

The Hydrogen Mirage: Why Green Steel Timelines Keep Slipping



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Why the Promise of Hydrogen Steelmaking Keeps Outrunning the Reality

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Executive Summary

Hydrogen-based steelmaking has been the centrepiece of European [green steel](#) strategy for a decade. Political commitments, investment roadmaps, and climate targets all assume that commercial-scale hydrogen [DRI](#) will be widely deployed by the early 2030s. The evidence does not support that assumption.

Project after project has slipped. Green hydrogen remains expensive at roughly \$3–6 per kilogram, against the \$1.50 or below that would make hydrogen steelmaking genuinely cost-competitive with coal-based routes. Several flagship projects — presented as proof that the transition is under way — have been delayed, rescaled, or quietly restructured. Electrolyser manufacturing is expanding, but not at the pace that aggressive deployment scenarios require.

The conclusion of this analysis is not that hydrogen steelmaking has failed. The technology is real, and the long-term direction is not seriously in doubt. What has failed is the timeline — and the policy frameworks built around it. Governments have structured support programmes around assumptions that are unlikely to hold. Companies have deferred decisions about existing blast furnace assets on the expectation that a hydrogen alternative will be ready before those assets become stranded. Regulators have set carbon milestones calibrated to a trajectory that has not materialised on schedule.

projects as delivered capacity. The hydrogen future for steel is coming. The question is whether industrial strategy is being built on evidence, or on green steel promises that have yet to be tested against delivery.

What Was Promised — and When

Green steel promises have been remarkably consistent in their optimism, and equally consistent in slipping. A decade ago, [industry roadmaps](#) produced by the [IEA](#), worldsteel, and the European Commission described hydrogen-based [DRI](#) reaching commercial scale around 2030, with meaningful cost parity following by 2035.¹ Those projections were not fringe positions. They were — and in many cases still are — the foundation of national steel strategies across Europe.

The projects announced to prove the point were substantial. H2 Green Steel (since rebranded as Stegra) announced a 5 million tonne hydrogen [DRI](#) facility in Boden, northern Sweden, with a target production date of 2025. ArcelorMittal announced hydrogen [DRI](#) investments at Hamburg and Dunkirk. Thyssenkrupp committed to converting its Duisburg operations. SSAB, together with LKAB and Vattenfall, launched the [HYBRIT](#) project with an explicit ambition to produce the world's first commercial volumes of fossil-free steel by 2026.

These were serious projects backed by serious companies. They were also presented to governments, investors, and the public as evidence that the transition was not merely possible but imminent. The problem is that virtually every one of them has slipped its original schedule. Some have slipped by years. A few have been reduced in scope.² The gap between announcement and delivery has become a structural feature of the sector — and it matters, because policy has been built around the announcements.

Why the Timelines Keep Slipping

The delays are not random, and they are not primarily caused by project mismanagement. They reflect structural challenges that were underestimated when the original timelines were set.

Green Hydrogen Is Still Too Expensive

The economic case for hydrogen steelmaking rests on the cost of green hydrogen — hydrogen produced by electrolysis powered by renewable electricity. For hydrogen [DRI](#) to compete with coal-based steelmaking without carbon pricing support, green hydrogen needs to cost approximately \$1.50 per kilogram or below. Current production costs in Europe range from \$4 to \$7 per kilogram, depending on electrolyser efficiency, electricity prices, and plant scale. Even in countries with the best renewable resource endowments, costs are not expected to fall below \$2 per kilogram before  in most credible scenarios. Many analysts place the \$1.50 threshold beyond 2035.³

embedded in steel decarbonisation roadmaps assumed. Every time the hydrogen cost curve has been updated with fresh data, the competitive crossover point has moved further into the future.⁴

Electrolyser Manufacturing Has Not Scaled Fast Enough

Commercial-scale hydrogen steelmaking requires large quantities of electrolyzers — the equipment that splits water into hydrogen and oxygen using electrical power. Early assessments of the transition assumed that electrolyser manufacturing capacity would scale rapidly, driven by demand from multiple industrial sectors. That scaling has begun, but it has been slower than anticipated. Supply chain bottlenecks, [the capital intensity of manufacturing expansion](#), and competition for skilled workers have all contributed to delays. Projects that assumed electrolyser availability on a given timeline have found themselves waiting longer than planned.

Renewable Electricity Infrastructure Is a Bottleneck

Hydrogen steelmaking requires very large quantities of renewable electricity — both to produce the hydrogen and to power the EAF that processes the reduced iron. In northern Sweden, where Stegra is building, the renewable resource is excellent. But grid connection, transmission capacity, and permitting timelines have all added delay to projects that assumed infrastructure would be in place when needed. The Stegra facility in Boden, for instance, required grid upgrades that were not available on the original schedule. This is a recurring theme: the steel project is ready before the energy infrastructure that feeds it.

Carbon Pricing Has Not Provided Enough Revenue Certainty

Investment in hydrogen steelmaking depends on a credible long-term carbon price signal. Producers need confidence that the cost disadvantage of high-carbon steel will persist — and increase — over the 20 to 30 year life of new assets. The EU ETS carbon price has been volatile, falling sharply during economic slowdowns and recovering unevenly. While [the long-term trajectory is upward](#), short-term volatility creates genuine uncertainty for investors trying to model project returns over decades. Several financing processes for hydrogen steel projects have stalled precisely because lenders and equity investors cannot get comfortable with long-run carbon price assumptions.

What the Flagship Projects Actually Show

The clearest evidence of the gap between ambition and reality is the record of the projects themselves.

Stegra's Boden facility, the most closely watched hydrogen steel project in the world, has faced repeated delays. The original first-steel target of 2025 has shifted to 2026 and then beyond,  I-scale production of 5 million tonnes now targeted for the late 2020s at the earliest. The project

ArcelorMittal's Hamburg facility produced small volumes of hydrogen-reduced iron in 2024 using an existing pilot unit, which is a genuine milestone. But Hamburg's planned scale-up to commercial volumes remains dependent on green hydrogen availability at costs that are not yet achievable. The company's broader decarbonisation plan once anticipated tens of millions of tonnes of hydrogen DRI capacity by the early 2030s.⁵ That plan has since been presented in more cautious terms in recent investor communications. The company has also delayed final investment decisions on several European low-carbon steel projects, citing unfavourable policy, energy and market conditions.⁶

HYBRIT, the collaboration between SSAB, LKAB, and Vattenfall, produced the world's first small quantity of hydrogen-reduced steel in 2021 — a genuine technical achievement. Commercial production at SSAB's Luleå site was originally targeted for 2026. That timeline has been extended, with full commercial scale now not expected before 2030.

[Thyssenkrupp's Duisburg plans](#) continue amid a broader restructuring of the company's steel division. Talks with Jindal Steel International over a possible sale of the unit ran for several months. Both sides paused negotiations in May 2026, and Thyssenkrupp opted instead to pursue a standalone turnaround following a restructuring agreement with its labour union.⁷ Investment decisions for the hydrogen DRI conversion remain tied to the outcome of that broader restructuring.

None of these projects has been abandoned. All represent genuine progress toward a genuine goal. But collectively, they demonstrate something important: the gap between announcement and delivery in hydrogen steelmaking is measured in years. Policy frameworks that treat announced capacity as near-term reality are working from a false premise.

What Policy Got Wrong

The policy problem is not that hydrogen steelmaking was chosen as a long-term pathway. That choice is technically well-founded. The problem is that policy timelines were calibrated to the most optimistic plausible scenario, rather than to central estimates with appropriate uncertainty.

This matters in several concrete ways. First, carbon reduction milestones built into the [EGD and national steel strategies](#) assumed specific technology availability dates. When those dates slip, the milestones become unachievable — not because the ambition was wrong but because the assumed technical pathway was not ready. The credibility of the whole framework suffers.

Second, companies deferred investment decisions about existing BF-BOF assets on the grounds that hydrogen replacement capacity would arrive before those assets became stranded. They are now discovering that the replacement is further away than assumed. Some of those assets now require capital decisions without a clear hydrogen successor in sight. The result is a choice between continuing to invest in assets that will eventually need to close, or [closing them before a replacement is](#)

presented as evidence that the transition is impossible rather than evidence that timelines need adjusting. Honest, updated assessments would serve the industry and the policy process better than continued optimism that is repeatedly disappointed.

The Bridge Question: Natural Gas DRI

The technology that sits uncomfortably in the middle of this debate is natural gas-based DRI. Processes such as Midrex and HYL can reduce iron ore using natural gas rather than coal, producing steel with roughly 40% lower CO₂ emissions than a conventional blast furnace. They are commercially proven, deployable today, and can be converted to hydrogen operation when green hydrogen becomes available and affordable.

For a period, natural gas DRI was treated as a bridge technology — the intermediate step that would reduce emissions whilst hydrogen scaled up. More recently, the bridge framing has fallen out of favour in some policy circles. This is partly due to concerns about locking in gas infrastructure, and partly due to the political optics of describing a fossil fuel route as part of a green transition.

This shift in framing has been a mistake. The choice facing the European steel industry is not between natural gas DRI and hydrogen DRI. It is between natural gas DRI now — with conversion to hydrogen later — and continuing to operate blast furnaces for longer whilst waiting for hydrogen costs to fall. On both climate and commercial grounds, the bridge route is likely to be preferable for many producers. Dismissing it as a detour rather than a bridge is a policy error that risks delaying decarbonisation rather than accelerating it.

[Italy's steel sector](#) provides instructive evidence here. Italian producers have operated substantial EAF and gas-based DRI capacity for decades, producing competitive steel at substantially lower carbon intensity than integrated blast furnace routes. The absence of dogmatic insistence on a single green technology pathway has allowed the Italian sector to decarbonise progressively, without waiting for a breakthrough that has not yet arrived.

What Honest Policy Requires

The starting point for better policy is honest assessment. That means updating official technology assumptions to reflect where costs actually are, not where they were hoped to be. It means acknowledging that commercial-scale hydrogen steelmaking will not be widespread in Europe before 2030, and possibly not before 2035 in any large-volume sense. And it means designing support frameworks that are robust to a range of timelines, rather than optimised for the most ambitious one.

Several practical adjustments follow from this.

revised. They should not be abandoned, but recalibrated to what is actually achievable with the technologies that will be available at the relevant date. This is not a retreat from ambition. It is the difference between targets that drive investment and targets that invite cynicism.

Support for natural gas DRI as a bridge technology should be explicit and unambiguous. Where a producer is converting from blast furnace to gas-based DRI with a credible hydrogen conversion commitment, that investment should attract the same policy support as a direct hydrogen route. The carbon saving is real, the conversion pathway is genuine, and the alternative — longer blast furnace operation — is worse on every relevant measure.

Announced projects should be distinguished from operational capacity in all public assessments. Governments, industry bodies, and the press habitually cite announced hydrogen steel capacity as if it were existing or imminent. It is not. Policy needs to be built on capacity that exists, backed by credible assessments of when additional capacity will be commissioned — with ranges, not point estimates.

Finally, research and development investment in hydrogen production cost reduction should be treated as the highest-priority enabling investment in the steel decarbonisation programme. Everything else — the DRI plants, the EAF expansions, the grid connections — is ready to deploy at scale when green hydrogen reaches \$1.50 per kilogram. The bottleneck is the hydrogen cost, and that is where sustained public investment will have the greatest return.

Conclusion

Hydrogen-based steelmaking is not a mirage in the sense of being an illusion. The technology works. The long-term economics are becoming credible. The projects exist. But the timelines that have framed a decade of European industrial policy have been, and continue to be, too optimistic. The gap between those timelines and reality is now large enough to require an honest response.

The steel industry and its policy backers face a choice. They can continue to describe the transition in terms that look increasingly implausible as each deadline passes, hoping that the next round of project announcements will close the gap. Or they can update their assessments and recalibrate their targets. They can design policies that are robust to the actual pace of change — including the bridge technologies that can reduce emissions now, while the hydrogen future arrives on its own schedule.

The second path is less politically convenient. It requires acknowledging that projections were wrong and timelines need adjustment. But it is the only path that produces industrial policy grounded in evidence rather than aspiration.

A mirage recedes the closer you approach it, always the same distance away. Hydrogen steel is not that. It is a real destination on a longer road than advertised — most credibly reached in the 2033–2038 window, not 2030. Policy that plans for that road, rather than for a shortcut that has not

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