

What If Steel Stays Dirty?



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The Consequences of Decarbonisation Failure

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Executive Summary

The global steel industry has committed to reaching net zero emissions by 2050. Major producers from ArcelorMittal to Nippon Steel have published roadmaps. Governments have allocated hundreds of billions in subsidies for hydrogen-based steelmaking and carbon capture technologies. The European Union's Carbon Border Adjustment Mechanism assumes clean steel will become the norm. Yet behind this consensus lies a question that prudent risk management demands we examine: **what happens if collective action fails to deliver steel decarbonisation by 2050?**

This is not pessimism about individual projects or initiatives. The technical, economic, and political challenges facing steel decarbonisation are formidable, and success depends critically on sustained international coordination. Hydrogen-based direct reduction requires renewable electricity at scales demanding unprecedented deployment rates. Carbon capture technology must prove itself at blast furnace scale. Scrap-based electric arc furnace production faces hard physical limits. The **€500 billion collective investment in green steel** technologies represents one of the largest coordinated industrial transitions in history. Understanding the consequences if coordination fails is not defeatism — it is prudent scenario planning that strengthens policy effectiveness by identifying risks requiring mitigation.

This analysis examines five critical risks emerging from coordination failure: the carbon price spiral creating structural steel cost inflation; geopolitical market division between high-carbon and premium low-carbon steel; accelerated material substitution potentially reducing global demand by 30–40%; emergency regulatory intervention potentially reviving Davignon Plan-style production quotas; and

erosion of public trust through litigation and backlash. The evidence suggests that whilst current policies and financing initiatives create pathways to success, understanding failure scenarios remains essential for effective risk management and contingency planning.

The Decarbonisation Challenge: Dependencies and Risks

Steel industry decarbonisation rests on three pillars: hydrogen-based direct reduction, carbon capture and storage, and increased scrap recycling through electric arc furnaces. Each pathway shows promise but faces obstacles that could delay the 2050 timeline if coordination or financing proves insufficient.

The Hydrogen Pathway and Its Electricity Demands

The hydrogen pathway — frequently identified as the cornerstone of [green steel](#) — requires vast quantities of green hydrogen produced from renewable electricity. A single direct reduction plant replacing a blast furnace needs approximately 2–3 terawatt hours of renewable power annually just for hydrogen production.¹ This is equivalent to a large offshore wind farm dedicated solely to one steel plant. Scaling this across global primary steel production of roughly 1.3 billion tonnes annually requires renewable capacity additions that, whilst technically feasible, demand sustained deployment rates exceeding current trajectories. The International Energy Agency's Net Zero Emissions scenario requires global renewable capacity to triple by 2030 — an ambitious target that would require accelerated investment and streamlined permitting across major economies.

The economics present challenges that financing mechanisms are working to address. Green hydrogen currently costs €4–6 per kilogramme, roughly three to four times the cost of natural gas on an energy-equivalent basis. Steel produced via [hydrogen direct reduction](#) faces a green premium of €200–300 per tonne compared to conventional blast furnace steel.² This premium requires either absorption by steelmakers (affecting profitability), transfer to customers (potentially reducing demand), or sustained government support during the transition period. Success depends on maintaining political commitment across multiple investment cycles.

The Scrap Ceiling

Electric arc furnaces using [scrap steel](#) offer lower emissions but cannot replace primary steelmaking entirely. Global scrap availability is constrained by the stock of steel in use — you cannot recycle steel that has not yet been produced. Even with optimal collection and recycling rates, scrap can supply approximately 30–35% of current steel demand. The remaining 65–70% requires virgin iron production, which means either blast furnaces or direct reduction — both currently reliant on fossil fuels without successful transition investments.

Carbon Capture: Scaling Requirements

Carbon capture and storage represents the third pillar, yet deployment at the required scale remains to be demonstrated. The technology works in principle but requires proving at steelmaking scale.³ Blast furnaces produce highly dilute CO₂ streams mixed with nitrogen, making capture energy-intensive and expensive. The handful of pilot projects provide valuable learning but must be scaled substantially. After decades of development and billions in subsidies, CCS currently contributes less than 0.1% of global emissions reductions — highlighting the magnitude of the scaling challenge ahead.

Coordination Requirements and Policy Persistence

Technical challenges are matched by coordination requirements. Steel decarbonisation depends on sustained policy support over decades, including carbon pricing, capital subsidies, and regulatory certainty. The gap between commitments and delivery is tracked in detail in the [Decarbonisation Timeline](#). Political cycles are short relative to industrial investment timeframes, and transition costs concentrate in steel-producing regions whilst benefits diffuse globally. The policy effectiveness of mechanisms like the [EU ETS](#) and [CBAM](#) depends critically on international alignment — unilateral action creates competitive disadvantages that can undermine domestic political support. The result is a collective action challenge where coordinated progress delivers success, but fragmented approaches risk undermining even well-designed individual policies.

Carbon Price Escalation: Economic Implications

If steel decarbonisation encounters significant delays, carbon pricing mechanisms — whether through the [EU Emissions Trading System](#), carbon taxes, or border adjustment mechanisms — will impose escalating costs on high-carbon steel. The [EU CBAM](#), which begins full implementation in 2026, charges importers based on the carbon intensity of steel products. This mechanism aims to create a level playing field that enables decarbonised steel to compete whilst preventing carbon leakage. However, if both domestic producers and international competitors struggle to decarbonise on schedule, the mechanism's effectiveness at driving transition whilst managing costs becomes the critical variable determining economic outcomes.

The Economics of Carbon Penalties

Carbon prices of €100–150 per tonne of CO₂ — levels already reached in the [EU ETS](#) during 2023 — add approximately €150–200 per tonne to the [cost of blast furnace steel](#), which emits roughly [1.8–2.0 tonnes of CO₂ per tonne of crude steel](#). As carbon prices rise toward the €200–300 per tonne levels many economists consider necessary for deep decarbonisation, [steel costs](#) increase by €300–500 per tonne. This represents a 30–50% cost increase on steel currently trading at €600–800 per tonne in European markets. Readers can model their own exposure using the [Steel Production Emissions Calculator](#).

These costs cascade through supply chains. Infrastructure construction — roads, bridges, rail networks — is intensely steel-dependent. A carbon-induced steel price increase of 40% translates to infrastructure project cost inflation of 15–20%, as steel typically represents 30–40% of major infrastructure costs.

Housing construction faces similar pressures. Renewable energy deployment becomes more expensive precisely when aggressive scaling is required: wind turbines, solar mounting structures, and electricity transmission towers all require substantial steel inputs.

The Infrastructure Paradox

High-carbon steel creates a challenging feedback loop: climate adaptation requires massive steel-intensive infrastructure — coastal defences against rising seas, reinforced electricity grids for extreme weather, expanded mass transit to reduce emissions. Yet if steel remains carbon-intensive during this infrastructure build-out, construction accelerates the warming it attempts to mitigate. A single kilometre of sea wall requires 2,000–3,000 tonnes of steel and concrete reinforcement. Protecting vulnerable coastlines could demand 50–100 million tonnes of additional steel — adding 90–180 million tonnes of CO₂ emissions whilst defending against climate impacts.

The Defence Industry Challenge

Elevated steel costs create particular challenges for defence procurement. [Armour plate](#), naval construction, and military vehicle production require specialised steel grades with limited substitution potential. A sustained 30–40% increase in steel costs either inflates defence budgets substantially or forces reductions in procurement volumes. Either outcome affects military capability precisely as geopolitical tensions increase. Defence ministries across [NATO](#) and Asia increasingly recognise strategic steel supply as a security consideration comparable to semiconductor or rare earth dependencies.

Winners and Losers in High-Carbon Scenarios

Market dynamics create winners and losers along predictable lines. Vertically integrated companies with low debt and diversified product mixes can absorb carbon costs more readily than highly leveraged commodity producers. Firms serving niche markets — aerospace alloys, electrical steel, specialised construction grades — can pass costs to customers more easily than those selling commodity rebar or hot-rolled coil. Geographically, producers with access to cheap renewable electricity (Nordic countries, parts of Latin America) gain advantage over those reliant on fossil-powered grids (Central Europe, much of Asia).

The most significant division is geopolitical. Steel-producing nations that delay imposing carbon costs gain temporary competitive advantage. If European and North American producers face €300 per tonne carbon costs whilst producers in other regions face minimal constraints, the result risks becoming industrial relocation rather than emissions reduction. Manufacturing could shift to lower-cost regions, taking emissions along — achieving limited global emissions reduction whilst disrupting Western industrial capacity. This is [carbon leakage](#) at global scale, precisely the outcome that [CBAM](#) and similar mechanisms aim to prevent.

Stakeholder Impact Analysis

Potential Beneficiaries: Material substitutes (timber, aluminium, composites, basalt rebar producers) gain market share if steel prices rise significantly. Scrap-based electric arc furnace operators benefit if scrap remains available. Renewable energy equipment suppliers profit from hydrogen steelmaking deployment, whether ultimately successful or not.

Potential Challenges For: Integrated steelmakers face stranded assets and capacity write-downs without successful transition. Steel industry employees encounter job displacement through plant closures. Shareholders in commodity steel producers risk capital destruction. Infrastructure developers and construction firms absorb higher input costs. Governments face reduced tax revenues from steel production whilst shouldering higher defence and infrastructure budgets. Energy-intensive downstream manufacturers (automotive, machinery, appliances) confront structural cost increases. End-users ultimately pay through higher prices for buildings, vehicles, and consumer goods.

Geopolitical Market Division: High-Carbon vs. Premium Low-Carbon Steel

If universal steel decarbonisation encounters significant delays, global markets risk division: high-volume conventional steel from producers prioritising industrial development, and lower-volume certified low-carbon steel commanding premium prices in regulated markets. This [carbon divide](#) would mirror and potentially reinforce broader geopolitical tensions.

Conventional Steel Production: Development Priorities

China, India, Indonesia, Vietnam, and other rapidly industrialising nations face a fundamental development challenge: constrain steel production to meet ambitious climate targets and slow infrastructure development, or prioritise economic advancement whilst working toward longer-term emissions reduction. For countries still building basic infrastructure — roads, housing, water systems, electricity grids — the development imperative is compelling. India's steel consumption per capita is roughly 80 kilogrammes annually compared to 400–500 kilogrammes in developed economies. Requesting that India decarbonise steel before achieving basic development standards presents legitimate sovereignty and equity concerns. The result could be major producers in rapidly developing economies supplying perhaps 60–70% of global steel demand at competitive cost, with emissions reduction timelines aligned to their development trajectories rather than 2050 deadlines set by already-industrialised nations.

This creates asymmetric competitive dynamics. A Chinese blast furnace using domestic coking coal and iron ore, operating without carbon constraints, produces steel at perhaps \$450–500 per tonne. A European hydrogen-based direct reduction plant, paying €100 per megawatt hour for renewable electricity and servicing capital costs from the €2.5 billion plant investment, produces steel at \$9.00

per tonne. Even with CBAM adding €200–300 per tonne to imports, cost differentials remain substantial. European producers face structural competitive disadvantage unless protected by trade measures — which risk retaliation and market fragmentation.

Certified Low-Carbon Steel as Premium Market

For producers in regions with carbon constraints, the strategic response focuses on serving niche markets requiring certified low-carbon steel: luxury automotive manufacturing demanding sustainability credentials, green building projects seeking environmental certification, export-oriented manufacturing supplying carbon-conscious markets. These segments may pay premiums of €200–400 per tonne for verified low-carbon steel, creating viable business models for early-transition producers.

However, premium low-carbon markets have limited size. The luxury automotive sector purchases perhaps 20–30 million tonnes of steel annually globally. Certified green building might consume 50–60 million tonnes. Together, these niche markets represent perhaps 5–7% of global steel demand. For conventional steel producers serving commodity markets in high-cost, carbon-constrained regions, this niche strategy offers limited relief. The middle ground — commodity steel production in regions with ambitious carbon constraints — becomes economically challenging without sustained policy support and financing.

The Strategic Steel Question

This market division forces consideration of strategic steel supplies. If Western producers struggle to compete in commodity grades, do they maintain capacity for genuinely strategic products — armour plate, reactor vessel steel, aerospace alloys — even at substantial public cost? Or do they accept dependence on other nations for defence-critical materials? The answer determines whether certified low-carbon steel represents a viable industrial strategy or creates strategic vulnerabilities disguised as climate leadership.

Trade Policy as Critical Variable

Trade policy becomes the central variable determining outcomes. The EU CBAM represents an initial approach to maintaining level competition whilst preventing carbon leakage. Its effectiveness depends on international acceptance and coordination. If decarbonisation timelines diverge significantly and cost gaps persist, expect increasing debate over trade policy responses: refined carbon intensity standards, local content requirements, discriminatory public procurement rules, and potentially import quotas. The World Trade Organisation framework, already under strain, faces fundamental challenges when carbon becomes the primary basis for trade restrictions. The risk is not merely fragmented markets but escalating trade tensions where steel becomes entangled in broader geopolitical competition.

Material Substitution and Evolving Steel Demand

If steel remains persistently expensive due to carbon costs, demand does not remain static — it shifts toward substitutes over investment cycles as builders, designers, and manufacturers adapt to the new cost structure. The scale of potential substitution is substantial but not unlimited.

Timber, Aluminium, and Composites

Timber construction has gained significant traction in residential and low-rise commercial buildings. Cross-laminated timber and engineered wood products can replace steel in many structural applications, offering lower embodied carbon and increasingly competitive costs. Scandinavian countries already construct timber buildings up to 18–20 storeys. If steel costs increase 40% whilst timber costs remain stable or decline, mass timber becomes economically compelling for a wider range of applications. The shift is already underway; elevated carbon costs would accelerate it substantially.

Aluminium substitutes for steel in transport applications where weight reduction offsets aluminium's higher cost and embodied energy. Automotive manufacturers have steadily increased aluminium content in vehicle bodies, frames, and components. A 30–40% steel price increase makes aluminium substitution economically attractive across broader vehicle segments. However, aluminium production itself is energy-intensive with significant emissions unless powered by renewable electricity — shifting rather than eliminating the decarbonisation challenge.

Composite materials — carbon fibre, glass fibre, advanced polymers — replace steel in aerospace, automotive, and specialised industrial applications. These materials offer superior strength-to-weight ratios but at substantially higher cost and with limited recycling pathways. They serve niche markets where performance justifies premiums, not mass commodity applications. Elevated steel costs expand the niche but do not make composites viable for construction rebar or automotive chassis at mass-market scale.

Emerging alternatives for concrete reinforcement include basalt fibre rebar, manufactured from volcanic rock through high-temperature melting and extrusion. [Basalt rebar](#) offers corrosion resistance superior to steel, tensile strength comparable to mild steel rebar, and substantially lower embodied carbon (approximately 0.6–0.8 tonnes CO₂ per tonne versus 1.8–2.0 tonnes for steel rebar). Current production remains limited — global capacity perhaps 50,000–100,000 tonnes annually — but elevated steel prices could accelerate scaling. Basalt rebar currently costs 30–50% more than steel rebar, but a sustained doubling of steel prices makes basalt economically competitive for infrastructure applications where corrosion resistance justifies premiums, particularly in marine environments and bridge decks.

The European development opportunity is noteworthy. EU steel demand approximates 120 million tonnes annually, of which long products represent roughly 60 million tonnes and rebar perhaps 30 million tonnes. If 30–40% of rebar applications shift to basalt over 2030–2045 due to sustained steel price premiums, this represents 9–12 million tonnes of substitution — potentially 15 million tonnes when including other long product applications. Spread across fifteen years, this equates to approximately 1 million tonnes per year of basalt rebar production capacity requiring development. This scale is

industrially achievable and represents a concrete industrial policy opportunity arising from steel sector challenges — European basalt production capacity could supply regional infrastructure needs whilst creating manufacturing employment in a lower-carbon material.

Demand Projections Under Elevated Carbon Cost Scenarios

How much does [global steel demand](#) decline if substitution accelerates? Conservative scenarios suggest **30–40% demand reduction in developed economies over 20–30 years** as buildings, vehicles, and infrastructure adapt to new cost structures. Developing economies with lower substitution rates see smaller declines. Global steel demand might decline from current 1.9 billion tonnes to perhaps **1.4–1.5 billion tonnes by 2050**. However, this represents managed adaptation rather than collapse — the steel industry remains substantial, operating under different economic conditions than today.

The One Percent That Matters

Yet substitution has hard limits. Certain applications genuinely require steel's unique properties: impact resistance, fracture toughness, weldability, fire resistance, and sheer strength. The [strategic one percent of steel products](#) — armour plate, nuclear reactor vessels, cryogenic storage tanks, high-strength fasteners, and specialised alloys — have no viable substitutes. These products represent perhaps 15–20 million tonnes annually from global production of 1.9 billion tonnes. They are strategically critical but relatively modest in volume terms.

The Commodity Middle Ground

The remaining question concerns the commodity middle ground: rebar for concrete reinforcement, structural sections for buildings, plate for shipbuilding, coil for appliances and machinery. These products are substitutable in principle but remain dominant due to cost, familiarity, and performance. Substitution rates depend on the magnitude and duration of steel price premiums. A temporary 20% increase changes little; a sustained 50% increase restructures material choices across the built environment over decades.

Emergency Regulatory Scenarios: Production Management and Supranational Coordination

If steel decarbonisation encounters severe delays and carbon pricing proves insufficient to drive adequate change, governments could face pressure for direct regulatory intervention. Historical precedents provide concerning insights into what such intervention might entail.

Historical Context: Schuman and Davignon

The European Coal and Steel Community, established under the Schuman Plan in 1951, represented history's first experiment in supranational industrial governance. Six nations — France, West Germany, Italy, Belgium, Netherlands, Luxembourg — pooled sovereignty over coal and steel production under

common authority. The goal was preventing war by making France and Germany economically interdependent. The model succeeded politically but established a precedent: **steel can require coordination beyond pure market mechanisms.**

When European steel faced structural crisis in the 1970s — [overcapacity](#), collapsing demand, intense Japanese competition — governments implemented direct intervention. The **Davignon Plan (1977–1988)** imposed mandatory production quotas, minimum pricing rules, and capacity reduction targets across European Community steel producers. It represented crisis management through coordinated adjustment, treating steel as a sector requiring managed transition rather than relying solely on market forces — a pattern explored further in [Zombie Steel Mills: Why State Aid Delays the Inevitable](#). Firms that opposed quotas faced sanctions. Competition policy was suspended. The European Commission effectively administered industry restructuring.

Potential Emergency Intervention: Carbon Management as Production Management

Could severe decarbonisation delays trigger comparable intervention? The logic is concerning. If decarbonisation timelines slip significantly and carbon prices prove politically difficult to sustain at levels needed to drive change, governments face a challenging situation: the steel industry continues emitting 7–9% of global CO₂, consuming disproportionate shares of remaining carbon budgets, whilst climate impacts intensify. Emergency regulation could become politically necessary.

A modern equivalent might impose **mandatory emissions caps that effectively function as production constraints**. Each major steel-producing nation or region could receive annual carbon allocations. Producers exceeding limits face penalties, forced shutdowns, or loss of operating licences. Strategic products — defence steel, nuclear-grade steel, specialised alloys — receive exemptions. Commodity production faces greater constraints. The result would be administered scarcity driving higher prices, allocating steel to highest-value uses, and managed contraction of emissions-intensive capacity.

Potential Emergency Scenario: Coordinated Carbon Management

If decarbonisation encounters severe delays and climate pressures intensify, potential emergency regulatory responses might include:

Annual emissions caps allocated to each steel-producing nation or region, effectively constraining production. **Strategic product exemptions** for armour plate, reactor vessel steel, aerospace alloys, and nuclear-grade materials — protecting the critical 1% whilst constraining commodity production. **Minimum carbon pricing** across participating nations to prevent competitive undercutting. **Managed capacity reduction targets** requiring coordinated closures of highest-emission facilities whilst preserving strategic capabilities. **Trade measures** on high-carbon steel from non-participating nations, enforced through border carbon adjustments. **Transition funding mechanisms** for worker retraining, community support, and industrial restructuring in affected regions.

This would represent coordinated intervention comparable to the 1977–1988 Davignon Plan, but triggered by climate crisis rather than overcapacity.

Such scenarios, whilst hypothetical, represent logical endpoints if decarbonisation encounters severe coordination failures combined with climate emergency. Geography dictates that effective European steel climate policy would need to encompass Turkey (35–40 million tonnes annually) alongside EU producers to prevent carbon leakage — a technical reality that would shape any future regulatory framework. However, implementing such intervention would face formidable obstacles.

Multi-Sectoral Coordination Challenges

The Broader Context: If EU decarbonisation encounters severe delays across foundational industries — steel, cement, glass, chemicals, fertilisers — coordinated capacity management could become structurally necessary. However, this logic extends beyond EU borders. Turkey's 35–40 million tonnes steel capacity, UK's post-Brexit production, Ukraine's facilities, Serbia's cement plants, and North African chemical complexes would require inclusion in any effective intervention framework. This makes supra-EU coordination structurally necessary rather than merely politically desirable.

The EU accepted comparable logic in 1951 with the European Coal and Steel Community, accepting supranational authority over foundational industries. Modern climate emergency scenarios might require similar frameworks at larger geographic scale and broader industrial scope.

Multi-Sector Scope: If steel decarbonisation encounters severe delays, comparable challenges across cement (8% of global CO₂), chemicals (3–4%), glass, fertilisers, and other energy-intensive sectors become probable. These industries face identical coordination challenges: first-mover disadvantages, capital intensity, international competition, and political obstacles. Steel-only intervention creates potential leakage to other sectors — manufacturers shifting from steel-intensive to cement-intensive construction, from steel packaging to glass and plastics. Effective intervention could require managing multiple emissions-intensive foundational industries simultaneously.

Institutional Considerations: Emergency multi-sector coordination mechanisms would address a narrow technical mandate: foundational industries represent approximately 5% of European employment and 10% of GDP, yet account for roughly 75% of industrial energy consumption and the majority of hard-to-abate emissions. Standard EU regulatory frameworks continue governing services, consumer manufacturing, agriculture, technology, and finance — the 95% of employment operating under normal market conditions. Emergency mechanisms would exist solely because foundational industries might require specialised coordination that cannot

function through standard regulatory approaches if market-based decarbonisation encounters severe delays. This institutional separation follows the ECSC precedent: technical necessity driving limited sovereignty pooling for strategically critical but economically narrow sectors.

Governance Challenges: Multi-sector emergency coordination faces simultaneous governance challenges. First, allocation conflicts — determining which nations and regions retain capacity when total production across multiple sectors must contract. Second, sovereignty-legitimacy tensions — requiring authority to impose adjustments whilst lacking democratic mandate across non-EU members. Third, enforcement paradoxes — losing participants can threaten exit, undermining frameworks.

These dimensions interact destructively. Solving allocation conflicts through political bargaining undermines legitimacy. Strengthening enforcement mechanisms intensifies sovereignty concerns. Improving democratic accountability slows decision-making below crisis response requirements. Any solution to one challenge can worsen others.

The Structural Challenge: Emergency coordination becomes necessary precisely when it becomes difficult to govern. Market failure, climate urgency, and industrial crisis across multiple sectors create conditions requiring intervention. Yet these same conditions — high stakes, political polarisation, economic distress — make legitimate, effective governance challenging.

Economic Compulsion Approach: Rather than direct enforcement, coordination mechanisms could operate through economic incentives — making non-compliance unprofitable rather than illegal across covered industries.

Phase 1 (Core Formation): Leading nations establish green standards and procurement commitments across steel, cement, glass, chemicals, and fertilisers. Major industrial buyers — automotive, construction, manufacturing — sign binding purchase agreements for certified low-carbon materials only. This creates protected markets for compliant producers.

Phase 2 (Market Development): As certified low-carbon supply chains consolidate across multiple industries, non-participants face shrinking markets. Nations outside initial frameworks confront choices: join coordination mechanisms and accept capacity constraints across covered sectors, or lose access to substantial industrial procurement markets. Decisions remain formally voluntary but become economically influenced.

Phase 3 (Border Management): Carbon Border Adjustment Mechanisms make non-certified materials economically challenging within coordination zones across all foundational industries. Non-compliance faces economic rather than legal consequences. Coordination mechanisms control access to markets paying premiums for certified low-carbon steel, cement, glass, chemicals, and fertilisers rather than imposing capacity cuts directly. Non-members retain formal sovereignty whilst facing difficult economic choices.

This approach converts enforcement from political to economic. Coordination mechanisms require capability to structure market access such that non-participation becomes economically difficult rather than legally prohibited across entire industrial sectors. Sovereignty is preserved formally

whilst economic incentives create strong alignment pressures.

Sectoral Complexity: Managing multiple industries simultaneously creates additional challenges. Steel and cement face different decarbonisation pathways. Glass production concentrates in specific regions. Chemical production spans thousands of products with varying emissions profiles. Fertiliser production links to food security. Each industry requires separate technical assessment, allocation methodologies, and transition timelines — whilst being coordinated to prevent leakage between sectors.

Implementation Barriers: Even economic compulsion approaches face challenges. Which nations join initial frameworks? How are capacity allocations determined within coordination zones across different industries? What prevents free-riding by nations delaying participation until others bear adjustment costs? How are strategic exemptions defined across diverse product categories — defence-critical steel, pharmaceutical-grade chemicals, food-security fertilisers? Economic incentive logic reduces some governance challenges but doesn't eliminate them entirely.

Implementation Resistance and Trade Law

Such intervention would face substantial resistance. Steel companies would argue that production constraints destroy shareholder value, eliminate employment, and surrender markets to international competitors. Developing nations would object to what they perceive as unfair constraints — industrialised countries developed using cheap fossil-fuelled steel, then changing rules after achieving development. Trade law complications would be substantial: do production quotas violate WTO obligations? Can they be applied to imports? Does this justify retaliation?

Litigation, Public Pressure, and Just Transition Challenges

Climate litigation adds further pressure. Shareholder lawsuits, citizen climate cases, and environmental group actions increasingly target heavy emitters. If steel companies maintain high-emission operations despite decarbonisation commitments, plaintiffs argue for damages, remediation costs, and transition funding. The precedent is tobacco litigation — decades of industry resistance followed by massive settlements and regulatory transformation. Steel is structurally different (society genuinely needs steel, whereas tobacco provides no benefit), but plaintiffs could employ similar legal strategies.

Public pressure compounds legal and regulatory challenges. As climate impacts intensify — heat waves, flooding, droughts, ecosystem disruption — publics demand accountability. Steel companies promoting net-zero roadmaps in 2020 then encountering severe delays in 2040 face reputational challenges. The industry risks becoming viewed as requiring strict constraint. ESG investors may exit positions. Social licence to operate faces erosion. Recruitment becomes difficult as young engineers avoid sectors seen as environmentally problematic.

Just transition challenges worsen social tensions. If decarbonisation initiatives encounter difficulties, workers in traditional steel regions may lose promised retraining, transition support, and alternative employment. If emergency regulation forces plant closures, job losses accelerate without adequate safety nets. Communities dependent on steel production face economic challenges without compensation. The result is political backlash against both industry and government — precisely when difficult long-term decisions are needed.

Compensation and Fiscal Implications

Compensation questions follow logically. If society determines existing steel plants must close to meet climate targets, who bears costs for stranded assets? Should governments compensate shareholders for lost investment, or does this reward past pollution? Should workers receive severance, retraining, and income support? Should communities receive infrastructure investment to offset economic decline? The fiscal costs could reach hundreds of billions across major steel-producing nations — costs that few governments have budgeted for because policies assume voluntary, market-driven transitions.

Risk Mitigation: What Policymakers Should Consider Now

Current steel decarbonisation policy emphasises pathways to success: assume technologies will mature, costs will decline, political commitment persists, and coordination challenges resolve. This is appropriate strategic planning. However, prudent policy also acknowledges that decarbonisation might encounter significant delays — and prepares accordingly.

Prioritise Genuinely Strategic Steel

First, distinguish commodity steel from genuinely strategic steel. The one percent of steel products with no viable substitutes and genuine security importance deserve targeted, sustained government support even at substantial cost. If hydrogen-based steelmaking struggles to become economically competitive for commodity rebar, that presents economic challenges. If it fails for armour plate and reactor vessel steel, that creates strategic vulnerabilities. Policy should focus public resources on the smallest, most critical segments rather than attempting uniform support across the entire industry — a distinction examined in depth in [Do G7 Countries Need Virgin Steelmaking? British Steel's Scunthorpe](#) experience, and the [unresolved questions the UK Steel Strategy leaves open](#), demonstrate the risks of indiscriminate support for commodity-focused operations lacking viable decarbonisation pathways.

Accept Material Substitution as Economic Adaptation

Second, accept material substitution as economically rational rather than resist it on industrial policy grounds. If timber, aluminium, or composites can serve specific applications more cost-effectively than high-carbon steel, that is efficient adaptation to carbon constraints — not necessarily industrial decline. Policies that artificially protect steel demand through restrictions on substitutes may waste resources and delay adjustment. Better to facilitate orderly substitution whilst managing workforce transitions.

Rigorous Cost-Benefit Analysis

Third, conduct rigorous cost-benefit analysis comparing decarbonisation investments against alternative climate responses. Does spending €500 billion on hydrogen steelmaking deliver optimal climate outcomes compared to spending €500 billion on renewable electricity deployment, building retrofits, or adaptation infrastructure? Steel decarbonisation has attracted broad political commitment that warrants rigorous comparative assessment alongside other climate investments. Some investments may prove worthwhile; others may not. Analysis should proceed case-by-case based on evidence rather than sector-wide commitments driven by political symbolism.

Prepare Regulatory Frameworks for Potential Emergency Scenarios

Fourth, prepare regulatory frameworks for potential emergency intervention whilst working to ensure they never become necessary. If climate pressures eventually require production management or coordinated adjustment, policy mechanisms should be designed in advance — not improvised during crisis. This includes emissions allocation methodologies, strategic product exemptions, transition support programmes, and international coordination frameworks. The Davignon precedent offers useful lessons, both positive and negative.

Communicate Realistic Timeframes and Acknowledge Uncertainty

Finally, communicate realistic timeframes and acknowledge uncertainty. Net-zero commitments that promise 2050 success whilst underemphasising implementation risks create potentially false confidence. Policymakers serve citizens better by explaining what success requires (unprecedented technological progress, massive capital investment sustained across decades, persistent political commitment, international coordination), what delays might entail (some combination of scenarios outlined above), and what governments will do in each scenario. This represents uncomfortable honesty, but it is preferable to discovering in 2045 that commitments made in 2020 were based on optimistic assumptions rather than rigorous scenario planning.

Conclusion: Scenario Planning for Uncertain Transitions

The question "what if steel decarbonisation encounters severe delays?" is not rhetorical defeatism. It is a legitimate scenario requiring serious policy attention alongside pathways to success. The industry may decarbonise successfully, validating current optimism and investment by governments, development banks, and private capital. That remains the goal and the preferred outcome. However, prudent risk management requires understanding what happens if coordination proves insufficient, technologies mature more slowly than projected, or political support proves unsustainable across required timeframes.

The consequences examined in this analysis — carbon price escalation, geopolitical market division, accelerated material substitution, potential emergency regulatory intervention, and erosion of social licence — are neither inevitable nor exhaustive. They represent plausible outcomes if current decarbonisation pathways encounter severe coordination failures. The probability of complete fr

impossible to quantify precisely, but it is demonstrably non-zero given the technical, economic, and political challenges involved. Acknowledging these risks strengthens rather than undermines transition efforts by identifying specific vulnerabilities requiring mitigation.

These scenarios are avoidable. Success depends on sustained coordination across governments and industry. Innovative financing mechanisms can help bridge the green premium gap. The EU's combination of carbon pricing through ETS, border adjustment through CBAM, and direct support for green steel creates a comprehensive policy framework. If complemented by international coordination, sustained political commitment, and adequate financing, these mechanisms can deliver the required transition.

The steel industry has twice before required extraordinary intervention, under Schuman and Davignon. Climate challenge may test coordination capabilities again. Whether responses take the form of coordinated carbon management, capacity constraints, managed adjustment, or other mechanisms depends on choices made in coming years. What is certain is that crisis responses developed without advance planning typically produce worse outcomes than thoughtful preparation conducted when options remain open.

Steel executives should conduct rigorous scenario planning for reputational risks, litigation exposure, and stranded asset challenges if net-zero commitments encounter implementation difficulties. The tobacco litigation precedent demonstrates that decades of confident public commitments followed by systematic underdelivery create extraordinary legal and financial liability. Companies promoting net-zero roadmaps today whilst underinvesting in transition pathways face foreseeable consequences that prudent risk management should address proactively.

The €500 billion collective investment in green steel deserves rigorous evaluation, honest assessment of both success pathways and risk factors, and contingency planning for scenarios where coordination proves more difficult than hoped.⁶ Current policy appropriately emphasises pathways to success. However, adding parallel contingency planning for coordination challenges is not defeatism but prudent risk management. The question is not whether to plan for potential steel decarbonisation delays, but whether to plan effectively or ineffectively when confronted with evidence that current trajectories require strengthening.

This analysis should be understood as examining structural risks requiring mitigation through stronger coordination, not as prediction of inevitable failure. Steel decarbonisation remains technically feasible and economically viable with adequate policy support and financing. The scenarios outlined above become probable only if collective action fails. They are preventable through sustained commitment to the transition pathways already identified, adequate financing mobilisation, and strengthened international coordination. Understanding these risks is the first step toward ensuring they never materialise.

The views expressed in this analysis are those of the author in their independent research capacity and do not represent the views of any client or institution.

Sources and Notes:

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- ³ Emirates Steel Al Taqana in Abu Dhabi captures approximately 800,000 tonnes CO₂ annually from DRI operations, representing the only commercial-scale steel sector CCS deployment. However, direct reduction produces concentrated CO₂ streams (>95% purity) versus blast furnace off-gas at 20–25% concentration, fundamentally altering capture economics. The Emirates project also benefits from enhanced oil recovery revenue and government support unavailable to most steelmakers.
- ⁴ Boston Consulting Group & World Steel Association (2021). *Net-Zero Steel: Sector Transition Strategy*. The report details technical pathways, investment requirements, and policy frameworks for steel decarbonisation, estimating cumulative capital investment of \$1.4–2.0 trillion globally through 2050.
- ⁵ Vogl, V., Åhman, M., & Nilsson, L.J. (2021). "The making of green steel in the EU: a policy evaluation for the early commercialization phase." *Climate Policy*, 21(1), 78–92. Analyses European policy instruments supporting steel decarbonisation and their effectiveness in driving technological transition.
- ⁶ This analysis examines binary success/coordination-failure scenarios for analytical clarity, but reality will likely produce partial outcomes. Steel decarbonisation may achieve 40–60% emissions reductions rather than net zero — sufficient to avoid worst-case scenarios but insufficient to meet Paris targets. Hydrogen-based direct reduction may succeed in Nordic countries with cheap renewable electricity whilst facing greater challenges in Central Europe. Some producers may transition successfully whilst others struggle. Partial success creates its own policy challenges: how to manage an industry where some firms achieve net zero whilst competitors remain carbon-intensive; whether to protect transitioning producers from low-cost conventional steel imports; how to allocate scarce green hydrogen between competing industrial users. Planning for partial outcomes — identifying which segments are most likely to succeed, which face greater obstacles, and how to manage the resulting landscape — may prove more important than planning for either complete success or total failure.

Note: This analysis should be understood as examining structural consequences of potential coordination failure in foundational industry decarbonisation. It is not a forecast, nor does it argue against decarbonisation — which remains essential to credible climate scenarios and is the focus of substantial policy and financing efforts. Rather, it maps second-order effects that must be understood for effective scenario planning and risk assessment. Understanding what could go wrong is essential preparation for ensuring it doesn't.

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