF-BOF per tonne

- **H_2-DRI:** Similar employment to modern EAF
- **Renewable Energy:** Significant job creation in construction, operation
- **Hydrogen Economy:** New skill requirements, training needs

7.2.3 Job Creation Opportunities

Sidersa Project Example:

- Direct jobs: 300 (EAF mill operation)
- Indirect jobs: 3,500–4,000 (scrap collection, logistics, services)
- Total employment impact: 4,000+ jobs created
- Net positive despite technology efficiency gains

Green Hydrogen Value Chain:

- Electrolyzer manufacturing and operation
- Renewable energy construction and maintenance
- Hydrogen transport and storage
- Research and development

7.3 Skills Development Needs

- EAF operations and scrap processing
- Hydrogen production and handling
- Renewable energy systems
- Environmental management and carbon accounting
- Digital technologies and automation

8 Comparative Analysis: Argentina vs. Global Approaches

8.1 Argentina vs. Germany

Table 9: Argentina vs. Germany: Steel Decarbonization Comparison

Factor	Argentina	Germany
Production Scale	4–5 Mt	37 Mt
Technology Mix	35–40% EAF	29% EAF
Primary Pathway	EAF + H_2-DRI long-term	H_2-DRI priority
H_2 Cost Advantage	Very High (USD 1.40/kg target)	Moderate (EUR 4.50/kg target)
Renewable Resources	Exceptional	Moderate
Policy Framework	RIGI (new)	CCfD, EU support
Investment Capacity	Limited, FDI-dependent	Strong domestic + EU
Timeline	Gradual (2030–2050)	Aggressive (2027–2045)

Key Insight: Argentina's natural advantages (renewables, H_2 cost potential) exceed Germany's, but investment capacity and policy maturity favor Germany for near-term transformation.

8.2 Argentina vs. Brazil

Table 10: Argentina vs. Brazil: Regional Comparison

Factor	Argentina	Brazil
Production Scale	4–5 Mt	31–33 Mt
Charcoal Steel	None	10–15% (low-carbon)
EAF Share	35–40%	30–35%
Iron Ore Access	Import-dependent	Abundant domestic
Renewable H_2 Potential	Very High	High
Policy Framework	RIGI (2024)	Established incentives
Major Producers	Ternium, Acindar, Gerdau	Gerdau, CSN, Usiminas

Key Insight: Brazil's charcoal-based production provides existing low-carbon capacity, but Argentina's wind resources offer superior green hydrogen potential.

8.3 Argentina vs. China

Table 11: Argentina vs. China: Scale and Strategy Contrast

Factor	Argentina	China
Production Scale	4–5 Mt	1,005 Mt
Global Share	<0.3%	54%
Approach	Market-driven	State-directed
Primary Pathway	EAF + future H_2	EAF expansion + H_2 demos
1.5:1 Capacity Policy	N/A	Mandatory
H_2 Cost Potential	Very competitive	Moderate
Transformation Speed	Gradual	Rapid (policy-driven)

Key Insight: China's scale dominates global dynamics; Argentina's opportunity lies in niche positioning as green steel producer for premium markets.

9 Critical Success Factors and Risks

9.1 Success Factors

9.1.1 Natural Endowments

- **Wind Resources:** Patagonian capacity factors exceeding 50%—world-leading
- **Solar Irradiation:** Northwestern Argentina among global best
- **Land Availability:** Vast territory for renewable development
- **Port Access:** Potential hydrogen export infrastructure

9.1.2 Policy and Institutional

- **RIGI Framework:** 30-year stability guarantees attractive to investors
- **Hydrogen Strategy:** Clear national commitment with quantified targets

- **Renewable Law:** Established legal framework (Law 27,191)
- **EPD Development:** Ternium leading certification for CBAM readiness

9.1.3 Industrial Base

- **Existing EAF Capacity:** 35–40% already lower-carbon route
- **Multinational Presence:** Ternium, ArcelorMittal bring global expertise
- **Domestic Champions:** Sidersa demonstrating local investment capacity
- **Skilled Workforce:** Established metallurgical expertise

9.2 Risk Factors

9.2.1 Macroeconomic Risks

- **Currency Volatility:** Peso depreciation increases capital costs
- **Inflation:** Triple-digit inflation erodes investment returns
- **Policy Continuity:** Political transitions may affect RIGI benefits
- **Country Risk:** Historical default concerns deter some investors

9.2.2 Infrastructure Risks

- **Grid Constraints:** Transmission bottleneck Patagonia-Buenos Aires
- **Hydrogen Infrastructure:** Pipelines, storage not developed
- **Port Capacity:** Export infrastructure requires investment
- **Natural Gas Transition:** Vaca Muerta development may compete with renewables

9.2.3 Market Risks

- **Domestic Demand:** 2024 crisis demonstrates vulnerability
- **Export Competition:** Chinese overcapacity affects regional markets
- **Green Premium Uncertainty:** Will customers pay for low-carbon steel?
- **CBAM Implementation:** Details and enforcement still evolving

9.3 Scenario Analysis

9.3.1 Optimistic Scenario: "Green Steel Leader" (20% probability)

Assumptions:

- RIGI attracts USD 5+ billion steel/hydrogen investments
- Green H_2 reaches USD 2/kg by 2030
- Grid transmission expanded to Patagonia
- Macroeconomic stabilization under Milei reforms

Outcomes by 2035:

- 6–7 Mt production capacity (growth from current)
- 70% EAF share, 15% H_2-DRI
- Green steel exports to Europe, Japan
- 60% emissions reduction achieved
- Regional leadership in Latin American green steel

9.3.2 Base Case Scenario: "Gradual Transition" (55% probability)

Assumptions:

- Sidersa project completes successfully
- Moderate renewable expansion continues
- Hydrogen pilots but limited commercial scale
- Economic volatility continues but manageable

Outcomes by 2035:

- 4–5 Mt production (stable)
- 55–60% EAF share
- Limited H_2-DRI (demonstration only)
- 30–40% emissions reduction
- Competitive in regional markets

9.3.3 Pessimistic Scenario: "Stagnation" (25% probability)

Assumptions:

- Macroeconomic crisis deepens
- RIGI benefits withdrawn or reduced
- Chinese imports overwhelm domestic market
- Infrastructure investment stalls

Outcomes by 2035:

- 3–4 Mt production (decline)
- Technology mix unchanged
- Minimal decarbonization progress
- Loss of competitiveness
- Missed green steel opportunity

10 Recommendations and Policy Implications

10.1 For Argentine Government

10.1.1 Immediate Actions (2025–2027)

1. **RIGI Implementation Excellence:** Ensure efficient, transparent approval process to attract steel sector investments beyond Sidersa
2. **Grid Transmission Priority:** Accelerate Plan Federal de Transporte to connect Patagonian renewables to industrial centers
3. **Hydrogen Pilot Support:** Fund 2–3 demonstration projects connecting green H_2 to steel operations
4. **Scrap Infrastructure:** Develop national scrap collection and processing strategy supporting EAF expansion
5. **Skills Development:** Partner with universities and industry for hydrogen metallurgy training programs

10.1.2 Medium-Term Actions (2027–2030)

1. **Green Steel Procurement:** Mandate low-carbon steel for public infrastructure projects
2. **Carbon Pricing:** Develop domestic carbon pricing mechanism aligned with CBAM
3. **Hydrogen Corridor:** Establish dedicated renewable-hydrogen-steel corridor (Patagonia to Buenos Aires/Santa Fe)
4. **Export Strategy:** Position Argentina as green steel supplier to CBAM-compliant markets
5. **Regional Cooperation:** Coordinate with Brazil on Latin American green steel standards

10.2 For Steel Companies

10.2.1 Ternium Argentina

- Complete 99 MW wind farm integration
- Develop H_2-DRI pilot at San Nicolás facility
- Expand EPD coverage to all product lines
- Position for CBAM-compliant exports
- Target 25% emissions reduction by 2030

10.2.2 ArcelorMittal Acindar

- Transition EAF operations to renewable PPAs
- Leverage global ArcelorMittal decarbonization expertise
- Develop closed-loop scrap partnerships with construction sector
- Stabilize operations following 2024 crisis

10.2.3 Sidersa

- Execute RIGI project on schedule (Q4 2027–2028)
- Secure renewable electricity contracts for EAF
- Develop domestic scrap supply chain
- Build export relationships for green steel
- Consider Phase 2 expansion with H_2-DRI integration

10.3 For International Investors

- **RIGI Opportunity:** 30-year stability framework reduces political risk
- **Renewable Integration:** Partner with steel producers on captive renewable projects
- **Hydrogen Projects:** Co-investment in green H_2 for steel applications
- **Technology Transfer:** Bring H_2-DRI expertise for early mover advantage
- **Due Diligence:** Assess macroeconomic and currency risks carefully

10.4 For International Community

- **Climate Finance:** Support grid transmission and hydrogen infrastructure
- **Technology Cooperation:** Include Argentina in global green steel initiatives
- **Trade Framework:** Ensure CBAM recognizes Argentine green steel credentials
- **Capacity Building:** Support technical training and standards development

11 Conclusions

11.1 Summary of Key Findings

Argentina's steel decarbonization presents a distinctive case within the MIFUS global comparative framework:

11.1.1 1. Exceptional Natural Advantages

Argentina possesses world-class renewable energy resources—Patagonian wind with capacity factors exceeding 50% and northwestern solar irradiation up to 2,000 kWh/kWp—that could enable green hydrogen production at USD 1.40/kg by 2050, potentially the lowest cost globally.

11.1.2 2. Favorable Starting Position

With 35–40% EAF share (above global average), Argentina's steel sector has a less carbon-intensive baseline than many competitors, requiring less dramatic technological transformation.

11.1.3 3. Emerging Policy Framework

The RIGI regime provides unprecedented 30-year stability guarantees, with Sidersa's approval demonstrating practical application. The National Hydrogen Strategy explicitly prioritizes steel decarbonization.

11.1.4 4. Scale Enables Agility

At 4–5 Mt production, Argentina's steel sector can transform more nimbly than Germany's 37 Mt or China's 1,005 Mt, potentially achieving high green steel percentages faster.

11.1.5 5. Macroeconomic Constraints Remain Critical

Historic currency volatility, inflation, and policy discontinuity pose significant investment risks that natural advantages alone cannot overcome.

11.1.6 6. Infrastructure Gap Requires Urgent Attention

Grid transmission from Patagonian renewable zones to industrial centers represents the binding constraint on transformation speed.

11.1.7 7. Regional Green Steel Leadership Achievable

Argentina could position itself as Latin America's green steel leader and supplier to CBAM-compliant European markets, capturing premium pricing.

11.2 The Three Possible Futures

Scenario A: "Green Steel Leader" (20% probability)

- Successful RIGI implementation attracts major investments
- Green hydrogen reaches competitive costs by 2030
- 6–7 Mt capacity with 60%+ low-carbon production
- Export success in premium green steel markets

Scenario B: "Gradual Transition" (55% probability)

- Sidersa project succeeds; moderate additional investment
- EAF share increases to 55–60%
- Limited hydrogen deployment (demonstration scale)
- 30–40% emissions reduction by 2035

Scenario C: "Stagnation" (25% probability)

- Macroeconomic crisis derails investment
- RIGI benefits reduced or withdrawn
- Minimal technological transformation
- Missed opportunity for green steel positioning

11.3 Critical Path Forward

2025–2027: Foundation

- Sidersa construction progresses
- Grid transmission projects advance
- Ternium wind farm operational
- Hydrogen demonstration projects launched

2027–2030: Demonstration

- Sidersa EAF operational
- First H_2-DRI pilot at scale
- Renewable share in steel electricity reaches 50%+
- CBAM compliance demonstrated

2030–2040: Scale-Up

- Commercial H_2-DRI deployment
- EAF share reaches 70%+
- Green steel exports established
- 50%+ emissions reduction achieved

2040–2050: Transformation

- Near-complete decarbonization pathway
- Green hydrogen at USD 1.40/kg
- 80–95% emissions reduction
- Regional green steel leadership consolidated

11.4 Final Assessment

Argentina's steel sector stands at a unique crossroads. The country's exceptional renewable energy endowments provide a natural competitive advantage that few nations can match—not Germany with its hydrogen import dependency, nor China with its coal-dominated grid. The National Hydrogen Strategy and RIGI framework signal government recognition of this opportunity.

However, realizing this potential requires overcoming persistent macroeconomic challenges, infrastructure gaps, and investment constraints. The Sidersa project represents a critical test case: if successful, it could catalyze broader transformation; if delayed or cancelled, it would reinforce skepticism about Argentina's investment climate.

MIFUS Perspective: Compared to the 20+ countries studied in this initiative, Argentina represents the "high potential, high risk" category. Unlike Germany's technology-focused transformation or China's policy-driven capacity replacement, Argentina's pathway depends fundamentally on realizing its natural resource advantages through sustained policy commitment and infrastructure development.

The next 5 years (2025–2030) will determine whether Argentina seizes its green steel opportunity or allows natural advantages to remain unrealized. Success would establish Argentina as a model for emerging economy decarbonization; failure would represent a significant missed opportunity for both national development and global climate objectives.

> *"Argentina possesses the natural resources to become a global leader in green steel production. The question is whether policy stability and infrastructure investment can transform this potential into reality."*
> — MIFUS Research Team, November 2025

11.5 Contribution to MIFUS Research

This Argentina study complements the MIFUS global analysis by:

- **Emerging Economy Perspective:** Documenting decarbonization challenges and opportunities in a middle-income context
- **Renewable Resource Advantage:** Demonstrating how natural endowments can offset other competitive disadvantages
- **Investment Framework Innovation:** Analyzing RIGI as potential model for attracting green industry investment
- **Regional Dynamics:** Examining Argentina's position relative to Brazil and Latin American markets
- **Scale Flexibility:** Showing how smaller producers can potentially transform faster than giants
- **Macroeconomic Constraints:** Illustrating how economic volatility affects decarbonization investment

Key Lesson for Other Countries:

Argentina's experience suggests that exceptional natural resource endowments are necessary but not sufficient for steel decarbonization. Policy stability, infrastructure investment, and macroeconomic management remain essential complements. Countries with similar resource advantages (Australia, Chile, Morocco) can learn from Argentina's evolving approach to realizing green hydrogen potential in heavy industry.

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