U.S. Green Steel Developments

2025 Year End Update

Reality Check

The U.S. green steel landscape in 2025 is no longer about aspirational megaprojects. It is now clearly bifurcated:

- **Several flagship hydrogen-based projects have been cancelled or mothballed** due to hydrogen availability, cost, and policy instability.
- **Incremental, commercially grounded decarbonization pathways are advancing**, particularly EAF-based routes, CCS, and product-level green steel offerings.
- **Technology development continues**, but commercialization timelines are pushing into the 2030s.

This 2025 update reflects cancellations, continuations, emerging technologies, and the continued development of green steel products being made available for the market.

I. Status of Major U.S. Decarbonization Pathways

1. Hydrogen-Based Primary Steelmaking

Cancelled / Dormant Projects

- **Cleveland-Cliffs – Middletown Works (OH)**: Hydrogen-ready DRI conversion cancelled. Core constraint was lack of reliable, affordable clean hydrogen combined with a less supportive federal policy environment.
- **SSAB – Mississippi HYBRIT Facility**: Withdrawn from DOE funding negotiations; hydrogen supply partner Hy Stor Energy delayed. Project currently inactive.

What this means: Full hydrogen DRI is not dead—but it is clearly **not commercially deployable in the U.S. at scale this decade** without massive green hydrogen production and long-term policy certainty.

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2. Blast Furnace Decarbonization (Incremental)

Continuing

- **Cleveland-Cliffs – Indiana Harbor BF #7**: Hydrogen injection trials successfully completed. Demonstrates partial emissions reduction without full asset replacement.

Reality: This pathway offers **single-digit to low-double-digit CO_2 reductions**, not green steel, but it extends asset life and buys time.

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3. Carbon Capture & Storage (CCS)

Active and Advancing

- **Nucor + ExxonMobil – Convent, Louisiana DRI**
  - Capture capacity: up to 800 kt CO_2/year
  - Status: EPC awarded; construction underway
  - Target start: 2026

Assessment: CCS is emerging as **the most viable near-term decarbonization lever** for gas-based DRI in the U.S., especially where geology and tax credits align. The tax credits associated with this project are favorable under the new administration and passage of the OBBBA.

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4. Biocarbon Developments

Emerging / Early Commercial

- **Steel Dynamics (SDI) + Aymium**: SDI has been actively working with Aymium to evaluate and deploy biocarbon as a partial substitute for fossil carbon in iron and steelmaking applications. Biocarbon derived from sustainably sourced biomass offers a drop-in pathway to reduce Scope 1 emissions without major process redesign.

Reality: Biocarbon is not a silver bullet, but it represents a **practical, near-term decarbonization tool**, particularly for EAF operations and for transitional use in ironmaking where fossil carbon remains structurally required.

II. Emerging Steelmaking Technologies (Beyond Hydrogen DRI)

1. Boston Metal – Molten Oxide Electrolysis (MOE)

- Zero-carbon ironmaking using high-temperature electrolysis
- No hydrogen, no coal
- Commercial relevance: **2030s**, dependent on abundant low-cost clean power

2. Hertha Metals – Hydrogen Plasma Smelting Reduction (HPSR / Flex-HERS™)

- Single-step electric smelting with in-furnace hydrogen generation
- Can transition from natural gas to clean hydrogen without hardware changes
- Demonstration scale expected mid-to-late 2020s

3. Electra – Low-Temperature Electrochemical Ironmaking

- Operates at ~60°C
- Extremely ore-flexible
- Still early-stage; scaling risk remains high

4. NEMO – Refined DRI-to-Pig Iron Pathway

- **Process clarification**: NEMO is not a novel electrochemical or electrolytic ironmaking technology. It is best understood as a **refinement of conventional DRI-based steelmaking**, incorporating an additional step to convert DRI into pig iron.
- **Purpose**: The conversion to pig iron is intended to improve melt shop consistency and chemistry control, ultimately supporting **more efficient and higher-quality EAF steel production**.
- **Energy profile**: Relies on electrification and process optimization rather than breakthrough chemistry.
- **Role in decarbonization**: Incremental—not transformational. NEMO improves operational efficiency and product quality but does not eliminate the need for upstream carbon or energy inputs.
- **Status**: Pilot / pre-commercial.

Strategic importance: NEMO should be viewed as an **optimization pathway within the existing DRI–EAF ecosystem**, not a disruptive green steel technology.

Bottom line on technology: These are **optionality plays**, not supply-chain solutions this decade.

III. Green Steel Products Available Today (Market Reality)

While primary ironmaking transitions struggle, **product-level green steel is already being sold**. This is where decarbonization is actually happening.

1. SSAB Zero™

- Fossil-free steel made using recycled scrap and fossil-free electricity
- Near-zero Scope 1 & 2 emissions
- Limited volumes, premium pricing
- Demand from automotive and OEM customers

2. Nucor ECONIQ™

- Low-embedded-carbon steel produced via EAFs using high recycled content
- Transparent EPD-backed emissions reporting
- Commercially scalable today
- A family of products available to meet varying customers requirements

3. JSW Steel USA – GreenEdge™

- EAF-produced steel with reduced carbon intensity
- Leverages scrap, energy efficiency, and operational optimization
- Positioned for customers needing incremental but credible emissions reductions to meet the requirements of Buy Clean California Act (BCCA)

4. Other Market Offerings (Emerging)

- Big River Steel (US Steel): Advanced EAF-based low-carbon flat-rolled products
- SDI: Low-carbon EAF steels with strong EPD support
- Imports: Limited volumes of certified low-carbon steel entering the U.S. market

IV. Strategic Takeaways

1. **Hydrogen-first strategies have overreached** current infrastructure and policy reality.
2. **EAF + scrap + clean power + CCS** is the dominant U.S. decarbonization pathway for the 2020s.
3. **Green steel is increasingly a product, not a plant**—buyers care about verified carbon intensity, not process purity.
4. Technology bets matter—but they will not materially decarbonize U.S. steel before 2030.
5. Expect widening gaps between:
    - Marketing claims vs. actual emissions reductions
    - Pilot announcements vs. delivered tonnage

V. What to Watch Next

- Survival and scale of regional hydrogen hubs
- Expansion of CCS beyond Louisiana and Texas
- CBAM-driven demand signals influencing U.S. mills
- Standardization of low-carbon steel definitions and EPD credibility

Bottom line: Green steel in the U.S. has entered its pragmatic phase. The hype cycle is ending. Execution, data, and product-level credibility now matter more than ambition.