SUSTAINABLE METALS MANUFACTURING OPPORTUNITIES IN INDIANA

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Contents

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The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

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The **Citizens Action Coalition** (CAC) is Indiana's oldest and largest consumer and environmental advocacy organization. CAC's mission is to initiate, facilitate, and coordinate citizen action directed at improving the quality of life of all inhabitants of the state of Indiana through principled advocacy of public policies to preserve democracy, conserve natural resources, protect the environment, and provide affordable access to essential human services.

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Executive Summary

Indiana's economy is based on industry. More than a quarter of the state's gross output is from the manufacturing sector, which employs more than 16% of the state's workforce. Metals and automotive manufacturing make up the core of Indiana's manufacturing output: Indiana is home to more than a quarter of the nation's steelmaking capacity and one of only five remaining U.S. primary aluminum smelters; it is also a leading state for automotive manufacturing. These well-established industrial value chains are paying off for the state: Just since the signing of the federal Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act and Inflation Reduction Act in August 2022, Indiana has captured more than $7 billion in investments in new manufacturing capacity for electric vehicles and batteries, yielding an expected 2,100+ new jobs. As federal funding opportunities meant to reshore domestic manufacturing supply chains continue to spur new investments across the country, Indiana must continue to secure private and public sector investments to maintain its position as a national manufacturing leader.

A key aspect of retaining Indiana's central role in U.S. manufacturing is incentivizing industry to invest now, in Indiana, in the transformative new technologies that are driving a sustainable, global industrial revolution. Much of the state's manufacturing facilities continue to be powered by fossil fuels, especially coal. In addition to relying on coal, Indiana's metals sector uses dated and emissions-intensive manufacturing processes, even though lower carbon alternatives are available and used in other states. With U.S. automakers and other manufacturers committing to carbon neutrality, Indiana is at risk of losing its competitive edge in metals manufacturing unless it pivots to a decarbonized industry. General Motors (GM), Honda, Toyota, Stellantis, and Subaru—all of which have plants in Indiana—have pledged to achieve carbon neutrality in their supply chains between 2038 and 2050. This would require the automakers to stop using steel and aluminum from Indiana's currently carbon-intensive metals facilities. Steel manufacturing employs 28,000 Hoosiers, but the steel workforce is half of what it was in 1990. To protect those Indiana jobs, now is the time to take advantage of the billions of dollars in tax credits and other financial incentives available for industrial decarbonization. Indiana needs to begin planning for industrial decarbonization, especially in the metals sector, to retain and expand its manufacturing base.

Luckily for both the iron and steel and aluminum manufacturing industries, clear technological roadmaps have already been established to produce these metals with minimal carbon emissions and pollution. This technological transition will require massive capital expenditures. Investing now, however, provides the opportunity to capture early-adopter incentives, which include billions of dollars in federal funding opportunities and fixed private contracts for high-value, low-carbon goods that are still in scarce supply. For example, a recent agreement was announced by GM to procure an advanced sustainable steel product from U.S. Steel, manufactured with 75% fewer carbon emissions than traditional blast furnace production (United States Steel 2023). These growing value chains

can encourage the necessary investment in transformative industrial technologies that will enable a productive and sustainable manufacturing sector in Indiana for decades to come.

In this report, we map out the opportunities and challenges that lie ahead for the steel and aluminum manufacturing industries in Indiana and highlight how a growing electric vehicle manufacturing ecosystem is key to supporting the necessary technological investments to upgrade primary metals manufacturing capacity. While Indiana metals manufacturers already produce a large proportion of the aluminum and steel demanded by our growing economy, their facilities continue to rely on outdated technologies (polluting coal-fired power plants and blast furnaces), when cutting-edge, efficient technologies that minimize carbon emissions and pollution are already commercially available and capable of replacing current manufacturing capacity. Achieving this transition will require a massive effort to strategize and coordinate across key stakeholder groups, including state policymakers, utilities and utility regulators, organized labor, industry, and community groups. Finding a path forward requires an honest assessment of energy, workforce, and infrastructure investment needs, especially for the massive primary metals manufacturing facilities located in the state (figure ES-1).

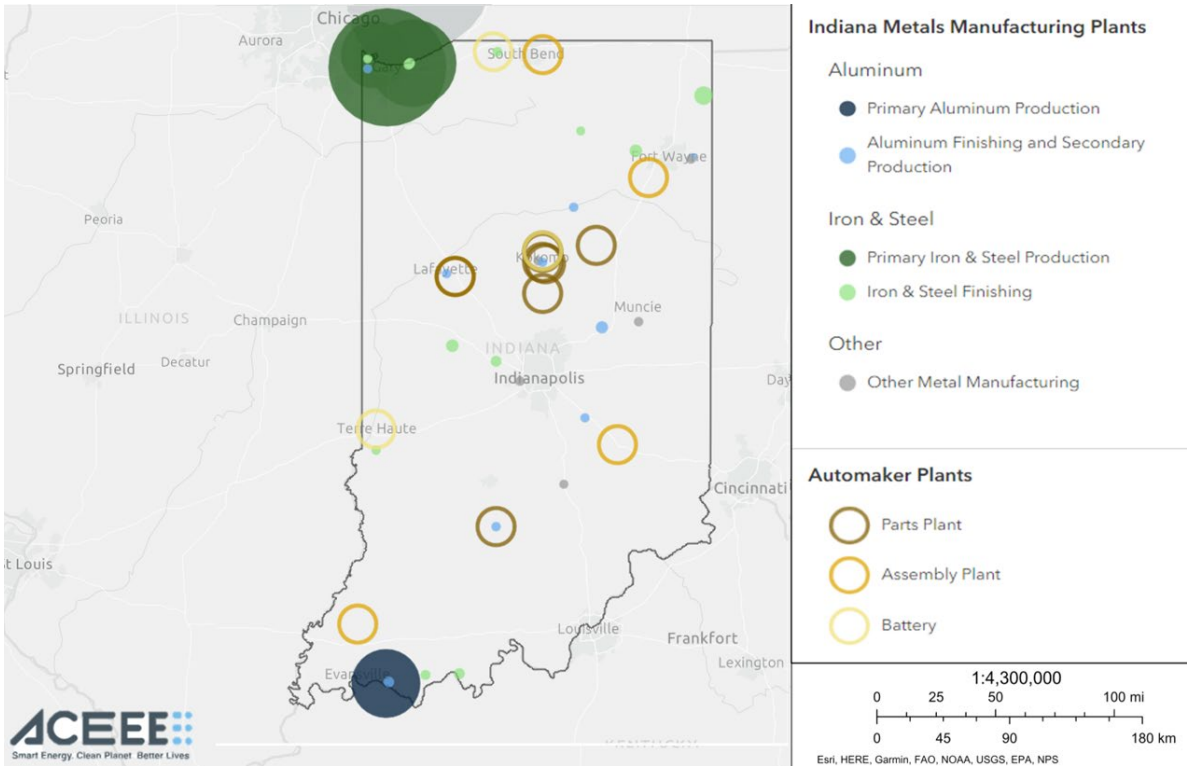

Figure ES-1. This figure shows the geography of metals manufacturing in Indiana and the automotive industry. Indiana has the highest concentration of manufacturing jobs in the country. The size of the metals manufacturing facility circles are proportional to the annual carbon emissions, as reported to the EPA. While many smaller facilities support the metals manufacturing value chains, the vast majority of pollution and

carbon emissions in Indiana come from a handful of primary iron and steel and aluminum manufacturing facilities. Data sources: EPA GHGRP, Third Way.

INTRODUCTION

Indiana's economy is grounded in industrial manufacturing. Industry consumes a plurality of energy in Indiana (45.8% in 2021), with 58% of the total state electricity demand sourced from coal (EIA 2022). Metals manufacturing, in particular, forms the backbone of Indiana's industrial sector (figure 1). More than a quarter of all steel produced in the United States comes from Indiana. Steelmaking employs 28,000 workers in Indiana, with an economic impact within the state of an estimated $12 billion (Ross 2022). Indiana likewise has a robust aluminum manufacturing value chain.

Automotive manufacturing, one of the major downstream demand sectors for steel and aluminum, also plays a strong economic role in the state, employing 116,000 workers, according to the Indiana Economic Development Corp. Overall, Indiana has the highest concentration of manufacturing jobs in the country. Moreover, automotive manufacturing garners huge private sector investments. For example, Stellantis recently pledged more than $2.5 billion, in partnership with Samsung SDI, to kick-start electric vehicle battery manufacturing in Kokomo, Indiana; GM and Samsung SDI followed by announcing plans to build a more than $3 billion electric vehicle battery cell manufacturing plant in New Carlisle, Indiana.

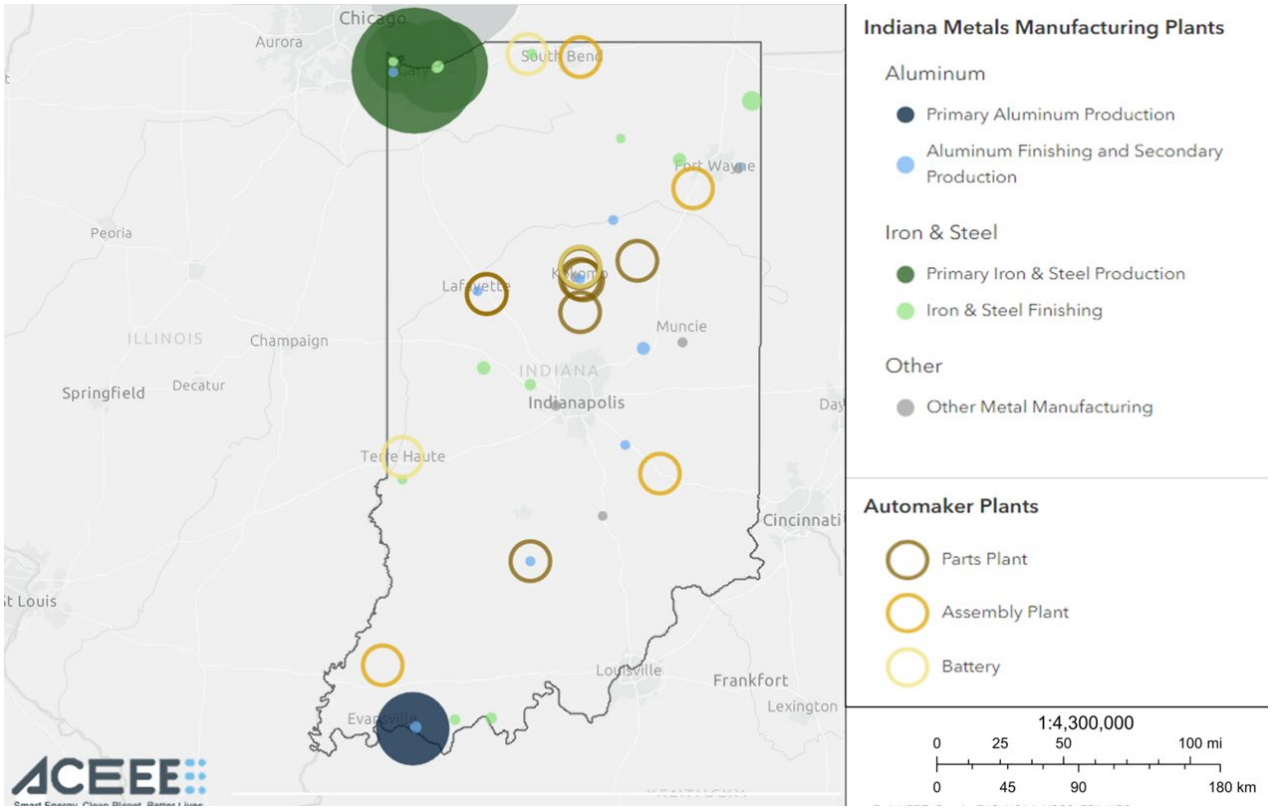

Figure 1. This figure shows the geography of metals manufacturing in Indiana and the automotive industry, a key demand pull for sustainably produced steel and aluminum. The size of the metals manufacturing facility circles are proportional to the annual carbon emissions, as reported to the EPA. While many smaller facilities support the metals manufacturing value chains, the vast majority of pollution and carbon emissions in Indiana are sourced from a handful of primary iron and steel and aluminum manufacturing facilities. Data sources: EPA GHGRP, Third Way.

For Indiana to maintain its place as a national leader in metals manufacturing and downstream reliant industries like the automotive sector, strategic investments are necessary in clean energy, workforce development, cutting-edge industrial technologies, and building of strong public-private partnerships to leverage an unprecedented level of federal funding to support a competitive American domestic industrial economy. Expanding electric vehicle (EV) value chains in Indiana represent a key market demand pull, supporting the investments in transformative technologies and an expanded clean energy system that can lead to a resilient and competitive steel and aluminum manufacturing sector. This is especially true as automotive manufacturers move toward developing fixed contracts with suppliers for specialty materials such as high-value steel and aluminum components.

The availability of cheap, abundant energy in Indiana was the initial draw for many energy-intensive industries. But as coal loses its economic edge and natural gas prices become more volatile, the energy sector must diversify and invest in expanding access to the most cost-effective energy resources for the future—especially wind and solar paired with energy storage. Indiana must also redouble energy efficiency efforts to ensure affordable, reliable, and resilient electric power to meet the needs of its industrial economy as well as new sources of electricity demand, such as EV charging and the production of renewably powered hydrogen.

Indiana can leverage its rich network of educational institutions and build on a variety of successful workforce programs to ensure that Indiana communities have access to training that leads directly to well-paying jobs and the necessary skills to successfully meet the needs of an evolving industrial future. State and local policy strategies that support a growing clean manufacturing sector and expand well-paying jobs to Indiana communities that have historically been left behind can also lead to community co-benefits, including reducing pollution and energy cost burdens, and supporting Indiana's small- and medium-sized businesses.

In this report, we lay out a set of viable paths to a resilient, competitive, and sustainable metals manufacturing sector in Indiana, focusing on the iron and steel and the aluminum industries. We highlight the greatest opportunities to maximize economic and manufacturing jobs growth in the state, while reducing energy costs, carbon emissions, and pollution burdens for Indiana communities. We identify workforce and clean energy needs and assets in the state, and highlight opportunities to leverage federal investments in clean energy infrastructure and manufacturing, and to support industries such as electrical vehicle (EV) manufacturing and aluminum packaging. These growing value chains can sustain demand for advanced, high-value metals and encourage investment in the transformative

technologies that will enable a productive and low-emissions manufacturing sector for decades to come.

Steel Manufacturing in Indiana

Global demand for steel, an essential material for transportation, construction, and energy infrastructure, could increase 15–30% by 2050. To meet internationally agreed-upon greenhouse gas (GHG) emissions goals, however, this extremely energy- and emissions-intensive industry[1] must find a way to continue to produce high quality steel while simultaneously increasing production and material efficiency, working toward eliminating carbon emissions from the manufacturing process, and supporting essential public benefits, including avoidance of health-harming local pollution and creation of good jobs with safe working conditions.

Indiana is the heart of U.S. steelmaking, accounting for more than a quarter of overall domestic production: In 2022 Indiana produced 21.5 million tons of steel. Following the decline of the steel industry in the United States in the 1970s, domestic steel production was consolidated into northwestern Indiana, where today some of the largest integrated[2] mills in the world continue to function—namely U.S. Steel's Gary Works and Cleveland-Cliffs' Burns Harbor and Indiana Harbor facilities—all of which rely on the traditional energy and emissions-intensive blast furnace–basic oxygen furnace (BF-BOF) route to manufacture steel from iron ore, coke, and limestone. The Gary Works facility is the single largest climate polluter in Indiana, emitting even more greenhouse gas emissions each year than any of Indiana's carbon-intensive coal-fired power plants. The Indiana Harbor and Burns Harbor facilities are the fourth and fifth largest GHG emitters, respectively. Metals manufacturing in Indiana is responsible for the largest portion of industrial emissions in Indiana, apart from fossil fuel combustion (e.g., coal or natural gas) power plants (United States Environmental Protection Agency 2023a). For scale, the emissions from the metal manufacturing sector (primarily driven by iron and steel manufacturing at these three largest facilities) in Indiana in 2019 was equivalent to the annual emissions from 1.36 million homes' energy use.

Most steel plants in the United States today, however, are not large integrated facilities, but instead are smaller electric arc furnaces (EAFs) that melt iron and steel scrap into recycled, or secondary, steel. These facilities usually rely on grid electricity with natural gas as a supplemental power source, although the steel industry is increasing its investments in behind-the-meter renewable power sources to ensure a consistent supply of carbon-free energy (e.g., NuScale Power 2023). Unlike BF-BOF facilities, EAFs can run intermittently, respond flexibly to market conditions, and are usually sited close to small steel processing

[1] Steelmaking today is responsible for 7% of the world's GHG emissions, but this is driven largely by inefficient coal-fired plants in China.

[2] Integrated in the sense that both iron ore smelting and steel making are integrated into the same location

mills and steel product markets, reducing shipping and transportation costs (Dock et al. 2021). While traditionally EAFs have produced lower value structural steel from recycled materials, process innovations now allow these mills to produce higher-performance steel alloys (Pistorius 2017; Tita 2023). For example, the newly constructed Big River Steel mill in Arkansas produces high performance steels with EAF technology and is currently completing construction of an associated electrical steel finishing line, with plans to also build out capacity for manufacturing advanced high strength steel (AHSS) for the automotive sector—an example of the high-quality steel grades that previously had not been attainable using EAF.

Because of the dominance of EAFs in the United States—67% of the steel produced in the United States in 2018 came from EAFs (Hasanbeigi and Springer 2019)—domestic steel production already has much lower carbon emissions than the global average. The reliance of U.S. BF-BOF facilities on iron ore pellets rather than sintered ore also reduces the carbon intensity of U.S. steel production compared to the global average. However, BF-BOF production remains a key pathway today for the steel industry to fulfill current demand, especially for higher-quality steels, due to a combination of shortages and high prices for steel scrap and pig iron (Tita 2022), a lack of investment to date in alternative high-value primary steelmaking paths, and anticipated growth in demand for steel in the future. Nonetheless, rapid progress in decarbonizing and modernizing the iron and steel industry in the United States could be made via public-private partnerships, federal incentives, new affordable sources of clean energy, maturing technologies, and increased demand and willingness to pay for more sustainable products. This would allow the United States to compete on the global stage for a share of the high-value, sustainable steel product marketplace.

THE FUTURE OF STEEL MANUFACTURING IN THE UNITED STATES

The blast furnace–basic oxygen furnace (BF-BOF) pathway for primary steelmaking has been in use since the 1400s. Modern BF-BOF facilities are much more energy efficient and incorporate pollution controls to reduce air and water emissions, but still follow the essential original steps and rely on coal and coke (a solid form of coal, reduced primarily to carbon) to fuel high temperature heat processes, as a reducing agent in the chemical reaction that transforms iron ore into pig iron, and as the source of carbon needed for the final steel alloy product. Fully replacing coal or coke in BF-BOF steelmaking facilities (e.g., with a combination of biochar and hydrogen) is not currently technically or economically feasible at the scale required.

A parallel primary steelmaking pathway relies on natural gas to fuel direct reduction iron (DRI) plants, creating iron feedstock that can be fed directly to EAFs. This DRI-EAF pathway is much more easily decarbonized, as natural gas can be replaced by green hydrogen with little additional capital expense and EAFs can run on renewable electricity. EAFs also can very efficiently recycle steel scrap. Because the steel industry in the United States is dominated by

EAFs, the carbon intensity per unit of steel is the second lowest globally; for comparison, China's steel is almost twice as carbon intensive, on average (DOE 2022).

Despite releasing comparatively few emissions compared to global steelmaking averages, the U.S. steel industry still is responsible for more than 66 million tons of carbon emissions per year, the vast majority of which come from facilities that still rely on the BF-BOF steelmaking pathways (United States Environmental Protection Agency 2023b). Northwest Indiana, the location of three BF-BOF facilities run by U.S. Steel and Cleveland-Cliffs , is ranked sixth in the United States for toxic releases per square mile and the surrounding residential communities experience numerous health burdens (Snider and Reilly 2022). Limited options exist for deep decarbonization or pollution mitigation for these facilities apart from carbon capture utilization and sequestration (CCUS) technologies. CCUS have not yet been applied successfully at scale to an iron or steel manufacturing facility (Thiele 2021); they are also energy intensive and expensive to operate.

Aside from limiting the demand for steel and enhancing recycling pathways, the only proven technological strategy available today for achieving net-zero steel production is to switch from BF-BOF manufacturing to green hydrogen–based DRI combined with EAFs. While there are technologies available now to reduce the carbon intensity of BF-BOF production (e.g., operating efficiencies or using lower-carbon feedstocks), none of these strategies can achieve deep decarbonization, compatible with a net-zero carbon emissions goal. However, the recent announcement by Cleveland-Cliffs of several large, long-term (10+ year) investments in BF infrastructure suggests that they are currently committed to maintaining their BF-BOF steelmaking pathway. While U.S. Steel has committed to achieving net-zero carbon emissions by 2050, Cleveland-Cliffs has not made any public commitments to a net-zero timeline.

Investment in new, efficient, and technologically advanced facilities that can produce steel with close to zero emissions is supported by increasing market demand for *low embodied carbon* steels: those made from manufacturing processes that emit relatively little GHGs. These market pulls for low-carbon products are coming from both the private and the public sector. For example, the U.S. federal government is favoring low-carbon, domestically produced steel with its new "Buy Clean" purchasing requirements through the Department of Transportation (DOT) and the General Services Administration (GSA). Additionally, investment and production tax credit bonuses of up to 10% are now available for energy infrastructure projects that make use of domestically produced iron and steel. Commitments by private companies to source low-carbon materials have led, for example, to General Motor's recently announced contract with U.S. Steel for an automotive steel product produced with 75% fewer emissions compared to traditional production methods (United States Steel 2023).

Steel manufacturing in the United States continues to shift to favor electricity-powered flex and mini-mills, but substantial investments in a variety of technological upgrades will be required to reconfigure steel production at the remaining large integrated facilities and move from the BF-BOF steelmaking pathways to newer, advanced steelmaking strategies

that rely primarily on green hydrogen and electricity. The iron and steel industry have taken some of the initial steps toward decarbonizing: Cleveland-Cliffs' direct reduction iron (DRI) plant, built in Toledo, Ohio, in 2020, relies on natural gas to manufacture hot briquetted iron (HBI), a lower-carbon feedstock that can be used in both traditional BFs and EAFs. This facility was designed to allow for hydrogen to be blended with natural gas as a fuel, providing a direct path to zero-emissions iron production at this facility if the hydrogen is produced from renewable energy (green hydrogen). U.S. Steel has not yet built DRI plants—the necessary precursor to a fully decarbonized steelmaking path—but they recently announced an investment in an iron ore processing facility that makes DR-grade iron pellets (Pete 2022b). They also recently built a new pig iron casting line ($60 million, operational as of January 2023) at Gary Works, which enables it to provide half of the pig iron needed for U.S. Steel's new EAF facility, Big River Steel, in Arkansas. DRI facilities, however, can also create iron feedstocks like HBI, which can be fed into EAFs in much the same manner as pig iron and result in higher-quality steels. Despite decarbonization goals and investments, neither major steel company's recent actions indicate a full commitment to updating their manufacturing approaches.

Ultimately, the most straightforward pathway to producing high quality primary steel with minimal carbon emissions is to convert all existing BF-BOF steelmaking to DRI-EAF pathways (currently ~8% of global steel production), as well as investing in a circular steel economy to ensure that all steel scrap is collected and recycled. Currently, the major barriers to converting BF-BOF production to this pathway are (1) the capital expense of building or expanding new facilities, combined with the cost of stranded assets related to infrastructure investments for current BF-BOF pathways; (2) the economics of hydrogen (green hydrogen is not yet economically viable, although natural gas could be used for an interim period as Cleveland-Cliffs is now doing in Toledo); (3) the availability of enough carbon-free electricity at scale; and (4) the obtainability of high-quality steel scrap, to allow for high performance recycled steel to meet demands at scale.

OPPORTUNITIES FOR STEELMAKING IN INDIANA

Indiana remains the largest source of primary steel manufacturing in the United States, with an essential economic impact within the state of an estimated $12 billion (Ross 2022). The remaining iron and steel workforce, however, is just half of what it was in 1990; in addition to job loss, the communities surrounding the large integrated mills have experienced many decades of poor air quality and poor health (Snider and Reilly 2022). To ensure a steelmaking future in Indiana that retains well-paying jobs, reduces harmful pollution, and contributes to a robust and sustainable domestic primary steel manufacturing economy, a clear plan should be established for the eventual transition away from BF-BOF facilities to DRI-EAF primary steel production pathways. While this is an ambitious goal, Indiana can build on a number of preexisting strengths to maintain its position as the heart of steelmaking in the United States and encourage industry to make the necessary investments to achieve deep decarbonization, such that Indiana becomes a global leader in clean steelmaking.

Deep, well-established value chains

Indiana's steel mills are already deeply embedded within a network of regional downstream steel finishing and product manufacturers. This steady demand, coupled with reduced transportation costs as a result of their proximity to production sites, access to shipping ports for raw materials, and a trained workforce that has established partnerships with organized labor, make a strong economic case for continued investment in steel manufacturing in Indiana (Pete 2022a), even given the substantial capital expenditures required to transition BF-BOF facilities to the more sustainable DRI-EAF pathway. For example, rail lines directly connect Indiana Harbor and Burns Harbor integrated mills to the Tek and Kote continuous cold-rolling plant in New Carlisle, Indiana, where raw steel can be transformed into sheet for automotive and appliance markets. Key regional customers for these cold-roll steel products include General Motors (Moggridge 2020) and other automotive manufacturing supply chain businesses concentrated in the Midwest (e.g., Michigan, Kentucky, Ohio), which in turn support a network of small businesses in Indiana, delivering a variety of necessary automotive supply chain components.

Opportunities to develop regional green hydrogen infrastructure

Hydrogen made from renewable energy is an essential tool for decarbonizing steel production, as it can replace natural gas in DRI operations as a reducing agent that transforms iron ore into a form usable in both EAFs and BF-BOFs. For example, at the DRI plant in Toledo, up to 30% of the natural gas currently used as the sole reducing agent can be substituted with hydrogen without any further modifications. With small additional investments, hydrogen usage could increase to 70%, which would eliminate over one million metric tons of GHG emissions per year compared to current operating conditions with natural gas (Cleveland-Cliffs 2023). A recent estimate of the hydrogen required to reach a net-zero steel industry in the United States by 2050 assumes a dramatic increase in DRI facilities (>600% increase in DRI capacity between now and 2050) with an expected ultimate demand of ~190 trillion Btu of green hydrogen per year to fuel these facilities in the Midwest census region (Pascale and Larson 2021). For context, the United States currently produces approximately 1 quadrillion Btu of hydrogen per year, and 95% of this hydrogen is *gray*, a highly emissions- and energy-intensive product of steam methane reforming of natural gas. A decarbonized iron and steel sector would be a significant demand sector for the future green hydrogen economy.

Two coalitions near Indiana have applied to the Department of Energy (DOE) $7 billion hydrogen hub program, which will fund 6–10 projects to kick-start regional clean hydrogen ecosystems across the country. The state of Illinois is the lead on a hydrogen hub application for the Midwest Alliance for Clean Hydrogen (MachH2), which Indiana has also signed on to support; the application cites northwest Indiana's heavy industry and logistics (e.g., freight transport) network as ideal end users of clean hydrogen and of an increasingly cleaner electricity supply. If DOE chooses to fund MachH2, this could increase support for shifting more steel production toward the hydrogen DRI-EAF pathway. However, few details on the MachH2 concept have been shared publicly at this time, and it is unclear what hydrogen

sources would be pursued and what end uses would be prioritized. A second, competing hydrogen hub in the region, the Great Lakes Clean Hydrogen Partnership (GLCH), identifies Cleveland-Cliffs' new DRI plant in Toledo, Ohio, as a key demand pull for the clean hydrogen it would produce.

CHALLENGES FOR STEELMAKING IN INDIANA

A SUSTAINABLE HYDROGEN ECONOMY REQUIRES ACCESS TO LOW-COST RENEWABLE ELECTRICITY

Green hydrogen produced with renewable energy is an essential tool for a variety of hard-to-decarbonize economic sectors, including heavy-duty shipping and transport, and manufacturing processes that require very high heat, such as chemicals, cement, and iron and steel sectors. Manufacturing hydrogen, however, is an extremely energy-intensive practice; large amounts of clean energy will be necessary to fuel this growing economy. And given the difficulties of transporting hydrogen over long distances, available clean energy close to the target end-use sectors is essential. Indiana must continue to invest heavily in a low-carbon power sector to support a growing regional hydrogen economy, as sustainable and affordable hydrogen is a necessary tool for a decarbonized DRI-EAF steelmaking path. The economics of manufacturing, storing, and transporting sustainable, low-carbon hydrogen at scale are not yet fully worked out, but state and federal incentives for sustainable hydrogen production have surged. Even if green hydrogen–fueled DRI facilities cannot ultimately produce iron at the same cost as with natural gas, the public and private sector are demonstrably willing to pay a premium for sustainably produced products. For example, The First Movers Coalition is a public-private partnership led primarily by large, global companies that have pledged to purchase lower-carbon materials to integrate into their products, including steel. Key downstream steel purchasers in Indiana, such as General Motors, have joined this program.

BUILDING DECARBONIZED NEW STEELMAKING FACILITIES IS MUCH MORE STRAIGHTFORWARD THAN RETROFITTING LEGACY BLAST FURNACES

Newer steelmaking facilities are built with an eye toward future clean manufacturing strategies. For example, the newly constructed DRI facility in Toledo was designed to allow easy switching of fuels from natural gas to green hydrogen, as soon as green hydrogen is cost competitive and available at the scale necessary. Given the costs, risks, and uncertainty of CCUS and the advantages provided by DRI-EAF technologies, retaining BF-BOF steelmaking pathways long term is unlikely to be an effective strategy for decarbonizing primary steel production in Indiana. Planning now for the transition to DRI-EAF pathways allows the steel industry to take advantage of federal funding opportunities for "first movers" and avoids sinking additional costs into facilities that will need to be fully redeveloped to support low-carbon manufacturing pathways in line with global commitments to net-zero emissions.

POTENTIAL PATHS FORWARD FOR STEELMAKING IN INDIANA

INVEST AT A SCALE REFLECTIVE OF NEEDS

Decarbonizing the iron and steel industry in the United States requires a massive investment—an estimated $1.4 trillion dollars by 2050 to achieve global success (Wu, Vora, and Chaudhary 2022). Additionally, to implement solutions at the scale needed, a variety of cross-cutting resources and economics must align. A decarbonized steel industry requires affordable and sustainably produced hydrogen, vast amounts of clean electricity to power DRI and EAF facilities, and a trained workforce able to make the transition to operating new steel production pathways. While U.S. Steel has committed to operating with net-zero emissions by 2050, Cleveland-Cliffs has not yet made any public commitments to a net-zero timeline. However, given that many of Cleveland-Cliffs' major contracts are with automakers with commitments to decarbonize supply chains, they are likely already experiencing pressure to invest more heavily in sustainable manufacturing technologies.

Cleveland-Cliffs' Burns Harbor plant, for example, just applied for funding from the U.S. DOE's Office of Clean Energy Demonstrations for a carbon capture project that would capture up to 2.8 million tons of CO_2 per year—only 28% of the CO_2 emitted from this facility annually. While this reduction may help Cleveland-Cliffs achieve shorter-term goals, ultimately they will need to either substantially expand the carbon capture system (an expensive and unproven strategy) or switch production to the DRI-EAF pathway to achieve a net-zero manufacturing pipeline.

IDENTIFY ALIGNMENT BETWEEN COMMUNITY NEEDS AND INDUSTRIAL VALUE PROPOSITIONS

State and local stakeholders (e.g., policymakers, community-based organizations, and organized labor groups) have the opportunity now to both pressure and support the steelmaking industry to make the necessary capital investments in Indiana to develop a sustainable industry for 2050 and beyond. To ensure that the expected future massive capital investments in primary steel manufacturing are made in Indiana, the groundwork must be laid well in advance. Multi-stakeholder coalitions can engage with the iron and steel industry and also work toward building strategic capacity in support of decarbonization technology investments.

All federal funding opportunities through DOE for decarbonization technology installations require substantial engagement with the broader community: Industry is incentivized through these funding mechanisms to work directly with organized labor, establish quality workforce training programs, gain support from local and state officials and fenceline communities, and identify core community benefits related to advanced energy investments. More robust community engagement will support more successful industry-led federal funding applications. Additionally, working with utility partners to identify the potential clean power needs of the manufacturing future can help guide development of necessary

interconnection, transmission, and distribution infrastructure, as well as the siting of utility-scale renewable energy.

Align sustainability investments with infrastructure upgrades

Continuing a "business as usual" path for integrated steel mill manufacturing still requires substantial periodic capital expenditures by industry. For example, blast furnaces (BF) periodically need to be relined, at great expense. When relining occurs, production from that BF on average stops for around three months, leading to hundreds of millions of dollars in lost revenue, combined with more than $100 million in capital expenses for the infrastructure upgrades. In general, this needs to happen every 15–20 years, providing a regular decision point at which companies could choose to instead invest in alternative production strategies, such as new DRI-EAF production pathways, or shift funding to other facilities (Vogl, Olsson, and Nykvist 2021). Cleveland-Cliffs recently announced a new 12-year contract term to purchase coke and plans to reline a blast furnace in 2025. While this will lock in emissions for this furnace, plans to convert the remaining BOFs at this facility could be developed now, to ensure this is the last major BOF investment in Indiana.

Aluminum Manufacturing in Indiana

Aluminum is an essential component of many products, including aircraft, solar photovoltaic panels, motor vehicles, electrical wires, and food and beverage packaging. Primary aluminum, produced directly from bauxite, is much more energy intensive to manufacture than recycled (or secondary) aluminum. While aluminum is infinitely recyclable, overall demand for aluminum is expected to grow substantially over the coming decades, leading to a continued need for primary aluminum production.

Accomplished via electrolysis, primary aluminum smelting is highly energy intensive, with electricity estimated to account for up to 40% of facility operating costs (Watson 2022). When electricity is sourced from fossil-fuel powered sources, primary aluminum manufacturing is also extremely emissions intensive. Aluminum manufacturing accounts for ~3% of global industrial carbon emissions. In Indiana, the Alcoa aluminum smelter in Warrick is the sixth largest source of GHG emissions in the state. While the majority (~70%) of the GHG emissions from aluminum smelting come from the electricity used to fuel the electrolysis process, additional emissions result from carbon anodes breaking down and reacting with oxygen to form GHGs. Some of the GHGs formed by anode reactions, such as perfluorocarbon (PFC), are substantially more potent and long-lived in the atmosphere than CO_2 (McKenna 2022). However, significant progress has been made in recent years on *inert* anode technologies, which are nonreactive during the electrolysis process. The leading example of inert anode technology is ELYSIS (https://www.elysis.com), co-developed by Alcoa and Rio Tinto, another aluminum production company. The combination of inert anode technology with 100% emissions-free power can fully decarbonize the production of primary aluminum.

Aluminum production in the United States peaked in the 1980s but the United States remained the world leader in production through 2000; today, the United States accounts for less than 2% of global primary aluminum production, and most of our remaining smelters do not operate at full capacity (SAFE 2023). Much of the shift in aluminum production has been away from countries with relatively high energy costs to countries with lower electricity costs (e.g., Canada, Russia, United Arab Emirates). As energy markets became more volatile and utility energy contracts more short term, the United States has continued to lose primary smelting capacity. While in 2000, 23 primary aluminum smelters operated in the United States, today only 5 smelters remain. Most recently, at the Intalco smelter in Ferndale, Washington, production was paused indefinitely as of April 2020, causing the loss of 700 jobs; the permanent closure was announced in March 2023 after state legislators, labor unions, and other local stakeholders were unable to negotiate access to a large enough contract for low-cost electricity with Bonneville Power Administration to restart the smelter. The site is now being redeveloped for other economic opportunities. Given the increase in demand for aluminum, a net increase in employment opportunities in the U.S. aluminum manufacturing sector is likely, but where these jobs will be distributed remains to be seen. While growth continues in secondary aluminum facilities in the United States, the future of the primary aluminum smelters in the United States is more uncertain.

Alcoa's Warrick smelter is one of the remaining five smelters still in operation in the United States, capable of producing 269,000 metric tons a year of aluminum. The closure of the Warrick smelter was announced by Alcoa in 2016, but it was reopened in 2018 at 60% capacity (three of five potlines running), as market demand picked up. In July 2022, however, one of these lines was again closed as a result of "operational challenges," potentially related to labor issues. The Alcoa Warrick smelter is co-located with an aluminum rolling mill that was recently acquired from Alcoa by Kaiser Aluminum, which provides can stock for the North American food and beverage packaging industry. The Warrick smelter runs on power generated from a coal-fired power plant that will be owned completely by Alcoa, assuming CenterPoint completes its divestiture in Unit 4, currently scheduled for the end of 2023. The smelter consumed more than 60% of the power generated by this plant, and the remaining energy was sold into the market in 2022. As of 2021 the coal plant and smelter employed a combined 660 people (Alcoa 2021).

The coal used to power this facility has fluctuated in sourcing, depending on market conditions and coal characteristics. Over the last few decades, coal has come from mines owned by Alcoa located near the smelter and from southern Illinois. When expansion plans for the Liberty Mine in Warrick County, Indiana, stalled in 2018, Alcoa determined that purchasing coal from third parties was more cost effective than mining it locally. As of now, the Liberty Mine remains closed. As emissions regulations on coal-fired power plants become more stringent and coal mining itself becomes more expensive, the economics of electricity access at Warrick have become more uncertain as well. Recent 200% tariffs on imported Russian aluminum, however, may bolster the economics of domestically produced aluminum even if energy costs increase.

To remain in Alcoa's operating portfolio, the Warrick smelter will need to transition to a long-term contract for low-cost renewable electricity. Alcoa has committed to net-zero GHG emissions by 2050. In Alcoa's November 2022 investors call, it was indicated that a key strategy for the company to support net-zero ambitions was to review their smelting portfolio and focus on "energy transformation," consisting of deploying renewable energy solutions while also working to "fix, curtail, close, or sell remaining assets under review." The Warrick smelter is one of the most polluting smelters in the Alcoa portfolio—coal-powered smelters are more than four times as polluting as renewable-powered smelters. Alcoa's 2022 annual report also cites one of their competitive strengths in the primary aluminum market as being "our decreasing demand for fossil fuels, as approximately 86% of the aluminum smelting portfolio operated by the Company was powered by renewable (primarily hydropower) energy sources in 2022. The Company intends to continue to focus on optimizing capacity utilization" (Alcoa 2023).

To retain the Warrick smelter and encourage Alcoa to allocate capital to this portion of their portfolio, Indiana should assist the company in making the transition to sustainable aluminum manufacturing by providing policy, communication, and stakeholder coordination support. The availability of federal funding opportunities paired with the rise of renewable energy developments are key enablers of success.

OPPORTUNITIES FOR ALUMINUM MANUFACTURING IN INDIANA

Space to Invest in Behind-the-Meter Renewables at Scale

The Warrick smelter is located on a large, sprawling campus with 8,300 acres of land owned by Alcoa surrounding the plant (Todd et al. 2009). Additional land owned by Alcoa is nearby, where one of the coal mines is located. Ample space is available to redevelop portions of the properties for renewable generation to cover a significant portion of the approximately 550 MW load requirement for the smelter, or to replace the approximately 755 MW of power supplied by the coal plant. For comparison, large solar installations with 500-MW capacity being built in the United States require 2,500–5,000 acres of land (SEIA 2023). In addition to sufficient available space, preexisting interconnection infrastructure built for the coal plant would also support a more straightforward shift to other energy generation sources and reduce time spent in interconnection queues. Alternatively, a combination of behind-the-meter generation and supplemental Power Purchase Agreements (PPAs) with off-site renewable energy generation could provide the total power load required for this facility.

Access to Energy Community Investment Incentives

Federal funding has been allocated specifically to support and revitalize communities historically reliant on coal mining and coal-fired power plants. Opportunities include clean energy production and investment tax credit bonuses as well as special consideration for advanced energy and manufacturing projects funded under the 48C tax credit of the Inflation Reduction Act (IRA). Through the DOE Loan Programs Office (LPO), the Energy

Infrastructure Reinvestment Program also can now finance up to $250 billion in low-cost loans to energy communities (Fong et al. 2022). The proximity of the Alcoa smelter to both a coal-fired power plant and coal mine provides an opportunity for Alcoa to continue to invest in the surrounding community by accessing a suite of federal tax credits to support workforce transition, site remediation, and reinvestment in new, sustainable energy resources that will be required to keep aluminum manufacturing jobs in Indiana for the long term. The designation of the area around the Warrick smelter as an energy community can also provide incentives for third-party energy developers or utilities to invest in building out the needed clean energy supply. These funding mechanisms are meant to ensure a fair and equitable energy transition for fossil fuel energy communities.

Growing Demand for Aluminum from the Clean Energy Economy

Strong and lightweight, infinitely recyclable, a good conductor of both heat and electricity, and a safe material to have in contact with food or beverages, aluminum is increasingly in demand in a number of growing market sectors. While relatively few workers are directly employed within primary aluminum smelting in Indiana, the availability of primary aluminum supports thousands of downstream jobs, including expanded aluminum recycling facilities (Taylor 2023). Aluminum is theoretically 100% recyclable, but estimates in the United States suggest we are likely closer to 50% recycling rates for all aluminum products (Klein 2021); closing the gaps in the circular aluminum economy will be necessary for supporting the growing demand for sustainable materials for manufacturing.

In 2018 in North America, the top three demand markets for aluminum were the transportation sector (35.5%), containers and packaging (16.9%), and buildings and construction (12.3%). As electric vehicles strive to expand battery range and meet more stringent emissions standards, aluminum is increasingly incorporated into automotive design to reduce the overall weight of vehicles; a recent survey of automakers and Tier 1 automotive suppliers estimated that by2030, an additional 100 lb. of aluminum per vehicle will be required, compared to 2020 (Ducker Carlisle 2023).

Recycled aluminum is a more sustainable alternative to single use plastic containers. Aluminum's use has expanded into some market sectors that have previously been dominated by plastic bottles or glass; for example, beer and wine, still water, or single-use cups. The food and beverage sector is also increasing its use of aluminum for packaging, which has spurred additional regional investments; for example, the global packaging manufacturer, CANPACK, announced its second U.S. facility would be built in Muncie, Indiana, bringing with it an expected 345 well-paying jobs. Another leading Indiana company in aluminum packaging, Ball Corporation, has joined the World Economic Forum's First Movers Coalition and committed to 10% of all primary aluminum purchased being low carbon, in addition to enhancing recycling and supporting their major customers (e.g., Coca-Cola, AB InBev, Unilever) in achieving desired value chain emissions reductions (Arratia 2023).

Aluminum is also the dominant material used in solar panels—an estimated 85% of solar photovoltaic panel components are constructed from aluminum. By 2035, aluminum demand from U.S. solar power alone could exceed today's *total* U.S. aluminum production, further highlighting how the ongoing transition to a clean energy economy will provide a significant demand pull for continued domestic primary aluminum production (Min et al. 2023).

Transformative New Technologies for Aluminum Production

Alcoa has co-developed a new decarbonization technology for primary aluminum production in partnership with aluminum manufacturer Rio Tinto. This transformative new technology, an inert anode called ELYSIS, is expected to reduce ~25% of aluminum manufacturing emissions, on top of the ~70% of emissions related to electricity consumption that can be eliminated by using renewable energy. An opportunity exists to develop almost entirely emissions-free primary aluminum production based in Indiana by combining this new technology, designed as a drop-in retrofit for existing smelters, with renewable energy and storage at the scale to meet electricity demands. Investing in these technologies would allow the Warrick facility to satisfy demand for the premium low-carbon materials that help major end users such as GM meet commitments to decarbonize supply chains. However, to date Alcoa has not committed to implementing the ELYSIS technology at any of its U.S. aluminum smelters.

Automotive markets, in particular, are competing to access zero-carbon materials. For example, Rio Tinto just recently signed a memo of understanding with BMW's Spartanburg, South Carolina, plant to provide primary zero-carbon aluminum from a Canadian smelter powered by carbon-free hydropower combined with ELYSIS technology (Hill 2023). The federal government is also working to accelerate the market transition to low-carbon manufacturing in an effort to bolster domestic competitiveness and ensure well-paying, sustainable jobs in manufacturing remain in the United States. Investing now in the needed technologies to manufacture aluminum with zero emissions would allow Alcoa to take advantage of these "first mover" funding opportunities[3] from the federal government.

CHALLENGES FOR ALUMINUM MANUFACTURING IN INDIANA

Stranded Coal Assets

While the Warrick coal plant remains operational, the economics of relying on coal-fired power are becoming more complex. Rather than continuing to make large capital investments in aging and uncompetitive coal infrastructure (e.g., a $400 million scrubber

[3] For example: https://energycommunities.gov/funding-opportunity/industrial-decarbonization-and-emissions-reduction-demonstration-to-deployment-2/.

investment at Warrick in 2007 to reduce air and water pollution), it would make sense to invest capital in transitioning to a more sustainable, long-term energy generation strategy. New emissions regulations for coal-fired generation are also creating uncertainty and additional cost burdens for coal resources (Davenport and Friedman 2023), while solar and wind-powered generation is becoming more affordable as technologies mature and manufacturing scales; a recent report from Energy Innovation analyzes 210 coal plants in the United States and finds that only one plant is more economical to retain than to replace with newly built wind or solar (Solomon et al. 2023).

At Warrick, surrounding utilities are responding to changing economics by moving away from coal resources: for example, CenterPoint Energy (formerly Vectren) co-owns the largest generating unit in the Warrick power plant, but is exiting its joint ownership agreement at the end of 2023 and replacing the coal-fired capacity with renewables and natural gas. This move aligns with CenterPoint's recently announced plan to retire the remaining coal plants that it owns within five years.

Ensuring Access to Affordable Power Supply from Renewables

Aluminum smelting requires a constant, uninterrupted source of electricity. Smelters are largely unable to adjust power demand in response to changing energy prices, apart from curtailing operations. Given that electricity is roughly 40% of operating costs, accessing affordable and reliable power is central to the economics of aluminum smelting. To accomplish this today, as the cost of coal rises and gas prices have become more volatile, smelters in other regions are signing long-term, low-cost contracts with renewable energy suppliers to guarantee needed power and avoid unexpected price spikes. For example, Alcoa's smelter in Spain recently signed contracts with wind farms that ensure enough low-cost power for them to restart operations, which had been curtailed as a result of high energy prices in Europe over the previous two years (Djunisic 2023). Globally, the growing consensus is that wind and solar power will be the most economical sources of electricity for the future. When paired with energy storage, backed by grid interconnections, and supported by favorable tariffs and contracts from utility providers or private energy developers, renewable energy can provide the reliable, economical power needed for aluminum smelters.

Although Alcoa can use onsite generation to power its Warrick smelter, it will likely need to procure at least a portion of its power from facilities located off-site to decarbonize its electricity usage, given its large power demand. However, Indiana currently has significant policy barriers that could prevent manufacturers like Alcoa from doing so. Currently, only seven industrial customers located in Northern Indiana Public Service Company's (NIPSCO) service territory in northwest Indiana have been expressly allowed to enter into third-party power purchase agreements to buy power from off-site renewable energy facilities at competitive prices. Likewise, no enabling legislation in Indiana allows for third-party community solar facilities, which could provide consumers with another option for procuring some of their electricity needs from renewable energy. Finally, Indiana's investor-owned utilities do not currently offer robust green tariffs, under which the utility would agree to

provide up to 100% of the participating customer's electricity from renewable energy sources.

In the coming years, continued research, development, and deployment efforts around longer-term energy storage will likely further unlock enhanced reliability and flexibility for wind and solar generated power, benefiting in the United States from sustained investments such as DOE's Long Duration Storage Shot initiative (U.S. Department of Energy 2021). Long-term energy storage is already gaining traction abroad; for example, the Hindalco aluminum smelter in India is currently contracting with an energy developer to build 400 MW of solar and wind generation, combined with 100 MW of pumped hydro energy storage to ensure continuous power supply entirely from renewables without relying on grid power backup (Gupta 2022). As new, renewable-powered smelters are gradually implemented around the world, Warrick can benefit from operational lessons learned for de-risking new energy management strategies and assembling reliable and low-cost energy solutions.

POTENTIAL PATHS FORWARD FOR ALUMINUM IN INDIANA

Policy Changes to Support Consumer Access to Renewable Energy

Customer access to renewable energy is a major existing policy barrier in Indiana that can be overcome through legislative and regulatory reforms. The General Assembly could enact legislation that provides consumers clear legal authority to enter into third-party power purchase agreements. This authority is especially critical for large industrial customers like Alcoa, whose very large power demands can be difficult to supply through onsite generation only. Legislative action authorizing third-party community solar facilities could also play a role in helping a variety of consumers access local clean energy benefitting their communities. Finally, utilities can work with industrial customers and consumer advocates to craft well-designed green tariffs that provide access to affordable renewable energy solutions while protecting other customers from potential cost shifts.

While other unique industrial tariff arrangements could also be considered, policymakers should ensure that robust consumer protections are in place to prevent undesirable outcomes for other consumers. For instance, the ill-conceived Rate 831 tariff, which allowed seven large industrial customers in northwest Indiana to procure the vast majority of their electricity outside of their utility, NIPSCO, resulted in tens of millions of dollars in legacy costs shifted onto other customers each year and skyrocketing rates for Hoosier families and businesses—an outcome that should be avoided going forward. Alcoa's situation in southwest Indiana compares favorably to this NIPSCO example because Alcoa currently produces its own power from the Warrick plant, so it does not have a share of legacy costs on utility CenterPoint's system that could be shifted onto other customers.

Building a Multi-Stakeholder Coalition in Support of Sustainable Primary Aluminum Production in Indiana

Energy transitions are complex. Despite support from a myriad of stakeholders in Washington, the Intalco plant was not saved, demonstrating that the risk of smelter

curtailments or shutdowns is real. Indiana can address this risk by investing proactively and in a sustained way. The primary goal should be to assemble a multi-stakeholder coalition to plan out a transition to renewable-powered primary aluminum production in Indiana: one that retains well-paying manufacturing jobs in the state while reducing local pollution and bolstering regional supply chains with the necessary raw materials to meet demand from growing automotive, can sheet, solar, and construction value chains. New coalitions, such as the Sustainable Aluminum Network (https://www.sustainablealuminumnetwork.org/home), may be able to provide support for connecting across stakeholder groups.

Organized labor is also a key constituency supportive of finding solutions to retain primary aluminum manufacturing in the United States (Holzman 2022). Alcoa recently reached a tentative new three-year labor agreement with the United Steelworkers union, which covers hundreds of workers at the Warwick smelter. The United Steelworkers also cover an additional 850 employees at the Kaiser rolling mill in Warwick—the majority of the workers at this plant—which processes primary aluminum from the smelter as well as hosting a remelt shop for recycling beverage cans (Taylor 2023).

Unlocking Federal Funding Incentives to Support Reinvestment in the Warrick Smelter

With the opportunity to access enhanced tax credits to invest in advanced energy solutions in energy communities, many economic barriers to shifting from coal to renewable energy for the Warrick smelter can now be overcome. Through the Office of Clean Energy Demonstrations (OCED) at DOE, opportunities may also exist to implement innovative energy storage solutions to address the variable nature of solar and wind power, and to invest in transformative decarbonization technologies such as ELYSIS.

Successfully funded projects will need to engage with a range of stakeholders, including organized labor, local and state policymakers, community members, and workforce training partners to demonstrate the broad coalition of support required to invest at scale in the region. See the federal incentives chapter of this report for additional details on these opportunities.

Electric Vehicle Manufacturing Demand for Sustainable Metals

Steel and aluminum are the two most essential materials in the automotive industry; according to the American Iron and Steel Institute, steel makes up ~54% of the average vehicle. Aluminum demand for vehicles is also growing rapidly, as the increase in market share of electric vehicles (EVs) spurs the need for stronger and lighter materials to counteract the increased weight of batteries. This is leading to the development of new, advanced, high-strength steel (AHSS) grades and specialty aluminum alloys, as well as competition between the two industries to meet automaker needs (PNNL 2023).

Indiana, in addition to being the leading steelmaking state in the country and home to one of the few remaining aluminum smelters, is also one of the major automotive manufacturing states, ranked third in the nation (Business Facilities Staff 2022). As the U.S. automotive industry transitions to prioritize EV manufacturing, Indiana will need to compete with other states to attract new investments. Already, over $200 billion in planned EV factory investments has been announced, and the majority of vehicles sold in the United States are expected to be electric by 2030 (Goldman Sachs 2023).

EV manufacturing is not just an extension of internal combustion engine (ICE) manufacturing. An entirely new set of plant investments by car manufacturers and their suppliers will be required, including separate production lines, separate value chains, and shifting investment strategies to support new products. Large investments in factories are also creating demand for more small- and medium-sized enterprises to support expanded supply chains (figure 2). Many new aluminum rolling and recycling mills have been announced over the last decade, often explicitly linked to automotive needs (Aluminum Association 2023). Automakers have also begun to expand metals fabrication facilities in support of growing EV lines. For example, GM announced plans to invest $491 million to expand a stamping plant in Marion, Indiana, to prepare it to make more steel and aluminum parts for EVs (LaReau 2022).

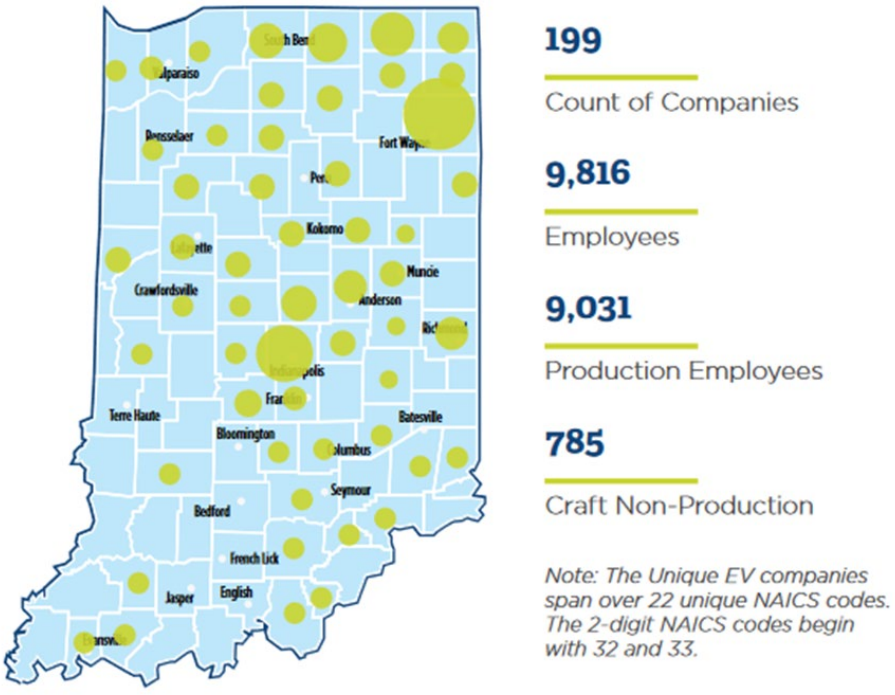

Figure 2. Distribution of companies in support of the automotive supply chain in Indiana (both EV and ICE). Source: Electric Vehicle Product Commission Tasking Report: Opportunities for the Hoosier Automotive Supply Chain and Talent. September 2022.

Many automakers are also signaling a growing demand for low-carbon materials across their supply chains in the form of fixed contract agreements with metals manufacturers; for example, General Motors signed a recent agreement with U.S. Steel for a sustainable domestic steel product (United States Steel 2023). All the automakers with assembly plants located in Indiana currently have commitments in place to reach carbon neutrality in their operations and products, including their supply chains (table 1). Reducing supply chain emissions, especially from batteries, aluminum, and steel, will be essential for automotive manufacturers to meet sustainability goals (Kearney 2023).

Table 1. Summary of sustainability commitments made by automotive manufacturers of either EVs or ICE vehicles, in the state of Indiana

Automotive manufacturing company	EV or ICE	Supply chain carbon emission goals
Toyota	ICE	Eliminate carbon emissions from supply chain by 2050
Subaru	ICE	Carbon neutrality, including products, by 2050
Honda	ICE	Carbon neutrality, including products, by 2050
Stellantis	ICE and EV	Carbon emissions cut in half by 2030, including products, and carbon neutral by 2038
GM	ICE and EV	Joined First Movers Coalition and made commitments to purchase low-carbon steel and aluminum; carbon neutrality in products and operations by 2040

The geographic distribution of EV manufacturers' new investments is shifting. ICE automotive value chains are well-established in the upper Midwest, including Indiana, but newer EV facilities are increasingly expanding into the Southeast and Southwest. The leading states for investments in EV and battery manufacturing include Georgia, Kentucky, and Michigan, along with Kansas, North Carolina, Ohio, and Tennessee (Northey and Lee 2023). These states are leading based on a variety of key factors, including incentives offered to companies (Georgia, Kansas, Michigan, Nevada, North Carolina, and Tennessee have each promised over $1 billion in incentives to EV manufacturers); state policy campaigns to streamline permitting, building, and hiring for new facilities; access to affordable clean energy; transportation networks and related supply chains; and lower labor costs. A

collection of recent EV factory announcements (table 2) highlights some of the reasons given, in press releases, for selection of facility location.

Table 2. Recent EV factory investment announcements

Company	Press release date	State	Facility cost	New jobs	Stated reason for location
Hyundai	May 2022	GA	$5.54 B	8,100	Favorable business conditions (speed-to-market, talented workforce, and existing network of affiliates and suppliers) Proximity to port of Savannah (fastest growing container terminal in the country)
BMW and Envision AESC	October 2022 December 2022	SC	$810 M	1,180	Strong automotive presence, established regional supply-chain, business friendly environment, and willingness to adapt to industry's innovation and changes
Rivian	December 2021	GA	$5 B	7,500	Weather, energy costs, size, central location, economic incentives, and availability of skilled labor and renewable energy sources Tennessee Valley Authority offering slightly lower utility rates and supplying electricity to support large infrastructure project
Stellantis and Samsung SDI	May 2022	IN	$2.5B	1,400	Weather, energy costs, size, central location, economic incentives, and availability of skilled labor and renewable energy sources State's commitment to workforce and technical education
Panasonic Energy	July 2022 November 2022	KS	$4 B	4,000	Considered Windsor, Ontario before IRA incentives passed Selected Kansas based on skilled manufacturing workforce, reliable infrastructure, and central location
Ford and SK innovation	September 2021	KY	$5.8 B	5,000	Business friendly environment, convenient proximity to interstate and inland Port Dillon, proximity to other major company investments

Company	Press release date	State	Facility cost	New jobs	Stated reason for location
Ford	February 2023	MI	$3.5 B	2,500	Proximity to Honda's plants, size of land, access to resources, and availability of labor
Ford	September 2021	TN	$5.6 B	6,000	Infrastructure, high-quality education system, diverse and skilled workforce, and business-friendly environment
GM and LG Energy Solution	January 2022	MI	$2.5 B	1,700	State incentives, property tax breaks, existing presence of an automotive manufacturing footprint
GM and Samsung HDI	June 2023	IN	$3 B	1,700	Strong state and local support, robust value chain, and proximity to nearby manufacturing facilities
Toyota	December 2021	NC	$1.29 B	1,750	North Carolina's strong commitment to building a clean energy economy and fighting climate change Lower taxes, fewer regulatory roadblocks, and a stronger workforce
Honda and LG	October 2022 January 2023	OH	$3.5 B	2,200	Business friendly climate, strong workforce, growing population
VinFast	March 2022	NC	$2 B	7,500	Skilled workforce, state and federal incentives, site preparation, and the state's commitment to a clean energy economy

Source: Various press releases

Indiana has the opportunity to leverage organized labor partnerships to compete successfully for additional investments in EV manufacturing. Union partnerships generally lead to higher wages, better organizational communication, and less worker turnover, which may be key in a tight labor market for ensuring that the 18,000 additional workers needed to staff new plants for GM, Ford, and Stellantis are available (Welch 2023; Katz 2022). Recent EV and battery factory investments in Indiana include more than $2.5 billion from Stellantis in partnership with Samsung to kickstart EV battery manufacturing in Indiana, and $3 billion from GM and Samsung, also for a new EV battery factory. Successful labor negotiations with the Big Three auto manufacturers (GM, Stellantis, and Ford) in advance of contracts that are

set to expire in September 2023 can demonstrate how organized labor and EV manufacturers can work together to ensure a just and productive automotive manufacturing transition.

SUMMARY AND RECOMMENDATIONS

EV manufacturing is a demand pull for both the steel and aluminum manufacturing industries. By leveraging well-established supply chains in metals and automotive manufacturing, Indiana has an opportunity to support an expansion of well-paying jobs in the state while also incentivizing steel and aluminum manufacturers to increase their investments in lower-carbon production methods and specialized finishing facilities for the growing EV market. Especially as automotive manufacturers move toward developing fixed contracts with suppliers for specialty materials, the higher-value finished steel- and aluminum-based products demanded by automotive companies and their Tier 1 suppliers can potentially provide additional economic incentives for investing in decarbonization of primary metals manufacturing.

Cross-Cutting Resources: Clean Energy Supply

Indiana has long been associated with manufacturing, and a changing energy landscape must continue to support energy-intensive industries. For many decades, coal has been the staple energy provider, and in recent years, natural gas has come to fill a substantial role as well. Going forward, renewable energy is rapidly growing to supply a larger share of the state's energy demands and support the many additional gigawatts that the state will need in the coming years. For example, while total electric generation today in Indiana is around 96 TWh per year, by 2050 this could double if electrification demand grows rapidly across transportation, buildings, and industrial sectors (Murphy et al. 2021).

To align with federal, corporate, and utility sustainability goals, this increased electricity demand will need to be met from renewable sources as well as additional energy efficiency measures. Utilities in the state have outlined their goals for using more renewables and have been seeking out greater portions of renewables in the form of all-source procurement in their Requests for Proposals. This is in line with the recent legislation passed in Indiana (HB 1007) that decisions regarding energy sources and infrastructure must consider reliability, affordability, resiliency, stability, and environmental sustainability, and also aligns with Indiana's all-of-the-above strategy for energy supply for the state, which supports growth in clean energy as part of a reliable and resilient power grid (Indiana General Assembly 2023; Indiana OED 2023).

OPPORTUNITIES FOR CLEAN ENERGY IN INDIANA

Indiana has several comparative advantages when it comes to expanding renewable energy to meet the needs of its manufacturing sector. First, it has relatively good wind and solar potential that can be cost effectively tapped for power generation; by comparison, the Southeast has far fewer commercially viable wind resources. Second, Indiana offers relatively inexpensive and flat land that can be developed for renewable energy. Third, projects can

access critical wholesale markets via Indiana's access to both the Midcontinent Independent System Operator (MISO) and the PJM Interconnection, as well as available transmission line capacity as existing generation is retired and planned new transmission lines are constructed.

The industrial sector is already looking to use more clean energy for all stages of production. For example, in 2022 Cleveland-Cliffs entered into a 15-year PPA for 180 MW of wind power located in Indiana. Other large, integrated steel mills in northwestern Indiana could follow suit with similar renewables procurement.

Most other industrial facilities in Indiana do not have clear authority to enter into PPAs and therefore rely on their electric utility, sometimes in combination with behind-the-meter generation located onsite, to meet their electricity needs. Fortunately, many of the utilities in Indiana are taking steps to rapidly expand their clean energy supply; these utilities have put out RFPs for all-source procurement and have collectively received approval to own or contract for thousands of megawatts of solar and wind power coming online over the next five years.[4] With less need for fossil fuel infrastructure due to increased clean energy supply, other fossil fuel plants might be retired early while new plants might be unable to fulfill their entire predicted lifespan or operate only at a low capacity factor (Bowman 2022). Some existing fossil fuel infrastructure within Indiana is already facing early retirement (Thiele 2021). The increased demand for renewables will further this trend. If more clean energy comes online sooner rather than later, Indiana can avoid fossil infrastructure lock-in.

Recent federal legislation has opened a number of opportunities for grants and other incentives like tax credits to help industry adopt clean energy. In addition to helping industry, these incentives can keep Indiana consumers from facing additional costs associated with these upgrades. Increasing renewables can benefit Indiana in a variety of ways. Clean energy sources emit far less pollution, improving air and water quality and lessening negative health impacts. These improvements could create new economic opportunities by making Indiana more attractive to people and companies that may be dismayed by the current pollution levels that persist in Indiana (Hopkins 2018).

CHALLENGES FOR CLEAN ENERGY IN INDIANA

In addition to the policy barriers preventing manufacturers from accessing renewable energy (described above in the section on aluminum), one of the main challenges to increasing clean energy in Indiana is local restrictions on solar and wind siting. Indiana has 92 counties,

[4] Some examples of utilities within Indiana calling for all-source submissions: Indiana Michigan Power, 2023 All-Source RFP https://www.indianamichiganpower.com/business/b2b/energy-rfps/2023All-SourceRFP; Duke Energy Indiana https://www.deirfp.com/; NIPSCO https://www.nipsco-rfp.com/; CenterPoint Energy https://investors.centerpointenergy.com/news-releases/news-release-details/centerpoint-energy-issues-all-source-rfp-targeting-renewables.

and 46 have adopted standards for commercial solar siting and 51 for commercial wind siting. At least 36 counties in Indiana, including many of the windiest in the state, have passed ordinances that effectively block future wind energy development, including 8 counties[5] that have banned commercial wind altogether (Ogle and Salazar 2022a; Field et al. 2023). Restrictive siting standards for solar, as well as moratoria on new commercial solar development, are also increasingly prevalent. In many of these counties, the restrictions impose a buffer zone between placement options for commercial renewable structures and residences, public buildings, and businesses (Ogle and Salazar 2022b). Although the Indiana General Assembly has enacted model solar and wind siting guidelines, local governments are not required to adopt them.

Competition from other states is also a concern. While some companies have looked to Indiana for expansion, many have announced their intentions of establishing EV and battery manufacturing in other states, often in the Southeast. Some are choosing their location based on proximity to existing manufacturing plants of other components, especially batteries. States in the Southeast are landing a number of these new components plants as their EV production also increases. States in the Southeast are also competing successfully for new clean energy developments; for example, Georgia and North Carolina are leading states for solar generation.

POTENTIAL PATHWAYS FORWARD FOR CLEAN ENERGY IN INDIANA

Indiana should support clean energy adoption across the state, including within the industrial sector. Other states are already doing so, especially as clean energy proves to be more available and reliable in many cases than fossil fuels for industrial purposes.

One way companies can improve their clean energy profiles is through virtual power purchase agreements, such as when Cummins, Inc., an engine and power generation manufacturer headquartered in Indiana, entered into an agreement to procure 75 MW of wind power from an existing wind farm (Zanchi and Kansal 2018). Although virtual PPAs can help some companies meet their sustainability goals without taking ownership of the asset, virtual PPAs are a financial transaction that could result in higher costs to the company; moreover, the company does not directly receive the physical power from the renewable energy facility, potentially limiting its usefulness to industrial customers if available energy supply is a constraint on manufacturing.

A number of the metal manufacturing companies and their customers operate internationally and are subject to clean energy requirements in other countries. These companies will incorporate clean energy into their production processes abroad to meet

[5] The counties that ban wind altogether are Pulaski, Fulton, Allen, Wells, Wayne, and Washington.

requirements, which could also lead to increased incorporation of clean energy into their processes in their U.S. facilities.

As the metals industry overall increasingly adopts clean energy, Indiana could be part of leading the way. Utilities within the state are already looking for ways to add more clean energy to their portfolios. NIPSCO aims to cut GHG emissions by about 90% by 2028 by expanding solar, wind, and storage to replace its closing coal plants (NIPSCO 2023). CenterPoint hopes to drop emissions by almost 97% in the new two decades, and they aim to stop using Indiana coal in 2027 (CenterPoint Energy 2023). AES Indiana plans to reduce carbon intensity by 70% by 2030 by increasing the use of clean energy and ending coal-fired generation at its power plants (Merchant 2018).

In addition to generally ramping up the proportion of generation from renewable energy, utilities could immediately offer options for industrial customers to procure all or part of their energy from renewable sources by creating dedicated green tariffs. To date, most Indiana utilities have not proposed meaningful green tariff options that bundle together generation with the environmental attributes of a project, making it difficult for industrial subscribers to be able to claim that participating in these tariffs increases the amount of renewable energy on the grid nor does it allow them to match their energy consumption with low-emission generation sources. By contrast, many utilities in other states have seized this opportunity to attract new industries and retain existing commercial and industrial customers. For example, Duke Energy South Carolina has proposed creating a green tariff program to increase access to clean energy for commercial customers—an example of a strategy that Indiana could pursue as well (Penrod 2022).

To facilitate the expansion of clean energy, Indiana can also focus on upgrading transmission to better incorporate renewables into the grid (Bowman 2023). Building more regional transmission in and connected to Indiana will allow lower-cost clean energy to be transported into the state, reducing electricity costs and saving customers money (MISO 2023).

CASE STUDY: CLEAN ENERGY AND INDUSTRY IN GEORGIA

Georgia is an attractive state for bringing in more manufacturing because of low tax rates, transportation links, and a diversely skilled workforce. For example, Hyundai recently broke ground on a $5 billion electric car factory in Georgia. Georgia is also becoming a hub for solar energy production and clean energy jobs, with companies like Qcells investing billions in solar panel manufacturing facilities.

The Inflation Reduction Act (IRA) includes clean energy incentives and other tax credits that can boost and support investment in clean energy as well as EV and battery production (Milman 2023). One notable motivator is the new federal EV tax credit that requires 40% of battery materials and 50% of battery components to come from the United States or another country that has a free trade agreement with the United States (Hanley 2022). In Georgia, Hyundai is partnering with other companies that will bring in three new battery

factories to support EV manufacturing while enhancing the supply chain with their proximity to each other. Hyundai also has parts manufacturer PHA joining their existing campus. This project benefits from the Georgia Ready for Accelerated Development (GRAD) program, which is a fast-track program that speeds the process for siting and constructing projects (Ruggles 2023).

Some companies are swayed to establish themselves in Georgia because the state is "willing to aggressively court companies" with tax breaks, infrastructure assistance, and even providing land in some instances (Kahn and Bluestein 2023; Burns 2023). As a result, a number of companies have already stated their plans for developing new production plants in the state, and others are likely to consider Georgia in the future.

Companies can be enticed to select the location for their manufacturing plant based on policies and market developments. (IEA 2023b). Developing policies that expand clean energy use in the industrial sector can help create an environment that attracts companies and benefits the economy of Indiana. (IEA 2023c). Clean energy infrastructure takes time to complete. (IEA 2023a). Taking the initiative to build out clean energy infrastructure now as part of an overall policy plan to support industry will help make Indiana an attractive option for companies looking to expand into the state.

SUMMARY AND RECOMMENDATIONS

Indiana's energy profile is slated to rapidly transition toward clean energy in the coming years. An adequate energy supply, including vast amounts of clean energy, is necessary for supporting the state's increasing manufacturing demands, including allowing Indiana manufacturers to meet the sustainability goals of the companies they work for. Renewable energy is also—in almost all cases—more affordable than coal-powered generation (Solomon et al. 2023). The industrial sector can incorporate clean energy into production processes either through behind-the-meter arrangements onsite, or through the grid. This is especially important for companies that have established goals for using clean energy in their own manufacturing or for using products made with clean energy.

Ensuring a sufficient energy supply to meet the growing demand from industry is a key challenge. In addition, state and utility policy barriers include a lack of legal clarity regarding a utility customer's ability to enter into third-party power purchase agreements with renewable energy companies and insufficient utility green tariff options. These barriers currently prevent many manufacturing facilities from procuring the low-cost, renewable electricity they need to transition to the modern, sustainable operations that their customers and shareholders increasingly expect. Moreover, some localities may inhibit development of solar and wind through siting restrictions, particularly for larger sources of solar or wind. The industrial sector, however, is already expanding the amount of clean energy used in production, and Indiana has the opportunity to embrace these advances. Other states are also taking steps, which could provide insight regarding successful clean energy integration into the industrial sector.

Cross-Cutting Resources: Workforce Needs

Jobs in the industrial sector have been an economic staple for Indiana. As the industrial sector within Indiana grows, the workforce must also grow and evolve with it. Some key questions to consider include, what skills will be necessary for the evolving industrial sector, and how to ensure sufficient skilled workers are available in the state to fill these roles. This may require substantial new investments in training and upskilling of the existing workforce.

Presently, unemployment is relatively low, and maintaining those numbers will require preparing the workforce for the future. With the potential for expansion of the industrial sectors in aluminum and steel and secondary markets like EVs that use the metals, ensuring a robust and diverse workforce will be key to Indiana's continuing success as a manufacturing state.

OPPORTUNITIES FOR WORKFORCE DEVELOPMENT IN INDIANA

Increasing industrial manufacturing means more job opportunities for citizens of Indiana, with many of these coming from EV production (Auslander 2022). The recent federal Bipartisan Infrastructure Law (BIL) and IRA legislation will encourage continued expansion of the EV sector to keep pace with increasing demand (Colato and Ice 2023).

The existing aluminum and steel manufacturing in Indiana can attract companies looking to take advantage of established supply chains and workforce. To ensure Indiana residents have the necessary skills, federal funding opportunities, such as tax incentives and grant programs can partner with and enhance state-based initiatives to advance workforce training. Agencies within Indiana—like the Governor's Workforce Cabinet and the Office of Economic Development—have the expertise to facilitate the development of programs that can support the shifting workforce.

Companies are already taking advantage of these incentives to establish new manufacturing plants within Indiana. Entek, a producer of lithium-ion battery separator materials, has announced that it will establish a production facility in Terre Haute that will create over 600 new jobs. The company will benefit from a $200 million grant from DOE under the BIL and future benefits of around $13 million that will come from state tax incentives and other grants (Magill 2023). The company stated additional reasons for the move, including available workforce, support from the Indiana Economic Development Corporation, vocational training, and an existing site with available utilities (IEDC 2023).

Stellantis, another manufacturer of EV components, also recently announced three plants in Indiana, bringing an investment of $155 million and the retention of about 265 jobs (Stellantis 2023). This comes on the heels of a previous announcement by Stellantis for its plants in Kokomo, Indiana, where the company was able to take advantage of training grants and tax credits to offset costs, available only upon hiring Indiana residents (Brown 2022).

These two examples highlight how incentives like tax credits and grants can entice companies to the state while at the same time ensuring the expected number of new jobs by making some of the incentives conditional on hiring Indiana residents and paying fair wages.

CHALLENGES TO WORKFORCE ADEQUACY IN INDIANA

The landscape of manufacturing jobs is shifting. As industries transition toward decarbonization, industrial electrification, green hydrogen production, and the variable nature of renewable energy may all impact the experience of industrial workers in Indiana (Pike 2023). Employers and trainers will need to assess what skills are necessary for these jobs in order to determine how and where to find suitable workers (OPM 2022). Understanding the existing gaps in the current workforce can shed light on necessary next steps.

Recent studies in other regions have found that shifting to decarbonized steel production, for example, would avert job losses associated with stranded assets from "business as usual" manufacturing practices (Hurdle 2023). Many of the new manufacturing jobs require more training and new skills because of changes in technology within particular manufacturing sectors, which can lead to difficulties in finding enough already-skilled workers or in providing sufficient training for those who are under-skilled (Lynch 2022). For some companies, on-the-job training will be an important strategy for developing their workforce (World Economic Forum 2023).

Workforce programs will need to determine what wraparound services are needed to bridge gaps while people train for new positions: for example, affordable and available childcare and transportation access (Gaskell 2021). Even with workforce development programs and other assistance, attracting and retaining employees requires that employers are committed to paying fair wages (Schweitzer and Ross 2021). In some instances, companies can take advantage of federal and state incentives to ensure fairly paid jobs grow alongside the steel and aluminum industries (Swalec 2023).

POTENTIAL PATHWAYS FORWARD FOR THE MANUFACTURING WORKFORCE IN INDIANA

Indiana has existing entities for assisting the state's workforce. For example, the Governor's Workforce Cabinet developed and submitted a Strategic Workforce Plan that aims to provide a comprehensive approach to workforce development, wherein agencies can collaborate to enroll individuals into programs and provide a spectrum of services (Indiana Workforce Cabinet 2020). Indiana can build upon established programs and explore optimal ways to expand them, including working with universities, colleges, and community colleges—or creating new programs that emulate past successes.

Maintaining and expanding the industrial sector within Indiana is a multifaceted project that will require more than just one governmental agency or initiative. The Governor's Workforce Cabinet specializes in workforce issues. With input from other entities like the Office of Energy Development and the Indiana Economic Development Corporation, workforce

programs can holistically address the needs of Indiana residents. Additionally, communicating with industrial companies can provide more specific insights into the skills necessary for the jobs that they are hoping to bring to the state.

The South Carolina case study below provides some specific insights, but other states can also offer lessons. Tennessee has mixed workforce development programs in with other tax incentives and grants to encourage greater participation in its burgeoning industrial sector. One such program is tuition-free enrollment for community college or technical college programs that prepare students for the manufacturing sector. (Udavant 2023).

CASE STUDY: WORKFORCE DEVELOPMENT IN SOUTH CAROLINA

South Carolina has been attracting a lot of new industry, including expansion of EV manufacturing—similar to what could be in Indiana's future. South Carolina provides a number of workforce incentives to help businesses develop and maintain a highly skilled workforce. These incentives include tax credits to encourage companies to choose the state for their latest endeavors. For example, Pallidus, a semiconductor manufacturer, is relocating to South Carolina, and the job development credits they will receive will help offset the costs to relocate and establish their new headquarters (Samora 2023).

South Carolina has developed a centralized website that brings together all the necessary information to one place to help companies fulfill their workforce needs and facilitate setting up EV-associated manufacturing within the state. Established by the governor, this virtual workforce hub allows employers to post when they are seeking new employees and connects potential employees to necessary training and other services (South Carolina Office of the Governor 2022).

South Carolina also has the ReadySC program, part of the state's Technical College System.[6] ReadySC provides customized recruiting and training options for companies that are expanding within the state. The program even locates instructors and provides training sites. Companies hoping to use the program must demonstrate that they are creating a sufficient number of permanent jobs to make the training cost effective. Additionally, the companies must offer wages that are competitive for the area and provide benefits that include health insurance.

Another workforce incentive program is the Incumbent Worker Training, which matches employers to funding for training and upskilling current employees; priority is given to training that will significantly improve the skills or wages of the employee. Companies can also be reimbursed 50–90% for new employee training, depending on the size of the

[6] Additional information and resources for ReadySC can be found on their website https://www.readysc.org/.

company and the specific skills necessary for the job. Along the same lines, the Apprenticeship Carolina Program connects employers to assistance for registering apprenticeship programs. And, if companies are looking to expand the technologies used in their facilities, the Enterprise Zone Retraining Program (Ezone) offers a tax incentive that lasts for five years once approved. To encourage competitiveness, the South Carolina Department of Commerce also has a Workforce Data Assistance program that evaluates company wages to confirm they are comparable for the area, identifies reasons why a company would struggle to recruit, and analyzes why high turnover may exist.[7]

To bring about similar initiatives and incentives within Indiana, the state will need to consider what programs already exist under different departments and agencies and investigate ways to unite them for the common goal of increasing and improving the workforce within the manufacturing industry.

WORKFORCE SUMMARY AND RECOMMENDATIONS

For Indiana to remain a leader in manufacturing, continued development and expansion of the industrial workforce is crucial. With the growth of new manufacturing opportunities within the state, Indiana must ensure programs are available to upskill or reskill existing workers and reach out to potential new workers. A regional network of educational institutions in Indiana already provides training aimed at high-tech manufacturing careers. Continuing to expand coordination among training programs, state economic development leaders, organized labor, and industry will help to ensure that students are being recruited and trained for the right jobs at the right time. To this end, companies will need to disclose what skill gaps remain and what training would alleviate these issues. At the same time, companies will need to pay competitive wages and offer sufficient support for workers and trainees, with wraparound services like adequate and reliable transportation and childcare options. Indiana can help companies utilize existing programs, and also look to other states that are experiencing a similar manufacturing boom, to see what programs they are instituting to recruit companies and workers.

7 There may be other factors not considered here about why companies may be drawn to certain states. For example, how favorable a state may be to unions could influence a company's decision. Prevailing wages tend to be lower in states with lower union presence, such as many states in the Southeast. Unions provide benefits to companies as well, such as reducing turnover, providing skills enhancement and assisting in recruiting, which is overall beneficial to helping companies retain a skilled workforce (Katz 2022). While Indiana is around the national average for union membership, South Carolina has one of the nation's lowest rates for population supported by a union (BLS 2023).

Leveraging Federal Investments to Support Manufacturing Growth in Indiana

With the passage of several major pieces of legislation in the last few years, the federal government is investing in domestic manufacturing at an unprecedented scale: $80+ billion in federal spending on industrial and advanced energy investments is expected over the next 5–10 years, primarily through the Department of Energy (DOE), Department of Commerce (DOC), and the Environmental Protection Agency (EPA). Major federal investments in industrial manufacturing resiliency, decarbonization, and sustainability since 2020 in the United States include the Energy Act of 2020, the Bipartisan Infrastructure Law of 2021, the Inflation Reduction Act of 2022, and the CHIPS and Science Act of 2022. A recent RMI report predicts that the Inflation Reduction Act (IRA) alone will catalyze $17 billion in investments in Indiana and 24K new jobs, by 2030 (Aggarwal, Corvidae, and Jaglom-Kurtz 2023).

These new laws work to drive a competitive edge for domestically produced, sustainable goods and ensure that new manufacturing and energy system investments bring direct benefits to U.S. communities. These benefits include a resilient, competitive, and sustainable economy that is protected from global supply chain disruptions in energy and materials. New clean energy technologies also pave the way for retaining and expanding well-paying jobs in energy communities while substantially reducing pollution emissions and environmental harms.

IRA funds, in particular, are at an early stage of roll out, and additional guidance and many more opportunities are forthcoming. Support for the industrial sector is available via a variety of funding mechanisms. Recognizing that a range of stakeholders are involved in setting up new manufacturing strategies and energy infrastructure, funding is available not just to businesses, but also to nonprofits, higher education, and local, state, and Tribal policy offices. For an illustration of the range of funding mechanisms currently available, see table 3, below.

Table 3. These federal funding opportunities are currently available to a range of industrial and energy stakeholders.

Program	Target stakeholder	Agency	Total amount of program funding	Description
48C: Advanced Energy Project Credit	Industrial facilities and manufacturers	DOE, Internal Revenue Service (IRS)	$10 billion	Eligible uses for this credit include installing technology in an industrial or manufacturing facility to reduce GHG emissions by at least 20%, upgrades to support critical material processing, and expanding clean energy manufacturing and recycling. Credit is open to projects

Program	Target stakeholder	Agency	Total amount of program funding	Description
				of all sizes, with 40% of credits allocated for projects in energy communities.
45X: Advanced Manufacturing Production Credit	Manufacturers of clean energy components	DOE, IRS	No limit on the amount of funding but will phase out beginning in 2030	This is a per-unit tax credit for clean energy components domestically produced and sold by manufacturers.
Industrial Demonstrations Program	Energy-intensive industries	DOE Office of Manufacturing and Energy Supply Chains (MESC) and Office of Clean Energy Demonstrations (OCED)	$6.3 billion	This program provides competitive financial support to owners and operators of facilities engaged in energy-intensive industrial processes to complete demonstration and deployment projects that reduce a facility's greenhouse gas emissions through installation or implementation of advanced industrial technologies, and to conduct early-stage engineering studies to prepare a facility to install or implement advanced industrial technologies.
Low-Carbon Transportation Materials Program	State, local, or Tribal governing bodies	Federal Highway Administration (FHWA)	$2 billion	This program reimburses or provides incentives to eligible recipients for the use of low-embodied carbon construction materials and products in federally funded highway projects.
Domestic Manufacturing Conversion Grants	Vehicle manufacturers	DOE	$2 billion	These cost-shared grants are for domestic production of efficient hybrid, plug-in electric hybrid, plug-in electric drive, and hydrogen fuel cell electric vehicles.
30C: Alternative Fuel Vehicle Refueling Property Credit	Businesses, residential consumers	DOE, IRS	tax credit	The qualified alternative fuel vehicle refueling property must be for clean burning fuels, as defined in the statute, and must be located in a low-income or rural area.

This table just represents a selection; see Key Resources section for further federal funding resources with more complete lists and further details.

Some of the already announced federal programs and strategies include tax credits to support energy developments and industrial technology upgrades, with additional (sometimes doubling) of these credits when the new investments occur within mining or coal communities. These tax credits also include requirements for companies to meet prevailing wages and use registered apprenticeships in an effort to ensure that community members benefit through expanded access to well-paying jobs. Funding applications from Indiana-based industrial companies can leverage organized labor connections in the state to strengthen proposals and compete successfully for investments.

Grants, loans, rebates, and other cost-sharing strategies available through DOE and EPA offices can kick-start implementation of industrial energy and decarbonization solutions. Many of these programs have been collected and organized into sortable tables by third-party organizations.[8]

The federal government is not only taking steps to increase energy supply and manufacturing capacity but also to expand markets for domestically made, lower-carbon goods (demand-side investments). For example, steel and aluminum emissions–based trade agreements between the United States and the European Union prevent "dirty" steel and aluminum from countries with less stringent emissions and labor standards from overwhelming U.S. markets and outcompeting domestic products. While various forms of these tariffs, especially for steel, have been in place for decades, recent international collaborations may help to achieve decarbonization goals without adversely impacting domestic steel and aluminum prices.

A newly established Federal Buy Clean Task Force is also working to promote the use of construction materials with lower-embodied emissions and pollutants across their life cycle. The cross-agency task force is developing new codes and standards for core construction materials such as steel, aluminum, cement, and asphalt that are produced domestically, to be applied to federal contracts and construction projects. This could have a significant impact as approximately one-third of construction projects in the United States are government-funded (Cox and Milko 2021).

The federal government has also helped to coordinate private investments in sustainable materials and clean technologies. The First Movers Coalition, for example, is a public-private partnership led primarily by large, global companies that have pledged to purchase lower-carbon materials to integrate into their products, helping to fund investments in new

[8] For example, RMI updates an IRA-focused funding program spreadsheet here: https://rmi.org/breaking-down-the-inflation-reduction-act-program-by-program-incentive-by-incentive/.

technologies, including in the steel and aluminum sectors. Major automotive companies such as Ford Motor Company, General Motors, and Volvo Group have committed to making 10% of their steel and aluminum purchases low carbon by 2030. Packaging and electronics companies like Apple, PepsiCo, and Ball Corporation have also made low-carbon aluminum commitments.

FEDERAL POLICY SUMMARY AND RECOMMENDATIONS

Federal support for both capital expenditures and operating expenses for manufacturing investments and clean energy deployments are changing the economics of many key new technologies. The distribution of this support is at the very early stages, but a wide variety of stakeholders in the industrial sector will ultimately have access to financing and technical support for projects. Additional guidance, funding announcements, and coordination between federal and state agencies should be expected soon. In the meantime, stakeholders can identify essential projects and needs, and establish local and state-level coalitions that will be able to rapidly apply for and successfully deploy technologies and infrastructure when relevant.

Indiana policymakers should continue to proactively support industrial companies and other stakeholders in accessing these new opportunities for federal funding, which can enable needed investments in sustainable, modernized manufacturing and clean energy deployment in the state, ensuring that Hoosiers reap the benefits of this once-in-a-generation economic development opportunity. Enhancing capacity by increasing staffing and resources at key state agencies such as the Office of Energy Development, Indiana Department of Environmental Management, the Indiana Utility Regulatory Commission, and the Indiana Department of Workforce Development could help maximize the state's potential to coordinate and apply for numerous federal funding opportunities to revitalize Indiana's manufacturing sector.

Overall Findings and Next Steps

This report identifies a set of viable paths to a resilient, competitive, and sustainable metals manufacturing sector in Indiana, focusing on iron and steel and the aluminum industries. Steelmaking, in particular, has been the core of Indiana's economy for decades, but Indiana facilities will require substantial capital investments to ensure that they can meet the growing demand for low-carbon, sustainable steel. A variety of opportunities exist in Indiana to maximize manufacturing jobs and economic growth in the state while reducing energy costs, carbon emissions, and pollution burdens for Indiana communities. Here, we summarize the key report findings across metals manufacturing sectors, the EV industry, clean energy, workforce, and federal policy support.

For iron and steel

- The only proven technological strategy available today for achieving net-zero steel production in Indiana is to switch from BF-BOF manufacturing to green hydrogen–based DRI combined with EAFs.
- The major barriers to this transition include (1) the capital expense of building or expanding new facilities, in addition to the cost of stranded assets from BF-BOF facilities, (2) the economics of hydrogen (green hydrogen is not yet economically viable), (3) the availability of enough carbon-free electricity at scale, and (4) the obtainability of high-quality steel scrap. Indiana will especially need to overcome the economics of green hydrogen with the help of federal and state policy support, although natural gas can be used in DRI facilities as a bridge.
- Major opportunities to support overcoming these barriers in Indiana include (1) deep, well-established steel value chains that incentivize continued growth of steelmaking in the region and (2) the efforts underway to kick-start a regional green hydrogen network.
- Indiana community, labor, and policy stakeholders will also need to build strong coalitions to pressure steel companies to make the necessary transformative technology investments that put Indiana facilities on track to manufacture the net-zero carbon steel of the future.

For aluminum

- The Alcoa smelter at Warrick is one of only five remaining primary aluminum smelters in the country; it is also one of the most emissions intensive, currently running entirely on coal.
- Primary aluminum manufacturing, including the Warrick smelter, has a clear path to carbon-free production by combining transformative inert anode technology with 100% emissions-free electricity.
- To successfully develop sustainable aluminum manufacturing in the state, local, state, and federal stakeholders will need to convene to support Alcoa in transitioning away from coal. The current smelter electricity supply will need to be replaced by a combination of behind-the-meter renewable generation and storage and long-term, affordable contracts for renewable power. Federal incentives that support just economic transitions for coal and energy communities will be integral to succeeding, but state and local coordination around siting, permitting, and organizing stakeholder support will also be necessary.
- Growing demand for sustainably produced aluminum in both packaging and EV value chains provide key demand pulls to justify continued regional investments in sustainable primary aluminum manufacturing.

For EV manufacturing

- All five major automotive manufacturers with factories in Indiana have made public commitments to reduce supply chain carbon emissions. All plan to be carbon neutral by 2050 and some have already committed to purchasing low-carbon steel and aluminum.
- By incentivizing steel and aluminum manufacturers to increase their investments in lower-carbon production methods and specialized EV finishing facilities, Indiana has an opportunity to support an expansion of well-paying jobs in the growing EV market.
- Indiana can leverage its strong autoworker union presence to ensure that well-paying automotive jobs are retained in Indiana, and a just and sustainable transition to EV manufacturing occurs in the state.

For clean energy

- Indiana's demand for electricity is expected to roughly double by 2050. To meet this need while reaching utility and national goals for a net-zero carbon emissions power sector, renewable energy supply will have to increase dramatically.
- Indiana state policymakers can work to create a more friendly policy environment for wind and solar development, including addressing renewable energy siting restrictions that prevent companies from accessing or procuring renewable energy and expanding opportunities for industry to access PPAs and green tariffs.
- Planned coal plant retirements can combine with federal incentives to support the development and production of clean energy in coal communities and achieve a just and affordable transition away from coal.

For workforce

- As the manufacturing sector evolves, Indiana will see an increased need for skilled workers who can operate in both established industries like aluminum and steel and also newer industries like EVs and batteries.
- Indiana should identify necessary skills and evaluate the state's available programs and options to facilitate training and upskilling for a prepared workforce. In this process, Indiana should consider programs that will provide sufficient wraparound services for people being trained.
- New federal tax credits and other incentives can be used to support workforce development programs as well as assisting companies with the costs of training new employees and providing benefits to retain employees.

For federal policy

- Over $80 billion in federal spending on industrial and advanced energy investments is expected in the next 5–10 years. These incentives are meant to drive a competitive

edge for domestically produced and sustainable goods and to ensure that new manufacturing investments directly benefit American communities.

- Indiana can ensure that it fully leverages federal opportunities by strategically forming multi-stakeholder partnerships to develop strong industrial and energy project proposals. By identifying funding needs now, Indiana will be prepared to submit strong proposals and ensure that some of the industrial "first movers" make transformative technology investments in the state of Indiana.
- State and local policymakers should be attentive to new funding opportunities in the form of grants, loans, and tax credits. These will continue to be rolled out in the coming months.

Conclusions

Indiana has the greatest concentration of manufacturing jobs in the country, especially within metals value chains. Indiana is home to more than a quarter of the nation's steelmaking capacity, as well as one of only five remaining U.S. primary aluminum smelters. Construction, energy infrastructure, and electric vehicle manufacturing demand sectors are all growing rapidly and constitute strong demand pulls for these metals. For example, just since August 2022, over $7 billion in EV manufacturing investments have been announced in the state of Indiana. All automotive companies investing in new factories in Indiana have also committed to decarbonizing their product supply chains. This will require Indiana-based metals manufacturers to change their energy use and production processes to remain competitive for high-value automotive contracts.

Now is the time to ensure that the massive current federal funding opportunities to build robust domestic manufacturing supply chains continue to catalyze private sector investments in Indiana and lead to just and equitable outcomes for our communities. Leaders from state and local government, communities, organized labor, and industry must come together to chart a path forward for sustainable metals manufacturing in the state. Successfully implementing transformative new industrial technologies in Indiana manufacturing facilities, expanding access to clean energy, and ensuring a well-trained workforce that is ready to engage with new, advanced manufacturing technology will enable Indiana to continue to lead our country into the future of sustainable domestic manufacturing.

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Key Resources

To support application of the findings in this report, we have gathered a set of toolkits, data sources, and reports providing more detailed information related to the main sections of this report. Many of these resources are updated frequently.

Decarbonizing Steel

- State level emissions reporting, by sector: https://cfpub.epa.gov/ghgdata/inventoryexplorer/
- Comprehensive technical and economic assessment of decarbonization pathways for iron and steel industry: https://www.energypolicy.columbia.edu/publications/low-carbon-production-iron-steel-technology-options-economic-assessment-and-policy
- Global tracker for steel industry decarbonization investments: https://www.industrytransition.org/green-steel-tracker/

Decarbonizing Aluminum

- Sustainable Aluminum Network: https://www.sustainablealuminumnetwork.org/home

Electric Vehicle Manufacturing

- Mapping automotive sector facilities and jobs: https://www.thirdway.org/memo/fall-2021-update-mapping-jobs-and-the-transition-to-electric-vehicle-assembly-in-the-us
- Indiana Electric Vehicle Production Commission Report: https://www.iedc.in.gov/program/electric-vehicle-product-commission/reports#skip-header

Clean Energy Supply

- Indiana Office of Energy Development, Indiana's Energy Policy: https://www.in.gov/oed/indianas-energy-policy/.
- International Energy Agency (IEA) 2023. *Energy Technology Perspectives 2023*: https://www.iea.org/reports/energy-technology-perspectives-2023.

Workforce Solutions

- United States Office of Personnel Management (OPM). 2022. Workforce Planning Guide: https://www.opm.gov/policy-data-oversight/human-capital-framework/reference-materials/talent-management/workforce-planning-guide.pdf.
- World Economic Forum. 2023. *The Future of Jobs Report 2023: Key Findings*: https://www.weforum.org/reports/the-future-of-jobs-report-2023.
- Indiana Workforce Cabinet. *A Better Future for Every Hoosier: Indiana's Strategic Workforce Plan*: https://www.in.gov/gwc/files/Indiana-Strategic-Workforce-Plan-Executive-Summary.pdf.

Federal Funding Opportunities

- Energy Community Tax Credit Information and Mapping Tool: https://energycommunities.gov/energy-community-tax-credit-bonus/
- Office of Clean Energy Demonstrations (OCED) project portfolio: https://www.energy.gov/oced/office-clean-energy-demonstrations
- Inflation Reduction Act funding incentives, organized by target stakeholders and programs: https://rmi.org/breaking-down-the-inflation-reduction-act-program-by-program-incentive-by-incentive/
- IRA and CHIPS federal funding investment results by state: https://www.jackconness.com/ira-chips-investments