

Memo Focus: Pennsylvania

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Pennsylvania overview

Pennsylvania is responsible for [5%](#) of all US crude steel production and ranks fourth in the Great Lakes in terms of production capacity behind Illinois, Indiana, and Ohio.

Pennsylvania ranks first in the country in coke production capacity, predominantly attributable to US Steel’s Clairton Coke Works, the largest coke plant in the country. The ELLWOOD and Tenaris facilities

produce low volumes of specialty steel. The Edgar Thomson BF-BOF facility is the largest production site in the state that relies on the neighboring Clairton plant to supply coke, while iron ore pellets are brought in from mines in Minnesota. By tracking historical investment patterns, the facility appears due for reline with the last major investment occurring in 2001.¹ The Edgar Thomson and Clairton sites are part of US Steel’s Mon Valley Works, which includes two finishing facilities, the Fairless and Irving plants located outside Philadelphia and Pittsburgh, respectively.² [Pennsylvania’s Climate Action Plan](#), released in 2021, acknowledges the steel industry

Figure 1: Pennsylvania steel and related assets

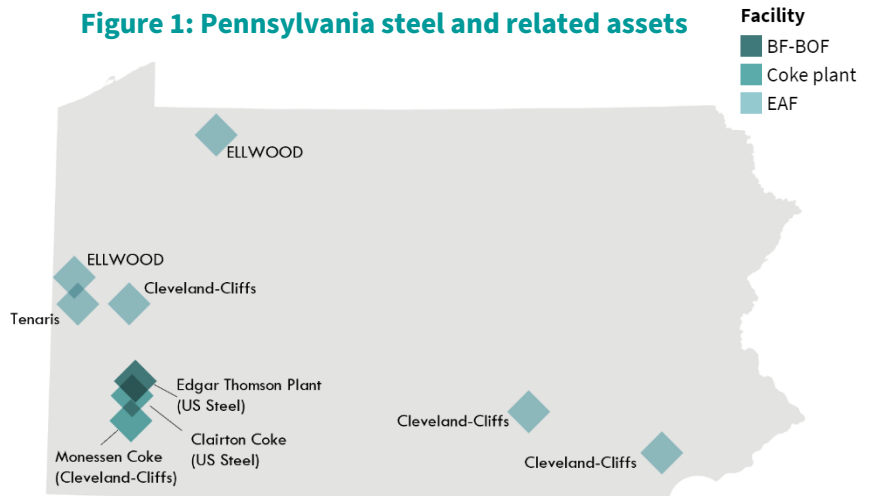


Table 1: Steel supply chain production capacity

| Product | Type | State production capacity (million tons) | Great Lakes production capacity (million tons) |
|-----------------------|---|--|--|
| Raw material | Iron ore pellets* | 0 | 41 |
| Raw material | Coke | 4.6 | 11.6 |
| Intermediate material | Direct reduced iron (DRI) | 0 | 1.9 |
| Steel (recycled) | Electric arc furnace (EAF) | 1.5 | 28 |
| Steel | Blast furnace-basic oxygen furnace (BF-BOF) | 2.9 | 36 |

*State and Great Lakes production capacity reflect production volumes for 2022.

¹ Reline assumption based on 20-year investment cycle and set based on public announcements.

² The Irving and Fairless finishing facilities are not depicted on the map as they do not produce crude steel.

and emissions associated with its value chain and production practices, but gives little specific directive for the industry moving forward. Looking ahead, Pennsylvania has the opportunity to expand and strengthen the 2021 plan with funding from the [Climate Pollution Reduction Grant Program](#). This DOE program will provide funding to the state and three of its largest municipalities (Pittsburgh, Philadelphia, and Allentown) to advance climate-related strategies and planning efforts.

Current issues and impact

In 2023, [3 of the 10 operating coke batteries at Clairton were permanently closed](#). This action stems from a 2021 decision by US Steel to halt a \$1.5 billion investment in Mon Valley Works to improve and expand production efficiency at multiple US Steel facilities. In 2022, Clairton was fined \$9 million for emissions violations across multiple lawsuits and now faces additional pressure as the [latest air quality permit filed with the EPA was rejected](#). The EPA sided with the local air pollution activist groups that brought the claim against US Steel. As a result, the steel manufacturer will have to update its proposal for testing, monitoring, and reporting air emissions, most likely resulting in increased operating costs. In 2019, a fire at the [Clairton facility was responsible for SO₂ emissions spikes](#) five times above the permitted level, leading to an official air quality alert issued by Allegheny County. The EPA is currently updating the [NESHAP standards for both coke and blast furnace facilities](#), but it remains unclear the impact this will have at individual facilities. The proposed updates for cokemaking operations include new fenceline monitoring for benzene, [a pollutant that many in the Mon Valley identify as a health concern](#).

As Figure 1 indicates, automotive manufacturing employment in Pennsylvania has been on the rise over the last decade. Unlike several other states in the region, Pennsylvania's automotive manufacturing employment is dispersed across multiple small facilities rather than at large-scale assembly plants. The downward trend in steel production employment is mostly attributable to US steel indefinitely idling a tubular facility in Lorain while navigating the idling and restarting of blast furnace #3 at Edgar Thomson. In both cases, US Steel blamed imports and demand loss for reducing production capacity. Growth rates for the GDP metrics included in Figure 2 are some of the lowest in the region. Additionally, the percentage share of state GDP coming from durable goods manufacturing (roughly 6%) is the lowest in the region. While Pennsylvania's industrial manufacturing sectors may not be growing as fast as others in the Great Lakes, the extensive incumbent steel industry provides evidence to support continued investment.

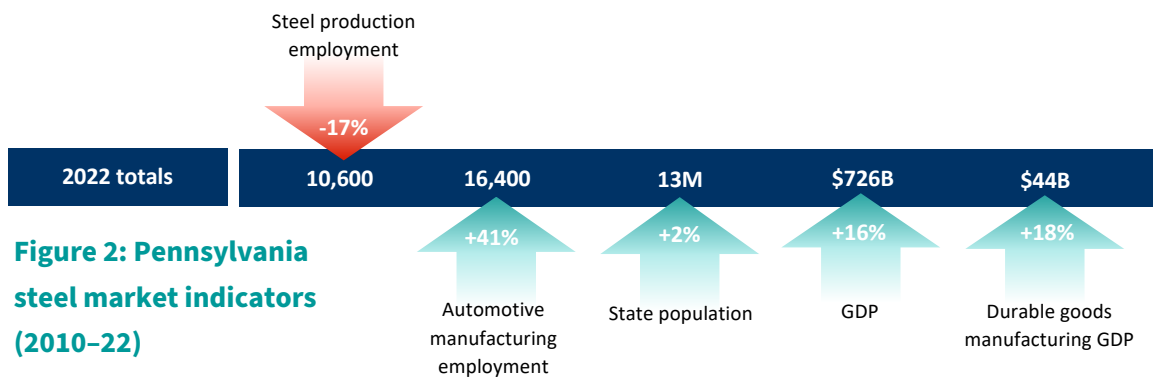


Figure 2: Pennsylvania steel market indicators (2010-22)

Note: GDP metrics are measured in 2012 chained dollars

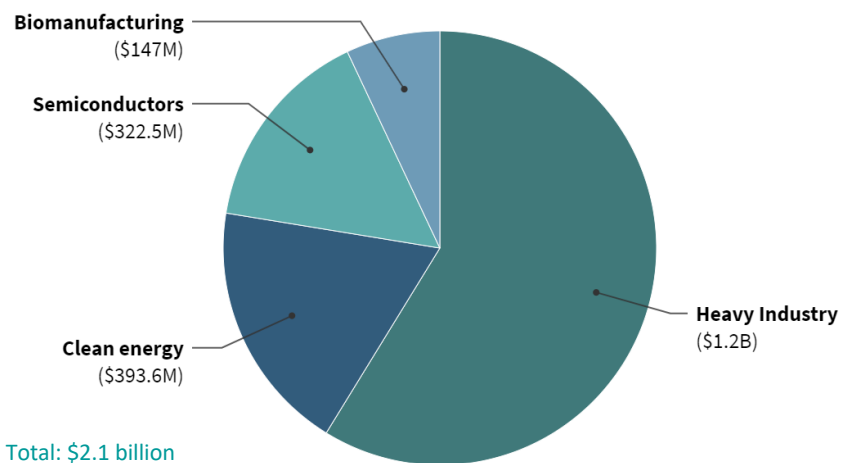
Data source: Bureau of Economic Analysis, United States Census Bureau. United States Regional Economic Analysis Project

Steel Development opportunities in Pennsylvania

In recent years, Pennsylvania has been less successful in attracting private investment in clean manufacturing sectors than other states in the Great Lakes. As shown in Figure 3, \$2.1 billion is tied for the least among states in the region along with Illinois and Minnesota. States such as Ohio and Michigan have secured more than 15 times that level of investment (approximately \$30 billion). Although the total investment pales compared with some others in the region, Pennsylvania leads in attracting clean manufacturing investment in the heavy industry sector. The \$1.2 billion investment represents more than half of the total private investment in heavy industry across the Great Lakes states. The bulk of that investment comes from a [new plastic recycling facility](#) in Northumberland operated by Encina. Although not directly impactful for the steel production value chain, the decision to site the facility in Pennsylvania demonstrates the desire of state and city officials to attract large capital projects that support clean industrial practices.

Large capital investments are necessary to move the Pennsylvania steel industry into a near-zero-emissions future. Some examples of plausible development pathways are listed in Table 2. Of the options listed in Table 2, converting the BF-BOF assets at Edgar Thomson to hydrogen leveraging DRI-EAF production is in many ways the most attractive. It offers the cheapest route toward the highest levels of emissions abatement potential while offering the maximum potential reduction in local environmental pollutants. This type of investment

Figure 3: Post-IRA clean manufacturing investments in Pennsylvania



Data source: Climate Power, US White House.

Note: data sources leverage information from public announcements, investment totals may not be comprehensive

would also help maintain employment levels at the site so long as upstream activities are collocated. Carbon capture and sequestration (CCS) options are viable pathways so long as high capture rates (>90%) are maintained and upstream methane leakage from natural gas and coal operations are accounted for and certified. CCS projects will also require subsurface storage and pipeline infrastructure to be closely monitored and regulated to mitigate leaks and malfunction. For steel producers exploring hydrogen pathways, it is critical to procure hydrogen produced with the lowest possible emissions profile. CCS development at the existing Edgar Thomson facility offers limited abatement potential considering upstream coke production is off-site, and a separate capture system would have to be installed to capture those emissions. To date, no BF-BOF facility globally operates commercial scale CCS systems.

Table 2: Potential near-zero-emissions steel production pathways in Pennsylvania

| Production pathway (2 mt/year) | Investment capital (\$billion) | | Emissions reduction potential | | Projected Timeline (years) |
|--|-----------------------------------|-----|----------------------------------|---------|----------------------------------|
| | H ₂ | CCS | H ₂ | CCS | |
| CCS development at Edgar Thomson | N/A | 1.3 | N/A | 46–59%* | 2 |
| BF-BOF → DRI-EAF asset conversion at Edgar Thomson | 1.9 | 2.1 | 68–86% | 57–79% | 3+ |
| DRI-EAF development at new site | 2.1 | 2.4 | 68–86% | 57–79% | 3+ |

Note: Emissions reduction potential relative to unabated BF-BOF steel production. Emissions reduction potential based on scope 1, 2, and 3 emissions for hot rolled coil production. Range is a product of varying scope 2 emissions from US grid average (0.37 tCO₂/MWh) to dedicated renewable energy, varying pellet-making fuel from natural gas to pyrolysis oil and varying natural gas methane leakage rate from 1.2% to 2.5%. Assumed capture rate for all CCS technology is 90%, conservative estimate yet to be proven at scale. Capital for hydrogen production pathways do not include upstream renewable energy or hydrogen assets.. Classification as near-zero-emissions production is dependent on actual system configuration and realized emissions abatement.

**BF-BOF with CCS range reflects the option of applying capture technology to the Clairton coke battery.*

Local air pollution

Allegheny and other counties in Southwestern Pennsylvania have some of [the worst air quality in the country](#). This issue stems from both a relatively high concentration of industrial and power generation emitters and weather patterns [that frequently create inversions, trapping emitted pollutants near the earth’s surface](#). In 2021, the Allegheny County Health Department authorized a new rule requiring US Steel and other emitters in the country to reduce particulate matter emissions during a forecast inversion. The effects of the new rule are unclear with limited biannual data available for review. Beyond particulate matter, the two coke batteries and BF-BOF facility in Southwestern Pennsylvania are responsible for a considerable portion of the state’s NO_x, SO₂, and hazardous air pollution. [These harmful pollutants can negatively affect community member health](#) in numerous ways, including lung and heart health as well as cancer rates. In 2020, Clairton Coke Works was the third largest emitter of NO_x in the state, ranking behind [two coal-based power generation facilities set to close prior by 2028](#). The Edgar Thomson plant ranked in the top 10 of SO₂ emitters and third among non-coal-based power generation facilities in 2020.³ As poor market economics force more coal power plants in Pennsylvania to shutter, coal-based steel production assets will quickly rise to the top of the emissions rankings for both NO_x and SO₂.

³ 2020 emissions totals for SO₂ and NO_x in Pennsylvania were provided by the Pennsylvania Department of Environmental Protection.

Developing hydrogen and CCS infrastructure

In October 2023, the DOE awarded funding to seven hydrogen hubs across the US as part of [the Regional Clean Hydrogen Hubs Program](#). Pennsylvania was the only state in the country to receive funding for multiple hubs, the Appalachian Hydrogen Hub (ARCH2), and the Mid-Atlantic Hydrogen Hub (MACH2). These hubs were awarded \$925 million and \$750 million, respectively, in potential cost-share funding and span adjacent states such as West Virginia, Ohio, Delaware, and New Jersey. Most hydrogen production proposed in the ARCH2 hub will be derived from natural gas using carbon capture to abate emissions. The MACH2 hub proposed hydrogen production via renewable pathways leveraging wind, solar, or [renewable natural gas](#). While neither hub included any specific indication of hydrogen off-take in the steel sector, the [majority of the ARCH2 hub infrastructure investment in Pennsylvania is slated for the southwestern portion of the state](#) near steel production assets. Collectively, these hubs are projected to create 32,800 construction jobs and 9,400 permanent jobs with the opportunity to expand beyond the inclusions in their initial proposals.

[KeyState Natural Gas Synthesis LLC](#) plans to be the first commercial scale CCS facility in Pennsylvania. The facility will extract natural gas, convert to hydrogen via steam methane reforming, and inject the captured CO₂ back into the subsurface. The facility is located in West Keating Township and expected to begin commercial operations in 2026, sequestering 300,000 tons of CO₂ annually. Underneath most of Pennsylvania, except for the southeastern corner of the state, lies the Appalachia basin, an area [viable for storing CO₂ in various geological formations](#).

Supporting policy

Thus far, major investments in near-zero-emissions steel production in Europe and Canada have received public funding support from national and local governments. The US federal government has provided multiple subsidies and tax incentive programs targeted at near-zero-emissions steel production, but more incentives and infrastructural support from states can expedite asset development. Beyond exploratory initiatives, Pennsylvania has little legislation governing or supporting CCS and hydrogen infrastructure. While the state does have a [joint hydrogen and natural gas procurement tax credit](#) (\$0.81 and \$0.47 per kilogram of each commodity, respectively) available, it comes with no specified emissions threshold and therefore can incentivize emissions-intensive hydrogen production pathways.⁴ In November 2023, a [Pennsylvania court halted efforts by state politicians to join the Regional Greenhouse Gas Initiative](#), a move that would have brought Pennsylvania into a cap and trade program designed to reduce emissions from power production in the state. Access to cost-competitive renewable energy is critical for steel producers seeking to cleanly power existing and new EAFs in addition to hydrogen producers seeking grid-connected electrolysis.

⁴ Pennsylvania HB 1059 indicates hydrogen must be procured from one of the Regional Clean Hydrogen Hubs, but specific regulation of emissions from hydrogen production is not included in the bill. The bill also mandates that the development project must include a \$500 million investment and create 1,200 full time jobs. Blending hydrogen in a BF-BOF would not meet either of these requirements, constructing a DRI-EAF has the potential too.

Figure 4: Great Lakes near-zero-emissions steel policy gap analysis

| Domains | Example Policy Instruments | Federal | MN | WI | MI | IN | IL | OH | PA |
|----------------------------|--------------------------------------|----------|----------|----------|----------|----------|----------|------|----------|
| Strategic Coordination | Technology Roadmaps | Strong | Moderate | Moderate | Moderate | Weak | Moderate | Weak | Moderate |
| Production Instruments | R&D/Jobs/Production Tax Credits | Strong | Weak | Weak | Weak | Weak | Weak | Weak | Weak |
| Demand-Pull Mechanisms | Public Procurement/Product Standards | Strong | Strong | Weak | Weak | Weak | Weak | Weak | Weak |
| Cross-Sectoral Integration | Hydrogen support | Strong | Weak | Weak | Weak | Weak | Weak | Weak | Weak |
| | Clean Electricity support | Strong | Weak | Moderate | Moderate | Moderate | Moderate | Weak | Weak |
| | CCS support | Strong | Weak | Weak | Weak | Moderate | Weak | Weak | Weak |
| | Land availability | Moderate | Moderate | Moderate | Moderate | Weak | Moderate | Weak | Weak |
| | Workforce development | Moderate | Moderate | Moderate | Moderate | Weak | Strong | Weak | Moderate |

Weak
 Moderate
 Strong

Looking forward, Pennsylvania expects to have access to an unprecedented volume of hydrogen, thanks to the multiple federally funded hubs slated for development. Leveraging this resource to reduce coke production and produce near-zero-emissions steel products will help considerably reduce environmental pollution and bolster the long-standing steel industry with multi-billion-dollar capital investments. State politicians and economic development offices can expedite investment by formulating legislation and incentive packages targeting new DRI-based steel production and the infrastructure required to abate emissions (CCS or hydrogen use). Pennsylvania representatives should focus on the following specific areas:

- 1. Leveraging existing BF-BOF facility infrastructure (Edgar Thomson) for new DRI-EAF asset development.**
- 2. Increasing production of hydrogen in the Pennsylvania hydrogen hubs by including new priority sectors such as steel, through long term offtake agreements or additional government de-risking mechanisms.**
- 3. Enticing steel producers to leverage Pennsylvania’s hydrogen procurement tax credit at new DRI facility, which will also help to expand and diversify hydrogen hub offtake.**
- 4. Advancing policies supporting renewable energy generation and integration with specific targets for industrial facilities.**