DEARBORN WORKS

AN INTEGRATED STEEL MILL TRANSITION STUDY

To meet the objectives put forward in the MI Healthy Climate Plan, Michigan needs to help its industrial sector quit pollutant-heavy coal — first, by securing the state's foothold in the emerging clean steel economy.

5lakes energy

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About This Project

Michigan is a recognized leader in the transition toward economy-wide carbon neutrality. But to achieve the objectives put forth in the state's *MI Healthy Climate Plan*, Michigan's emissions-intensive industrial sector needs its own leader, and that proposed leader – Cleveland-Cliffs, owner of the Dearborn Works integrated steel mill – needs its own viable transition plan. Disrupting decades of technological stasis and a precipitous decline in quality steelmaking jobs, breakthrough technology in clean steel produced using 'green' hydrogen is finally here. With Cleveland-Cliffs expected to commit the next round of major investments in Dearborn Works by 2027, to 'reline' the mill's coal-burning blast furnace – potentially locking Michigan into pollution-heavy, carbon-intensive steel production for decades to come – the state has just one opportunity to intervene.

Is clean steel produced using green hydrogen right for Michigan, and the fenceline residents of Dearborn Works? This report provides a thorough presentation of a potential transition plan – including costs, job creation, timeline, environmental and health impacts, and suggestions for co-funding and policy interventions – to educate key decision-makers on the steps needed to advance Michigan toward its healthy climate objectives while securing the state's foothold in the emerging clean steel economy.

About 5 Lakes Energy

5 Lakes Energy is a Michigan-based consultancy supporting nonprofits, businesses, and government agencies in their pursuit of clean energy goals, design and implementation of climate solutions, and delivery of economic, public health, and other benefits to the people they serve.

Acknowledgements

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Executive Summary

Across the Great Lakes Region, integrated steel mills that utilize iron ore for steelmaking still rely on a centuries-old technology: the blast furnace. In Michigan, Dearborn Works is no different. The steel mill's sole blast furnace consumes tremendous amounts of coal products, emitting huge quantities of hazardous air pollutants and greenhouse gases. Combined, Dearborn Works and EES Coke, the steel mill's likely coal products supplier — just two facilities — contribute an estimated 1.3% of Michigan's total carbon dioxide emissions, and both facilities have lengthy records of environmental noncompliance.

In 2027, Dearborn Works is expected to commit an estimated $470 million to 'relining' its blast furnace — an action that would lock Michigan into coal-based primary steelmaking *until the 2040s*. Meanwhile, Europe's steelmaking industry is on the cusp of disruptive, technological change: clean steel produced using an innovative process of solid-state direct reduction, driven by 'green' hydrogen made from water molecules split by renewable electricity. This new technology can slash a steel mill's hazardous emissions and convert its primary exhaust from carbon dioxide to steam. But for America's steel mills to join the emerging clean steel economy — and future-proof their quality union jobs — they first need a plan.

This report presents a comprehensive transition plan for Dearborn Works that lays out all key steps needed to decarbonize the steel mill's operations: first, replacing the mill's blast furnace and basic oxygen furnaces with, respectively, a direct reduction furnace and set of electric arc furnaces at an estimated cost of $1.57 billion; second, electrifying all of the steel mill's finishing operations, and supplying all needed electricity from new solar and wind. In parallel, Michigan needs to identify an owner-operator for a green hydrogen plant (estimated as 1300 MW, costing a minimum of $2.6 billion) and must work with DTE Energy and MISO to construct the new renewables generating, storage, and transmission assets needed to supply the steel mill and hydrogen plant — estimated as a minimum of 2 GW solar and 2 GW wind, as well as battery electric and hydrogen storage needs, depending on hydrogen plant design.

The report further provides a summary of the potential health impacts on workers and fenceline communities and effective approaches for engaging community members in planning, outlines the significant barriers that a Dearborn Works transition is likely to face, and lays out key opportunities for leveraging existing policies, developing strategic public-private partnerships, and financing both of these large-scale projects. The report then concludes with a comprehensive timeline of all major activities and recommendations for the next steps that Michigan should take.

In short, for Michigan to accomplish the objectives declared in its forward-thinking MI Healthy Climate Plan by 2050, it is critical that the state turn its attention to Dearborn Works *today*.

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Introduction to Dearborn Works

Modern-day Dearborn Works operates on the site of a facility that produced its first steel over a century ago, in 1920 (Figure 1). The production capacity and capabilities of the steel mill have fluctuated over time. Originally owned by Ford, the mill expanded along with Ford's market share of automobiles. More recently, the facility has changed hands among several owners, each with their own business priorities. Its second owner, Russian steel manufacturer Severstal, invested $1.2 billion in facility upgrades in the early 2000s before selling Dearborn Works to AK Steel in 2014. Just six years later, Cleveland-Cliffs, a long-time mining company, launched a capital-intensive campaign to rapidly diversify its holdings and build an integrated value chain — purchasing two U.S. steelmakers, including AK Steel. That purchase, in 2020, folded Dearborn Works into the company's business portfolio, and Cleveland-Cliffs remains the facility's owner today.[1]

Figure 1 *The Ford Rouge integrated production complex, originally built by Ford Motor Company so that ore could be brought in and processed into steel, then cars built from that steel — all in one complex. In 1989, Ford sold the steel mill (shown here in 1950). Today, the steel mill is known as Dearborn Works and owned by Cleveland-Cliffs. Credit: Keystone/Getty Hulton Archive*

[1] Breana Noble, Kalea Hall, and Christine Ferretti, "Former Rouge Steel mill closing some operations, throwing more than 200 out of work," Detroit News, May 5, 2020. https://www.detroitnews.com/story/business/2020/05/05/cleveland-cliffs-closing-operations-ak-steel-dearborn-works-plant/3086633001/

STEEL PRODUCTION PROCESSES IN USE AT DEARBORN WORKS TODAY

Dearborn Works relies on a centuries-old technology for crude iron production from mined iron ore: the blast furnace (Figure 2). The crude iron output of Dearborn's sole blast furnace is then refined into crude steel in either of two basic oxygen furnaces. Next, the hot, liquid crude steel is tailored into specialty steel compositions in two ladle metallurgy furnaces, before passing to a set of slab casters. See [GET THE FACTS: How is steel made?]

The facility (Figure 3) also houses a pickling line tandem cold mill and a hot-dipped galvanizing line, both of which process steel slabs into finished steel products. Dearborn Works' hot strip mill and annealing and tempering operations have been idled since 2020,[2] originally due in part to decreased demand during the COVID-19 pandemic. Cleveland-Cliffs has stated no plans to bring this portion of the facility's operations back online.

Figure 2 *Dearborn Works relies on one blast furnace for the production of iron metal from iron ore in a process that consumes large quantities of the pollutant-heavy refined coal product coke. Credit: Clear the Air*

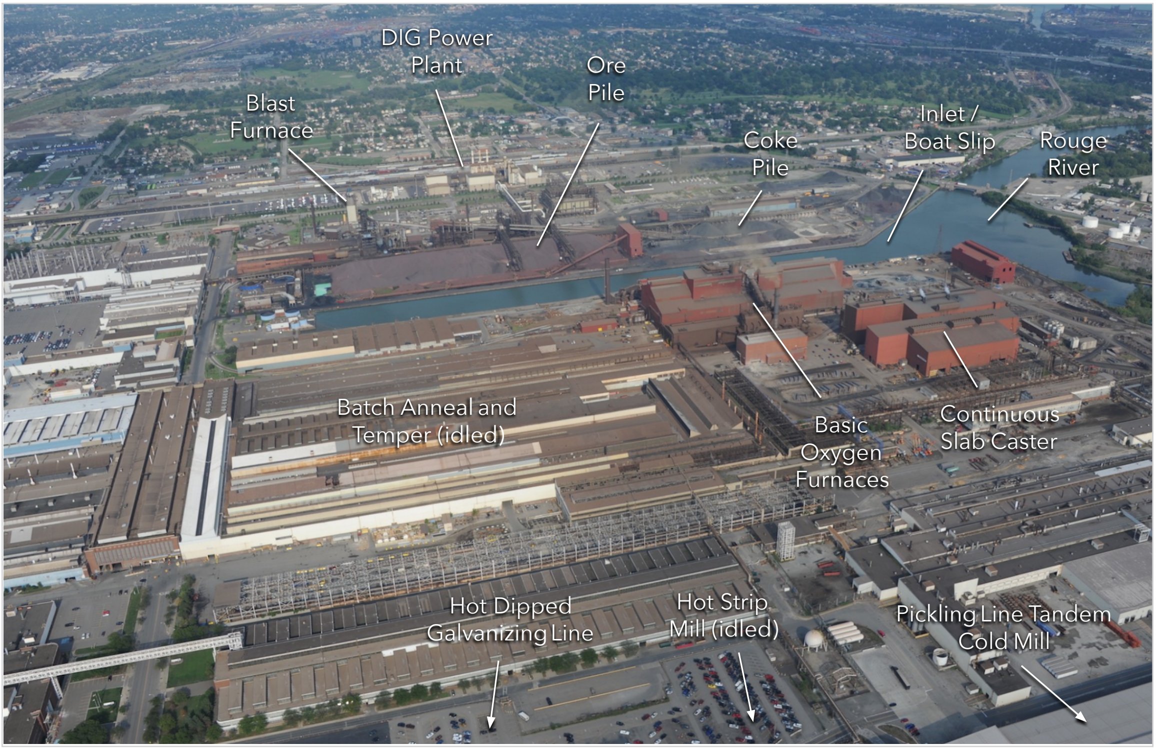


Figure 3 *An aerial view of modern-day Dearborn Works, looking Eastward. The facility's hot dipped galvanizing line, hot strip mill, and pickling line tandem cold mill are out-of-frame on the West side of the facility. A portion of the land in the image foreground belongs to Ford. Credit: CLUI*

[2] "Dearborn Works," Cleveland-Cliffs, accessed August 2024. https://www.clevelandcliffs.com/operations/steelmaking/dearborn-works

How is steel made?

Steel made from iron ore continues to be in high demand for the U.S. automotive industry and construction sectors because of their need for higher grade steels, less commonly achieved from steel scrap recycling. Most of the iron ore consumed in the United States is mined in Minnesota and the upper peninsula of Michigan, then shipped by boat in a pellet form to ‘primary steel’ manufacturers in states throughout the Great Lakes Region.

Primary steel manufacturers use conveyor systems to load the iron ore pellets into a multi-story furnace known as a ‘blast furnace.’ In the gravity-fed furnace, the ore pellets are heated and chemically reacted with a refined coal product known as ‘coke,’ fluxing agents like limestone and dolomite, and recycled hot exhaust gases that contain large quantities of carbon monoxide, which is combustible. The gases are injected through ports called tuyeres, giving rise to a cyclone-like effect inside the furnace. The carbon in the coke chemically reduces the iron ore by stripping off the oxygen atoms – producing liquid iron metal rich in dissolved carbon (known as ‘crude iron’) and large quantities of carbon dioxide gas, dust, and other pollutants. Much of the dissolved carbon must be removed to convert the crude iron into useful steel, which has a lower carbon content than 'cast iron' products.

The dust created by this process includes large volumes of particulate matter, which can be particularly hazardous when inhaled due to its fine nature and the inclusion of various metal and other health-harming compounds. As a result, blast furnaces require a series of pollution controls to reduce the dust volumes and other pollutants in their exhaust gas before it can be released into the atmosphere.

Sometimes the volume of combustible exhaust gas builds up faster than the blast furnace can receive it. While some steel mills ‘flare’ this gas by burning it on-site, in the case of Dearborn Works, the excess exhaust gas is piped across the road to the Dearborn Industrial Generation power plant. The power plant burns the excess exhaust gas, in combination with natural gas, to produce electricity.

After the crude iron has been tapped from the blast furnace, it is fed into a basic oxygen furnace, in which lances inject concentrated oxygen into the liquid metal. The oxygen chemically reacts with the dissolved carbon, giving off additional carbon dioxide while reducing the carbon content of the iron to a satisfactory level for steel production. Further chemical tailoring can be carried out in ladle metallurgy furnaces before the refined steel product is transferred to other steel finishing operations within the complex.

In both of these furnace-based operations, fluxing agent additions help to separate impurities of silica and alumina from the desired liquid metal. Those impurities float to the top of the molten metal, forming a layer known as ‘slag.’ The slag is separated from the molten metal and allowed to cool into a solid byproduct. In many cases, the slag is suitable for use in the cement industry as a substitute for cement made from limestone.

The last step in steel production at an integrated mill is casting of the liquid steel into solid steel slabs, which are then subjected to a range of finishing operations to produce the mill’s semi-finished and finished steel products.

IMPACT OF CURRENT OPERATIONS ON THE ENVIRONMENT AND LOCAL COMMUNITY

Blast furnace-based production of crude iron is a highly coal-dependent process that emits large quantities of greenhouse gases and carbon monoxide, among other hazardous pollutants. Because blast furnaces are designed to melt iron ore for processing into iron metal, they are operated at extremely high temperatures (up to 3000°F, depending on the 'zone' inside the furnace). Injections of hot gas are used to create vortices and stir the molten matter, as the hot constituents chemically react. This process generates tremendous volumes of coarse (also known as PM10) and fine (PM2.5) dust, much of which is drawn into the furnace's exhaust system. Dust capture systems remove large fractions of dust from the exhaust, but even with the best available current technology (BACT), blast furnaces emit thousands of tons of oxide-, metal-, and coal-containing dust each year — among many other U.S. Environmental Protection Agency (EPA)-defined criteria air pollutants (CAPs), like sulfur dioxide (SO_2) and nitrogen oxides (NOx), and hazardous air pollutants (HAPs), like hydrochloric acid. All of these compounds can contaminate the air that residents of fenceline communities breathe, which is why the exhaust from steel mills is regulated by airborne emission permits in accordance with Clean Air Act standards set by the U.S. EPA.

Despite the facility upgrades bankrolled by Severstal in the early 2000s, Dearborn Works and nearby EES Coke, which is the likely supplier of the processed coal known as 'coke,' that the steel mill's blast furnace relies on for crude iron production, have faced numerous lawsuits and fines for violations of the Clean Air Act within just the last decade (see *GET THE FACTS: Dearborn Works has a poor track record with the U.S. EPA*). EPA's records also show a history of repeatedly failed emissions

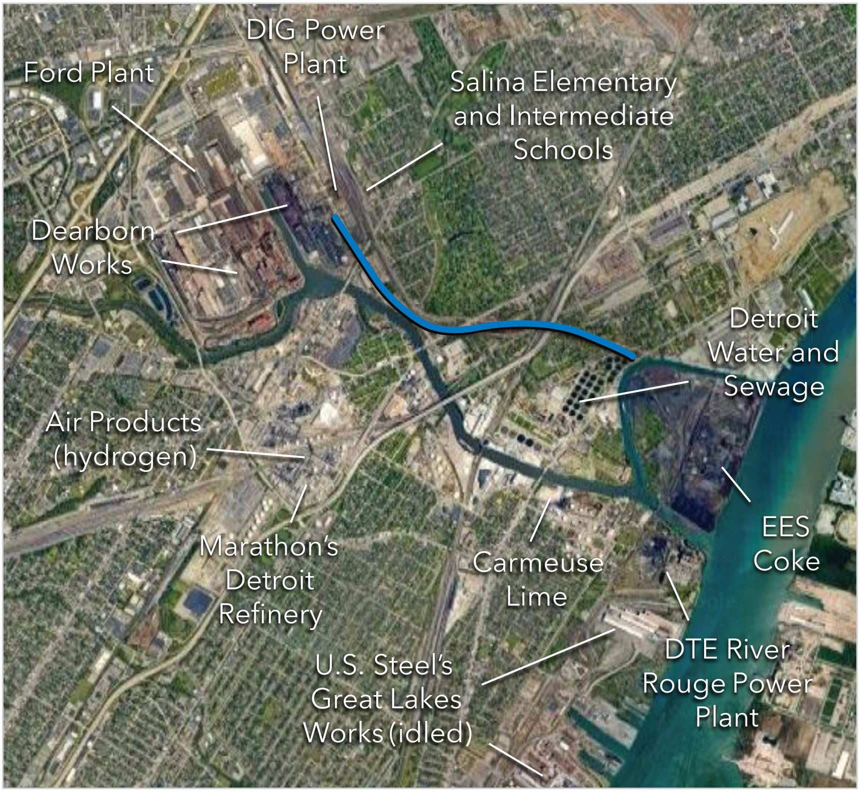


Figure 4 *The Dearborn industrial corridor. Dearborn Works, the DIG power plant, and the Ford plant all share a common water intake system; the approximate path of the underground intake tunnel is indicated by the blue line. EES Coke and Carmeuse Lime are likely sources of coke and fluxing agents, respectively. Dearborn Works, Carmeuse Lime, and EES Coke all exhaust coal combustion products Air Products produces 'gray' hydrogen for Marathon's Detroit Refinery using steam methane reforming. Credit: Google Maps (2024)*

Figure 5. *The exhaust stacks of the DIG power plant, immediately behind the Salina Elementary playground. The exhaust of the steel mill's blast furnace is just visible behind the green canopy, to the right of DIG (blue arrow). Credit: Aaron J. Thornton*

monitoring tests of the facility's exhaust systems, regular reports of deviations from permitted allowances of pollutants, and a marked increase in surface water discharges of toxic compounds within the past few years (the latter being regulated under the Clean Water Act).[3] In 2023, following a U.S. EPA mandate and years of costly litigation, Cleveland-Cliffs began upgrading the air pollution control system tied to Dearborn Works' basic oxygen furnaces – at a cost of $100 million.

Shortly thereafter, in early 2024, the City of Dearborn installed and activated a series of air quality monitors, to track levels of particulates and nitrogen dioxide (NO_2), both of which are associated with heavy industry and heavy fleet traffic. By February, some monitors had already reported unhealthy air quality[4] – underscoring the need for broad-scale action to further limit industrial air pollution in what has become known as the 'Dearborn industrial corridor' (Figure 4). That corridor includes EES Coke, Marathon's Detroit Refinery, Ford's Dearborn plant, a rail yard containing nearly 40 parallel sets of tracks, NorthStar Clean Energy's Dearborn Industrial Generation power plant, and a range of other industrial facilities.

Workers and residents of fenceline communities – especially children – suffer the brunt of the violations tallied by Dearborn Works and EES Coke and the cumulative impacts of industrial airborne emissions associated with activities throughout the industrial corridor (see *GET THE FACTS: Pollution from Dearborn Works disproportionately impacts some of Michigan's most vulnerable: Children and EJ communities*). More than 800 children attend the Salina Elementary and Intermediate schools less than half a mile from the highest-polluting part of the Dearborn Works steel complex: its sole blast furnace, known as 'C3.' At recess, the children who attend Salina Elementary step outside to a playground that overlooks the rail yard, the Dearborn Industrial Generation power plant, and the eastern side of the steel mill's operations (Figure 5). In the span of a single year, Dearborn Works alone can pump over 450 tons[5] of health-harming dust (PM10 and PM2.5 particulate matter) into the air those children, their families, and the many other residents of the Dearborn industrial corridor breathe. See *GET THE FACTS: A look at the air pollution associated with Dearborn Works*.

450
TONS OF PM10 & PM2.5 PER YEAR

[3] U.S. EPA Enforcement and Compliance History Online (ECHO) detailed facility report for Facility ID 110060497001, accessed August 2024. https://echo.epa.gov/

[4] Carol Thompson, "Air quality monitors installed in Dearborn to track pollution," Detroit News, February 20, 2024. https://www.detroitnews.com/story/news/local/wayne-county/2024/02/20/air-quality-monitors-installed-in-dearborn-to-track-pollution/72659773007/

[5] A note on units: In general, this report uses U.S. customary units, which include the 'short ton,' typically known as the 'ton.' Values extracted from data sources specified in metric tons, also known as 'tonnes,' have been converted to short tons. In some cases, both figures are provided. The only exception is the unit Mtpa (million tonnes per annum); although this is a metric unit, because it is broadly familiar with many in the industry, it will still be used here.

GET THE FACTS

Dearborn Works has a poor track record with the U.S. EPA

Dearborn Works has a long – and costly – history of environmental noncompliance in Michigan. For example:

- The state has issued 18 notices for violations of the Clean Air Act and 3 for violations of the Clean Water Act in the past five years alone.

In the past 5 years alone, the state has issued Dearborn Works:

18	3
NOTICES FOR VIOLATIONS OF THE CLEAN AIR ACT	NOTICES FOR VIOLATIONS OF THE CLEAN WATER ACT

- A 2015 complaint filed against Dearborn Works' then-owner AK Steel alleged major violations of the Clean Air Act associated, primarily, with the basic oxygen furnace's operations, amounting to a federal fine of $757,943 and a state penalty of $676,563.
- In a 2023 modification to that 2015 consent decree, Cleveland-Cliffs was fined a further $81,380 by the state of Michigan for continued Clean Air Act violations, including thousands of short-term events in which the facility exceeded its air permit limits for exhaust opacity (visible emissions), as well as additional violations of its manganese and lead emissions limits.
- In the settlement, Cleveland-Cliffs further agreed to install a new air pollution capture system in association with its basic oxygen furnaces at an estimated cost of $100 million, as well as to fund the installation of home air purifying systems in more than 1,000 nearby residences at an estimated cost of $244,000.
- However, Dearborn Works continues to tabulate violations of the Clean Air Act and the Clean Water Act, with air violations recorded in 4 of the facility's most recent 12 operating quarters (3 years), and water violations in 8 of the most recent 12 operating quarters.

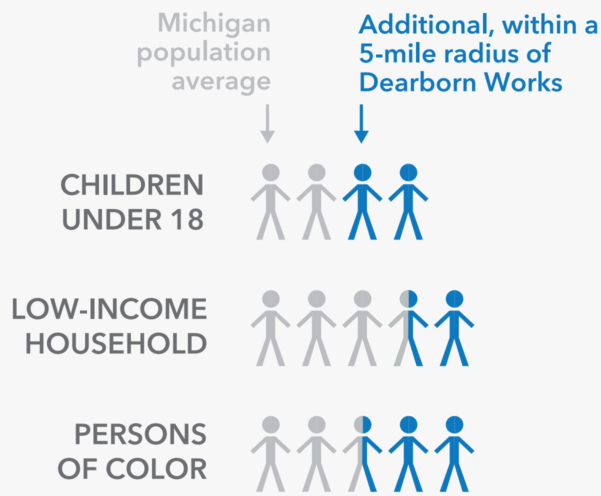
GET THE FACTS

Pollution from Dearborn Works disproportionately impacts some of Michigan's most vulnerable: Children and EJ communities

Children are especially sensitive to many air pollutants, which can cause respiratory and other ailments that can continue to impact an individual throughout their life or lead to health problems later in life. Environmental justice (EJ) communities are neighborhoods that are disproportionately burdened by pollution, and as a result, may have a lower quality of life due to the impacts of that pollution. Children constitute a much larger fraction of the population in the Dearborn industrial corridor than in Michigan on average, while EJ communities in the region are disproportionately constituted by persons of color and individuals with limited education attainment and household income.

Specifically, according to U.S. Census Bureau data (via U.S. EPA ECHO), within a 5-mile radius of Dearborn Works:[6]

- Roughly 2 in 5 residents are under the age of 18 (compared to just 1 in 5 statewide), with nearly 1 in 10 being a child age 5 or younger.



- At least half of the area's 312,000 residents are low income (compared to just one-third statewide), living on less than $50,000 per year in household earnings.
- Fewer than 2 in 5 adults aged 25 and older have any college-level training, while more than 1 in 5 adults have no high school diploma.
- Half of the area's population is a person of color (compared to just one-quarter statewide), with 3 in 10 residents identifying as African-American and nearly 2 in 10 residents identifying as Hispanic.

These families and their children deserve every opportunity to live healthy, prosperous lives – and that opportunity begins with a pollution-slashing transition plan for Dearborn Works.

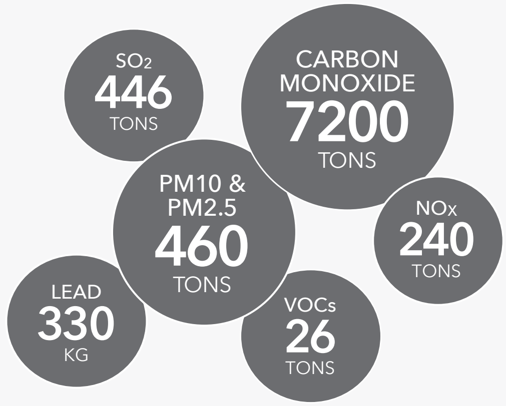
[6] U.S. EPA Enforcement and Compliance History Online (ECHO) detailed facility report for Facility ID 110060497001, accessed August 2024. https://echo.epa.gov/

GET THE FACTS

A look at the air pollution associated with Dearborn Works

Air pollution from industrial facilities is classified into several categories: criteria air pollutants (CAPs), which are constituted by six common hazardous air pollutants with identified acceptable exposure limits; hazardous air pollutants (HAPs) known to cause cancer or other health concerns; and greenhouse gases (GHGs) which contribute to warming effects in our climate.

Dearborn Works produces a tremendous volume of these various airborne pollutants during routine operations. For example:[7]



- In 2020, Dearborn Works pumped roughly 460 tons of particulate matter (CAP, including coarse and fine dust, known as PM10 and PM2.5) into the air around the facility.
- That same year, the facility also exhausted 7200 tons of carbon monoxide (CO; CAP), 240 tons of nitrogen oxides (NOx; CAP), 446 tons of sulfur dioxide (SO_2; CAP), nearly 26 tons of volatile organic compounds (VOCs; CAP), 100 kg of chromium compounds (HAP), and 380 kg of lead compounds (HAP).
- According to EPA, Dearborn Works operates in ozone and sulfur dioxide air quality 'nonattainment' areas, meaning that both of these criteria air pollutants exist at persistently high levels, in excess of the exposure limits established in the National Ambient Air Quality Standards.

PRODUCTION CAPACITY AND ECONOMIC IMPACT OF DEARBORN WORKS

Dearborn Works has the capacity to produce 2.5 million tonnes per annum (Mtpa; 2.8 million tons) of crude iron from one blast furnace ('C3') and 3 Mtpa (3.3 million tons) of crude steel from two basic oxygen furnaces.[8] That crude steel is further processed into semi-finished and finished rolled steel products that include carbon semi-finished slabs, hot dip galvanized steel (a source of zinc pollution in discharged water), and advanced high-strength steel. The majority of these steel products find their end uses in the automotive and building and infrastructure construction industries, with a minor amount of Dearborn's steel supplied to the steel packaging and tools and machinery industries.[9] This profile is consistent with the company's overall steel sales, with the American automotive industry being the largest purchaser, primarily for light-duty (passenger) vehicle production.

Dearborn Works is a major contributor to the region's economy, indirectly through tax revenue and directly through jobs. In 2022, Dearborn Works reportedly produced 1.6 Mtpa (1.8 million tons) of crude iron and 2.2 Mtpa (2.4 million tons) of crude steel (a value that includes additions of recycled scrap to refined crude iron produced on site). Despite market volatility throughout

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[7] U.S. EPA online 2020 NEI Data Retrieval Tool, accessed August 2024. https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data

[8] "Cleveland-Cliffs Dearborn Steel Plant," Global Energy Monitor (GEM) Wiki, accessed August 2024. https://www.gem.wiki/Cleveland-Cliffs_Dearborn_steel_plant

[9] 2023 Annual Report to Security Holders, Cleveland-Cliffs, April 3, 2024. https://www.clevelandcliffs.com/investors/sec-filings

that year,[10] Cleveland-Cliffs reported record revenue ($22.9 billion) and an average sale price of $1360 per ton of steel product[11] — meaning that sales from Dearborn Works alone contributed an estimated $3.3 billion to the company's revenue stream in 2022. In Michigan, large corporate entities, including industrial manufacturers, are subject to a 6% corporate income tax. While the company's SEC filings do not specify income tax paid to each state, its public 10-K states that the corporation paid $71 million in net state taxes in 2022.[12] Proportionally based on estimated production volume by facility, Cleveland-Cliffs paid an estimated $10 million in income tax to the state of Michigan.

Furthermore, the mill complex directly supports the Dearborn region by employing about 1500 workers (1200 union — United Auto Workers [UAW] Local 600[13]), although permanent idling of a portion of the facility's complex in 2020 saw a reported loss of 211 jobs.[14] As is typical for steel mills, many of these jobs require specialized skills in metal-related trades.

FY 2022

$22.9 BILLION	$3.3 BILLION
CLEVELAND-CLIFFS REVENUE	DEARBORN WORKS (ESTIMATED)

CONNECTIONS BETWEEN DEARBORN WORKS AND MICHIGAN'S INDUSTRIAL ECOSYSTEM

Dearborn Works is deeply interconnected with Michigan's broader industrial ecosystem through its supply chain, customers, energy needs, and waste handling needs — including physical interconnections to other industrial facilities and shared environmental permits.

Production of steel from iron ore with blast furnace technology requires a suite of raw materials. Although the details of Dearborn Works' supply chain are not public, likely sources include Cleveland-Cliffs-owned Tilden Mine[15] in the upper peninsula of Michigan (blast furnace-grade iron ore pellets), Carmeuse Lime's nearby River Rouge site (limestone and dolomite), and EES Coke on Zug Island (coke and coal products), located just a few miles down the Rouge river. Combustion of coal products during blast furnace-based crude iron production supplies the majority of the facility's heat needs, with natural gas purchased from DTE Energy providing the balance for other portions of the steel mill's production systems, like its finishing operations.

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[10] "What's happening with the steel market in 2022?," Metallic Building Systems, accessed August 2024. https://www.metallic.com/news-item/market-update-2/

[11] 2022 Annual Report to Security Holders, Cleveland-Cliffs, April 3, 2023. https://www.clevelandcliffs.com/investors/sec-filings

[12] 2022 10-K Annual Report, Cleveland-Cliffs, February 14, 2023. https://www.clevelandcliffs.com/investors/sec-filings

[13] Dearborn Works chapter webpage, UAW Local 600. https://uawlocal600.org/?page_id=57

[14] Breana Noble, Kalea Hall, and Christine Ferretti, "Former Rouge Steel mill closing some operations, throwing more than 200 out of work," Detroit News, May 5, 2020. https://www.detroitnews.com/story/business/2020/05/05/cleveland-cliffs-closing-operations-ak-steel-dearborn-works-plant/3086633001/

[15] Nick Yavorsky, Chathurika Gamage, Kaitlyn Ramirez, and Maeve Masterson, "Great Lakes Near-Zero-Emissions Steel. Memo Focus: Michigan," RMI, accessed August 2024. https://rmi.org/wp-content/uploads/dlm_uploads/2024/02/MI_steel_memo.pdf

DTE Energy Services is the parent company of EES Coke.[16] The 85-oven coke battery can produce an estimated 1 million tons of blast furnace-grade coke per year, using an emissions-intensive process that creates a range of coal-derived byproducts. While details indicate Cleveland-Cliffs is likely EES Coke's largest customer, the battery's customer portfolio includes a suite of other industrial producers in iron and steel (ArcelorMittal Dofasco, Algoma Steel, E.J. Bognar, United States Steel), energy (Citgo Petroleum, Mid-Continent Coal & Coke, Lone Star Specialties), and chemicals (Rain CII Carbon). The facility and its parent company, DTE Energy, have been the target of ongoing litigation as a result of years of persistently high quantities of sulfur dioxide in exhaust emissions from the coke battery, in violation of legal requirements for air pollution controls under the Clean Air Act. The U.S. EPA originally brought the suit in June 2022.[17]

The production of steel from ore generates large quantities of a solid byproduct known as 'slag.' Dearborn Works contracts with Edw. C. Levy Co. for slag recovery and processing, which converts the steel mill's solid byproduct into a cementitious material for use in the concrete industry. While Levy Co. has worked with Cleveland-Cliffs in recent years to implement a new slag cooling process designed to reduce dust generation at Dearborn Works,[18] issues with slag production and handling reportedly continue to contribute to poor air quality throughout the vicinity. Since 2018, the Levy Co. facility that contracts with Dearborn Works has been the recipient of 16 violation notices related to air quality, making it one of the most frequent violators of air quality permits for major emitters in the Detroit metro area.[19]

The Dearborn Works complex is physically interconnected with the 770-MW Dearborn Industrial Generation (DIG) natural gas and industrial waste gas cogeneration power plant,[20] and to both DIG and a portion of Ford's production operations through a shared cooling water intake system.[21] The DIG power plant, owned by NorthStar Clean Energy, was initially constructed to power Ford's nearby production complex (Dearborn Works was once part of the Ford complex). After various upgrades, today the natural gas-burning power plant also offtakes waste industrial gas from Dearborn Works, to reduce flaring (on-site combustion of steel mill exhaust gases) from the mill. These industrial gases are pumped to DIG via a large-diameter pipe that runs above Miller Road, while the facility's shared water intake system draws fresh water from Rouge River, through an intake near Zug Island, using a 15-foot-diameter, gravity-fed tunnel that traces a 2.3-mile course along Dearborn Street.

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[16] "EES Coke Battery," DTE Energy Services, accessed August 2024. https://dtevantage.com/project/ees-coke/

[17] Timna Axel and Edward Smith, "Federal Judge Names DTE a Defendant in SW Detroit Pollution Case," Earthjustice, May 21, 2024. https://earthjustice.org/press/2024/federal-judge-names-dte-a-defendant-in-sw-detroit-pollution-case

[18] "Reducing our footprint: improved slag processing at Dearborn Works," Cleveland-Cliffs, accessed August 2024. https://www.clevelandcliffs.com/sustainability/environment/reducing-our-footprint-improved-slag-processing-at-dearborn-works

[19] Planet Detroit's Air Permit Violations Dashboard, accessed August 2024. https://planet-detroit.github.io/air-permit-violation-dashboard

[20] "Dearborn Industrial Generation," NorthStar Clean Energy, accessed August 2024. https://northstarcleanenergy.com/projects/dearborn-industrial-generation/default.aspx

[21] NPDES Permit No. MI0043524, accessed via the Michigan Department of Environment, Great Lakes, and Energy (EGLE)'s MiEnviro Portal, August 2024. https://www.michigan.gov/egle/maps-data/mienviroportal

Pathways to Clean Steel Production at Dearborn Works

Clean steel production is about more than slashing greenhouse gas emissions — it also offers a path to cut health-harming industrial pollution, support a robust steel economy, and future-proof quality steel jobs, including the union jobs that form the backbone of every proud steel community. While there are multiple possible paths to curb a facility's pollution and reduce the embodied carbon of its steel products, for Dearborn Works there is just one path that can bring *the cleanest steel production process*, while imparting net-positive ripple effects across Michigan's economy and workforce.

That path involves several critical shifts in the ecosystem of steel production that supports Dearborn Works. On-site at the steel mill, the coal-consuming blast furnace must be swapped for a 'green' hydrogen-fed direct reduction furnace, while the two basic oxygen furnaces must be replaced with clean electricity-powered electric arc furnaces (see *GET THE FACTS: The role of hydrogen and renewable energy in the production of clean steel*). Other critical elements of this transition plan include: additional facility-level changes, upgrades to Tilden Mine's ore pelleting operations, major additions of solar, wind, and battery installations to Michigan's electric grid, and the construction of an electricity-powered hydrogen production plant, possibly located on-site at Dearborn Works or nearby on a recommissioned industrial site, such as the existing EES Coke plant or idled Great Lakes Works steel mill.

The associated costs, workforce impacts, and land, water, and electricity needs, among other factors, are outlined below for each critical element of this transition plan. Anticipated reductions to the pollution burden faced by Dearborn area communities are discussed in the following section, *Benefits to Health and the Environment*.

GET THE FACTS

The role of hydrogen and renewable energy in the production of clean steel

Figure 6 *Because HYBRIT's direct reduction furnace is designed to produce fossil fuel-free iron, the facility will have a trivial greenhouse gas footprint and significantly cleaner exhaust compared to the American integrated mill fleet. Credit: www.hybritdevelopment.se*

Hydrogen has a similar ability to chemically reduce iron ore into iron metal as the carbon in refined coal (coke). In the case of hydrogen, the gaseous molecule strips the oxygen atoms out of the iron ore, yielding solid iron metal as the oxygen and hydrogen chemically recombine to make water vapor. This process is carried out in a specialized piece of equipment known as a 'direct reduction furnace.' Like a blast furnace, the direct reduction furnace is gravity-fed with iron ore pellets and reactive gases are injected through ports. Unlike a blast furnace, the direct reduction furnace is operated at much lower temperatures (roughly half the temperature of a blast furnace) — and significantly below the melting temperature of iron ore and iron metal. As a result, the direct reduction furnace generates significantly less particulate matter and other volatile compounds, meaning its air pollution control system functions more effectively. The major exhaust from a direct reduction furnace is water vapor, followed by comparatively lower quantities of all other criteria and hazardous air pollutants (CAPs and HAPs) relative to a typical blast furnace, per ton of product. Steel made from iron produced with hydrogen-based direct reduction (in the solid state, without melting) is known as either 'clean steel' or 'green steel.' SSAB's HYBRIT mill under construction in Sweden is an example facility (Figure 6).

Some steel mills — including Cleveland-Cliffs' Indiana Harbor integrated mill in northwestern Indiana — have experimented with hydrogen injection into blast furnaces, which can achieve marginal reductions in carbon dioxide emissions. Importantly, despite public statements by the company's CEO Lourenco Goncalves that hydrogen injection into blast furnaces during operation is a "cutting edge technology to decarbonize" iron production,[22] this processing method is not considered effective for producing clean steel by the majority of advocates in the field, because only small fractions of coke can be displaced by hydrogen injection, and no impact on air pollution has been demonstrated.

In the case of direct reduced iron, for the crude iron product to be truly 'clean' or 'green,' the hydrogen used in its production must be made using renewable resources, like solar or wind energy. This is possible when renewable energy is used to power a water electrolysis plant. In that plant, the electricity splits water molecules into highly pure oxygen and hydrogen, which are collected separately. The oxygen can be sold or vented to the atmosphere, while the hydrogen is captured and stored, then transferred to the mill for iron production.

A few other features are necessary to produce the cleanest, most sustainable steel. First, the hydrogen must be heated before it is injected into the direct reduction furnace. If electricity is used for heating, it must come from additional renewable energy sources. Second, the basic oxygen furnace used to process the crude iron into crude steel is commonly swapped for an electric arc furnace. While electric arc furnace technology is used in countries across the world, most such furnaces today rely on natural gas for a portion of their heating needs. In contrast, for clean steel, the melting operation carried out in the electric arc furnace must be fuel-free and entirely powered by renewable electricity. Finally, in an ideal scenario, the heat needed for finishing operations at an integrated steel mill would be supplied from renewable electricity, not natural gas.

CLEAN STEEL PRODUCTION AT DEARBORN WORKS: A VISION FOR THE FUTURE

'Clean steel' — also known as 'green steel' — is steel produced without fossil fuels, using a production process that dramatically reduces health-harming pollution. The blast furnace-basic oxygen furnace (BF-BOF) production process yields steel with a footprint, on average, of about 2 tons of CO_2 per ton of crude steel product. Cleveland-Cliffs' 2023 sustainability report[23] indicates that steel produced by the company's integrated mill fleet evolves slightly lower emissions, at just 1.70 tons (1.54 metric tons) of CO_2e[24] per ton of steel product. The vast majority of carbon dioxide evolved during integrated steel production is associated with coke — a coal-derived fuel that emits large quantities of pollutants

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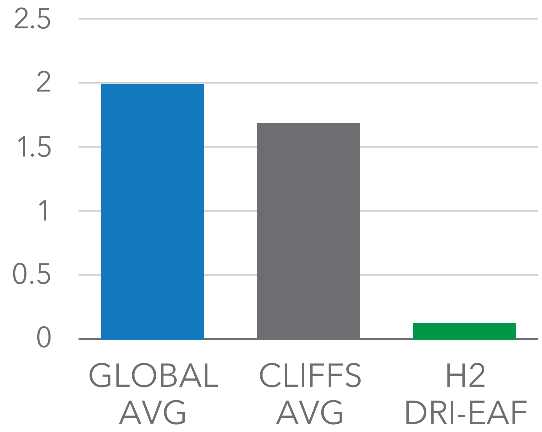
[22] "Cleveland-Cliffs Completes Successful Blast Furnace Hydrogen Injection Trial at Indiana Harbor #7 Blast Furnace," Cleveland-Cliffs, January 26, 2024. https://www.clevelandcliffs.com/news/news-releases/detail/620/cleveland-cliffs-completes-successful-blast-furnace

[23] "Sustainability Report 2023," Cleveland-Cliffs, accessed August 2024. https://www.clevelandcliffs.com/sustainability

[24] Carbon dioxide (CO_2) and carbon dioxide equivalent (CO_2e) values are related, but not always the same. Typically, CO_2e is used to indicate that climate warming potential-equivalence of another greenhouse gas, such as methane, has been combined with that of CO_2 to give a total CO_2e value for a given process or industry based on the various gases that it emits. In this case, while Cleveland-Cliffs has expressed the emissions associated with crude steel production through BF-BOF processes in units of CO_2e, in reality nearly all of those emissions are, in fact, CO_2, with very little coming from methane or other greenhouse gases that evolve during coke and gaseous product combustion. Thus, in this case, comparing the CO_2e value reported by Cleveland-Cliffs against a typical CO_2 value for the average crude steel product is reasonable.

as it reacts with the iron ore and/or burns. In comparison, models have demonstrated that crude steel produced using a green hydrogen-fed direct reduction furnace paired with an electric arc furnace (hydrogen DRI-EAF) – in a process that virtually eliminates the need for fossil fuels – can have an embodied carbon value of just 0.12 tons of CO_2 per ton of crude steel.[25] Thus, such a process shift could yield a reduction in CO_2 emissions of more than 90% for the crude steel produced at Dearborn Works. Moreover, installing a direct reduction furnace in place of a blast furnace would also slash health-harming pollution, because the direct reduction furnace processes iron ore into crude iron in the solid state, without any melting. The anticipated changes to the complex's pollution profile, in the context of worker and community health impacts, are described below in *Benefits to Health and the Environment*.

CO_2 FOOTPRINT in TONS per TON of CRUDE STEEL PRODUCT



To further ensure that the steel produced at Dearborn Works using the new production process is as clean and sustainable as possible, the following are necessary:

- Ensure all needed hydrogen is sourced as 'green' hydrogen.
- Electrify all associated crude steel production steps, like hydrogen preheating.
- Electrify all on-site steel finishing operations, such as galvanizing treatments.
- Ensure all electricity needed to power these operations is supplied by new solar and wind farms and battery storage built into Michigan's electrical grid.

> *Installing a direct reduction furnace in place of the blast furnace at Dearborn Works would slash health-harming pollution, because the direct reduction furnace processes iron ore into crude iron in the solid state, without any melting.*

Moreover, because Dearborn Works is physically tied into the nearby Dearborn Industrial Generation (DIG) power plant and Ford manufacturing complex, this type of transition would require physical retrofits to DIG's exhaust gas intake system and the entire complex's cooling water intake system. As a result, this transition plan offers an additional opportunity to retrofit the portion of Dearborn Works' wastewater treatment system associated with crude iron and crude steel production, by upgrading to ultrapurification. The use of ultrapurification for waste water processing in a steel mill can significantly reduce the facility's water usage and minimize the discharge of metals and other toxic compounds, in this case, into the Rouge River, which flows into the Detroit River and ultimately into Lake Erie.

[25] Sa Ge et al., "A Low-Carbon Emission Flowsheet for BF-Grade Iron Ore Using Advanced Electric Smelting Furnace," Proceedings of the Iron and Steel Technology Conference 2023.

TRANSITION PROFILES OF KEY ASSETS

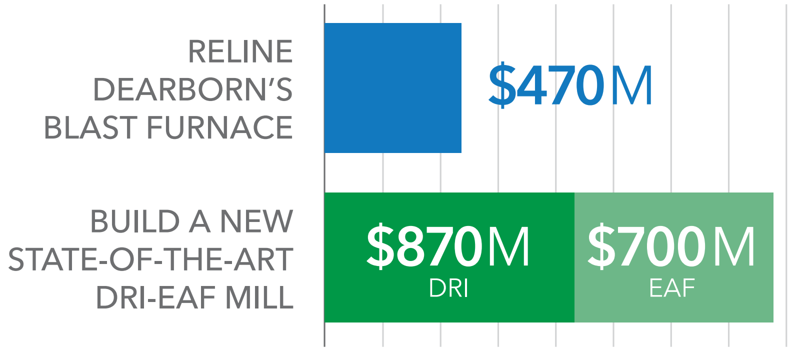
For a redesigned, state-of-the-art Dearborn Works to come online using DRI-EAF technology while sourcing as much of its energy needs as possible from renewable electricity, and ultimately using hydrogen as the iron ore reducing agent instead of coke, multiple development efforts must be carried out in parallel. The associated costs, workforce impacts, and land, water, and electricity needs, among other factors, are described here for the key assets in Dearborn Works' full transition profile.

Dearborn Works integrated steel mill complex

Cost. While Cleveland-Cliffs does not publicize planning activities related to its blast furnace fleet, external sources have estimated that C3, the sole operating blast furnace at Dearborn Works, will need relining around the year 2027. During relining, a blast furnace's entire refractory interior layer is stripped out, and a new layer is installed, which helps protect the metal elements of the furnace from the extremely high processing temperatures inside. Relining C3's refractory interior would extend the blast furnace's coal-based production ability into the 2040s. The cost to reline a blast furnace scales approximately with production capacity. Thus, based on C3's known capacity of 2.5 Mtpa, relining would cost Cleveland-Cliffs an estimated $470 million.

> **2027**
>
> *If Cleveland-Cliffs commits to relining the blast furnace at Dearborn Works, the facility's carbon-intensive, pollution-heavy processes will be locked in until the 2040s.*

In comparison, replacing the blast furnace with a newly built hydrogen-ready DRI furnace would cost at least $870 million. Cleveland-Cliffs reportedly spent $1 billion to build its 1.9 Mtpa hydrogen-ready hot-briquetted iron (a similar product to direct-reduced iron) plant in Toledo, Ohio, in 2020,[26] indicating that additional factors not publicized could drive a final price tag. A full conversion of the complex would further require replacement of the two basic oxygen furnaces with two (2×1.5 Mtpa) or three (3×1 Mtpa) large electric arc furnaces, for a total capacity of 3 Mtpa, at an estimated, collective cost of $700 million. Further changes to



[26] "Producing High Quality HBI In Toledo," Cleveland-Cliffs, accessed August 2024. https://www.clevelandcliffs.com/sustainability/environment/producing-high-quality-hbi-in-toledo#:~:text=Creating%20Economic%20Value,benefits%20of%20approximately%20$17%20million.

existing physical infrastructure, like wastewater treatment and material handling, would add to these figures, as would the eventual electrification of on-site steel finishing operations. While the net cost for the construction of this new, state-of-the-art complex would be, at minimum, $1.57 billion — notably, exceeding the cost to reline C3 by $1.1 billion — that investment would have positive financial ripple effects throughout communities in the region, by reducing the number of ER visits for respiratory ailments and the number of lost work and school days suffered by residents due to chronic inhalation of the particulate matter exhausted by Dearborn Works and EES Coke.[27]

Workforce. Citing "rapidly deteriorating business conditions" in the steel market, in 2020 Cleveland-Cliffs permanently idled the hot strip mill and annealing and tempering operations at Dearborn Works — eliminating 211 quality unionized jobs affiliated with the United Auto Workers (UAW) Local 600.[28] Today, the complex's estimated workforce is 1500 with 1200 unionized jobs. Projections of the impact on a mill's workforce following a facility transition to sustainable steel production via DRI-EAF vary. Modeling by the *Ohio River Valley Institute* indicates that the DRI-EAF transition can add 6 new permanent jobs for every 10 existing jobs in the portion of a mill's workforce dedicated to crude iron and crude steel production (with steel finishing operations

assumed largely unimpacted).[29] Favorably, Cleveland-Cliffs has estimated that the transition plan for its Middletown, Ohio, integrated steel mill — which will convert the site's blast furnace to a 2.5 Mtpa DRI furnace paired with two electric melting furnaces, but keep the existing basic oxygen furnace — will add 170 permanent jobs.[30] These new positions could be filled by prior Great Lakes Works workers, or through an intentional retraining and up-skilling initiative tied to workers from EES Coke (see below, *Hydrogen plant*). Also based on Cleveland-Cliffs' estimates for Middletown, a Dearborn Works construction project of this scale would likely create 1200 temporary jobs during peak construction activities.

Either case should be contrasted against the bleak reality of steelmaking in the United States, in which the number of quality jobs has declined precipitously in recent decades,[31] in part following

[27] Synapse Energy Economics Inc., "Coming Clean on Industrial Emissions: Challenges, Inequities, and Opportunities in U.S. Steel, Aluminum, Cement, and Coke," prepared for Sierra Club, September 12, 2023. https://www.sierraclub.org/sites/default/files/2023-09/Coming-Clean-On-Industrial-Emissions.pdf

[28] Breana Noble, Kalea Hall, and Christine Ferretti, "Former Rouge Steel mill closing some operations, throwing more than 200 out of work," *Detroit News*, May 5, 2020. https://www.detroitnews.com/story/business/2020/05/05/cleveland-cliffs-closing-operations-ak-steel-dearborn-works-plant/3086633001/

[29] Jacqueline Ebner, PhD, Kathy Hipple, Nick Messenger, and Irina Spector, MBA, "Green Steel in the Ohio River Valley: The Timing is Right for the Rebirth of a Clean, Green Steel Industry," Ohio River Valley Institute, April 2023. https://ohiorivervalleyinstitute.org/green-steel-in-the-ohio-river-valley-the-timing-is-right-for-the-rebirth-of-a-clean-green-steel-industry/

[30] "The US Department of Energy awards $500 million for Middletown Works steel plant," BlueGreen Alliance, March 25, 2024. https://www.bluegreenalliance.orag/resources/the-u-s-department-of-energy-awards-500-million-for-middletown-works-steel-plant/

[31] U.S. Bureau of Labor Statistics, BLS Data Finder 1.1, accessed August 2024. https://data.bls.gov/dataViewer/view/timeseries/IPUEN331110W200000000

the trend of declining steel production that began in the 1970s.[32] The steelworkers of Michigan know this fact all too well: In 2020, nearly 1500 people were laid off when U.S. Steel idled Great Lakes Works[33] — located just two miles from Dearborn Works — in response to a souring economic outlook after new steel tariffs were implemented by the federal government in 2019. It is imperative that Michigan takes the steps needed to preserve the quality union jobs that do remain at Dearborn Works. This means supporting a disruptive intervention that can deliver 'future-proofed' jobs — jobs associated with a cutting-edge steelmaking industry that will not be outcompeted by foreign producers.

Duration of construction. Based on Cleveland-Cliffs' estimates for Middletown, all on-site construction activities are expected to last between two and four years. This number has two major implications. First, although classified as 'temporary,' the 1200 construction jobs created by transitioning Dearborn Works would exist for a minimum of two years. Second, with 2027 just three years away, the window of opportunity for Michigan and Cleveland-Cliffs to commit to transitioning the steel mill to DRI-EAF is rapidly closing.

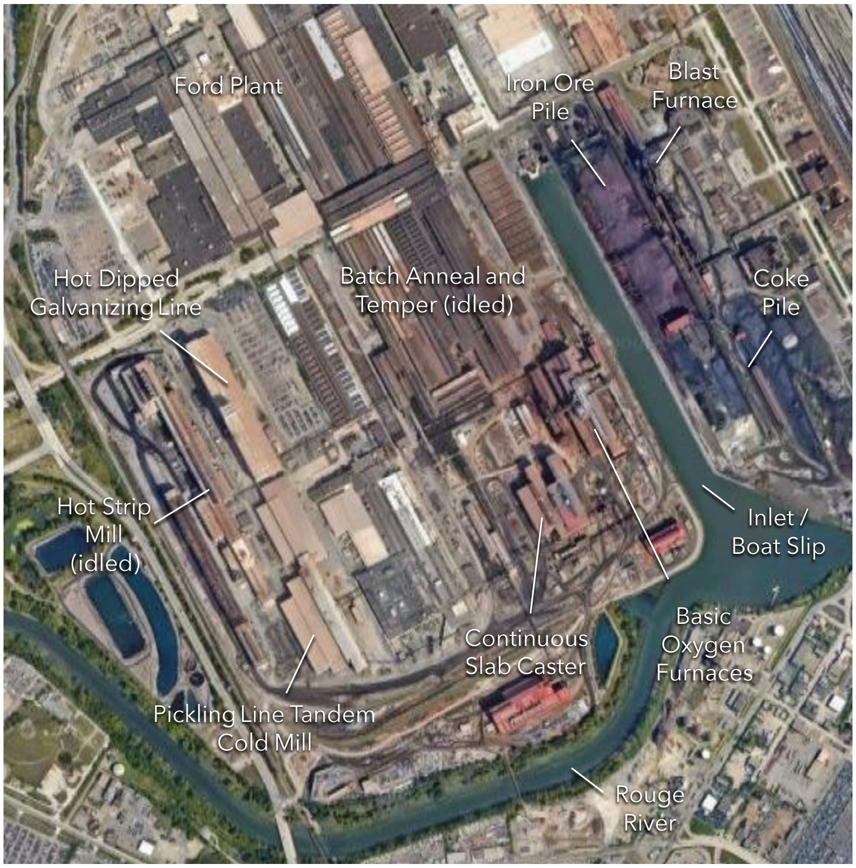


__Figure 7__ Dearborn Works is a relatively landlocked site. Crude iron is produced on the Eastern side of the Rouge River inlet at the blast furnace site, while crude steel is produced on the immediate Western side at the basic oxygen furnaces site. Idled assets that could be cleared to create space for a new DRI-EAF mill and/or green hydrogen plant include the batch anneal and temper operations in the middle of the complex, or the hot strip mill and pickling line tandem cold mill, both to the far West. Additional constraints include the location of the ore pile, on the Eastern side of the inlet and the need for continued use of coke through blast furnace decommissioning, after which point in time the coke pile could be cleared to yield buildable land. A portion of Ford's complex separates the idled batch anneal and temper and hot dipped galvanizing line operations. Credit: Google Maps (2024)

Land. A new 2.5 Mtpa DRI furnace and two to three large EAFs would require an estimated 10 to 20 acres of land, depending on facility layout constraints. Unfortunately, one of the most

[32] "Iron and Steel Decarbonization by 2050: An Opportunity for Workers and Communities," The Roosevelt Project, MIT Center for Energy and Environmental Policy Research, July 2024. https://ceepr.mit.edu/wp-content/uploads/2024/07/The-Roosevelt-Project-Iron-and-Steel-Decarbonization-by-2050.pdf

[33] "U.S. Steel to 'indefinitely idle' portion of Great Lakes Works facilities across river near Detroit," CBC News, December 20, 2019. https://www.cbc.ca/news/canada/windsor/us-steel-indefinitely-idle-portion-great-lakes-works-facility-1.5403894

challenging aspects of transitioning Dearborn Works to clean steel production is the facility's landlocked nature: Not only is the complex confined by a river and other industrial sites, it's also wrapped around the Rouge River inlet and a portion of Ford's manufacturing facility (Figure 7). As a result, the complex's crude iron and steel production activities occur on opposite sides of the inlet, located at various distances from the idled assets that could be demolished to yield a significant amount of buildable land (all west of the inlet). On the eastern side of the inlet, despite constraints, the complex does offer a few possibilities for new construction, in the form of several acres of untapped land near the existing blast furnace, as well as the land currently occupied by the large on-site coke storage pile (an estimated 5 acres). Careful reconfiguration of other assets, such as exhaust capture and cleaning and wastewater treatment, might be sufficient to supply the remaining land needs. Ultimately, however, only the complex's owner, Cleveland-Cliffs, is best-positioned to answer questions pertaining to land opportunity for an on-site facility transition with new construction.

Energy. Conversion of the Dearborn Works steel complex to a hydrogen-ready DRI-EAF mill would substantially increase the plant's electricity demand — while beginning to liberate the facility from its heavy dependence on highly polluting fossil fuels. Roughly 2.5 TWh of electricity would be needed per year to support the on-site needs for the production of crude iron and crude steel, and another 1 TWh to electrify steel finishing operations. To ensure the cleanest steel product, with the lowest embodied emissions, this increased electricity demand would require significant additions of renewable generation to the state's existing power grid, as discussed below in *Solar and wind installations* and *Other electric utility upgrades*.

Water. Traditional steelmaking uses significant volumes of water, mostly for cooling purposes, but also for dust scrubbing to reduce airborne emissions. At a mill like Dearborn Works, the major concerns associated with wastewater are, therefore, the temperature of the water used for cooling when released back into the source water body, and the levels of pollutants in the wastewater (i.e., from 'wet' dust scrubbers, and from uptake of oil, grease, and other lubricants during finishing operations) that must be remediated before the water can be discharged back into the source water body. An estimated 90% of the water used[34] by Dearborn Works for steel production is eventually released back into the Rouge River (which drains to the Detroit River and ultimately Lake Erie) — meaning that Dearborn Works consumes roughly 10% of the water that it sources, predominantly via evaporation.

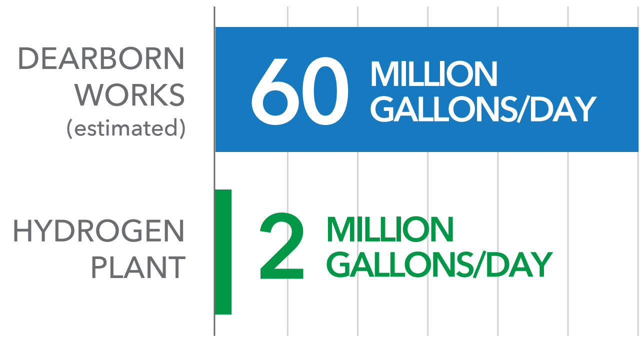
In practice, Dearborn Works both 'uses' and 'consumes' a tremendous amount of water following its existing BF-BOF production pathway. According to the facility's National Pollutant Discharge Elimination System (NPDES) permit documentation, the DIG-Dearborn Works complex draws fresh river water through a 15-foot-diameter, gravity-fed tunnel with an intake location on the Rouge River near Zug Island (a 2.3 mile travel distance). Dearborn Works alone is permitted for a designed outflow of roughly 500 million gallons per day (MGD) from 'outfalls' associated with the mill's blast furnace (348 MGD associated with blast furnace wastewater treatment), while another 5.1 MGD is permitted for one outfall associated with the basic oxygen furnace and a total of 105 MGD is permitted for three outfalls associated with the facility's range of steel finishing operations.[35] At maximum outflow, therefore, the Dearborn Works complex can emit over 600

[34] "Water management in the steel industry," World Steel Association, 2020. https://worldsteel.org/wp-content/uploads/Water-management-in-the-steel-industry.pdf

[35] NPDES Permit No. MI0043524, accessed via the Michigan Department of Environment, Great Lakes, and Energy (EGLE)'s MiEnviro Portal, August 2024. https://www.michigan.gov/egle/maps-data/mienviroportal

MGD of used water into Rouge River. Assuming 10% of the complex's water usage is lost via evaporation (i.e., 'consumed' before reaching an outflow), Dearborn Works uses an additional estimated 60 MGD – for an incredible total of 660 million gallons of fresh water usage *per day*. In comparison, a typical American household uses just 300 gallons of water per day.

A FACILITY-LEVEL COMPARISON OF DAILY WATER CONSUMPTION



Changing Dearborn's production process from BF-BOF to DRI-EAF would create two opportunities to reduce the facility's water usage and water consumption. Critically, these reductions have the potential to offset some, if not all, of the water that would be consumed for hydrogen production (considered below, in *Hydrogen production*). For example:

- Because a DRI furnace operates at roughly half the temperature of a blast furnace, it has significantly lower cooling needs, amounting to proportionally lower evaporative losses.
- The need for system-level reconfiguration to tie in the new DRI and EAF facility elements would create an opportunity to entirely redesign the complex's water handling system, opening the door to the introduction of an alternative purification technology, like ultrapurification. This could drastically cut the facility's water usage and reduce the environmental impact of its discharged effluent.
- Ultrapurification could also serve as a solution to the anticipated increase in iron levels in a portion of the complex's wastewater, due to the switch to direct reduction technology for crude iron production.
- Lastly, a carefully designed DRI complex might also be able to cut water consumption by capturing steam produced as a byproduct of crude iron production, condensing and cooling that steam, and circulating it back into the facility's cooling water system.

Hydrogen plant

Electricity. To sustain a crude iron production level of 2.5 Mtpa through direct reduction of iron ore using hydrogen, Dearborn Works would need a total of 154,000 tons (140,000 metric tons) of hydrogen per year. Because steel mills operate almost continuously every day of the year, a hydrogen production facility would need to supply on average 17.6 tons (16.0 metric tons) of hydrogen per hour, nearly uninterrupted. In producing this quantity of hydrogen, an electrolysis plant would consume roughly 7.7 TWh of electricity per year, which must be supplied entirely from renewable generation additions to the existing power grid to ensure a green hydrogen product for clean steel production.

1300 MW

GREEN HYDROGEN PLANT

154,000 TONS
ANNUAL H2 PRODUCTION

2 MILLION GAL
DAILY WATER CONSUMPTION

7.7 TWh
ANNUAL POWER NEEDS

$2.6 BILLION (min.)
H2 PLANT CONSTRUCTION COST

>410 (estimated)
NEW FULL-TIME JOBS

26 ACRES (min.)
LAND PARCEL

Water. Estimates of water consumption for hydrogen production involve two values, the water consumed during a complex series of filtration and cooling system processes and the water consumed to produce hydrogen (H_2) and oxygen (O_2) from electrolytic water (H_2O) splitting. The production of 154,000 tons (140,000 metric tons) of hydrogen per year would consume an estimated 740 million gallons of water annually. For comparison, Dearborn Works consumes an estimated 60 million gallons per day at peak production, meaning that every 12 days of operation, Dearborn Works is estimated to consume the amount of water that hydrogen production to supply a new DRI furnace would consume in 1 year. Alternatively stated, hydrogen production would consume less than 4% of the amount of water that Dearborn Works, as a facility, consumes at peak capacity today. Moreover, it is likely that the swap to a lower-temperature direct reduction furnace, versus the existing blast furnace, could be sufficient to fully offset this additional water consumption by significantly decreasing steel mill water consumption associated with evaporative losses during cooling operations.

Cost. The estimated hydrogen plant size is 1300 MW, which totals to a cost of at least $2.6 billion, fully built. This is a minimum estimated cost. The addition of compressed hydrogen storage on-site in either pipeline or canister formats would increase any costs associated with hydrogen plant construction. While salt cavern storage is considered a lower-cost alternative, comprehensive geological studies in the vicinity of Dearborn Works have not been conducted to date.

Workforce. It is estimated that a 1300 MW green hydrogen plant would create roughly 410 permanent on-site jobs.[36] This is a sufficient number to employ the majority of workers who could be displaced by the possible shuttering of EES Coke, which has an estimated workforce of 500-600, due to the anticipated significant decline in demand for coke products if Dearborn Works switches from BF-BOF to hydrogen DRI-EAF production methods. Repositioning these workers would require intentional planning for retraining and up-skilling initiatives, considered as a part of the complete economic considerations of a transition plan.

Land. In this scenario, the modeled 1300 MW hydrogen plant would require roughly 26 acres of land (in addition to the land needed to convert Dearborn Works' production system to DRI-EAF). Note that this number does not include any land requirements for on-site hydrogen storage or clean electricity storage in batteries. In hydrogen plant design, hydrogen storage and electricity storage can be viewed as competing elements. If additional electricity storage is built on-site, the planned hydrogen storage amount can be decreased. Without greater clarity regarding the potential for salt cavern storage of hydrogen, it is not possible to calculate final land needs for the hydrogen plant.

Even so, ideally, this facility would be constructed as close as possible to Dearborn's new DRI-EAF mill. Several options exist. On-site at Dearborn Works, either the coal pile, permanently idled annealing and tempering operations, or permanently idled hot strip mill could be repurposed. Otherwise, any nearby off-site option would require repurposing an existing facility (including site remediation). Two sites are reasonable candidates: that of the currently operating EES Coke battery on Zug Island, or the decommissioned Great Lakes Works steel mill immediately southwest of Zug Island. The former case would be a practical option in the event that a Dearborn Works transition plan triggers DTE to plan for shuttering of its existing EES Coke facility. This approach would also require extensive site remediation, followed by

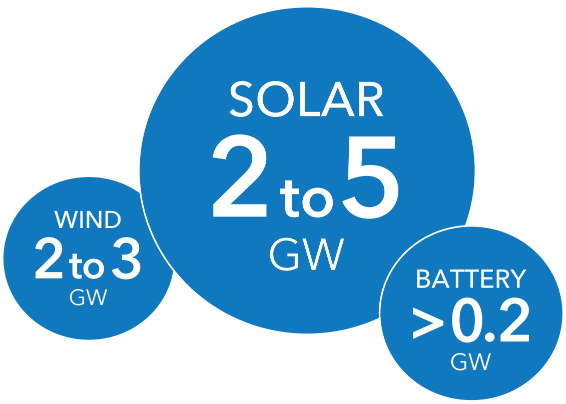
[36] Jacqueline Ebner, PhD, Kathy Hipple, Nick Messenger, and Irina Spector, MBA, "Green Steel in the Ohio River Valley: The Timing is Right for the Rebirth of a Clean, Green Steel Industry," Ohio River Valley Institute, April 2023. https://ohiorivervalleyinstitute.org/green-steel-in-the-ohio-river-valley-the-timing-is-right-for-the-rebirth-of-a-clean-green-steel-industry/

a complete rebuild of the complex as a state-of-the-art green hydrogen plant. As mentioned above, this approach could conserve the vast majority – if not all – of the estimated 500-600 existing jobs on Zug Island that might otherwise be lost if EES Coke is shuttered.

Pipeline delivery. One major Michigan utility has estimated that it would cost $1.5-4 million per mile of pipeline to construct a new, large-diameter (36") pipeline for hydrogen, depending on material selection and other project factors.[37] With Zug Island located at a distance of roughly 2.3 miles from Dearborn Works, a hydrogen pipeline could cost on the order of $3.5-10 million to build. That same utility has stated that a project of this magnitude could easily be completed within a single pipeline construction season (i.e., within one summer). This figure does not include any estimated costs for pipeline storage, which would greatly increase the length of pipeline required.

Solar and wind installations

New generation. To meet the renewable electricity requirements of green hydrogen production, modeling shows that Michigan would need to add a minimum of 2 GW solar and 2 GW wind. Further electrification of the DRI-EAF mill and all steel finishing operations at Dearborn Works would increase these needs to roughly 5 GW solar and 3 GW wind. These numbers assume a degree of electricity storage in batteries, which could be built either into the power grid (as a DTE asset) or on-site at the green hydrogen plant (as a plant asset, owned by whichever entity owns the plant). Significant quantities of electricity storage would be needed to minimize hydrogen storage needs, in the event that salt cavern storage is deemed unfeasible.



Workforce. It is estimated that renewable installations of this size would create a minimum of 550 permanent jobs and thousands of temporary construction jobs. Considering the scale of renewables construction required to adequately serve both the steel mill and hydrogen plant, these 'temporary' jobs would likely last through the next decade as DTE works to add new renewables to its infrastructure in time for the green hydrogen plant to come online at full capacity.[38]

[37] MI Hydrogen's State of Michigan Workshop: Building Foundations for a Hydrogen Economy, in-person, May 13, 2024.

[38] Jacqueline Ebner, PhD, Kathy Hipple, Nick Messenger, and Irina Spector, MBA, "Green Steel in the Ohio River Valley: The Timing is Right for the Rebirth of a Clean, Green Steel Industry," Ohio River Valley Institute, April 2023. https://ohiorivervalleyinstitute.org/green-steel-in-the-ohio-river-valley-the-timing-is-right-for-the-rebirth-of-a-clean-green-steel-industry/

Land. Land use for renewables has grown increasingly contentious among many rural communities. The minimum renewable energy farm additions would cover roughly 9 square miles (5700 acres) for solar and 245 square miles (157,000 acres) for wind. In the latter case, most of that acreage would simply be needed to provide adequate spacing between wind turbines. Based on data from other large-scale wind farms, just 2.45 square miles (1570 acres) of land would be 'permanently disturbed' due to equipment placement, service road construction, and other associated needs.

Construction timeline. Recently passed legislation (Public Acts 233 and 234 of 2023)[39,40] in Michigan was designed to reduce the barriers to new 'large' wind, solar, and power storage developments (>50 MW of solar, >100 MW wind, >50 MW storage) otherwise encountered as a result of restrictive siting ordinances at the local level. With the new legislation, large developments could face approval timelines as short as 120 days (or as long as 1 year), depending on whether the permitting authority is the local government or the Michigan Public Service Commission (MPSC). This new legislation brings the time needed for these permitting activities inline with the typical time estimated by the Solar Energy Industries Association (SEIA). A further 4-5 years would be needed to carry out additional planning activities, and at least 2-3 years for construction activities, according to SEIA projections for utility-scale solar projects.[41] This means that a typical large-scale renewable energy farm requires between 6 and 9 years to complete — which is a critical timeline element that must be observed to be able to deliver green hydrogen to a state-of-the-art DRI-EAF Dearborn Works.

Other electric utility upgrades

An industrial electrification project of this magnitude would require extensive electric system upgrades to generation systems (as discussed above, in *Solar and wind installations*), transmission systems, distribution systems, and the on-site power handling systems at Dearborn Works and the new hydrogen plant. Although the Detroit metro area has significant transmission capacity, there is less capacity in outlying regions of the state. Therefore, depending on the location of renewables installations, significant transmission system upgrades would be required.

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[39] House Bill 5120 of 2023 (Public Act 233 of 2023), Michigan Legislature, accessed August 2024. https://legislature.mi.gov/Bills/Bill?ObjectName=2023-HB-5120

[40] House Bill 5121 of 2023 (Public Act 234 of 2023), Michigan Legislature, accessed August 2024. https://legislature.mi.gov/Bills/Bill?ObjectName=2023-HB-5121

[41] "Development Timeline for Utility-Scale Solar Power Plant," Solar Energy Industries Association, accessed August 2024. https://www.seia.org/research-resources/development-timeline-utility-scale-solar-power-plant

Tilden Mine pelletizing plant

Cost. Cleveland-Cliffs' Tilden Mine in the upper peninsula of Michigan is the likely source of the iron ore pellets used at Dearborn Works. At full crude iron production capacity, Dearborn Works requires roughly 4 million tons of iron ore pellets annually, a similar production capacity as U.S. Steel's Keetac Mine in Minnesota. Keetac's pelletizing plant was recently upgraded — at a reported cost of $150 million[42] — to allow the facility to produce up to 4 million tons of blast furnace- and/or direct reduction-grade ore pellets per year. Similarly, Cleveland-Cliffs upgraded its Northshore Mining operation to direct reduction-grade pellets in 2019, before relocating its DR-grade pelletizing operations to Virginia, Minnesota.[43] The initial construction reportedly cost $100 million, with the facility launching at a production level of 3.5 million tons of pellets annually.[44] Therefore, estimated costs to upgrade Tilden Mine's pelletizing operations range from $138-150 million.

Workforce and construction timeline. U.S. Steel reported that its pellet plant upgrade created 33 full-time union and management jobs and 250 construction jobs, with construction taking just under one and a half years.[45] A similar timeline and workforce impact could be expected for Tilden Mine.

+33
FULL-TIME UNION AND MANAGEMENT JOBS

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[42] "United States Steel Celebrates Opening of DR-Grade Pellet Production Facility in Minnesota," U.S. Steel, May 23, 2024. https://investors.ussteel.com/news-events/news-releases/detail/680/united-states-steel-celebrates-opening-of-dr-grade-pellet

[43] "Cleveland-Cliffs Announces Ribbon Cutting Ceremony at its Northshore Mining in Minnesota," Cleveland-Cliffs, June 6, 2024. https://www.clevelandcliffs.com/news/news-releases/detail/61/cleveland-cliffs-announces-ribbon-cutting-ceremony-at-its

[44] Jimmy Lovrien, "Cliffs to idle Northshore Mining as fight over royalty fees intensifies," MPR News, February 11, 2022. https://www.mprnews.org/story/2022/02/11/cliffs-to-idle-northshore-mining-as-fight-over-royalty-fees-intensifies

[45] "United States Steel Celebrates Opening of DR-Grade Pellet Production Facility in Minnesota," U.S. Steel, May 23, 2024. https://investors.ussteel.com/news-events/news-releases/detail/680/united-states-steel-celebrates-opening-of-dr-grade-pellet

Benefits to Health and the Environment

The production of steel from iron ore is a relatively dirty business. On average, three-quarters of a ton of coke (a refined coal product) are needed to produce just one ton of crude steel[46] — meaning that a complex like Dearborn Works can consume upwards of 2.1 million tons of coal-based products in a high-production year. The coke and iron ore, together, contain a range of heavy metals, organic compounds, and other substances that when subjected to high temperatures and combustion reactions produce an array of health-harming compounds and greenhouse gases (GHGs).

> *When ranked against other major facilities, Dearborn Works is Michigan's 6TH LARGEST emitter of PM2.5, while EES Coke is Michigan's 4TH LARGEST emitter of PM2.5, 5TH LARGEST emitter of SO_2, and 10TH LARGEST emitter of NOx.*

U.S. EPA data shows that Dearborn Works is the single largest emitter of carbon monoxide and lead and the 6th largest emitter of fine particulates (PM2.5) in the state of Michigan, when ranked against 1400 other facilities tracked in EPA's NEI database. Similarly, EES Coke is the 4th largest emitter of fine particulates (PM2.5), 5th largest emitter of sulfur dioxide (SO_2), and 10th largest emitter of nitrogen oxides (NOx).[47] Separated by less than 3 miles, these facilities create a significant cumulative emissions burden for adjacent communities.

From an environmental perspective, the impacts of these two facilities extend beyond reductions in air quality and discharges of substances toxic to aquatic life — Dearborn Works and EES Coke are also tied to massive quantities of greenhouse gas emissions (GHGs), with the steel mill ranked as the 3rd largest emitter of carbon dioxide (CO_2) and the coke plant, the 9th largest emitter of carbon dioxide (CO_2), when compared to other industrial facilities within Michigan.[48]

BENEFITING WORKER HEALTH

The federally-reported emissions from Dearborn Works only tell a part of the facility's story in relation to its significant impacts on human health. While most of the facility's pollution is exhausted via stacks or discharged via wastewater outfalls, the specific concentrations of different pollutants and health hazards vary throughout the complex. Doors and valves on furnaces, transfer vessels, and material storage sites all release hazardous airborne compounds and particulates. As a result, workers in different parts of the facility can suffer different exposure levels, despite pollution control systems (like active ventilation). More specifically, routine exposure of workers to pollutants from coke ovens and blast furnaces is known to increase their risk of emphysema and lung cancer, among other adverse health conditions.[49]

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[46] "Metallurgical coal," BHP, accessed August 2024. https://www.bhp.com/what-we-do/products/metallurgical-coal

[47] Based on data from the U.S. EPA online 2020 NEI Data Retrieval Tool, accessed summer 2024. https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data

[48] U.S. EPA Facility Level Information on GreenHouse gases Tool (FLIGHT), accessed summer 2024. https://ghgdata.epa.gov/ghgp/

[49] "Steelworkers and Mesothelioma," Mesothelioma Hub, accessed August 2024. https://www.mesotheliomahub.com/mesothelioma/occupations/steelworkers/

Transitioning Dearborn Works from BF-based iron production to DRI has the potential to significantly cut pollutant exposure rates for workers, as high-purity hydrogen is swapped for pollutant-laced coke and the ore processing temperature is reduced by nearly half.

Transitioning Dearborn Works from blast furnace-based production methods to direct reduction furnace-based production has the potential to significantly cut pollutant exposure rates for workers responsible for crude iron production — just by swapping for a lower processing temperature and substituting high-purity hydrogen for pollutant-laced coke. Pollutant exposure can also be reduced by switching basic oxygen furnace-based steel production to electric arc furnace-based steel production, and by electrifying all steel finishing operations.

While there is no way to fully eliminate exposure risk for plant floor workers in steel mills, these changes to production processes at least offer steps to reduce exposure — with the potential to further reduce incidences of adverse health outcomes, including cancer-related deaths, ER visits, and missed work days.

BENEFITING COMMUNITY HEALTH

Various studies have demonstrated the extent to which exposure to pollutants from integrated steel mills and coke plants can harm individuals living in nearby communities. For example, children living near Clairton Coke Works in Allegheny County, Pennsylvania, suffer higher rates of asthma[50] and childhood cancer[51] than children across the United States as a whole, and residents near the Gary Works integrated steel mill in Indiana are in the top 10-20% for having a projected low life expectancy due to chronic exposure to heavy industry pollution.[52]

Figure 8 *On Earth Day 2024, students and educators of Salina Intermediate School gathered with Dearborn Residents for an event urging Cleveland-Cliffs to address the ongoing pollution problem associated with its Dearborn Works steel mill. Speakers at the event spoke of the irony that General Motors has recognized Cleveland-Cliffs as its steel "Supplier of the Year" for six years even though the steelmaker contributes to tremendous pollution and health concerns for the children of the Salina school complex and residents of nearby neighborhoods. Credit: Mighty Earth*

[50] Brian Bienkowski, "Coke plant pollution linked to "asthma epidemic" in Pittsburgh-area elementary school," EnvironmentalHealthNews, February 27, 2018. https://www.ehn.org/asthma-near-clairton-coke-plant-2539978896.html

[51] Kristina Marusic, "Kids in Southwestern Pennsylvania are exposed to carcinogenic coke oven emissions at shockingly higher rates than the rest of the country," EnvironmentalHealthNews, April 22, 2019. https://www.ehn.org/us-steel-pittsburgh-cancer-2634765539.html

[52] Aydali Campa, Phil McKenna, and Victoria St. Martin, "Industrial Plants in Gary and Other Environmental Justice Communities Are Highlighted as Top Emitters," Inside Climate News, September 14, 2023. https://insideclimatenews.org/news/14092023/gary-steel-works-top-emitter-environmental-justice/

Many of these studies consider residents living within a radius of three or five miles of a plant – but the potential harm of Dearborn Works can be seen by looking just over the railroad tracks from blast furnace C3 to the Salina Elementary and Intermediate school complexes. Over 800 children attend school here (Figure 8), less than half a mile away from a steel mill that, in 2020, pumped 7204 tons of carbon monoxide (CO), 446 tons of sulfur dioxide (SO_2), 241 tons of nitrogen oxides (NOx), and 459 tons of particulate matter (PM10 and PM2.5)[53] – among other harmful compounds – into the air those children, and their families, breathe. See GET THE FACTS: Health impacts of the air pollutants emitted by Dearborn Works and EES Coke.

Asthma, childhood cancer, and an elevated risk of low life expectancy are just some of the health burdens faced by communities living near coke plants and blast furnaces.

Over 800 children attend school less than half a mile from the blast furnace at Dearborn Works – which, in 2020 alone, pumped over 7200 tons of carbon monoxide and 460 tons of PM10 and PM2.5 into the air they breathe.

As Dearborn Works' likely coke supplier, it is not surprising to observe that the annual emissions of EES Coke track estimated steel mill production – and like Dearborn Works, EES Coke exhausts a lot more than carbon dioxide and dust into the air on any given day. In 2020, EES Coke exhausted 2089 tons of sulfur dioxide (SO_2), 1210 tons of nitrogen oxides (NOx), 334 tons of carbon monoxide (CO), 26 tons of benzene, 17.5 tons of hydrochloric acid, 5.3 tons of ammonia, 4.6 tons of toluene, and nearly 4.4 tons of methyl chloride[54] – all of which are harmful to human health. That same year, EES Coke emitted roughly 50% more particulate matter than Dearborn Works.

Dearborn Works	EES Coke Battery
7204 TONS CARBON MONOXIDE	**334** TONS CARBON MONOXIDE
446 TONS SULFUR DIOXIDE	**2089** TONS SULFUR DIOXIDE
241 TONS NITROGEN OXIDES	**1210** TONS NITROGEN OXIDES
459 TONS PARTICULATE MATTER	**682** TONS PARTICULATE MATTER

As a direct result of the quantity and composition profile of the airborne pollutants exhausted from these two facilities, EPA's Risk-Screening Environmental Indicators (RSEI) model places residents of Wayne county, Michigan, where Dearborn Works and EES Coke are located, as the most at-risk for health problems of all 64 Michigan counties tracked by the RSEI.[55]

With advances in steelmaking technology, these emissions can be slashed – in some cases, nearly eliminated. For example, switching to a direct reduction method for crude iron production drastically cuts facility particulate emissions by two mechanisms: one, the switch eliminates the need for pollutant-heavy coke as a chemical reducing agent, and two, processing in the solid state, without melting, prevents many particulates from

According to U.S. EPA, of the 64 Michigan counties tracked in RSEI, the residents of Wayne County, where Dearborn Works and EES Coke are located, rank #1 as the MOST AT-RISK for HEALTH PROBLEMS.

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[53] Based on data from the U.S. EPA online 2020 NEI Data Retrieval Tool, accessed summer 2024. https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data

[54] Based on data from the U.S. EPA online 2020 NEI Data Retrieval Tool, accessed summer 2024. https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data

[55] U.S. EPA's Risk-Screening Environmental Indicators (RSEI) Model, accessed summer 2024. https://www.epa.gov/rsei

forming. And transitioning an entire integrated steel mill off fossil fuels, including the natural gas used for finishing operations, significantly reduces the amount of organic compounds exhausted – including carbon monoxide (CO), volatile organic compounds (VOCs), benzene, and toluene. Stripping the coal out of the process reduces sulfur dioxide (SO_2) emissions, and lowering the temperature used for iron production decreases emissions of nitrogen oxides (NOx).

The extent to which these reductions can be realized for Dearborn Works by transitioning the complex to clean steel production methods would depend on the extent of the ultimate transition plan (for example, whether steel finishing operations are electrified or remain on natural gas) and key choices for adapting existing or installing new pollution control systems.

GET THE FACTS

Health impacts of the air pollutants emitted by Dearborn Works and EES Coke

The U.S. EPA has established exposure limits[56] for six airborne pollutants commonly emitted by industrial complexes. These 'criteria air pollutants' (or CAPs) can cause a range of health problems for workers and residents of nearby communities. The five CAPs associated with steel production and coal refining can give rise to a range of health problems, outlined here:

- **Carbon monoxide (CO).** Binds to red blood cells, diminishing the body's ability to deliver fresh oxygen to important organs like the brain and heart.
- **Sulfur dioxide (SO_2).** Irritates the respiratory tract, eyes, and skin, and can worsen common respiratory ailments, like asthma.
- **Nitrogen oxides (NOx).** Irritate the respiratory tract, and can worsen common respiratory ailments or cause chronic lung disease with long-term, high levels of exposure.
- **Particulate matter (PM10 and PM2.5).** Irritates the eyes, nose, and throat, can aggravate lung diseases and certain heart conditions, and long-term exposure can lead to premature death, with the finest particles (<2.5 microns) having the greatest impacts on health. Also leads to reduced visibility and hazy air quality around industrial facilities.
- **Lead.** In children, can cause learning deficits and behavioral challenges, while in adults, can lead to an array of health issues, including cognitive, behavioral, and motor problems, affecting most major organ systems.

MITIGATING THE EFFECTS OF CLIMATE CHANGE

Many of the gases produced by integrated steel production and coal refining to yield coke contribute to the extensive facility-level emissions associated with drivers of climate change. These gases include carbon dioxide (CO_2), methane, nitrous oxide (N_2O), and water vapor. Because each of these gases has a different relative potential to trap heat, the respective climate-warming potential of these 'greenhouse gases' (GHGs) is often expressed in like-units known as 'carbon dioxide equivalent' or CO_2e. It's

Combined, Dearborn Works and EES Coke contribute MORE THAN 8% of Michigan's industrial manufacturing CO_2 emissions.

[56] "Criteria Air Pollutants," U.S. EPA, accessed August 2024. https://www.epa.gov/criteria-air-pollutants

not just that Dearborn Works and EES Coke emit 'large' quantities of CO_2e – they're also outsized contributors to Michigan's CO_2e footprint overall. These two facilities contribute more than 8% of industrial manufacturing carbon dioxide emissions in the state, as tabulated by EPA's GHG Reporting Program (specific to 'large' fixed facilities).[57]

Michigan's MI Healthy Climate Plan has an overarching goal of cutting all carbon emissions to net-zero by 2050. The state estimates that energy-intensive industries contribute 14% of its total GHG emissions.[58] Combining these values, production of steel from ore using coke in the state of Michigan contributes 1.3% of the state's GHG emissions. That's just two facilities, Dearborn Works and EES Coke, emitting 1 of every 80 molecules of climate-warming carbon dioxide associated with human activity in the state – and that figure does not include the emissions associated with the electricity that those facilities consume during operation (known as Scope 2 GHG emissions) or the mines and quarries that Dearborn Works sources its raw materials from.

Transitioning Dearborn Works to clean steel production using green hydrogen and renewable energy is a CRITICAL STEP toward achieving the objectives of the state's MI Healthy Climate Plan.

It cannot be stated with greater emphasis: Transitioning Dearborn Works to clean steel production using green hydrogen and renewable energy is a critical step toward achieving the objectives of the state's MI Healthy Climate Plan.

[57] U.S. EPA Facility Level Information on GreenHouse gases Tool (FLIGHT), accessed summer 2024. https://ghgdata.epa.gov/ghgp/

[58] "By the Numbers: Michigan's future counts on climate action," Michigan's Department of Environment, Great Lakes, and Energy (EGLE), accessed August 2024. https://www.michigan.gov/egle/newsroom/mi-environment/2022/11/30/by-the-numbers-michigans-future-counts-on-climate-action

Ensuring That the Communities Surrounding Dearborn Works Have a Voice

Communities deserve a say in the industrial development activities that occur near them — especially if those industrial facilities impact the air that a community's residents breathe and the water they drink. Community benefits plans are one way to ensure that communities have a voice in industrial development activities and the processes those industries employ. When thoughtfully constructed, they effectively engage local voices to understand, and attend to, the needs of their surrounding communities. This is especially important for the fenceline communities around industrial facilities — because these communities are more commonly composed of historically marginalized, low-income families, and often have disproportionately higher numbers of residents who are people of color, immigrants, and/or non-native English speakers. The importance of effective community engagement in planning activities related to steel mill transitions is underscored in the recent MIT Center for Energy and Environmental Policy Research report, "Iron and Steel Decarbonization by 2050: An Opportunity for Workers and Communities."[59]

THE FOUR PRINCIPLES OF A COMMUNITY BENEFITS PLAN

Because of the disproportionate burden of industrial pollution borne by some historically marginalized communities, community benefits plans have become a central element of all funding initiatives for clean energy infrastructure launched by the U.S. Department of Energy. These initiatives include funding programs designed to prioritize the production of clean hydrogen for uses in key, hard-to-decarbonize industrial sectors, like steelmaking.[60]

The Department of Energy requires that community benefits plans be developed based on four principles:[61]

- Engaging community and labor
- Investing in workers by creating and supporting quality jobs
- Advancing diversity, equity, inclusion, and accessibility
- Implementing the federal government's Justice40 initiative

While the Department of Energy allows flexibility in how plans are developed, it also mandates that plans be specific, actionable, and measurable. These plans are considered in the technical merit of a proposal when reviewing a funding application, and the performance of the project is ultimately weighed against the original community benefits plan, among other factors. The Department of Energy's Office of Clean Energy Demonstration offers freely accessible community benefits plan templates that any company can use.[62]

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[59] "Iron and Steel Decarbonization by 2050: An Opportunity for Workers and Communities," MIT Center for Energy and Environmental Policy Research (CEEPR), July 2024. https://ceepr.mit.edu/wp-content/uploads/2024/07/The-Roosevelt-Project-Iron-and-Steel-Decarbonization-by-2050.pdf

[60] "U.S. National Clean Hydrogen Strategy and Roadmap," U.S. DOE, accessed August 2024. https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/us-national-clean-hydrogen-strategy-roadmap.pdf

[61] "About Community Benefits Plans," U.S. DOE, accessed August 2024. https://www.energy.gov/infrastructure/about-community-benefits-plans

[62] "About Community Benefits Plans," U.S. DOE, accessed August 2024. https://www.energy.gov/infrastructure/about-community-benefits-plans

SUPPORTING THE EFFECTIVE DEVELOPMENT AND IMPLEMENTATION OF A COMMUNITY BENEFITS PLAN

Figure 9 *For years, fenceline communities in the Dearborn area, as well as their advocacy organizations and coalitions, have consistently expressed a demand for cleaner industrial practices and better air quality within the Dearborn industrial corridor – shown here in a wall mural. Credit: Clear the Air*

RMI, a nonprofit working toward a clean, prosperous, low-carbon future for all, outlines a series of steps[63] that companies should follow during the development and implementation of a community benefits plan, in part based on analysis of the proposals received by the U.S. DOE's Office of Clean Energy Demonstration for funding from its Regional Clean Hydrogen Hubs program.[64] RMI summarizes all activities leading to a community benefits plan in six key stages:

1. Publish online a draft community benefits plan that includes a statement regarding the company's intent.
2. Gather feedback on the project and proposed community benefits plan.
3. From that feedback, identify priorities and address concerns.
4. Identify groups and individuals who can represent the community and labor forces during community benefits plan negotiations.
5. Obtain the necessary resources to support the negotiation and implementation of the community benefits plan.
6. Publicize with community and labor groups the plans developed to handle any further community benefits plan negotiations, so that these key stakeholder groups are able to effectively participate in the process.

RMI has outlined a series of 6 STEPS that all companies should following during the development and implementation of a community benefits plan.

63 Patience Bukirwa, Chathurika Gamage, Moana McClellan, Hadia A. Sheerazi, and Gareth Westler, "Delivering equitable and meaningful community benefits via clean hydrogen hubs," RMI, January 28, 2024. https://rmi.org/delivering-equitable-and-meaningful-community-benefits-via-clean-hydrogen-hubs/

64 "Regional Clean Hydrogen Hubs," U.S. DOE, accessed August 2024. https://www.energy.gov/oced/regional-clean-hydrogen-hubs-0

Similarly, the Roosevelt Institute, a nonprofit working to advance progressive policies, has issued a series of recommendations for shifts to policies that could support a green energy transition while enhancing community participation and consent. The institute's recommendations include:[65]

- Strengthening community participation in permitting processes
- Engaging Indigenous communities in negotiations relating to land stewardship
- Applying cumulative impact analyses for industrial projects
- Providing a range of community benefits, including shared ownership

Unlike RMI's six key stages to develop and implement an effective community benefits plan, not all of the Roosevelt Institute's policy recommendations may be feasible in the Dearborn industrial corridor (e.g., shared ownership of new assets among industry and communities).

ESTABLISHING COMMUNITY-MINDED PRINCIPLES FOR THE PRODUCTION AND USE OF GREEN HYDROGEN

An effective community benefits plan is viewed as particularly necessary for Dearborn Works, because its surrounding community and workers are simultaneously overburdened with industrial pollution and skeptical of any proposed changes to industrial activities. This is especially true for proposed changes tied to fundamental shifts in production methods, because of perceptions that both the changes to pollution profiles and techno-economic impacts of switching to new production methods are unknown.

As a result, community-based organizations and coalitions working in the Dearborn industrial corridor continue to express concern regarding the shift to green hydrogen-based steelmaking, despite a strong interest in cleaner industrial practices more generally (Figure 9) . While the higher-profile advocacy organizations pushing for cleaner steel production methods across the United States have launched full-force clean steel campaigns, these interests are, in fact, not fully embraced by the people of Dearborn — or by the communities that surround other integrated steel mills in the Great Lakes Region. The information provided in this report is also intended, in part, to help educate workers and fenceline community members on these key topics, with the hope of gaining additional traction for the clean steel transition in Michigan.

Across the region, as interest in green hydrogen grows, environmental justice-oriented organizations and coalitions are asking to be included in the process for making decisions regarding its production and use in industrial applications near their homes and schools. These organizations should be encouraged to establish their own principles for the production and use of green hydrogen in industrial contexts, and those principles should be considered in the development of a community benefits plan to support a Dearborn Works transition, as well as in associated planning activities, like the development of a hydrogen regulatory framework.

65 Johanna Bozuw and Dustin Mulvaney, "A Progressive Take on Permitting Reform: Principles and Policies to Unleash a Faster, More Equitable Green Transition," August 22, 2023. https://rooseveltinstitute.org/publications/a-progressive-take-on-permitting-reform/

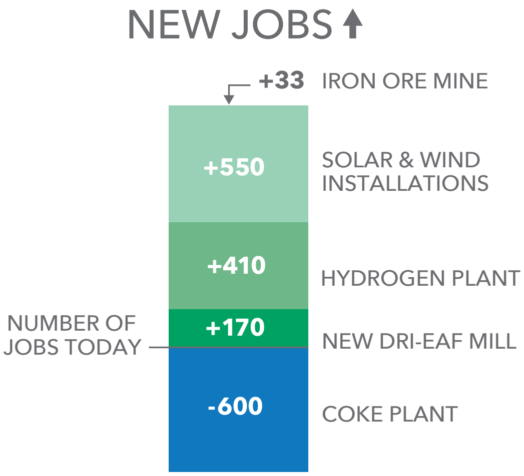
Barriers to a Clean Steel Transition at Dearborn Works

A range of barriers threaten a timely transition of Dearborn Works to sustainable steel production methods. Major barriers are explored here, and potential solutions through a combination of state-level leadership, advocacy, policy, and funding initiatives are considered in *Public-Private Partnerships Will Be Critical for Ensuring Clean Steel Becomes a Reality at Dearborn Works*, below.

DEARBORN WORKS: PART OF AN ECOSYSTEM, NOT AN ISLAND

Dearborn Works exists not as an island but as a key player in an industrial ecosystem, a material and energy economy, and a community. As a major steel producer, the plant is also a major buyer of raw materials from upstream companies, and a major seller of finished and semi-finished steel products to downstream companies, like Michigan's array of automotive manufacturers. Dearborn Works is also physically connected to the Dearborn Industrial Generation (DIG) power plant and part of Ford's manufacturing complex through its water intake system, and to DIG via piping to convey off-gas from the blast furnace to the power plant for combustion.

Because any change to Dearborn Works' production practices would have significant ripple effects up and down the supply chain, and impacts on physical infrastructure, air and water quality permits, jobs (for a summary of the net direct impact on jobs, see graphic), land use, and more, such changes must be explored with all interested parties having a seat at the table. This includes fenceline community members, the companies of interest, the relevant utilities, associated government agencies, and state and local elected leaders.



THE RENEWABLE ENERGY BOTTLENECK

Multiple bottlenecks in renewable energy generation have the potential to throttle progress toward a clean steel transition at Dearborn Works. Michigan's 2023 Clean Energy & Jobs Act addresses one bottleneck by creating a streamlined path for permitting utility-scale solar and wind energy projects. The legislation also mandates 100% clean energy in Michigan by 2040, including that 50% of Michigan's energy be supplied by renewables by 2030 and 60% by 2035.[66] An electrified Dearborn Works complex would be a DTE Electric customer, while a nearby hydrogen plant would either be a utility customer or a utility-owned asset. As a result, reliance on DTE's clean energy obligations under the Clean Energy & Jobs Act is the most straightforward path to clean energy for clean steel production at Dearborn Works.

[66] "Governor Whitmer Signs Historic Clean Energy & Climate Action Package," Executive Office of the Governor of the state of Michigan, November 28, 2023. https://www.michigan.gov/whitmer/news/press-releases/2023/11/28/governor-whitmer-signs-historic-clean-energy-climate-action-package

And yet, because Cleveland-Cliffs has made no commitment to produce clean steel at Dearborn Works, DTE Electric's investments in its clean energy generation assets are not on pace to scale with the potential needs of a decarbonized industrial sector broadly, much less for the steel produced at Dearborn Works. While the utility has publicly stated plans to add 1 GW of new wind and solar annually through 2042,[67] as well as 2.9 GW of energy storage,[68] an electrified Dearborn Works relying on hydrogen-based DRI and the associated new green hydrogen plant would, in combination, require an estimated 5 GW solar, 3 GW wind, and (likely) significant battery storage. Moreover, those assets would need to come fully online by the mid-2030s, meaning that of DTE Electric's planned ~18 GW of renewable additions by 2042, upwards of 8 GW could be needed to support clean steel production alone. Clearly, there is significant misalignment between DTE Electric's build out rate and the projected needs for clean electricity — which is why it is crucial that Cleveland-Cliffs commit to clean steel production at Dearborn Works as soon as possible.

MISO, the manager of the midcontinent power grid, has planned long-range transmission additions for Michigan.[69] These will help bring the large quantities of clean electricity needed to power sustainable steelmaking toward the Dearborn Works site, although the complete scope of the planned additions does not extend fully to the existing steel mill's location. Careful attention must be paid to these plans to ensure that the necessary physical interconnections are made, at scale, to ensure sufficient renewables-based power can be supplied to an electrified Dearborn Works and a new hydrogen plant located nearby.

FINDING THE RIGHT LAND, AND THE RIGHT OWNER-OPERATORS

The Dearborn Works transition to clean steel would require a significant quantity of land: 0.02-0.03 square miles (10-20 acres) for construction of the new DRI-EAF capabilities, 9 square miles (5700 acres) of solar farm, 245 square miles (157,000 acres) of wind farm (including setback distances), up to 0.04 square miles (26 acres) for a hydrogen plant (at minimum), a possible construction path for roughly 2.3-3.5 miles of hydrogen pipeline (depending on the eventual hydrogen plant location and on-site storage needs), and additional land needs for hydrogen storage and/or electricity storage in batteries.

The land challenge at Dearborn Works is created by the interplay of the need to continue production while constructing the new DRI-EAF assets on a land-limited site. The land for these new assets is largely occupied by existing assets that the mill would either retire after switching to clean steel production, such as the coal pile on the eastern side of the Rouge River inlet/boat slip, or has already idled but would require demolition and remediation. Careful planning led by the mill's owner, Cleveland-Cliffs, would be necessary to effectively address this dilemma.

Efforts are underway to enhance the rate of siting and permitting for new utility-scale renewable energy farms in Michigan, despite growing concern and opposition from some in the agricultural sector or who live in rural areas. These tensions must be adequately addressed to ensure buy-in from rural regions, on a timeline that can effectively support a complete transition of Dearborn Works to clean steel production methods.

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[67] "Michigan's Renewable Energy Leader: Creating a cleaner future for all Michiganders," DTE Energy, accessed August 2024. https://www.dteenergy.com/us/en/residential/community-and-news/renewable-energy/introduction.html

[68] "Energy Storage: Aligning Renewable Energy and Electricity Demand," DTE Energy, accessed August 2024. https://www.dteenergy.com/us/en/residential/community-and-news/renewable-energy/energy-storage.html

[69] "Long Range Transmission Planning," MISO, accessed August 2024. https://www.misoenergy.org/planning/long-range-transmission-planning/

The land needed for hydrogen production and transmission to Dearborn Works poses a two-fold problem. As of yet, Michigan has no regulatory framework for hydrogen pipeline permitting, hydrogen pipeline construction, or hydrogen distribution as a metered utility. This impacts any potential provider of hydrogen by obfuscating the risks and economics of such a prospect. As a result, no energy provider has explicitly stated interest in such a project to date, although DTE Energy is a likely potential owner-operator of an industrial-scale hydrogen plant and pipeline, especially if situated on its existing parcel on Zug Island.

ENSURING THE AVAILABILITY OF GREEN HYDROGEN AT SCALE

Multiple factors must be addressed to ensure the availability of green hydrogen at the scale needed to transition Dearborn Works to clean steel production methods. While these have been identified in various locations throughout this report, they are summarized here, for clarity:

- The siting, permitting, and construction of sufficient new renewable electricity generation in Michigan's power grid (at least 2 GW solar, 2 GW wind) to serve the new green hydrogen plant
- Upgrades to local power substations in the vicinity of Dearborn Works and the eventual site of the green hydrogen plant
- The identification of an owner and operator for the industrial-scale green hydrogen plant and hydrogen pipeline
- The creation of hydrogen pipeline permitting and hydrogen utility regulatory frameworks
- The siting, permitting, and construction of the 1300 MW (estimated) green hydrogen electrolyzer plant within a minimal distance of Dearborn Works
- The construction of an appropriate length of hydrogen pipeline to store and/or transmit hydrogen from the production plant to Dearborn Works

Public-Private Partnerships Will Be Critical for Ensuring Clean Steel Becomes a Reality at Dearborn Works

The solutions to the barriers presented in the previous section cross policy and financing measures and include critical public-private partnerships, in addition to ensuring that fenceline communities and advocacy organizations are effectively engaged throughout the process. Identifying all the right 'pieces' isn't sufficient to ensure an effective solution — they must also be pursued in the right order and by critical deadlines to ensure that Cleveland-Cliffs is committed to retiring blast furnace C3 instead of relining it in 2027 (estimated). If that date is missed and C3 is relined, Dearborn Works' pollutant-heavy, coal-based production process will be locked in until the 2040s, which would significantly impede Michigan's net-zero goals as outlined in its MI Healthy Climate Plan.

THE ECONOMIC INCENTIVE FOR CLEAN STEEL PRODUCTION AT DEARBORN WORKS

The proposed production path outlined above would necessitate a near-term cost premium to Dearborn Works' steel products, due in part to the relative cost of electricity to fossil fuels today. Estimates for that premium hover around US$165 per ton (US$150 per metric ton) [70] of steel, with that premium decreasing as greater renewables penetrate the power grid and ultimately being eliminated at electricity rates of $15-20/MWh.[71] For a near-term annual production capacity of 3 Mpta, this cost premium could amount to $450 million in additional revenue for Dearborn Works owner Cleveland-Cliffs.

> *A short-term price premium of $165 per ton on Dearborn steel could net Cleveland-Cliffs an estimated $450 million in additional revenue annually.*

Because a significant portion of the steel produced at Dearborn Works is purchased for use in the automotive industry, it is also important to consider the implications for the downstream product — and that product's customer base. Major automakers have given mixed signals regarding automotive market readiness for vehicles with lower embodied carbon values. In Michigan, they are simultaneously pressuring their supply chain to reduce the carbon footprint of their products and, in some cases, balking at the clean steel price premium that would extend to the vehicles they produce. Nonetheless, RMI estimates the current demand for clean steel in the automotive industry as tallying to 3.5 million tons by 2030, with automakers such as Ford, General Motors, and Volvo leading the way.[72] Modern passenger vehicles contain, on average, more than 1 ton of automotive-grade steel, which, at present, can only be produced from ore-based processes. As a result, estimates place the anticipated cost premium for clean

> *RMI estimates the current demand for green steel in the automotive industry as tallying to 3.5 million tons by 2030.*

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[70] Isha Chaudhury, Charvi Trivedi, and Priyanka Agrawal, "Green steel: challenging the status quo," Wood Mackenzie, May 9, 2024. https://www.woodmac.com/news/opinion/green-steel-challenging-the-status-quo

[71] Thomas Koch Blank, "The disruptive potential of green steel," RMI, September 2019. https://rmi.org/wp-content/uploads/2019/09/green-steel-insight-brief.pdf

[72] Alesha Alkaff, "Auto industry's green steel awareness varies, according to CALSTART," Fastmarkets, February 19, 2024. https://www.fastmarkets.com/insights/auto-industrys-green-steel-awareness-varies-according-to-calstart/

steel at $100 to $200 per vehicle.[73] With the average cost of a new vehicle in the United States at about $47,000,[74] the clean steel price premium for the average vehicle translates into an increase of just 0.2-0.4% over the existing vehicle price tag.

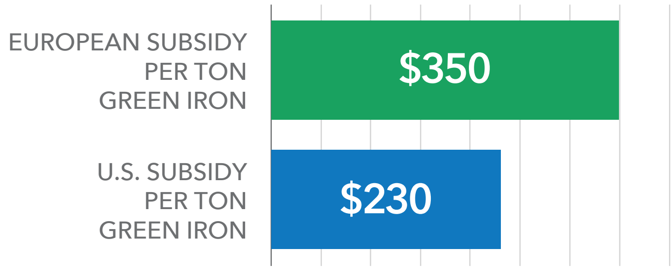
As the price premium on clean steel wanes, competition in the market will increase, as well as the demand for clean steel products. An early transition at Dearborn Works could secure the steel mill's position as a market-leader. In turn, this would help future-proof the quality union jobs, steel industry jobs, and manufacturing jobs that Michigan, Cleveland-Cliffs, and the many automakers that call Michigan home are known for. This fact is crucial to underscore, because in the alternative scenario, where Dearborn Works relines blast furnace C3 and locks carbon-intensive steel production into Michigan's future until the 2040s, the steel mill's competitiveness on a national scale could suffer dramatically — significantly increasing the odds that Dearborn Works will eventually lose its market share and 1500 jobs to new mills coming online in the south.

A TRANSFORMATIVE VISION FOR PUBLIC-PRIVATE PARTNERSHIPS

Overcoming the series of barriers identified in the preceding section would require an innovative public-private partnership between the state of Michigan and Dearborn Works' parent company, Cleveland-Cliffs — just as companies, and countries, around the world are racing to be the first to deliver hydrogen-based clean steel to the market. Several examples of clean steel projects already underway include:

- Two new clean steel production facilities in Sweden: SSAB's HYBRIT and H2 Green Steel
- Recommissioning of ArcelorMittal's Dofasco plant in Ontario, Canada, to hydrogen-ready DRI-EAF
- Recommissioning of Cleveland-Cliffs' Middletown, Ohio, plant to hydrogen-ready DRI coupled with electric smelting and the facility's existing basic oxygen furnace (recipient of up to $500 million in U.S. DOE federal cost-share)
- A new SSAB-owned hydrogen DRI mill in Mississippi (recipient of up to $500 million in U.S. DOE federal cost-share)

These projects have one critical factor in common: *They are backed by substantial public cost-share*. Public funding isn't simply a carrot to incentivize companies to experiment with innovative leaps in technology — it's also a tactical 'de-risking' tool that government agencies can use to promote transformational change in key industries. It can unlock additional private funding mechanisms, and lift companies over early-stage barriers to catalyze economic growth.



Previous research by [Industrious Labs]() and [Public Citizen]() found that 10 clean steel projects in Europe are currently benefiting from public investment. Across Germany, Sweden, Spain, Finland, France, and Romania, the committed public funding amounts to a median subsidy

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[73] Alesha Alkaff, "Auto industry's green steel awareness varies, according to CALSTART," Fastmarkets, February 19, 2024. https://www.fastmarkets.com/insights/auto-industrys-green-steel-awareness-varies-according-to-calstart/

[74] "New-Vehicle Average Transaction Prices Drop to Lowest Level in nearly Two Years, According to Latest Kelley Blue Book Estimates," Cox Automotive, April 12, 2024. https://www.coxautoinc.com/market-insights/kbb-atp-march-2024/

of over $350 per ton ($385 per metric ton) of green iron product — totaling to approximately one-third of the cumulative costs of these 10 projects. For example, the Swedish government has invested a total of US$800 million into the construction of the HYBRIT and H2 Green Steel facilities, and the governments of Ontario and Canada will contribute roughly US$600 million to the recommissioning of ArcelorMittal's Dofasco plant. In contrast, even with U.S. Department of Energy support, the Middletown and SSAB green iron projects are slated to receive just $230 per ton ($250 per metric ton) of iron product (the precursor to clean steel).[75] For Michigan to step in and close this gap with additional public funding, the state could need to provide a subsidy of at least $300 million for construction of the new DRI-EAF plant alone.

The international projects with the best potential to truly decarbonize steel production, and yield clean steel products, are in countries with significant renewables penetration into the power grid. About two-thirds of Sweden's energy is derived from renewables,[76] and nearly 60% of Germany's energy consumption comes from renewable sources.[77] In Michigan, as of 2022, just 12% of the state's electricity was generated from renewable sources — hence, for Michigan to support a clean steel transition at Dearborn Works, new renewables equivalent to the needed additional energy (4-8 GW of renewable generation, in total) must be built into the state's power grid before Cleveland-Cliffs switches its new DRI furnace from (presumably) natural gas to green hydrogen (or clean electricity would have to be purchased and imported from producers in nearby states).

If Michigan is committed to its MI Healthy Climate Plan goal of net-zero carbon emissions by 2050, the state's government must also be committed to supporting its heavy industries through a radical, rapid transition — especially its emissions-intensive primary steel producer, Dearborn Works. That support can only be realized through a transformative public-private partnership. The following are suggested guidelines for how that partnership should be shaped:

- Michigan's government needs to commit public funding to a Dearborn Works transition plan, and the amount committed should be sufficient to close the gap between public funding commitments for clean steel projects here in the United States and in Europe. Considering previous federal awards for green iron production and a continued Dearborn Works production level of 2.5 Mtpa, Michigan might need to provide upwards of $300 million in public funding for the steel mill alone.
- Michigan's government needs to establish clear expectations for the direction of change expected from industry. The net-zero by 2050 goal outlined in the state's MI Healthy Climate Plan sets a single long-term target, across the state's sectors, for carbon emissions without declaring explicit expectations for the state's industrial and manufacturing sectors — which are responsible for *many more* types of pollution than just greenhouse gases.
- Michigan should consider establishing a new institution, or re-organizing and re-aligning a portion of its Department of Environment, Great Lakes, and Energy (EGLE), with the sole purpose of supporting net-zero transition activities within its industrial and manufacturing sectors. Central to this office's mission should be fostering deep public-private relationships and partnerships, and an explicit commitment to identifying and removing the barriers that industry is facing in its effort to decarbonize.

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[75] "Government Subsidies for the Green Steel Transition, Industrious Labs and Public Citizen, March 2024. https://industriouslabs.org/archive/press-release-europe-leads-u-s-with-35-higher-subsidies-for-green-steel-new-report-finds

[76] "Swedes use a lot of energy, yet emissions are low. The key? Renewable energy." Swedish government website, accessed August 2024. https://www.coxautoinc.com/market-insights/kbb-atp-march-2024/

[77] "Public Net Electricity Generation 2023 in Germany: Renewables Cover the Majority of the Electricity Consumption for the First Time," Fraunhofer Institute for Solar Energy Systems, January 15, 2024. https://www.ise.fraunhofer.de/en/press-media/press-releases/2024/public-electricity-generation-2023-renewable-energies-cover-the-majority-of-german-electricity-consumption-for-the-first-time.html

- Michigan should boost its efforts to work collaboratively with electric utilities to forecast renewable electricity demand as a direct result of industrial decarbonization and electrification activities. Similarly, Michigan should also consider re-envisioning its role in the utility sector, perhaps by establishing a partial state ownership model to accelerate the buildout of solar and wind farms and battery storage, to correct what is otherwise a significant misalignment between current buildout rates and the tidal wave of forecasted demand for clean electricity needed for deep decarbonization of the state's industrial sector.
- Michigan should plan to lean into this new partnership model to better forecast needs in the areas of workforce up-skilling and education, to ensure that the state is best-positioned to supply the workers needed to fill the new jobs created by a clean steel transition at Dearborn Works. These interests should consider how workers likely to be displaced from EES Coke can be repositioned for hydrogen plant, solar and wind farm, and battery storage jobs.

This outline is provided merely to serve as a starting point for the state of Michigan, Cleveland-Cliffs, and Michigan's utilities, as these entities consider how best to move forward and develop plans that ensure the state can meet its MI Healthy Climate Plan objectives, while helping to clean up the air that Dearborn area residents breathe and future-proof the quality jobs in the state's steel industry.

USING POLICY AS A LEVER

Michigan has multiple opportunities to use state policy as a lever to enable the clean steel transition at Dearborn Works. Existing levers include electric utility development targets established in the 2023 Clean Energy and Jobs Act, the existing electric utility regulatory structure, which encompasses DTE Electric's MIGreenPower program (also known as a 'buy green' program), the alignment of state tax credits with the federal Qualifying Advanced Energy Project Credit (*48C(e)*) of the American Recovery and Reinvestment Act of 2009 (offering up to $200 million, for up to 33% of related federal tax credits for clean energy manufacturing and industrial decarbonization activities), and a state-level air quality permitting program for industrial emitters, run through EGLE.

But there are additional opportunities. For example, Michigan could revise its utility rate structure to spur economic development in the manufacturing sector, with an eye toward incentivizing DTE Energy to become the state's first public hydrogen utility while catalyzing additional industrial electrification efforts throughout the iron and steel sector.

Michigan could also revise its air permitting regulatory framework. The National Ambient Air Quality Standards of the Clean Air Act establishes minimum standards for air quality and assigns implementation activities to lower regulatory bodies. In Michigan, EGLE's Air Quality Division is the designated body. Any state's implementation plan can be more strict — but not less strict — than the federal guidelines. This creates an opportunity for Michigan to pursue either more stringent emissions requirements at the facility level, or a new path that could dramatically benefit communities living in industrial corridors via the establishment of a cumulative impacts law. Momentum in support of such an act already exists in Michigan: U.S. Rep Rashida Tlaib (MI-12) has sponsored such a bill at the federal level,[78] and many coalitions in Michigan have called for similar legislation at the state level.

Creating a path to clean steel in Michigan also requires the design of critical policies related to

[78] "Tlaib Introduces Bill to Fight Air Pollution with Cumulative Impact Requirement," Congresswoman Rashida Tlaib 12th District Strong, July 12, 2023. https://tlaib.house.gov/posts/tlaib-introduces-bill-to-fight-air-pollution-with-cumulative-impact-requirement

renewables and hydrogen. Michigan must ensure that its utility regulatory structure is prepared to handle a rapid surge in demand for renewables — as well as a demand for hydrogen in industrial end uses. Finally, Michigan needs to be prepared with policy that effectively governs siting and permitting for hydrogen pipelines and storage.

FINANCING LARGE-SCALE INDUSTRIAL PROJECTS

Companies finance large-scale projects through multiple means, including capital on-hand, financing, tax rebates, grants, and new revenue generation. The anticipated costs for constructing the new DRI-EAF assets and modifying air and wastewater treatment systems at Dearborn Works, as well as for constructing a hydrogen plant, hydrogen pipeline, and other infrastructure elements, are non-trivial — summing to the multi-billion-dollar range.

Even though Cleveland-Cliffs' annual earnings (2023 revenue was $22 billion, with $1.6 billion free cash flow)[79] greatly exceed the projected costs for redeveloping Dearborn Works to produce clean steel, the company has recently committed to several other substantial investments (e.g., Middletown plant upgrades). Thus, from a cost perspective, transitioning Dearborn Works to clean steel production may not be a high priority for facility owner Cleveland-Cliffs in the near-term. To help Cleveland-Cliffs off-set its costs, both the federal Qualifying Advanced Energy Project Credit (*48c(e)*) and the state of Michigan's stackable tax credit could be leveraged to reduce long-term operating expenses and allow Cleveland-Cliffs to more rapidly recoup its investment. Michigan could also create new public-backed funding mechanisms tailored to support the net-zero transitions of key industrial facilities.

The costs to construct a sufficient amount of new wind, solar, and battery storage fall largely on Cleveland-Cliffs' presumed electric utility, DTE Electric, while the costs to upgrade power substations are divided among the utility and its industrial customer (the customer's costs are known as a Contribution in Aid of Construction) according to a tariff formula and the costs to ensure adequate transmission capacity fall on MISO. For DTE, these costs would be substantial — and the electric utility would incur them at the same time that it is actively working to meet other infrastructure needs. As a result, these costs have the potential to impact the rates of other industrial customers and of millions of residential customers. Moreover, DTE Energy, as the owner of EES Coke and the Zug Island property on which the coking plant resides, is a likely candidate for the owner-operator of the new green hydrogen plant needed to supply Dearborn Works. If this project comes to fruition, construction of the green hydrogen plant would come at a significant expense to the energy company — at least $2.6 billion. Risk to DTE Energy could be reduced by Cleveland-Cliffs signing an advance agreement to buy its power from DTE Energy under its MIGreenPower program. Here again, both state and federal tax credit programs could be leveraged.

OPPORTUNITIES TO ENGAGE ADVOCATES

Michigan has a strong advocacy base in favor of cleaning up the industrial corridor surrounding Dearborn Works. For years, a range of nonprofits, community groups, and coalitions have actively lobbied for change — with the central goal of cleaning up the air, to reduce the pollution burden on those living in fenceline communities. Organizations such as the Michigan Environmental Justice Coalition (MEJC), Clear the Air, and at least 10 more advocacy groups can provide a direct link to the region's residents, as well as its current and future workforce. As

[79] 2023 Annual Report to Security Holders, Cleveland-Cliffs, April 3, 2024. https://www.clevelandcliffs.com/investors/sec-filings

key stakeholders in a transition plan for Dearborn Works — that necessarily includes its upstream suppliers, downstream steel purchasers, and its gas and electric utility provider — their voices must be engaged in shaping the ultimate vision and the policy levers that are crafted to bring about that vision.

Importantly, the clean steel opportunity at Dearborn Works offers more than cleaner air that's healthier to breathe: It also offers a chance to slash industrial carbon emissions, for Michigan to continue as a leader in efforts to mitigate the effects of climate change. Hence, this opportunity also appeals to advocates for state-wide decarbonization, and industrial decarbonization, more narrowly.

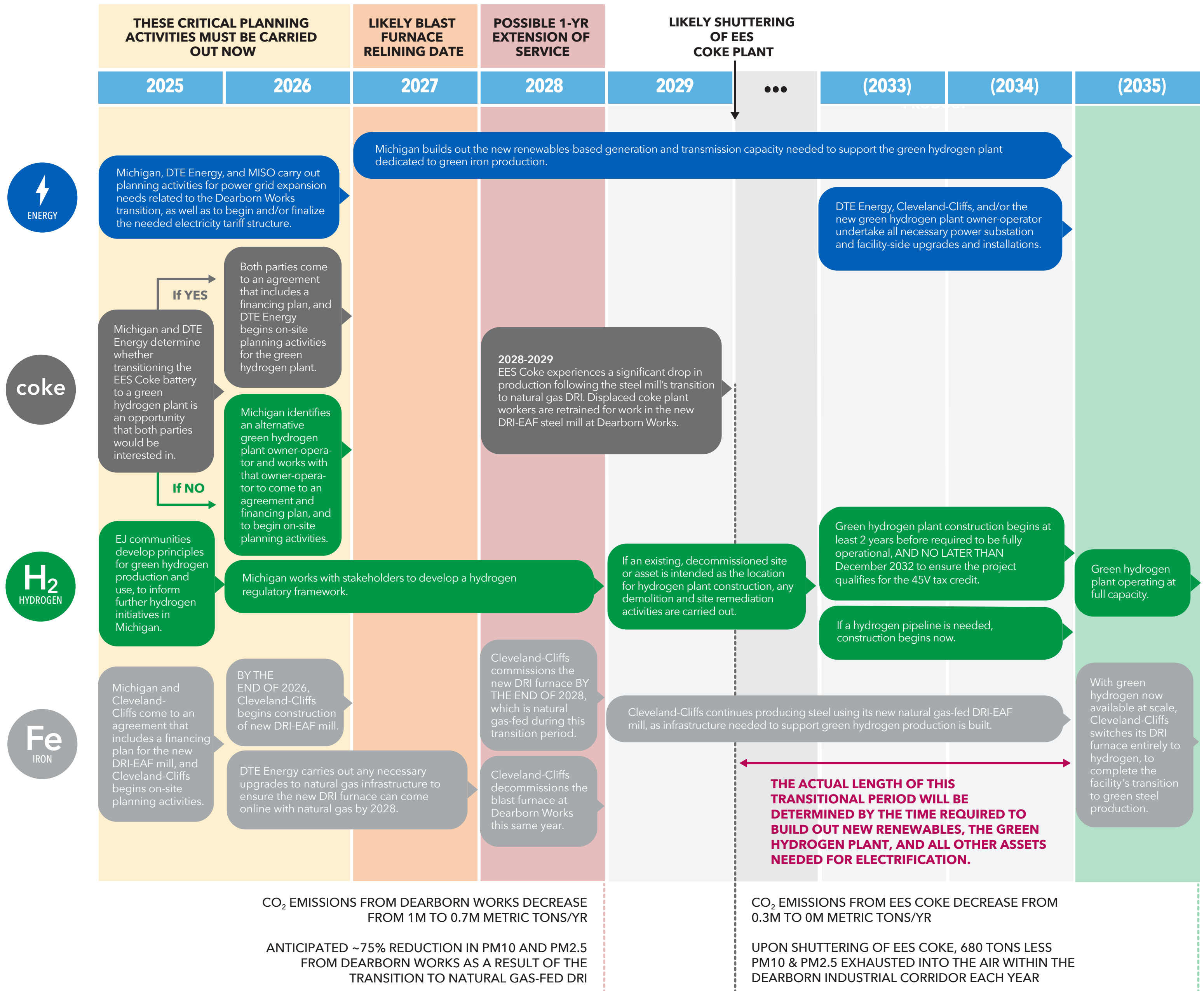
ABOVE ALL, TIME IS OF THE ESSENCE

With the anticipated relining date of blast furnace C3 to be around 2027, it is critical that key steps are taken now to ensure that the entire schedule of needed activities can be developed and adhered to, to ensure that when the blast furnace is decommissioned, Dearborn Works is also able to commission a state-of-the-art DRI-EAF mill. In some instances, it is possible to extend the lifetime of a blast furnace lining by 1-2 years. Conservatively, this implies that, with care and intentional planning, the existing blast furnace could operate through 2028, allowing additional time to finalize the facility's transition plan. Only Cleveland-Cliffs can advise regarding these details of the blast furnace's lifetime and lining.

All the relevant time elements laid out in earlier sections of this report are here compiled into a single timeline (Figure 10) — one that can also demonstrate the many interdependencies. To ensure that a DRI-EAF mill at Dearborn Works can come online by the end of 2028, the figure shows that several activities must be initiated *now*. This will ensure that by the end of 2025, the state of Michigan and Cleveland-Cliffs can come to an agreement for a transition plan that includes both a financing plan and a community benefits plan. This plan should also include input and/or buy-in from other key entities — at least: DTE Energy, EES Coke, NorthStar Clean Energy (owner of DIG Power), and MISO. This approach allows three years for DRI-EAF construction at Dearborn Works, as well as any necessary upgrades to natural gas infrastructure, to ensure that the steel mill can seamlessly continue operation in 2028 as it transitions production to the DRI-EAF assets. A seamless transition is critical for ensuring that steel mill workers remain employed.

In this scenario, the transition to natural gas is seen as *temporary* — it is a placeholder intended to provide sufficient time for DTE Energy, MISO, and Cleveland-Cliffs to finalize plans for a green hydrogen plant, any electricity tariffs, and additional renewables generation and transmission needs and then to begin the associated construction activities. The federal 45V tax credit associated with clean hydrogen production stipulates that to be eligible, construction of the facility must begin *before* January 1, 2033 — this means that hydrogen plant construction *must begin* in December 2032, at the absolute latest. Assuming roughly two years for hydrogen plant construction, this sets 2035 as the latest expected date for green hydrogen availability at scale for DRI production. Further, it is expected that all procedures related to regulatory structures and tariffs could require until 2027 or 2028 to complete. These two dates — 2027 and 2035 — leave roughly eight years for the construction of all renewables generation and transmission elements needed to supply the green hydrogen plant. For a project of this scale, it should be noted that this is a relatively accelerated timeline — thus, every effort to ensure that negotiations are completed as soon as possible is critical for further ensuring that all construction can also be completed as soon as possible.

Because these timeline elements are bounded by an end date in 2035, the timeline also shows a period of flexibility. The extent to which this timeline could be shortened will depend on the negotiations and planning activities of the various parties, including community members, and associated construction activities. There is also potential for hydrogen production to come online in a phased manner that could allow for mixed-feed crude iron production, using natural gas blended with green hydrogen. This approach would offer several advantages, such as earlier (partial) reductions in GHG emissions and other pollutants associated with natural gas usage, as well as shorter investment recoup times for the new green hydrogen plant's owner-operator.
It is beyond the scope of this report to analyze the timeline elements of the transition plan in any further detail. Instead, this timeline should be seen as a rough guide, with the primary takeaway being that the state of Michigan must take the initiative to bring all interested parties to the table and begin these discussions as soon as possible — because time is of the essence.



Figrure 10
The timeline presented here lays out all critical elements described in this transition plan, and indicates interdependencies as well as milestones in production and drops in greenhouse gas and pollutant emissions. The early timeline elements are critical to complete now, to position Dearborn Works to retire its blast furnace by the end of 2028 while seamlessly transitioning its production and workforce to the new DRI-EAF mill. The later timeline elements are bounded by two critical events: starting construction on the green hydrogen plant in December 2032, to ensure that the project qualifies for the federal 45V tax credit, and commissioning the green hydrogen plant so that the DRI-EAF mill can be switched from natural gas to green hydrogen to deliver its first truly green iron and green steel products ('clean steel'). This allows DTE Energy an upper limit of roughly eight years for the construction of all new renewable power generation and storage assets. There is also the possibility that green hydrogen-based iron production could be phased in through blending as portions of the green hydrogen plant and renewables buildout are brought online. Cleveland-Cliffs and other key parties will need to verify the details of certain timeline elements, like the anticipated blast furnace relining date or possible one year extension of service. Communities, coalitions, and advocacy organizations should be engaged in as many steps of this transition plan as possible.

Conclusion and Next Steps

Industrial facilities like Dearborn Works are, in many ways, cornerstones of the communities where they reside. They contribute thousands of quality jobs, generate millions of dollars in state revenue, and often lend themselves to iconic legacies rooted generations deep among proud local families. But they also adversely impact local air quality and water quality, which in turn can negatively impact the health of facility workers and community residents. Further, integrated steel mills like Dearborn Works pump millions of tons of climate-warming gases into the atmosphere each year. In Michigan, Dearborn Works and EES Coke, the steel mill's likely coal products supplier, contribute an estimated 1.3% of all the state's carbon dioxide emissions — that's more than 1 in every 80 molecules of carbon dioxide emitted by all activities and sectors, originating from just two industrial facilities.

Fortunately, new technology that replaces pollutant-heavy coke (a coal product) with clean-burning hydrogen in the production of crude iron from iron ore is poised to disrupt the decades-old primary steelmaking industry — *across the world*. Michigan has the chance to play a leading role in this historical transition to 'clean steel' by investing directly in Dearborn Works, thereby accelerating the rate at which the mill's owner, Cleveland-Cliffs, can transition its fleet of U.S.-based blast furnaces to hydrogen-based direct reduction, coupled with established electric arc furnace technology for steelmaking (hydrogen DRI-EAF).

Transitioning Dearborn Works to green hydrogen-based integrated steelmaking will slash greenhouse gas emissions and health-harming air pollution — vaulting the state an entire leap closer to the objectives set in its MI Healthy Climate Plan. The transition will also create more than 960 new jobs in hydrogen production and renewables and future-proof quality jobs in the steelmaking industry by ensuring that the advanced steel products manufactured at Dearborn Works remain in high demand as steel purchasers increasingly pursue lower carbon footprints of the products they source from every step of their supply chain.

But to secure Dearborn Works' future as an early mover in the global transition to clean steel production, Michigan must act now. To date, Cleveland-Cliffs has publicly stated no plans to transition Dearborn Works to green hydrogen DRI-EAF steelmaking — and meanwhile, the mill's sole blast furnace is anticipated to need relining in 2027, which would lock emissions-intensive, coal-based steelmaking into Michigan's future until the 2040s. Thus, to ensure that Cleveland-Cliffs halts any plans to reline the blast furnace at Dearborn Works — and instead, commits to the construction of a new hydrogen DRI-EAF mill — Michigan must initiate critical discussion and negotiations with Cleveland-Cliffs and other key stakeholders as soon as possible.

As outlined in Figure 10, the steps that Michigan must take today to ensure that the path to clean steel becomes a reality at Dearborn Works by 2028 include the following:

- Michigan, Cleveland-Cliffs, and DTE Energy (the steel mill's utility and owner of EES Coke) must initiate negotiations and planning discussions toward a new hydrogen-fed DRI-EAF steel mill at the existing Dearborn Works site.

- Michigan must work with Cleveland-Cliffs to develop a financing plan that includes a degree of state co-funding (i.e., a subsidy) to close the gap between existing U.S. clean steel project funding rates (estimated at $230 per ton) and European funding rates ($350 per ton), totaling to a suggested state commitment of at least $300 million in the steel mill complex.
- Michigan must identify an owner-operator and location for a green hydrogen plant, to supply the necessary hydrogen for clean steel production at Dearborn Works.
- Michigan, DTE Energy, and MISO must initiate planning activities for power grid expansion needs (including renewables generation, storage, transmission) related to powering a green hydrogen plant large enough to supply 140 million kg of hydrogen to Dearborn Works per year.
- Michigan must begin working with stakeholders to develop a hydrogen utility regulatory framework and a regulatory framework for hydrogen pipelines.

Most importantly, all of these actions must be undertaken while engaging community members and advocacy groups, to ensure effective community benefits plans are put in place, so that the Dearborn Works transition aligns with the needs of all stakeholders, not just a few.