

Iran Steel Research and Industrial Policy: Sanctions, Self-Sufficiency, and Natural Gas Advantages

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Abstract

This document examines Iran's steel research and industrial policy under unique constraints of comprehensive international sanctions while possessing significant natural resource advantages. With 31.4 million tonnes of annual crude steel production, ranking 10th globally, Iran demonstrates how a middle-income country can develop substantial steelmaking capacity despite isolation from Western technology and markets. The analysis explores Iran's distinctive reliance on natural gas-based direct reduced iron (DRI) production, representing the world's largest DRI capacity, the sanctions-driven imperative for technological self-sufficiency and domestic equipment manufacturing, state-directed industrial policy through entities like IMIDRO coordinating a mixed state-private sector, and the paradox of abundant natural gas enabling cleaner steelmaking pathways while carbon emissions remain peripheral concerns given geopolitical priorities. The document highlights how Iranian steel exemplifies autarkic industrialization driven by resource endowments and external constraints rather than climate policy, offering insights into technology development trajectories when conventional international cooperation channels are blocked.

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1 Strategic Context: Sanctions and Self-Reliance

1.1 Production Capacity and Global Position

Iran ranks as the world's tenth-largest steel producer:

2024 Production: 31.4 million tonnes crude steel

- Global rank: 10th
- Middle East dominance: Largest producer in region
- Per capita production: ~360 kg (relatively high)
- Export orientation: 25-30% of production

Technology distribution:

- DRI-EAF (natural gas-based): ~55% of capacity
- Integrated BF-BOF: ~35% of capacity
- Scrap EAF: ~10% of capacity
- World's largest DRI production: ~30 million tonnes annually

Growth trajectory:

- Rapid expansion 2000-2020: From 6 MT to >30 MT
- Government-promoted industrial development
- Import substitution and export development strategy
- Continued capacity expansion despite sanctions

1.2 The Sanctions Environment

Comprehensive sanctions regime:

- US: Secondary sanctions targeting third parties
- EU: Coordinated sanctions on financial, energy, technology sectors
- UN: Periodic sanctions (currently reduced but monitoring continues)
- Impact: Isolation from Western technology, financial systems, markets

Effects on steel industry:

- Technology access: Limited to Chinese, Russian, domestic suppliers
- Equipment procurement: Complex circumvention, higher costs, delays
- Export markets: Restricted to friendly countries, complicated logistics
- Financial transactions: Payment difficulties, currency restrictions
- Knowledge exchange: Academic and technical isolation

Sanctions circumvention and adaptation:

- Development of domestic equipment manufacturing capability
- Technology partnerships with China, Russia, occasionally India
- Barter arrangements and non-dollar trade
- Front companies and indirect procurement channels
- Reverse engineering and technology indigenization

1.3 Natural Resource Advantages

Natural gas abundance:

- World's second-largest proven reserves (after Russia)
- South Pars/North Dome field: Largest gas field globally (shared with Qatar)

- Domestic gas prices: Heavily subsidized, very low cost
- Stranded gas: Limited export infrastructure creates domestic surplus
- Strategic advantage: Natural gas-based DRI economics highly favorable

Iron ore resources:

- Significant domestic reserves (concentrated in central Iran)
- Quality: Variable, generally moderate grade (50-60% Fe)
- Beneficiation industry developed to upgrade domestic ores
- Some high-quality ore imports from neighbors when economically attractive

Coal resources:

- Limited high-quality coking coal
- Domestic coal generally unsuitable for steelmaking without blending
- Historically imported coking coal (Australia, others) when possible
- Sanctions complicating coal imports, favoring gas-based routes

2 Conclusions

Iran's steel industry demonstrates how a middle-income country can develop substantial industrial capacity despite comprehensive international sanctions, leveraging natural resource advantages and state-directed development policy. The overwhelming reliance on natural gas-based DRI reflects both resource endowments and constraints imposed by isolation from global coal markets and technology suppliers.

Key characteristics:

- Autarkic development driven by sanctions, not choice
- Natural gas abundance enabling large-scale DRI production
- State-coordinated industrial policy through IMIDRO
- Technological self-reliance through necessity
- Climate policy peripheral to economic and geopolitical imperatives

Future trajectory:

Iran's steel sector future depends overwhelmingly on geopolitical factors beyond industry control. Sanctions relief would enable technology leapfrogging and market expansion. Sanctions persistence means continued gradual development with widening technology gaps versus global leaders. In either scenario, decarbonization remains unlikely priority given development needs and absence of carbon pricing or international pressure mechanisms effective under sanctions.

The Iranian case offers lessons on industrial development under extreme constraints but is not a model other countries would choose to replicate. It exemplifies how resource endowments and political circumstances shape technological pathways more than optimal policy design.

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