Mexican Steel Industry and Decarbonization Strategy: A Study of North American Integration and Electric Arc Furnace Leadership

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Abstract

This document examines Mexico's steel industry within the context of North American economic integration and global decarbonization challenges. As the 15th largest steel producer globally and second in Latin America, Mexico demonstrates a distinctive approach characterized by 93.5% Electric Arc Furnace (EAF) production, yielding significantly lower carbon emissions than the global average. With 18.2 million tonnes annual production (2024) and extensive participation in the USMCA (United States-Mexico-Canada Agreement), Mexico's steel sector operates at the intersection of competitive manufacturing advantages, nearshoring opportunities, and evolving climate commitments. This analysis explores Mexico's industrial structure dominated by scrap-based steelmaking, its integration with North American automotive and construction supply chains, regional production dynamics, and the complex political economy surrounding energy policy and decarbonization. The document highlights Mexico's competitive environmental advantage in steel production while addressing challenges including import competition, energy security concerns, and the need for enhanced policy coherence to achieve climate targets while supporting industrial growth.

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1 Strategic Context: Mexico's Steel Industry Position

1.1 Production Profile and Global Standing

Mexico occupies a significant position in global steel production:

2024 Production Data:

- Crude steel production: 18.2 million tonnes (down from 19.85 MT in 2023)
- Global ranking: 15th largest producer
- Regional ranking: 2nd in Latin America (after Brazil)
- Global market share: Approximately 1% of world production
- Hot rolled steel production: 19.5 million tonnes (2022)

Technology Distribution:

- Electric Arc Furnace (EAF): 93.5% of total production
- Blast Furnace-Basic Oxygen Furnace (BF-BOF): 6.5%
- Recycled steel utilization: 10.9 million tonnes annually
- Technology advantage: Highest EAF proportion among major producers

Geographic Distribution:

- Northern states (Nuevo León, Coahuila): Major integrated and mini-mill clusters
- Central/Bajío region: Growing automotive supply base
- Coastal locations (Lázaro Cárdenas, Michoacán): ArcelorMittal integrated facility
- Regional specialization reflecting proximity to US border and automotive manufacturers

1.2 Economic and Strategic Significance

Industrial Integration:

- Automotive sector: 3.7% of GDP, 20.2% of manufacturing GDP
- Construction sector: Approximately 8% of GDP
- Steel exports: 77% to United States, reflecting deep USMCA integration
- Trade position: Steel product deficit (imports exceed exports in finished products)

Employment and Investment:

- Direct employment: Data not centralized; distributed across multiple producers
- Foreign Direct Investment (2023): $2.23 billion in iron and steel industry
- Sector GDP contribution: 96.8 billion Mexican pesos (2022)
- Major employers: Ternium, ArcelorMittal Mexico, Gerdau, DeAcero, Altos Hornos de México (AHMSA)

Trade Dynamics:

- Steel exports (2024): 3 million tonnes (2.3 MT to US, 118,000 tonnes to Canada)
- Steel imports (2024): 12.6 million tonnes (46% of apparent consumption)
- Import penetration: Significant competition from Asian producers
- Trade vulnerability: Dependence on US market creates tariff exposure

1.3 Emissions Profile and Environmental Advantage

Current Emissions Performance:

- CO_2 emissions: 1.0 tonne per tonne of steel produced
- Global comparison: 48% reduction vs. global average (approximately 1.9 tonnes/tonne)
- Energy intensity: 11 GJ per tonne of steel (48% less than world average)
- Structural advantage: Dominance of EAF technology (0.4-0.5 tonnes CO_2/tonne vs. 2.0 for BF-BOF)

Factors Enabling Low Emissions:

- High proportion of scrap-based production
- Well-developed scrap collection and recycling infrastructure
- Relatively modern EAF fleet with efficient technology
- Lower reliance on coal-based primary steelmaking

2 Mexican Steel Industry Structure

2.1 Major Producers and Ownership

Ternium Mexico:

- Ownership: Part of Techint Group (Argentina/Italy)
- Major facilities: Pesquería (Nuevo León), Monterrey
- Technology: Integrated BF-BOF facility plus downstream processing
- Capacity expansion: New 3.0 million tonne slab mill in Pesquería (expected H1 2026)
- Total capacity post-expansion: Approximately 7-8 million tonnes annually
- Market focus: Flat products for automotive, construction, manufacturing
- Strategic positioning: USMCA region supply, particularly US and Canada

ArcelorMittal Mexico:

- Ownership: ArcelorMittal (Luxembourg/Netherlands)
- Major facility: Lázaro Cárdenas (Michoacán) - integrated coastal mill
- Current capacity: 4 million tonnes flat steel
- Expansion project: $1 billion investment to reach 5.3 million tonnes (32.5% increase)
- Technology: BF-BOF route with modern downstream processing
- Recent addition: 750,000 tonne pickling line commissioned (2023)
- Market focus: Automotive, white goods, construction

Gerdau Mexico:

- Ownership: Gerdau (Brazil)

- Current capacity: 1.5 million tonnes across three facilities
- Technology: EAF-based long product production
- Planned expansion: New 600,000 tonne Special Bar Quality (SBQ) plant
- Total projected capacity: 2.1 million tonnes
- Target timeline: Potential start 2025 (subject to commercial studies)
- Strategic rationale: Supply reshoring manufacturers relocating from Asia
- Products: Long steel, rebar, wire rod, special bars

DeAcero:

- Ownership: Mexican family-owned (Zamora family)
- Current capacity: 1.5 million tonnes
- Major investment: $1.3 billion new mill in Coahuila
- Expansion capacity: Additional 1.2 million tonnes
- Total projected capacity: 2.7 million tonnes
- Completion target: February 2026
- Technology: New EAF using renewable energy, lower carbon footprint
- Market positioning: Supply nearshoring manufacturers
- Scrap operations: ISRI and BIR member, 50% of Mexico's scrap recycling

Altos Hornos de México (AHMSA):

- Ownership: Mexican (Alonso Ancira family) - currently under financial restructuring
- Location: Monclova, Coahuila
- Historical significance: One of Mexico's oldest integrated steel producers
- Technology: BF-BOF integrated facility
- Status: Production disruptions, financial challenges, operational uncertainties
- Recent incident: Explosion at Apizaco facility (October 2024) halted melting operations

2.2 Production Technology and Infrastructure

Electric Arc Furnace Dominance:

- Scrap availability: 90 million tonnes generated annually (estimated regional availability)
- Collection infrastructure: Extensive network of scrap yards and collection centers
- Quality considerations: Growing attention to tramp element control (copper, tin)
- Technological sophistication: Modern EAF technology with advanced process control
- Energy source: Predominantly natural gas and electricity

Integrated Mills:

- Limited BF-BOF capacity: Approximately 6.5% of national production
- Strategic locations: Coastal (Lázaro Cárdenas) and northern (Pesquería) positions
- Iron ore sourcing: Domestic resources supplemented by imports
- Coking coal: Primarily imported
- Capacity utilization: Variable depending on market conditions

Downstream Processing:

- Hot rolling, cold rolling, and coating facilities
- Galvanizing lines serving automotive sector
- Pickling and specialty processing
- Tube and pipe manufacturing

3 Institutional and Policy Framework

3.1 Industry Association and Governance

CANACERO (Cámara Nacional de la Industria del Hierro y del Acero):

- Established: 1948
- Official status: Recognized by Mexican federal government
- Functions:
  - Industry advocacy at federal, state, and local government levels
  - National Standards Body (ONN): Issues Mexican standards (NMX) for steel products
  - Statistical data collection and publication
  - Trade policy representation
  - Environmental compliance support
  - International liaison
- Membership: Steel producing companies, processors, and associated firms
- Strategic priorities: Competitiveness, trade defense, sustainability

Government Regulatory Structure:

- Secretaría de Economía (Ministry of Economy): Industrial policy, trade
- Secretaría de Energía (SENER): Energy policy, sector planning
- Comisión Reguladora de Energía (CRE): Energy regulation
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT): Environmental policy
- PEMEX: State-owned petroleum company (energy supply)
- CFE (Comisión Federal de Electricidad): State-owned electricity utility

3.2 Trade Policy and USMCA Context

USMCA Framework (United States-Mexico-Canada Agreement):

- Effective: July 2020 (replaced NAFTA)
- Steel provisions: Duty-free access with "melted and poured" requirements
- Regional value content rules for automotive steel
- Impact: Deep integration with North American supply chains
- Vulnerability: Subject to Section 232 tariff considerations and political negotiations

Trade Defense Measures:

- Anti-dumping duties on various products from China and other countries
- Safeguard measures responding to import surges
- Monitoring systems for rapid response to trade distortions
- Challenges: Limited effectiveness against persistent Asian overcapacity

Recent Trade Tensions (2024-2025):

- US Congressional proposals: "Stop Mexico's Steel Surge Act" seeking 25% tariffs
- Concerns about indirect Chinese steel entering through Mexico
- Impact on conduit pipes and other products
- Reciprocal tariff threats affecting approximately $10.4 billion in bilateral steel trade
- Mexican position: Emphasizes already competitive position without subsidies

3.3 Climate and Energy Policy

National Climate Commitments:

- Nationally Determined Contribution (NDC) updated November 2022
- Unconditional target: 35% GHG reduction by 2030 (vs. Business-as-Usual baseline)
- Conditional target: 40% reduction with international support
- Black carbon: 51% unconditional, 70% conditional reduction
- Long-term: No official net-zero target announced (only G-20 country without one)
- Mid-century strategy: References 50% reduction by 2050 from 2000 levels

Energy Transition Goals:

- Clean energy target: 35% of electricity by 2024 (Energy Transition Law)
- Updated commitment: 40 GW additional non-fossil capacity by 2030
- Current status: Approximately 29% clean electricity (2022)
- Renewable capacity: Solar 7+ GW, wind 7.7 GW, geothermal 976 MW, hydro significant
- Investment pledge: $48 billion in renewable energy announced at COP27 (2022)

Policy Implementation Challenges:

- López Obrador administration (2018-2024): Prioritized fossil fuel development
- CFE and PEMEX strengthening: Focus on state energy sovereignty
- Renewable auction cancellations: Fourth round electricity auctions cancelled
- Regulatory obstacles: Permit denials for private renewable projects
- Dos Bocas refinery: New oil refinery construction prioritized
- Court challenges: 2021 lawsuit suspended NDC for insufficient ambition

Sheinbaum Administration (2024-present):

- National Development Plan 2025-2030: Published April 2025
- Priority sectors: Semiconductors, electronics, medical devices, EVs, agroindustry
- Energy sovereignty with sustainability: 51 strategic energy projects
- Target: 22,000 MW additional generation capacity
- Renewable energy: Solar panel program for northern homes
- CFE mandate: 54% of electricity generation
- Infrastructure: 1 million homes construction pledge (steel-intensive)
- Interoceanic Corridor: Railway development in southern Mexico

Carbon Pricing:

- Carbon tax: Introduced 2014, rate approximately \$3 per tonne CO_2
- Exemptions: Natural gas exempt, limited coverage
- Emissions Trading System: Pilot program launched 2020, completed 2023
- Coverage: Power generation and industrial sectors
- Effectiveness: Low prices and limited scope constrain climate impact

4 Decarbonization Pathways and Challenges

4.1 Structural Advantages

EAF Technology Leadership:

- Already 93.5% EAF production (vs. global average approximately 30%)
- Emissions per tonne 48% below global average
- Limited need for primary steelmaking transformation
- Incremental improvements rather than revolutionary change
- Competitive advantage in carbon-constrained future trade environment

Scrap-Based Circular Economy:

- Established scrap collection infrastructure
- DeAcero: Handles 50% of national scrap recycling
- Export capacity: Scrap exports to various markets including US
- Quality enhancement opportunities: Advanced sorting and processing
- Potential for expanded collection rates and quality improvement

4.2 Remaining Decarbonization Needs

EAF Electricity Decarbonization:

- Current electricity grid: Approximately 29% clean energy
- EAF electricity intensity: High consumption requiring grid decarbonization
- Renewable integration: Need for reliable, cost-competitive clean power
- Grid infrastructure: Transmission capacity and stability requirements
- Industrial renewable procurement: Power purchase agreement (PPA) frameworks

Integrated Mill Transformation:

- Remaining BF-BOF capacity: Approximately 1.2 million tonnes
- Retrofit options: Carbon capture, hydrogen injection, fuel switching
- Investment requirements: Substantial capital for low-emission technologies
- Strategic decisions: Conversion to EAF vs. technology upgrading
- Economic viability: Cost competitiveness of transformation pathways

Process Improvements:

- Energy efficiency: Optimization of EAF operations
- Heat recovery: Waste heat utilization
- Digitalization: AI and process control for efficiency gains
- Material efficiency: Yield improvements, reduced scrap losses
- Auxiliary emissions: Natural gas use in reheating, processing

4.3 Technology Development and Investment

Current Investment Wave (2024-2026):

- Total planned capacity additions: Over 5 million tonnes
- Technology focus: Modern EAF with renewable energy integration
- Examples:
  - DeAcero Coahuila: $1.3 billion, renewable-powered EAF
  - Ternium Pesquería: Major slab mill expansion
  - Gerdau SBQ plant: Specialized steel for nearshoring

  - ArcelorMittal pickling line: Automotive supply chain
- Environmental performance: Lower carbon footprint emphasized
- Strategic rationale: Nearshoring, USMCA market access, automotive growth

Research and Innovation:

- Limited domestic R&D infrastructure compared to major producers
- Technology transfer: Adoption from parent companies (Ternium, ArcelorMittal, Gerdau)
- Focus areas: Process optimization, quality improvement, digitalization
- Collaboration potential: North American research partnerships
- Gap: Limited breakthrough technology development domestically

5 Market Dynamics and Competitive Position

5.1 Demand Drivers

Automotive Sector:

- Global position: Major automotive manufacturing hub
- Production volume: Top exporter to US market
- EV transition: Tesla, BMW, other manufacturers investing
- Steel requirements: High-strength steels, advanced grades
- Challenge: Ensuring Mexican steel competitiveness vs. imports

Construction:

- Historical patterns: Boom following 2017-2018 natural disasters
- Recent softness: Major federal projects (Tren Maya, AIFA airport, Olmeca refinery) completed
- Future potential: Sheinbaum's 1 million homes initiative
- Infrastructure: Interoceanic Corridor, regional logistics
- Trend: Gradual shift from brick/cement toward steel construction

Apparent Steel Consumption:

- 2024: Approximately 27.6 million tonnes
- 2025 projection: 29.3 million tonnes (World Steel Association)
- Per capita: 194.8 kg finished steel products (2022)
- Trend: Volatile but generally growing
- Import dependence: 46% of consumption from imports (2024)

5.2 Competitive Challenges

Asian Overcapacity and Imports:

- Import volume: 12.6 million tonnes (2024)
- Sources: China, Southeast Asia ("satellite countries"), other regions
- Price pressure: Below-market pricing from subsidized producers
- Product categories: Wide range of semi-finished and finished products
- Mexican response: Trade defense measures, but limited effectiveness

Cost Competitiveness:

- Labor advantage: $3.8/hour vs. US $29.5, China $6.67
- Energy costs: Natural gas and electricity pricing critical
- Scrap costs: Market-driven, subject to global fluctuations
- Logistics: Proximity to US market reduces transport costs
- Exchange rate: Peso fluctuations affecting competitiveness

Quality and Product Mix:

- Automotive grades: Advanced high-strength steels development
- Consistency: Quality control and traceability requirements
- Product breadth: Capacity across commodity and specialty grades
- Technical service: Supporting end-user applications

6 Regional and Social Dimensions

6.1 Geographic Production Clusters

Northern Border Region (Nuevo León, Coahuila):

- Monterrey cluster: Historic center of Mexican steel industry
- Proximity advantage: Close to US Texas market
- Infrastructure: Rail, road connections to border crossings
- Industrial ecosystem: Automotive, manufacturing supply chains
- Employment: Significant regional economic dependence

Bajío and Central Mexico:

- Automotive hub: Major assembly and parts manufacturing
- Growing steel demand: Supporting expanding automotive sector
- Logistics: Central location for domestic distribution
- Development: Increasing steel processing capacity

Pacific Coast (Lázaro Cárdenas):

- Port advantage: Iron ore and coal imports
- Export orientation: Coastal location for maritime trade
- Integrated production: ArcelorMittal major facility
- Regional development: Steel industry as economic anchor

6.2 Labor and Social Considerations

Employment:

- Direct jobs: Distributed across multiple producers and regions
- Indirect employment: Extensive supply chains and service providers
- Skills requirements: Technical training and workforce development
- Wage levels: Competitive advantage but also social considerations

Community Impact:

- Steel towns: Significant dependencies in Monterrey, Monclova, other locations
- Infrastructure: Company towns and community services
- Environmental concerns: Local air quality and health impacts
- Transition challenges: Restructuring and closure impacts (e.g., AHMSA uncertainties)

7 International Dimensions and Collaboration

7.1 North American Integration

US-Mexico Steel Relationship:

- Export dependence: 77% of Mexican steel exports to US
- Supply chains: Deeply integrated automotive and construction sectors
- Investment flows: US companies in Mexico, Mexican companies serving US
- Policy coordination: USMCA framework, but tensions over market access
- Mutual dependence: US benefits from Mexican capacity, Mexico needs US market

Trilateral Opportunities (USMCA):

- North American steel self-sufficiency goals
- Coordinated trade defense against third-country dumping
- Technology and best practice sharing
- Environmental standards harmonization
- Workforce development and training exchanges

7.2 Global Positioning

Competitive Advantages:

- Environmental performance: Lower emissions than global average
- Geographic location: Proximity to major markets
- Cost structure: Labor and logistics advantages
- Trade agreements: USMCA and numerous bilateral agreements
- Investment attractiveness: Nearshoring destination

Collaboration Potential:

- Technology transfer: Learning from global leaders
- Research partnerships: Joint projects on decarbonization
- Standard setting: Participation in international methodologies
- Best practice exchange: Operational excellence and efficiency
- Climate finance: Access to international funding for green investments

8 Future Outlook and Strategic Choices

8.1 Scenarios for Mexican Steel (2025-2035)

Optimistic Scenario: Green Manufacturing Hub

- Capacity growth to 25+ million tonnes by 2035
- Near-complete grid decarbonization enabling ultra-low-emission EAF production
- Major nearshoring beneficiary with advanced manufacturing ecosystem
- Technology leadership in efficient scrap-based steelmaking
- CBAM and carbon border measures creating competitive advantage
- Successful execution of 1 million homes and infrastructure programs

Pessimistic Scenario: Squeezed by Imports and Policy Uncertainty

- Production stagnates around 18-20 million tonnes
- Import penetration increases above 50% of consumption
- US tariff barriers disrupt export-oriented strategies
- Grid decarbonization delays undermine environmental advantage
- Policy inconsistency discourages investment
- Nearshoring opportunities captured by other regions

Realistic Scenario: Gradual Transformation with Regional Strengths

- Production grows to 22-24 million tonnes by 2035

- Capacity additions serve nearshoring and domestic infrastructure
- Grid gradually decarbonizes to 40-50% clean energy
- Mexican steel maintains environmental edge in North American market
- Selective import protection and trade agreements balance market access
- Regional specialization: North (automotive), Central (construction), Coast (exports)

8.2 Critical Success Factors

Policy Coherence and Stability:

- Alignment of energy, climate, and industrial policies
- Predictable regulatory environment for long-term investment
- Consistent enforcement of trade defense measures
- Coordination between federal and state governments
- Private sector engagement in policy development

Energy System Transformation:

- Accelerated renewable energy deployment
- Grid modernization and transmission expansion
- Competitive electricity pricing for industrial users
- Reliable power supply without compromising stability
- Integration of CFE strategy with industrial needs

Market Access and Competitiveness:

- USMCA relationship maintenance and strengthening
- Effective trade defense against unfair competition
- Quality and technical capability advancement
- Logistics and infrastructure investment
- Cost management through efficiency and scale

Investment and Technology:

- Capital availability for capacity expansion and modernization
- Technology transfer and adaptation from global leaders
- Domestic R&D capability development
- Digitalization and Industry 4.0 adoption
- Workforce skills development aligned with technology evolution

Environmental Leadership:

- Capitalizing on existing low-carbon advantage

- Continuous improvement in EAF efficiency and emissions
- Participation in international carbon accounting and standards
- Positioning for carbon border adjustment mechanisms
- Corporate sustainability commitments and transparency

9 Conclusions

Mexico's steel industry presents a distinctive case study in the global steel sector. With 93.5% EAF production delivering 48% lower emissions than the global average, Mexico already occupies an enviable position in an increasingly carbon-constrained world. This structural advantage, combined with deep USMCA integration, competitive labor costs, and geographic proximity to major markets, positions Mexican steel favorably for the decarbonization era.

However, realizing this potential requires addressing critical challenges:

First, policy coherence and stability are essential. The tensions between energy sovereignty, fossil fuel development, and renewable energy deployment under recent administrations have created uncertainty. The Sheinbaum government's stated commitment to energy transition alongside sovereignty offers hope for better balance, but execution will be critical.

Second, grid decarbonization is the pivotal variable for Mexican steel's environmental advantage. EAF production is only as clean as the electricity powering it. Accelerating renewable deployment to meet the 40 GW target by 2030 while ensuring industrial electricity costs remain competitive is a complex balancing act requiring sophisticated policy design.

Third, trade policy navigation will shape industry viability. The US-Mexico steel relationship involves both deep interdependence and recurring tensions. Managing this relationship while defending against Asian overcapacity requires diplomatic skill and effective trade remedies.

Fourth, capturing nearshoring opportunities demands investment, quality, and reliability. The current expansion wave (DeAcero, Ternium, Gerdau, ArcelorMittal) demonstrates industry confidence, but sustained growth requires continued capital deployment, workforce development, and supply chain integration.

Fifth, leveraging environmental leadership for competitive advantage requires proactive engagement. As carbon border adjustments and green steel standards emerge globally, Mexico's emissions profile becomes a strategic asset if properly documented, certified, and communicated.

The divergence between Mexico's structural position (already low-carbon) and policy momentum (historically inconsistent) creates both opportunity and risk. If policy aligns with industrial reality—supporting grid decarbonization, maintaining trade access, and enabling investment—Mexican steel could emerge as a model for efficient, low-carbon production in the developing world. If policy uncertainty persists and investment stalls, the opportunity may pass to other nearshoring destinations.

For the global steel community and initiatives like Steel X Future, Mexico offers important lessons: sometimes the path to decarbonization runs through maximizing existing low-carbon technologies (EAF) rather than pioneering breakthroughs; integration with regional markets and supply chains creates mutual dependencies supporting transformation; and environmental advantage alone is insufficient without policy support, investment, and market access.

Mexico's steel journey over the next decade will test whether mid-sized producers in developing economies can leverage structural advantages, regional integration, and policy reform to thrive in the transition to low-carbon steel. The outcome matters not only for Mexico but for the broader question of how the global steel industry transforms while maintaining competitiveness and supporting economic development.

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