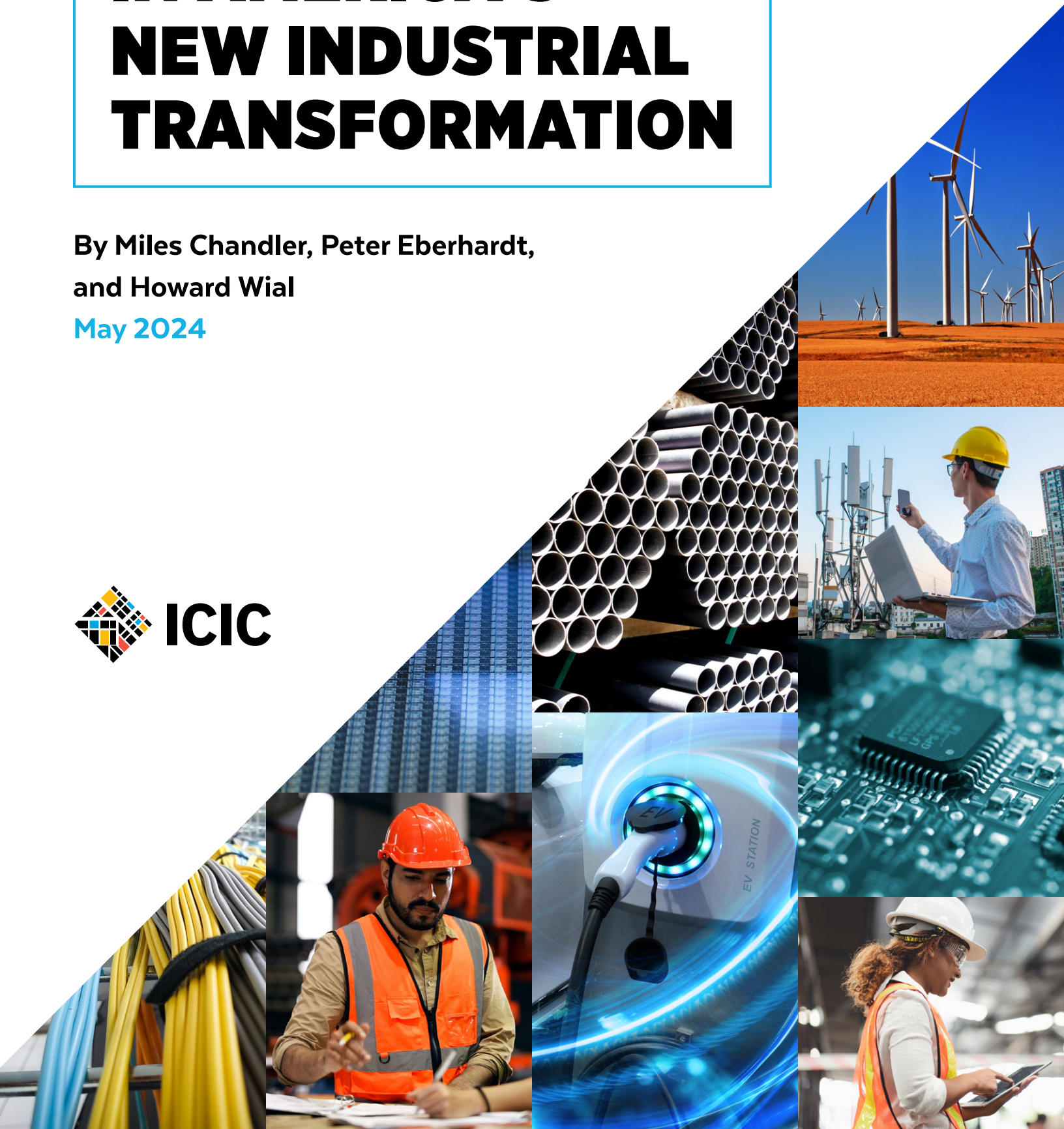
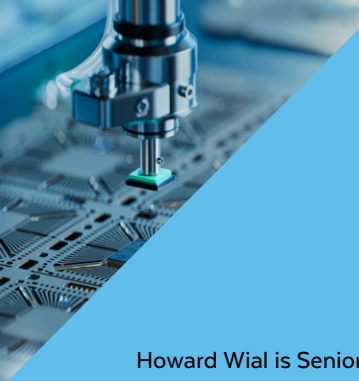


RACIAL EQUITY IN AMERICA'S NEW INDUSTRIAL TRANSFORMATION

By Miles Chandler, Peter Eberhardt,
and Howard Wial
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Howard Wial is Senior Vice President and Director of Research at the Initiative for a Competitive Inner City, where Miles Chandler and Peter Eberhardt are senior research associates.

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For More Information

Howard Wial

Senior Vice President and Director of Research
617.238.3043
hwial@icic.org

For more information about ICIC,
please visit www.icic.org.

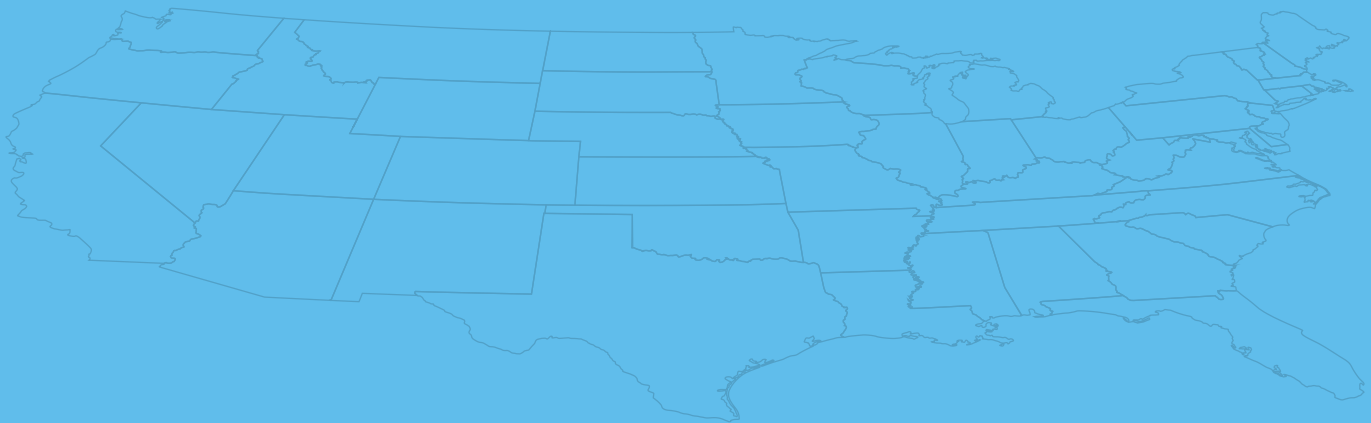


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EXECUTIVE SUMMARY

The U.S. is on the cusp of a groundbreaking moment. Three pieces of federal legislation enacted in 2021 and 2022—the Infrastructure Investment and Jobs Act (IIJA), CHIPS and Science Act (CHIPS Act), and Inflation Reduction Act (IRA)—collectively authorize nearly \$1.5 trillion in an effort to reshape America’s industrial landscape while meeting the nation’s critical infrastructure, high technology, and clean energy needs. They can also create a once-in-a-lifetime opportunity to close the nation’s racial wealth gaps, but their ability to do so depends on the extent to which members of historically disadvantaged groups own businesses in the manufacturing supply chains that the legislation is designed to support.

This report examines Black and Hispanic ownership of manufacturing businesses in 13 key supply chains supported by one or more of the three laws: batteries,

carbon capture and storage, critical minerals, electric vehicles, fiber optic cables, fuel cells and electrolyzers, hydropower, nuclear energy, rail cars, semiconductors, solar power, wind power, and wireless technology. Based on analysis of Dun & Bradstreet data and extensive online investigation of companies’ products and the race/ethnicity of their owners, the report shows the numbers of Black- and Hispanic-owned manufacturers that are original equipment manufacturers (OEMs) (manufacturers of end products that are sold to individual consumers or other firms) or first-tier suppliers (manufacturers of components sold directly to OEMs) in these supply chains. It also compares their size (employment and revenue) and location with those of white-owned manufacturers in the same supply chains. The report finds that:

Black and Hispanic owners are highly underrepresented in the 13 supply chains we examined.

Nationwide, there are 107 Black-owned and 151 Hispanic-owned manufacturers among OEMs and first-tier suppliers in the 13 supply chains we examined. Black-owned businesses are 0.5 percent and Hispanic-owned businesses are 0.8 percent of all privately held businesses in these supply chains. By contrast, Black people are 13.6 percent of the U.S. population and 0.9 percent of all business owners in manufacturing, while Hispanic people are 19.1 percent of the U.S. population and 4.8 percent of all business owners in manufacturing.

Among the 13 supply chains, the ones with the highest percentage of Black owners are electric vehicles and critical minerals, each of which have 1.2 percent of business owners who are Black. The highest Hispanic ownership percentage is found in nuclear energy, where 1.7 percent of owners are Hispanic. In the vast majority of supply chains, first-tier suppliers outnumber OEMs among Black- and Hispanic-owned manufacturers.

Table 1. Number of Businesses, Median Employment, and Median Revenue by Race of Business Owner in 13 Manufacturing Supply Chains

	Number of Businesses*	Median Revenue	Median Employment
Black-owned	107	\$897,056	10
Hispanic-owned	151	\$2.22 million	18
White-owned	15,233	\$498,530	8

*Note: OEMs and first-tier suppliers only.

Source: Authors’ analysis of Dun & Bradstreet Hoovers 2023 data, 2023 Census Population and Housing Estimates, 2023 American Community Survey 1-year estimates, 2021 Annual Business Survey data, business websites, and business owner race/ethnicity sources described in the Appendix.

EXECUTIVE SUMMARY

Black- and Hispanic-owned manufacturers are larger than white-owned manufacturers in the 13 supply chains.

The typical (median) Hispanic-owned firm in these supply chains has 18 employees and annual revenue of \$2.22 million, compared to 10 employees and \$897,056 in annual revenue for the typical Black-owned firm and eight employees and \$498,530 in annual revenue for the typical white-owned firm. Among individual supply chains for which we are able to make size comparisons, Black- and Hispanic-owned manufacturers are larger than their white-owned counterparts in electric vehicles and wireless technology but white-owned companies are larger than Black-owned companies in carbon capture and storage.



In the larger supply chains, the top states for Black- and Hispanic-owned manufacturers are similar to those for white-owned manufacturers.

Black- and Hispanic-owned manufacturers in all 13 supply chains are generally clustered in major manufacturing regions in parts of the Midwest and South and in California and Texas. Geographic patterns differ somewhat by supply chain. In electric vehicles, for example, Black- and Hispanic-owned companies are clustered in the historic auto manufacturing centers of the Midwest and South as well as in Texas and California. In wireless technology, the majority of Black- and Hispanic-owned manufacturers are in California, New York, and Texas. Half of Black- and Hispanic-owned semiconductor manufacturers are in California, Georgia, New Mexico, and Texas.



Relatively few Black- and Hispanic-owned companies in the 13 supply chains are located in under-resourced communities, defined by ICIC as highly populated areas of concentrated poverty and low income located in central cities and suburbs within metropolitan areas. Although the majority of residents of under-resourced

communities are people of color, only 28 percent of all Black-owned businesses and 22 percent of all Hispanic-owned businesses in our 13 supply chains are located in these communities, compared with 14 percent of white-owned businesses in these supply chains.

Recommendations

Government agencies, OEMs, lenders and investors, technical assistance providers, and philanthropic foundations can support increased participation of Black and Hispanic business owners in these supply chains by taking the following steps.

1 Increase capital access for Black- and Hispanic-owned businesses.

- Encourage financial institutions or technical assistance providers that serve manufacturers to promote the use of supply chain finance in manufacturing supply chains over traditional asset-based lending to help smaller businesses resolve cash flow issues.
- Federal, state, and local governments should devote more effort to enforcing anti-discrimination laws and policies, such as the Equal Credit Opportunity Act.
- Small business assistance providers and industry thought leaders should advocate for greater racial and ethnic diversity among angel investors and venture capital firms and work to protect a dwindling number of Minority Depository Institutions (MDIs) from acquisition by non-minority-owned banks.

2 Improve the flexibility and competitiveness of Black- and Hispanic-owned suppliers through technical assistance and training.

- Use federal funding to expand the geographic reach of industry-specific technical assistance networks such as MBDA's advanced manufacturing centers.
- Expand the curricula of existing procurement technical assistance providers, such as those that operate APEX Accelerators (formerly Procurement Technical Assistance Centers), to meet the specific needs of suppliers in advanced manufacturing supply chains.
- Procurement technical assistance providers should develop curricula for manufacturers so that Black- or Hispanic-owned companies that already provide goods to OEMs can position themselves as essential suppliers by expanding into adjacent markets.



3 Identify and remove barriers in the advanced manufacturing STEM educational pipeline, which is a source of startup manufacturing companies.

- Increase state and federal funding for graduate education at HBCUs and other minority-serving institutions in science and engineering fields that feed into advanced manufacturing.
- Provide federal funding for further research into structural or organizational-cultural factors that filter Black and Hispanic students out of STEM education programs or prevent them from starting in those programs, and for implementation of culturally competent program support aimed at increasing retention of Black and Hispanic candidates for advanced degrees in STEM fields.
- Strengthen large companies' hiring initiatives with minority serving institutions, such as HBCUs, to help broaden the pool of talent contributing to high-tech and renewable energy innovation and increase representation of minority-owned businesses among startups in these sectors.

4 Reform the procurement practices of OEMs and large purchasers in supplier industries to increase access and opportunity for Black- and Hispanic-owned companies.

- OEM leadership should emphasize the importance of supplier diversity and incentivize procurement officers to diversify the company's supplier portfolio.
- Banks and funders that invest using ESG frameworks should offer financial incentives, such as more favorable short-term loan terms, to large purchasers that enact procurement policies that increase opportunities for minority-owned companies, such as preference for smaller suppliers, shorter payment schedules, or limited-term contracts to increase supplier turnover.
- To the extent feasible, large OEMs should unbundle large contracts into smaller ones to make their procurement opportunities accessible to smaller companies.
- Governments should offer OEMs and first-tier suppliers that reform their procurement policies (as specified above) preference for federal, state, and local contracts; funding for state and local pass-throughs of IIJA, CHIPS Act, and IRA funding; and funding under state-level counterparts to these federal laws.
- As they roll out future rounds of funding to supplement IIJA, CHIPS Act, and IRA funds (including funding under state-level counterparts to the CHIPS Act), state and local governments should echo federal policies that give preference to bids that include an actionable, specific supplier diversity plan, such as the provisions attached to federal CHIPS Act funding for manufacturing plants. This should apply to both OEMs and first-tier suppliers.
- State and local governments should make the provision of additional support to manufacturers that previously received federal funding under the IIJA, CHIPS Act, and IRA contingent on the successful implementation of their supplier diversity plans.
- Firms that receive funding or incentives through these pieces of legislation should actively seek out minority-owned companies, including Black- and Hispanic-owned manufacturers in the supply chains covered in this report.

5 Collect and disseminate data about advanced manufacturing supply chains, including supply chain mapping and detailed information on the demographics of the companies' owners.

- The Census Bureau, Bureau of Labor Statistics, and National Science Foundation should coordinate comprehensive supply chain mapping of advanced manufacturing industries to complement the promising but disconnected efforts that have already begun.
- The Census Bureau should expand its publicly available information to include aggregate business owner demographics for specific supply chains to fill considerable gaps in the data on minority representation in manufacturing.
- For the purposes of both data collection and the distribution of public funding to manufacturers, companies that count as minority-owned should be required to demonstrate that they are producing at least some manufactured products in the U.S.

6 Black- and Hispanic-owned manufacturers may have opportunities to operate at lower tiers of their supply chains and hire residents of under-resourced communities.

- Black- and Hispanic-owned manufacturers at lower tiers of their supply chains may have more opportunities to benefit from the IIJA, CHIPS Act, and IRA.
- Black- and Hispanic-owned manufacturers may be uniquely positioned to hire residents of under-resourced communities.

Despite the small numbers of Black- and Hispanic-owned OEMs and first-tier suppliers in the 13 supply chains included in this report, there is considerable opportunity for Black- and Hispanic-owned firms to participate in the transformation that the IIJA, CHIPS Act, and IRA are creating. With the help of the right policies, existing Black- and Hispanic-owned firms can expand and new ones can be established in supply chains supported by the legislation, including lower tiers of supply chains covered in this report as well as supply chains not included here. As a result, Black and Hispanic communities can gain jobs, income, and wealth. Although federal agencies have already begun to distribute funding under the three pieces of industrial policy legislation, there is still time to create a more racially and ethnically inclusive industrial future in the U.S.



INTRODUCTION

Three recent federal laws—the Infrastructure Investment and Jobs Act, CHIPS and Science Act, and Inflation Reduction Act—promise to renew and transform the American industrial base through investments in such advanced industries as semiconductors and clean energy, including zero-emission vehicles, electric batteries, solar and wind production, and other types of advanced renewable energy. These investments can also create a once-in-a-lifetime opportunity to close the nation’s racial wealth gaps. But they can achieve those goals only to the extent that entrepreneurs from historically disadvantaged groups—especially Black and Hispanic entrepreneurs—own businesses in the industries whose growth they will spur.

Little is currently known about the extent to which Black- and Hispanic-owned firms are represented in the industries that are the targets of the new legislation or in the U.S. supply chains of those industries. Similarly, little is known about the characteristics of these firms. As a result, the federal agencies that are responsible for disbursing the new investments, the state and local governments that will receive much of the funding, and the

original equipment manufacturers (OEMs) whose procurement spending will catalyze growth throughout their supply chains lack the knowledge they need to ensure that eligible Black- and Hispanic-owned manufacturers have the opportunity to compete for the federal funding. Without that knowledge, Black and Hispanic entrepreneurs are likely to miss out on opportunities to build wealth and contribute to America’ industrial renaissance and that renaissance will be less robust without their contributions.

This report helps fill these knowledge gaps. For 13 key supply chains that are targets of the new legislation, the report examines the extent to which Black- and Hispanic-owned manufacturers are represented in the supply chain, their revenue and employment, and their geographic location. It recommends public policy changes to remedy the racial/ethnic disparities that it identifies and enable the nation to benefit from the largely untapped potential of Black and Hispanic manufacturers. Box 1 lists the supply chains and types of manufacturers included in the report.



Box 1. Manufacturers Included in This Report

This report covers manufacturers in 13 supply chains:

- Semiconductors.
- Wireless technology.
- Electric vehicles.
- Batteries.
- Rail cars.
- Wind power.
- Solar power.
- Nuclear power.
- Hydroelectric power.
- Fuel cells and electrolyzers.
- Carbon capture and storage.
- Critical minerals.
- Fiber optic cables.



We selected these supply chains after consulting with industrial policy experts, taking into account the broad importance of each supply chain for public policy and the recent legislation, the availability of data, and the time constraints on our research.

Within these supply chains, the report covers manufacturers whose products could make them:

- Original equipment manufacturers (OEMs), which we define as the manufacturers of end products that are sold to individual consumers or other firms. OEMs assemble their products from components and raw materials produced by other companies. For example, the manufacturers of electric vehicles are OEMs. OEMs may differ in the extent to which they produce their own components. For example, some electric vehicle manufacturers produce electric vehicle batteries themselves, while others buy them from battery manufacturers.
- First-tier suppliers, which are manufacturers of components sold directly to OEMs. For example, manufacturers of seats, electric motors, and tires are first-tier suppliers in the electric vehicle supply chain. Manufacturers of electric vehicle batteries are also first-tier suppliers in this supply chain as well as OEMs in the batteries supply chain.

In many manufacturing industries, there are one or more tiers of suppliers below the first tier. Second-tier suppliers make products that they sell to first-tier suppliers, third-tier suppliers make products that they sell to second-tier suppliers, etc. Most U.S. manufacturers are small and medium-sized firms; over 70 percent have fewer than 20 employees.¹ This report covers only OEMs and first-tier suppliers because the availability of data on lower-tier suppliers is much more limited and because the products of lower-tier suppliers have a wider variety of business users and, therefore, are more difficult to attribute to specific supply chains. However, Black- and Hispanic-owned firms are likely to be more underrepresented among OEMs and first-tier suppliers than among lower-tier suppliers. OEMs and first-tier suppliers include some of the largest manufacturing companies in the country, such as General Motors (an OEM) and Continental Corporation (a first-tier auto supplier). Many of these companies are publicly held. Among those that are privately held, few are owned by Black or Hispanic people because of the considerable historic challenges of starting and growing minority-owned businesses.

Although the benefits of the legislation extend to many industries outside of manufacturing (e.g., solar panel installation and the construction of roads and transit systems), we focus on manufacturing because it plays a critical role in achieving major national policy goals: creating high-wage jobs for workers without bachelor's degrees, spurring innovation, reducing the trade deficit, and creating a more environmentally sustainable future.²

BACKGROUND

The Infrastructure Investment and Jobs Act, CHIPS and Science Act, and Inflation Reduction Act collectively authorize nearly \$1.5 trillion toward the nation's largest and most explicit industrial policy effort in at least the last eight decades. Technology policy expert Robert Atkinson has defined industrial policy, or what he also terms “advanced industry and technology strategy,” as “a set of policies and programs explicitly designed to support *specific* targeted industries and technologies.”³ Each law is intended to strengthen U.S. production capabilities in a set of industries and technologies that are essential for achieving critical national goals: improving the nation's infrastructure by building new infrastructure and repairing or upgrading existing infrastructure (Infrastructure Investment and Jobs Act), increasing U.S. production of semiconductors and related products (CHIPS and Science Act), and promoting the transition to clean energy (Inflation Reduction Act).

The Infrastructure Investment and Jobs Act (IIJA, also known as the Bipartisan Infrastructure Law)⁴ was enacted on November 15, 2021. It authorizes more than \$1 trillion to rebuild the nation's transportation infrastructure, support the transition to cleaner energy and vehicles, and strengthen national communications connectivity. Most of the law's funding is distributed to the states according to formulas. Other funding recipients include local and tribal governments, for-profit and nonprofit organizations, producers, and individual consumers. The Act prioritizes grants to minority-owned manufacturers of advanced energy solutions and includes numerous provisions to bolster the Minority Business Development Agency (MBDA).

The CHIPS and Science Act (CHIPS Act)⁵ was enacted on August 9, 2022. It authorizes \$52.7 billion to promote semiconductor manufacturing in the U.S., including both R&D and production. It provides funding to manufacturers via a 25 percent investment tax credit as well as funding for local workforce development. It also



promises expanded investments in STEM programs in K-12 education, community colleges, and historically Black colleges and universities and increased Manufacturing Extension Partnership and Manufacturing USA programming for underserved businesses and businesses owned by people of color. In addition to semiconductor manufacturing, the Act also authorizes funding to promote wireless technology and computing, critical minerals mining, and innovative uses of clean technology in manufacturing and transportation.

The Inflation Reduction Act (IRA)⁶ was enacted on August 16, 2022. It authorizes \$370 Billion to accelerate the U.S. transition to clean energy, strengthen critical clean energy supply chains, and create green jobs, primarily by offering tax credits to create incentives for private investment. Most of its funding is distributed through tax credits. It also includes direct consumer subsidies, grants for public-private R&D partnerships, and funding to state, local, and tribal governments. Key areas of focus include advancing and deploying clean energy technology, modernizing U.S. energy infrastructure, reducing emissions, and promoting electric vehicles.

METHODOLOGY

We began our research by reviewing congressional and executive branch summaries of the IJJA, CHIPS Act, and IRA. Using these summaries and our own judgment and knowledge of manufacturing, we identified the kinds of manufactured products that each law is most likely to affect directly. These products are generally the ones produced by OEMs in their respective supply chains. For each of these products, we identified the most specific (six-digit) North American Industry Classification System (NAICS) industry code(s) of companies that are likely to manufacture that product. As explained in Box 1, we narrowed our focus to the 13 supply chains covered in this report.

NAICS codes provided us with broad industry groupings that include the OEMs in each supply chain. However, they do not correspond to entire supply chains and do not, by themselves, make it possible to identify the specific industries that include first-tier suppliers of manufactured products. To identify those first-tier supplier industries, we used Bureau of Economic Analysis input-output tables and, where possible, supply chain reports produced by the Department of Energy and the Departments of Commerce and Homeland Security.⁷ The Appendix provides more detail about these data sources and how we used them.

Using the Dun & Bradstreet (D&B) Hoovers business record database, we created a list of all privately held companies in the relevant NAICS codes that are categorized as minority-owned.⁸ A minority-owned business is conventionally defined as any company with at least 51 percent minority ownership. We supplemented the D&B data with information from the National Minority Supplier Development Council's (NMSDC) list of minority-owned manufacturers. We then individually verified information about each business in our dataset through internet searches. We verified that a company is minority-owned if publicly available information from at least one of a variety of reliable sources (described in the Appendix) also categorized the firm in the same way or if it self-defined as minority-owned on its website.⁹

By scanning each company's website, we verified whether it manufactures products that fall within one or more of our priority supply chains and whether its activities and products mean that it is better classified as an OEM or as a first-tier supplier within its supply chain(s). Some companies in our dataset may be suppliers or OEMs for multiple supply chains, so we categorized them by their first and second most likely supply chains. Some companies are OEMs in one supply chain but first-tier suppliers in another. (For example, electric vehicle battery manufacturers are OEMs in the batteries supply chain and first-tier suppliers in the electric vehicle supply chain.)

Because we classified companies into supply chains and OEM or first-tier supplier positions on the basis of their products rather than on the basis of their business relationships, we were not able to determine whether a company is actually doing business with any other company (regardless of the owner's race or ethnicity) that we classified into the same supply chain, but only whether its products potentially put it in a position to do so. The Appendix provides more detail about the specific kinds of manufacturing activities and products of manufacturers in each supply chain, as well as about our criteria for classifying companies as OEMs or first-tier suppliers in each supply chain.

Once we had verified the demographic and supply chain details of our minority-owned sample and sorted all businesses into the appropriate supply chain(s), we repeated the product verification process on a 3 percent random sample of businesses not categorized by Dun & Bradstreet as minority-owned, assuming that these companies are white-owned. As we did with the minority-owned sample, we verified that each white-owned company is currently active and sorted it into the relevant supply chain(s). See the Appendix for a complete description of our methodology and its limitations.

FINDINGS

In this section, we report counts and percentages of Black- and Hispanic-owned businesses in each of our 13 supply chains and in all 13 supply chains combined. For individual supply chains, we also compare Black- and Hispanic-owned business representation among OEMs and first-tier suppliers.¹⁰ Next, we report statistically significant differences in median revenue and employment (at the 5 percent level of significance) between businesses with owners of different races. We also report any median revenue or employment estimates that are notably similar across two groups. Finally, we examine the locations of the Black- and Hispanic-owned manufacturers.

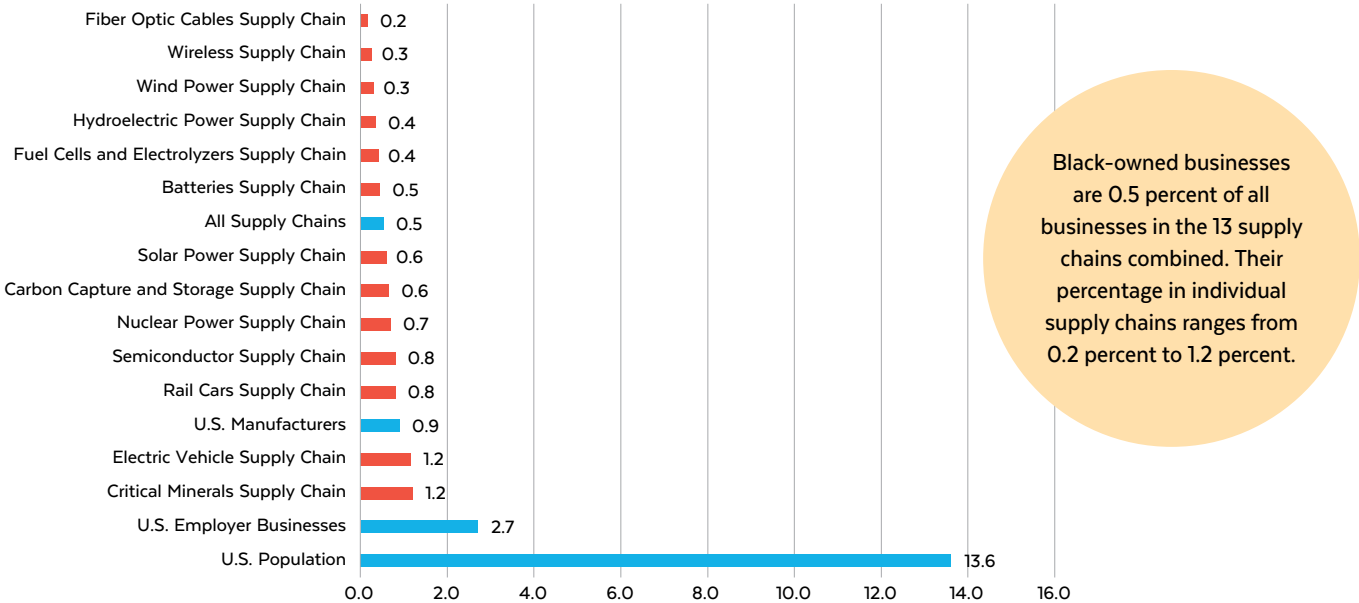
Black and Hispanic owners are highly underrepresented in the 13 supply chains

We identified 107 Black-owned and 151 Hispanic-owned manufacturers among OEMs and first-tier suppliers in the combination of 13 supply chains we examined.

Black-owned businesses are 0.5 percent and Hispanic-owned businesses are 0.8 percent of all businesses we identified in these supply chains. (See Figure 1 for Black-owned businesses and Figure 2 for Hispanic-owned businesses.)

Unsurprisingly, Black and Hispanic-owned businesses are extremely underrepresented in these 13 supply chains in comparison to the Black and Hispanic percentages of all business owners in U.S. manufacturing, all U.S. business owners, and the U.S. population. Black people are 13.6 percent of the U.S. population, 2.7 percent of all employer businesses, and 0.9 percent of all owners of manufacturing firms. Hispanic people are 19.1 percent of the U.S. population, 6.9 percent of all employer businesses, and 4.8 percent of all manufacturers.

Figure 1. Black-owned Businesses as Percent of Businesses in 13 Manufacturing Supply Chains, All U.S. Manufacturing, and the U.S. Economy, and Black Percent of U.S. Population



Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data, 2023 Census Population and Housing Estimates, 2023 American Community Survey 1-year estimates, 2021 Annual Business Survey data, business websites, and business owner race/ethnicity sources described in the Appendix.

FINDINGS

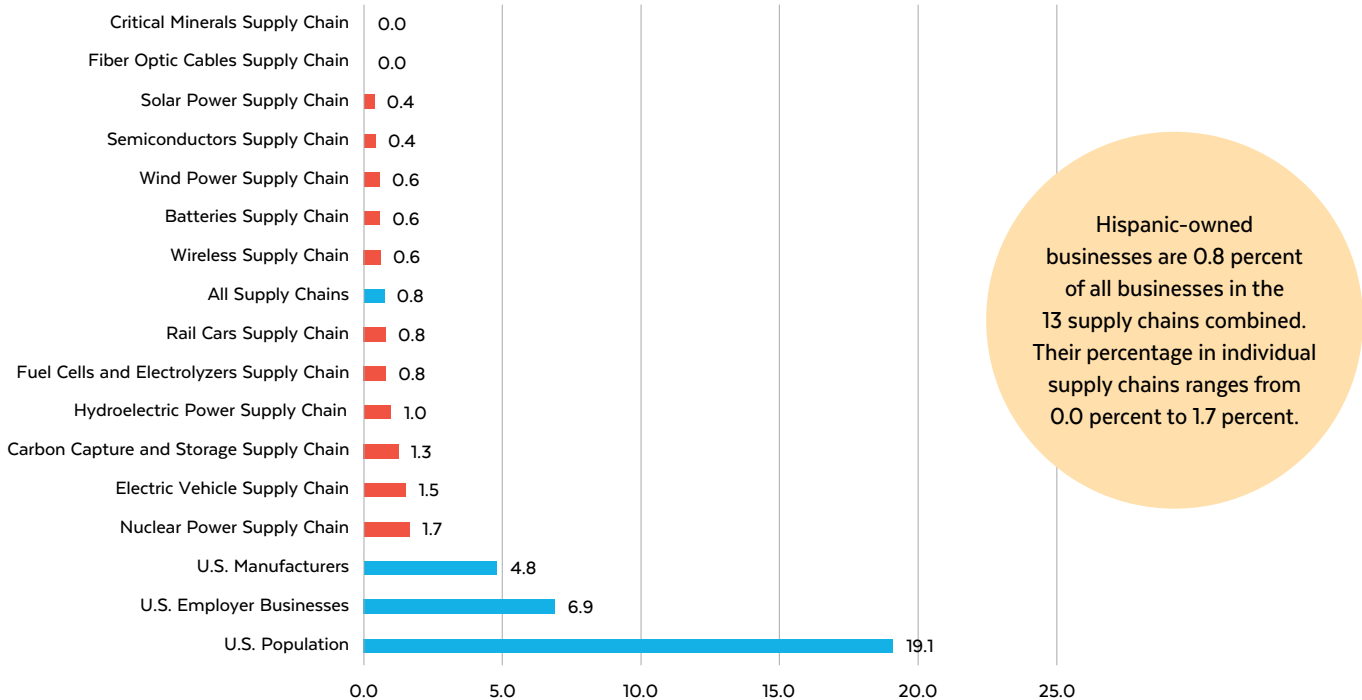
Among the supply chains we examined, electric vehicles (1.2 percent), critical minerals (1.2 percent), semiconductors (0.8 percent), rail cars (0.8 percent), nuclear power (0.7 percent), carbon capture and storage (0.6 percent), and solar power (0.6 percent) have Black ownership percentages above the percentage of Black owners in all 13 supply chains combined. Only Black-owned businesses in the electric vehicle and critical minerals supply chains surpass the national rate of representation of Black-owned employer businesses in the manufacturing sector as a whole.

The absolute numbers of Black-owned manufacturers are also very low in all supply chains except electric vehicles, which has 56 Black-owned companies. Each of the other supply chains has fewer than 10 Black-owned companies except for semiconductors (12 Black-owned

companies) and carbon capture and storage (10). Fiber optic cables has only one Black-owned manufacturer and critical minerals has only two.

Among the supply chains we examined, only nuclear power (1.7 percent), electric vehicles (1.5 percent), carbon capture and storage (1.3 percent), and hydropower (1.0 percent) have Hispanic ownership percentages above the percentage of Hispanic owners in all 13 supply chains combined, although none of these percentages come close to the Hispanic percentage of owners in all U.S. manufacturing. At the other extreme, there are no Hispanic owners in either the critical minerals or the fiber optic supply chain. This is not surprising because the energy- and resource-intensive nature of these industries means that they are dominated by a few large players globally.

Figure 2. Hispanic-owned Businesses as Percent of Businesses in 13 Manufacturing Supply Chains, All U.S. Manufacturing, and the U.S. Economy, and Hispanic Percent of U.S. Population



Hispanic-owned businesses are 0.8 percent of all businesses in the 13 supply chains combined. Their percentage in individual supply chains ranges from 0.0 percent to 1.7 percent.

Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data, 2023 Census Population and Housing Estimates, 2023 American Community Survey 1-year estimates, 2021 Annual Business Survey data, business websites, and business owner race/ethnicity sources described in the Appendix.

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In a few supply chains (electric vehicles, carbon capture and storage, and nuclear power), both the Black and Hispanic ownership percentages exceed the respective ownership percentages for all 13 supply chains combined. Electric vehicles stands out as the only supply chain in which both the Black and Hispanic ownership percentages exceed 1 percent. The greater representation of Black and Hispanic owners in electric vehicles might be related to the high historical representation of Black and Hispanic workers and of lower-tech “legacy” companies in auto parts manufacturing. Less technologically advanced portions of the supply chain may present fewer barriers to ownership for Black and Hispanic owners.

As with their Black-owned counterparts, the absolute numbers of Hispanic-owned manufacturers are also very low in all supply chains except electric vehicles, which has 73 Hispanic-owned companies. Each of the other supply chains has fewer than 10 Hispanic-owned manufacturers except for carbon capture and storage (20 Hispanic-owned companies), wireless technology (16), hydropower (11), and fuel cells and electrolyzers (10). There are no Hispanic owners in either fiber optic cables or critical minerals.



FINDINGS

First-tier suppliers generally outnumber OEMs among Black- and Hispanic-owned manufacturers

Among both Black- and Hispanic-owned manufacturers, first-tier suppliers outnumber OEMs in the vast majority of supply chains we examined (Table 2). This could result from the suppliers' generally lower capital intensity and consequent lower entry barriers for Black and Hispanic owners. In the batteries supply chain, there are more Black and Hispanic owners of OEMs than of first-tier suppliers. There are more Hispanic owners of OEMs than of first-tier suppliers in wind power. There are one or more Black-owned OEMs but no Black-owned first-tier suppliers in critical minerals and fiber optic cables.

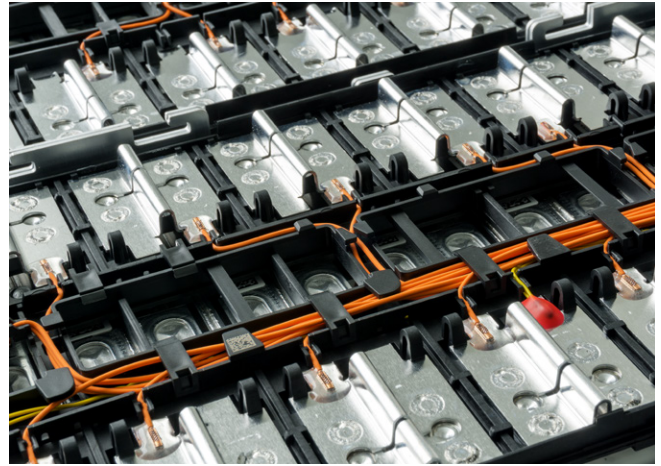


Table 2. Numbers of Black- and Hispanic-owned OEMs and First-tier Suppliers in 13 Manufacturing Supply Chains

	Number of Black-owned OEMs	Number of Black-owned First-tier Suppliers	Total Number of Black-Owned Firms	Number of Hispanic-owned OEMs	Number of Hispanic-owned First-tier Suppliers	Total Number of Hispanic-owned firms
Batteries	3	1	4	4	1	5
Carbon Capture and Storage	0	10	10	0	20	20
Critical Minerals	2	0	2	0	0	0
Electric Vehicle	0	56	56	0	73	73
Fiber Optic Cables	1	0	1	0	0	0
Fuel Cells and Electrolyzers	0	5	5	0	10	10
Hydroelectric power	0	4	4	0	11	11
Nuclear Power	0	3	3	1	5	6
Rail Cars	0	4	4	0	4	4
Semiconductors	1	11	12	0	8	8
Solar Power	1	5	6	0	7	7
Wind Power	1	2	3	3	2	5
Wireless Technology	2	5	7	3	13	16

Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data, business websites and business owner race/ethnicity sources described in the Appendix. Note: Because some firms were both OEMs in one supply chain and first-tier suppliers in another, the total numbers of Black- and Hispanic-owned firms shown in this table do not add to the totals for all 13 supply chains provided in the text.

Black- and Hispanic-owned manufacturers are larger than white-owned manufacturers in the 13 supply chains combined but not in all individual supply chains

While documenting minority-owned firm representation in our 13 supply chains enables us to examine the number of owners from historically disadvantaged backgrounds who might currently benefit from public and private investment in each supply chain, comparing the revenue and employment of firms in each supply chain offers an additional dimension of detail. We were able to make statistically valid size comparisons among Black-, Hispanic, and white-owned manufacturers for all 13 supply chains combined and for the electric vehicle, carbon capture and storage, and wireless technology supply chains.

For all 13 supply chains combined, Hispanic-owned manufacturers are larger than Black-owned manufacturers, which are larger than white-owned manufacturers. However, median revenue and employment for each of these demographic groups is very small. Hispanic-owned manufacturers in all supply chains combined have higher median revenue (\$2.22 million) than Black-owned businesses (\$897,056) and white-owned businesses (\$498,530). Hispanic-owned manufacturers in all supply chains combined also have higher median employment (18 employees) than Black-owned businesses (10 employees) and white-owned businesses (eight employees).¹¹ Although the vast majority of Black-owned, Hispanic-owned, and white-owned businesses are very small, this pattern is most pronounced among white-owned businesses. About 15 percent of white-owned businesses have revenue under \$100,000, while only 5 percent of Black-owned businesses and 3 percent of Hispanic-owned businesses are below this threshold. Roughly 17 percent of white-owned businesses have fewer than three employees, as compared to 28 percent of Black-owned businesses and 16 percent of Hispanic-owned businesses. The relatively large percentages of white-owned businesses with low revenue and employment result in lower medians for the group as a whole.

In the electric vehicle supply chain, Black- and Hispanic-owned businesses are similar in median

revenue (\$2.51 million for Black-owned companies and \$2.45 million for Hispanic-owned companies) and both have much higher median revenue than their white-owned counterparts, whose median revenue is only \$523,290.¹² Combined with the relatively strong representation of Black- and Hispanic-owned businesses by counts and percentages, their higher revenue (compared with white-owned firms) suggests that barriers to participation and success may be lower for minority-owned companies in the electric vehicle supply chain than in the other supply chains we examined. It will be crucial to monitor the efficacy of federal investments in this supply chain from a racial equity standpoint.

As in electric vehicles, Black- and Hispanic-owned companies in the wireless technology supply chain are typically larger than their white-owned counterparts. The median revenue of both Black- and Hispanic-owned wireless companies is \$2.67 million, much higher than that of white-owned businesses (\$446,952).¹³ Our size comparisons for the 13 supply chains combined as well as for electric vehicles and wireless technology show that Black- and Hispanic-owned manufacturers in those supply chains are typically larger than their white-owned counterparts.

In the carbon capture and storage supply chain, unlike in the other supply chains for which we were able to compare firm size, white-owned companies are larger than Black-owned ones. In this supply chain, median employment is significantly higher for white-owned businesses (8.5 employees) than for Black-owned businesses (4.5 employees). This is most likely because the Black-owned companies we found in the supply chain tend to be legacy companies or small parts manufacturers that make such products as ducting and gaskets, while the white-owned companies are more often large refinery or petrochemical companies. Most of the companies identified as potential first-tier suppliers to the carbon capture and storage supply chain are currently in the oil and gas industry. That industry is not especially diverse in the racial and ethnic composition of its business owners; white-owned firms are more than 88 percent of the oil and gas extraction industry nationwide while Black-owned businesses are less than 0.1 percent.¹⁴

FINDINGS

In the larger supply chains, the top states for Black- and Hispanic-owned manufacturers are similar to those for white-owned manufacturers

We tallied the number of Black- and Hispanic-owned companies in each supply chain by state and metro area to identify geographic concentrations of those companies. We also compared the locations of businesses owned by Black and Hispanic people to those of white-owned businesses in each supply chain to determine whether there are any important differences in the spatial distribution of companies by the owner's race.

Finally, we examined the presence of Black-, Hispanic-, and white-owned businesses in under-resourced communities (URCs)—defined by ICIC as heavily populated areas of high poverty and low income located in metropolitan areas.¹⁵

Black- and Hispanic-owned manufacturers in all supply chains are generally clustered in major manufacturing regions in parts of the Midwest and South and in California and Texas. Geographic patterns differ somewhat by supply chain. For the larger supply chains, however, they are similar for Black- and Hispanic-owned firms and white-owned firms.



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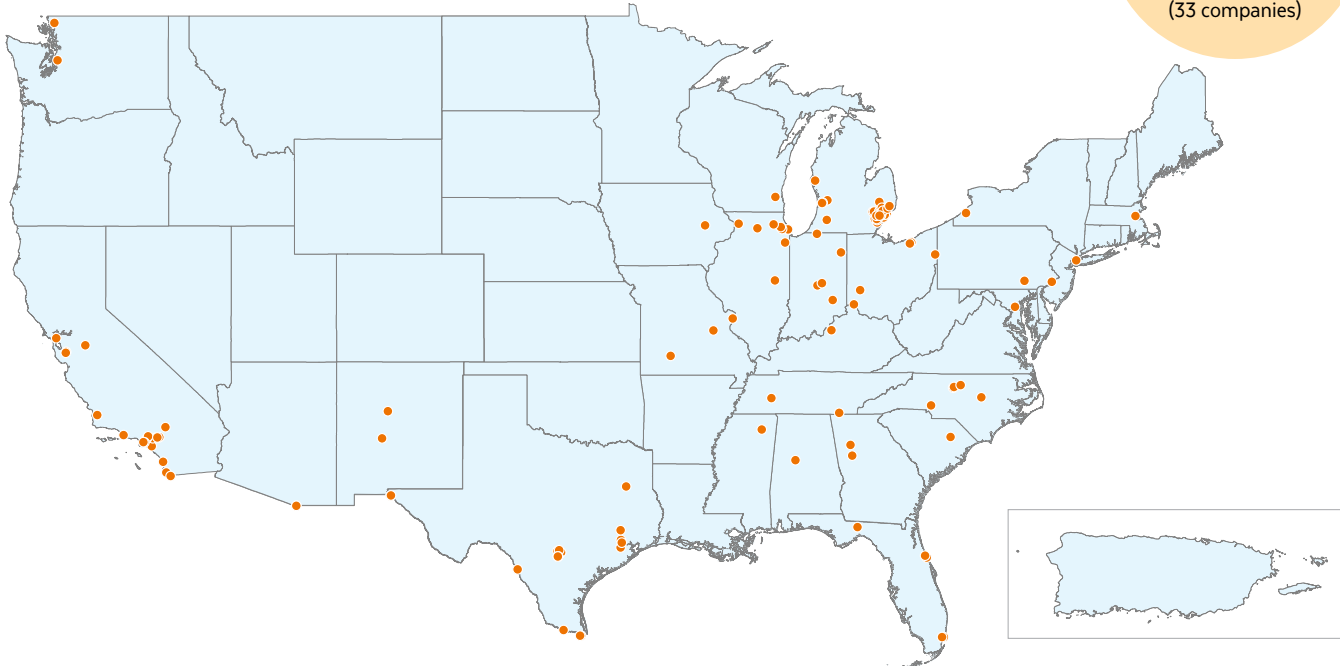
Electric vehicles. The top metropolitan areas for Black- and Hispanic-owned manufacturers in the electric vehicle supply chain are Detroit with 28 companies, San Antonio with nine companies, Los Angeles with seven companies, and Chicago with six companies (Figure 3). Houston and Riverside-San Bernardino (CA) each had four companies. Brownsville (TX), Cleveland, San Diego, and Grand Rapids (MI) had two companies each.

The top states for Black- and Hispanic-owned businesses in the electric vehicle supply chain are Michigan with 33 companies (25.5 percent of all Black-and Hispanic-owned companies in the supply chain); Texas with 21 companies (16.2 percent); California with 20 companies (15.5 percent); Illinois with nine companies (6.9 percent); Ohio with six companies (4.6 percent); Florida, Indiana, and North Carolina with five companies (3.8 percent) apiece, and Missouri with three companies (2.3 percent). With the exceptions of Texas and Florida, all these states are historic auto manufacturing centers,



while Texas has recently gained auto and auto parts plants, including a major Tesla factory in Austin.¹⁶ By comparison, white-owned companies in the electric vehicle supply chain are concentrated in Michigan (13.1 percent), followed by California and Ohio (8.8 percent each) and Texas (7.3 percent). All these states are also among the top locations for Black- and Hispanic-owned companies in the electric vehicle supply chain.

Figure 3. Locations of Black- and Hispanic-Owned Manufacturers in the Electric Vehicle Supply Chain



Note: Locations shown are those of company headquarters.
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data and business owner race/ethnicity sources described in the Appendix.

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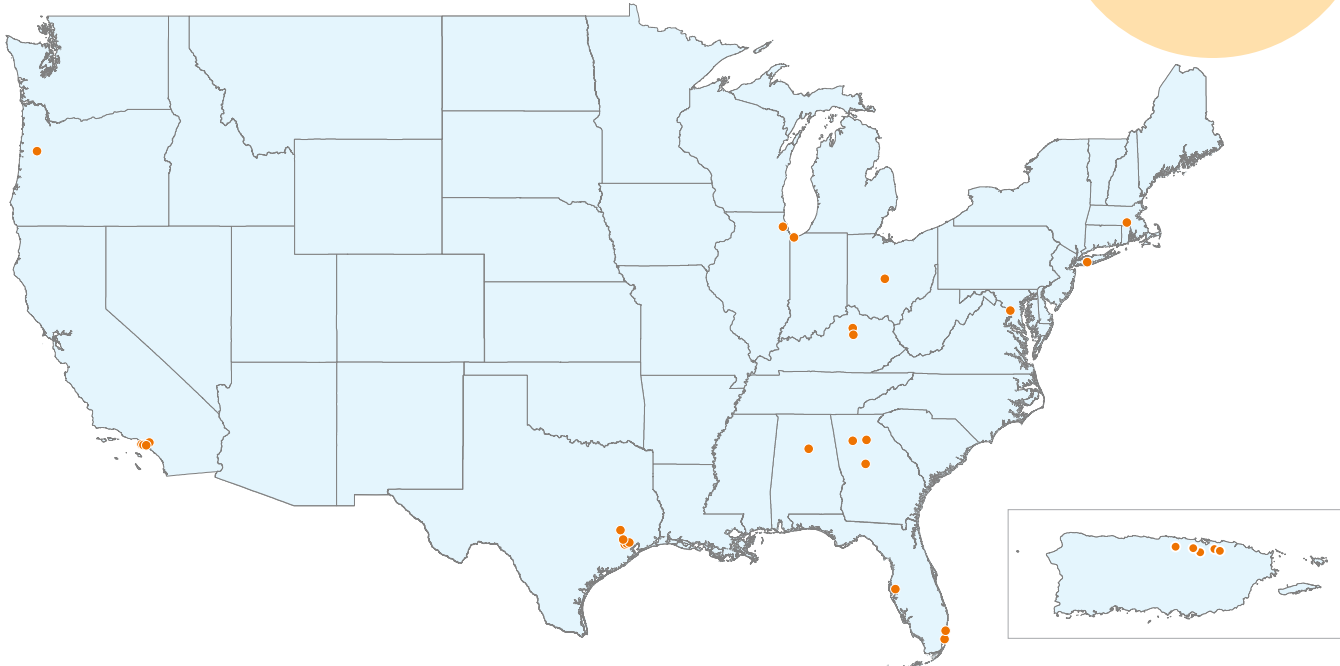
Carbon capture and storage. Figure 4 shows that the top metro areas for Black- and Hispanic-owned businesses in the carbon capture and storage supply chain are Los Angeles with four companies, and Atlanta, Chicago, Lexington (KY), Miami, Houston, and San Juan (PR), each with two companies.

The top states and territories for Black- and Hispanic-owned companies in the carbon capture and storage supply chain are Puerto Rico and Texas with 5 companies apiece (each with 16.6 percent of all Black- and Hispanic-owned companies in the supply chain), California with four companies (13.3 percent), Florida and Georgia with three companies (10 percent) each, and Kentucky with two companies (6.6 percent). White-owned companies in the carbon capture and storage supply chain are concentrated in Texas (26.1 percent), followed by Florida (8.7 percent) and Illinois, Ohio and



Pennsylvania (each with 6.5 percent). Texas and Florida are among the top states for both white-owned and Black- and Hispanic-owned companies in this supply chain. Both states are centers for petrochemical and fuel manufacturing-related activities.

Figure 4. Locations of Black- and Hispanic-Owned Manufacturers in the Carbon Capture and Storage Supply Chain



Note: Locations shown are those of company headquarters.
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data and business owner race/ethnicity sources described in the Appendix.

FINDINGS

Wireless technology. The top metro areas for Black- and Hispanic-owned businesses in the wireless technology supply chain are Riverside-San Bernardino (CA) and Rochester (NY), each with two companies (Figure 5).

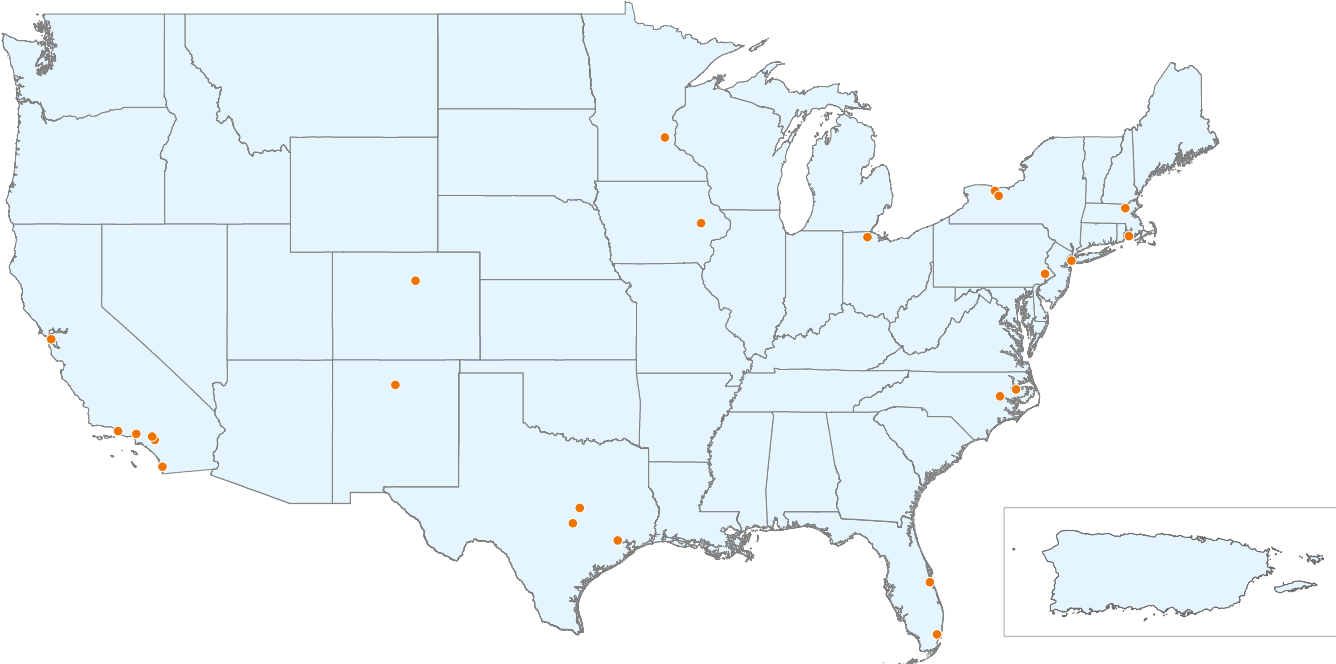
The top states for Black- and Hispanic-owned companies in the wireless technology supply chain are California with six companies (26 percent of all Black- and Hispanic-owned companies in the supply chain); New York and Texas with three companies (13.5 percent) each; and Florida and North Carolina, each with two companies (8.6 percent). White-owned businesses in the wireless technology supply chain are concentrated primarily in California (28.4 percent of all white-owned companies in the supply chain), Texas (14.9 percent),

and Florida (6.8 percent). The top states for Black- and Hispanic-owned manufacturers in this supply chain are the same as those for white-owned manufacturers except that white-owned firms do not have a strong presence in New York or North Carolina. As in the other large supply chains, California and Texas are top states for both white-owned and Black- and Hispanic-owned companies. Some of the largest wireless technology OEMs (such as Ericsson, Nokia, and Satelink) are clustered in Texas, but we did not find as many large wireless OEMs in California.¹⁷ However, these are enormous companies with a high degree of vertical integration, so OEMs in related industries such as semiconductor manufacturing could also be engaged in wireless technology development.

Figure 5. Locations of Black- and Hispanic-Owned Manufacturers in the Wireless Technology Supply Chain

Top U.S. Metropolitan Areas:
Riverside-San Bernardino (CA) and Rochester (NY) (2 companies each)

Top U.S. State:
California (6 companies)



Note: Locations shown are those of company headquarters.
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data and business owner race/ethnicity sources described in the Appendix.

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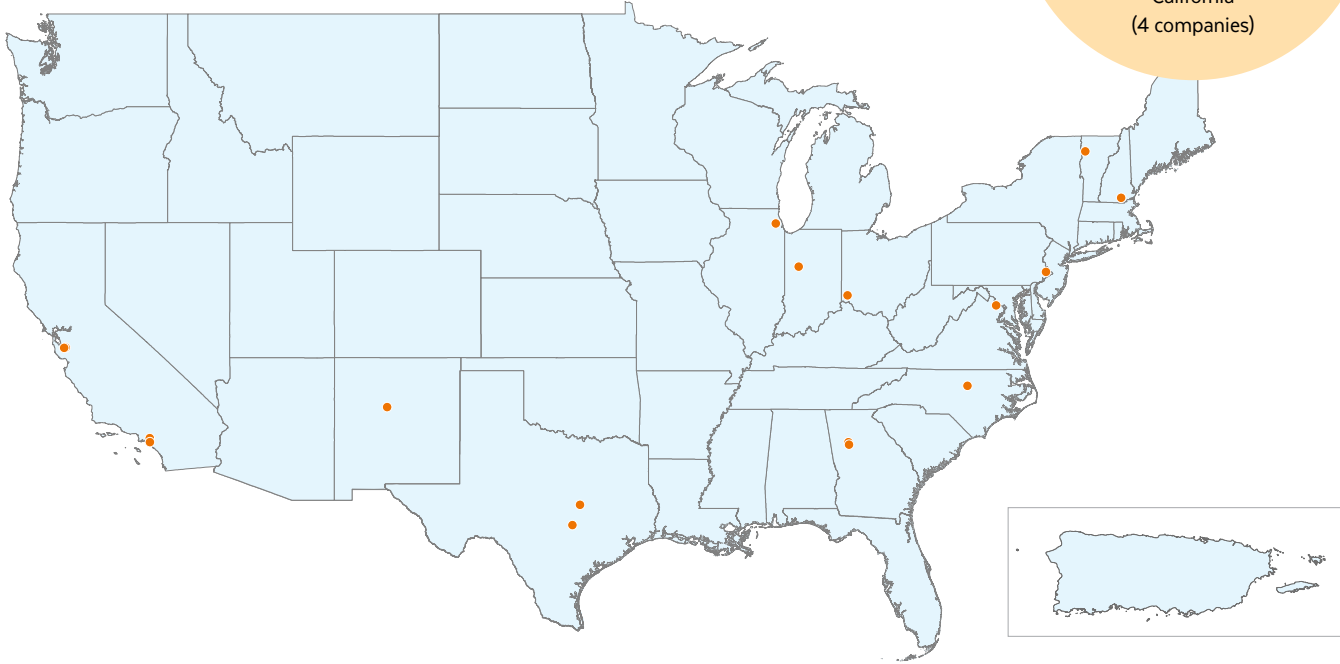
Semiconductors. The top metro areas for Black- and Hispanic-owned companies in the semiconductor supply chain are Albuquerque, Atlanta, Los Angeles, and San Jose, each with two companies (Figure 6).

The top states for Black- and Hispanic-owned companies in the supply chain are California with four companies (20 percent of all Black- and Hispanic-owned manufacturers in the supply chain), and Georgia, New Mexico, and Texas, each with two (10 percent). White-owned companies in the semiconductor supply chain follow a similar pattern; a large minority (37.5 percent) are located in California and some are located in Pennsylvania (7.1 percent) and Michigan and Texas (each with 5.4 percent). The importance of California and (to a lesser extent) Texas for white-owned as well as Black- and Hispanic-owned companies in the supply chain is also consistent with what we know about the



locations of the largest semiconductor OEMs; Advanced Micro Devices, Qualcomm, and Taiwan Semiconductor Manufacturing all have flagship locations in California and Texas Instruments, Micron, Samsung Semiconductor, Intel, and NXP Semiconductors have locations in Texas.

Figure 6. Locations of Black- and Hispanic-Owned Manufacturers in the Semiconductors Supply Chain



Note: Locations shown are those of company headquarters.
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data and business owner race/ethnicity sources described in the Appendix.

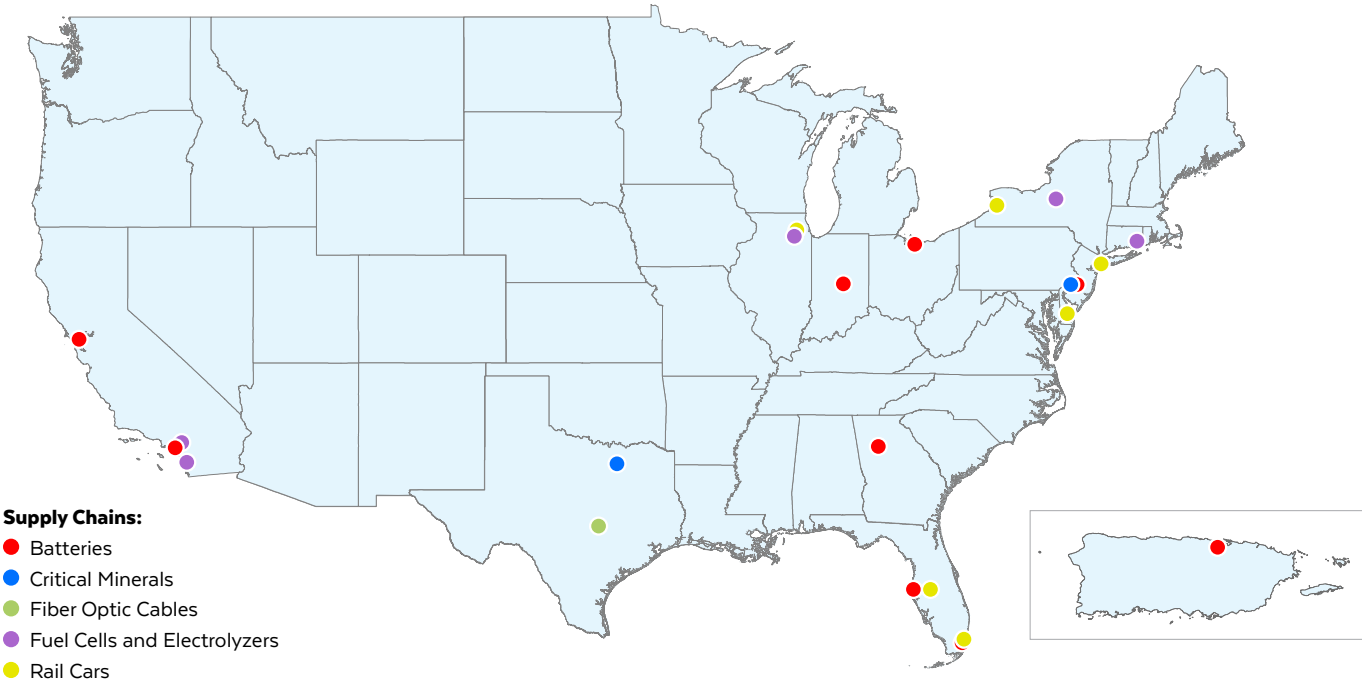
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Other supply chains. Figures 7 and 8 show that the top metro areas for Black- and Hispanic-owned manufacturers in all other supply chains combined are Los Angeles with six companies; Chicago, Dallas, Miami, and San Francisco, each with five companies; and Houston and Philadelphia with four each. (The supply chains are split between two maps to facilitate visualization of the individual supply chains.)

The top states for Black- and Hispanic-owned manufacturers in all other supply chains combined are California with 17 companies (21.3 percent), Texas with 13 companies (16.3 percent), Florida with 10 companies (12.5 percent), Illinois with six companies (7.5 percent), and Georgia with four companies (5 percent). The states with the highest percentages of white-owned companies in all other supply chains are California, Ohio and Texas, each with 9.8 percent, and Massachusetts with 6.2 percent.



Figure 7. Locations of Black- and Hispanic-Owned Manufacturers in the Rail Cars, Batteries, Fuel Cells and Electrolyzers, Fiber Optic Cables, and Critical Minerals Supply Chains



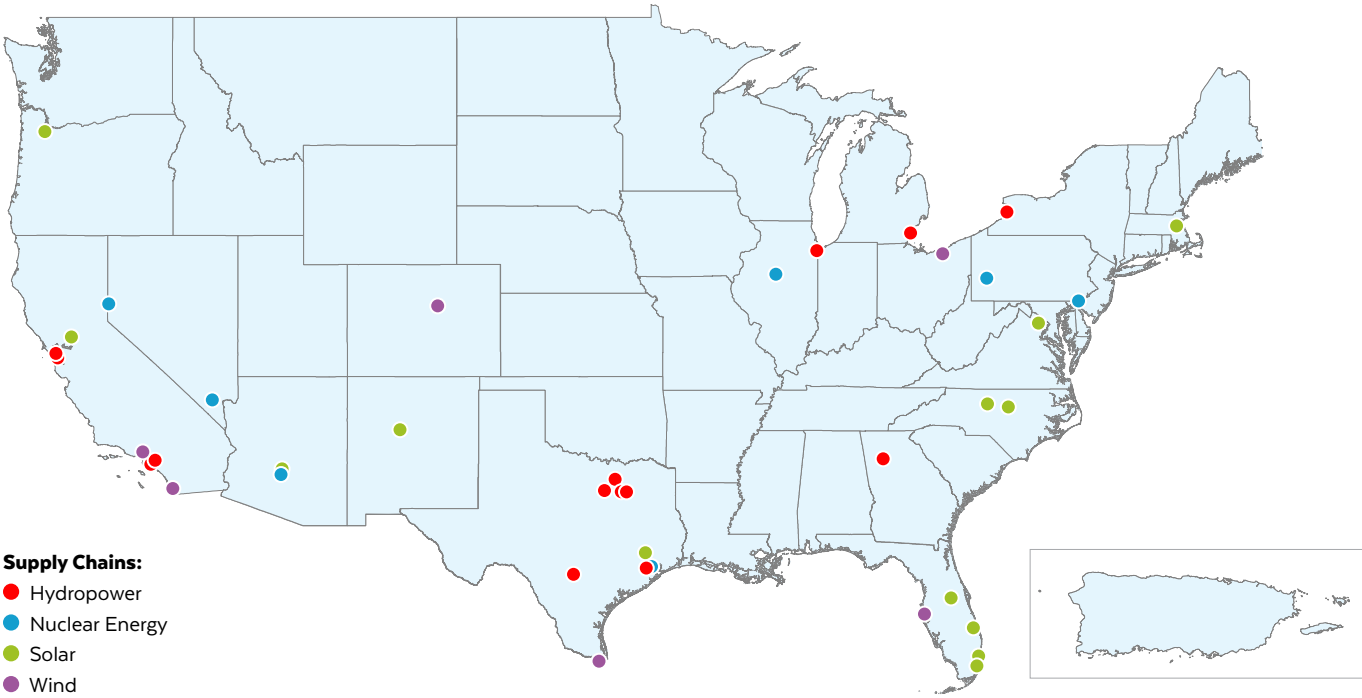
Note: Locations shown are those of company headquarters.
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 and business owner race/ethnicity sources described in the Appendix.

FINDINGS

Differences in geographic concentration between white-owned and Black- and Hispanic-owned businesses in these smaller supply chains are more pronounced than in the larger supply chains. Ohio and Massachusetts are not among the top states for the Black- and Hispanic-owned manufacturers, and Florida and Georgia are not among the top states for white-owned companies. However, as with the larger supply chains, Texas and California are the top two states for both white-owned and Black- and Hispanic-owned companies.



Figure 8. Locations of Black- and Hispanic-Owned Manufacturers in the Solar Power, Hydroelectric Power, Nuclear Power, and Wind Power Supply Chains



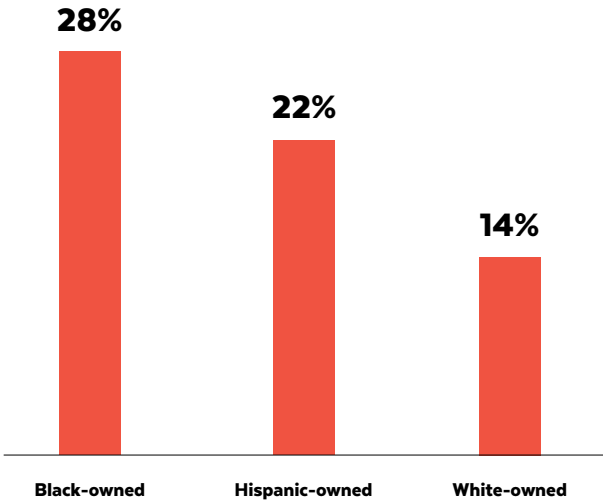
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data and business owner race/ethnicity sources described in the Appendix.
Note: Locations shown are those of company headquarters.

FINDINGS

Under-resourced communities (URCs). In our 13 supply chains combined, there are 29 Black-owned businesses (28 percent of all Black-owned businesses in the supply chains), 33 Hispanic-owned companies (22 percent of all Hispanic-owned businesses), and 2,167 white-owned businesses (14 percent of all white-owned businesses) located in URCs (Figure 9).

Although large majorities of Black- and Hispanic-owned businesses in our 13 supply chains are not located in URCs, higher proportions of Black- and Hispanic-owned companies than of white-owned companies in those supply chains are located in URCs. URC residents are disproportionately Black and Hispanic compared to the U.S. population.¹⁸ This creates important workforce development opportunities for manufacturers operating in URCs, especially those owned by Black and Hispanic people. Black- and Hispanic-owned manufacturers located outside of URCs but in metropolitan areas that have URCs can also take advantage of these opportunities if they are accessible via public transportation or are willing to provide transportation to workers who live in URCs.

Figure 9. Percentages of Black-, Hispanic-, and White-Owned Manufacturers* Located in Under-Resourced Communities



*Manufacturers in the 13 supply chains included in this report.
Source: Authors' analysis of Dun & Bradstreet Hoovers 2023 data, American Community Survey 5-year estimates for 2013-2018, business websites, and business owner race/ethnicity sources described in the Appendix.



RECOMMENDATIONS

Our results suggest that the current lack of diversity in the supply chains we examined not only results in inequitable exclusion of Black and Hispanic people nationwide, even relative to their underrepresentation in manufacturing more generally. This exclusion also harms the U.S. advanced manufacturing economy by preventing individuals who might be successful entrepreneurs and employers from participating in the essential work of reshaping the nation's future through technology and innovation. Government agencies, OEMs, lenders and investors, technical assistance providers, and philanthropic foundations can support increased participation of Black and Hispanic owners in these supply chains by taking the following steps.¹⁹

1 Increase capital access for Black- and Hispanic-owned businesses.

Encourage financial institutions or technical assistance providers that serve manufacturers to promote the use of supply chain finance in manufacturing supply chains over traditional asset-based lending to help smaller businesses resolve cash flow issues.

Though this method of finance, suppliers benefit from enhanced cash flow, are shielded by the financial stability and credit enhancement of the purchaser, and avoid the risks of traditional asset-based lending. This could improve the representation of Black- and Hispanic-owned manufacturers, who struggle with a combination of industry-specific and racially discriminatory practices. Manufacturers have unique financial needs, requiring extremely expensive fixed assets such as machinery and large amounts of real estate. New manufacturers rely on patient capital, as it takes them much longer to become profitable. Smaller manufacturers are also likely to face cash flow problems because of harmful informal practices, including Just in Time (JIT) purchasing strategies,²⁰ spontaneous renegotiation of terms, and ambiguity around ownership of stock which often result in an asymmetric distribution of risk and costs in a supply chain.²¹ Underscoring these industry-specific challenges, Black- and Hispanic-owned companies are also less likely to have access to capital for startup or growth and they encounter more difficulty securing loans or equity.²²

Federal, state, and local governments should devote more effort to enforcing anti-discrimination laws and policies, such as the Equal Credit Opportunity Act.

Racial discrimination in lending,²³ differential availability of quality financial services,²⁴ and the underlying landscape of racial wealth inequality are serious impediments to minority entrepreneurship. Black and Hispanic business owners' loan applications are rejected more often and, if accepted, they are often offered less favorable terms than white business owners.²⁵ These issues translate to broad underrepresentation of Black and Hispanic businesses, who have less success starting, maintaining, and scaling their businesses.

Small business assistance providers and industry thought leaders should advocate for greater racial and ethnic diversity among angel investors and venture capital firms and work to protect a dwindling number of Minority Depository Institutions (MDIs) from acquisition by non-minority-owned banks.

In 2019, only about 5.3 percent of angel investors were minorities, and a little under a quarter of businesses backed by venture capital were minority-owned.²⁶ The success of venture capital and angel investment deals depends enormously on interpersonal relationships, and minority startup founders

RECOMMENDATIONS

1 Increase capital access for Black- and Hispanic-owned businesses (continued).

may find better success with diverse investors who can relate to their experiences of discrimination or underrepresentation.²⁷ MDIs, which include any financial institution that is 51% or more owned by people of color,²⁸ represent an essential financial resource for minority communities and the businesses they support. While the number of banks and other depository institutions majority-owned by people of color is diminishing, data show that

MDIs originate a greater proportion of loans in low- or moderate-income areas with large non-white populations than non-MDI banks and provide a disproportionately large share of Small Business Administration 7(a) business loans to underserved communities.²⁹ Working toward meaningful diversity in the small business financing industry will help reduce barriers to capital access for Black- and Hispanic-owned businesses.

2 Improve the flexibility and competitiveness of Black- and Hispanic-owned suppliers through technical assistance and training.

Use federal funding to expand the geographic reach of industry-specific technical assistance networks such as MBDA's advanced manufacturing centers.

Currently, the Minority Business Development Agency (MBDA) operates advanced manufacturing centers in Baltimore, San Antonio, Connecticut, and Kentucky. Although all these centers share the central goal of expanding the number of domestically produced products to be sold within the U.S., each center is customized to fit the needs of its local landscape. These centers offer a mixture of technical assistance, capacity building, advanced manufacturing program referrals, and even (in the case of the Kentucky center) manufacturing facilities for program participants to use. They resemble the Manufacturing Extension Partnership (MEP) centers, which work with individual manufacturers to help them improve their productivity and competitiveness. However, the MBDA centers emphasize manufacturer needs that are especially common among minority-owned companies. Expanding the number of these centers and widening their geographic coverage would be an excellent way to meaningfully engage small minority-owned manufacturers.

Expand the curricula of existing procurement technical assistance providers, such as those that operate APEX Accelerators (formerly Procurement Technical Assistance Centers), to meet the specific needs of suppliers in advanced manufacturing supply chains.

APEX Accelerators are a federally funded program. They currently help small businesses familiarize themselves with the requirements and procedures of government contracting and provide grant-related technical assistance, but do not assist prospective suppliers with OEM (or any private sector) contracting.³⁰ If they were to offer this sort of technical assistance, the organizations that operate these centers would have to become familiar with the purchasing practices of private sector OEMs and first-tier suppliers. However, the substantial benefits of having an extensive preexisting network of industry-compatible technical assistance centers could outweigh the administrative burdens of retraining APEX staff, especially relative to the time and costs that it would take to establish an analogous network of procurement technical assistance centers geared toward the private market.

RECOMMENDATIONS

2 Improve the flexibility and competitiveness of Black- and Hispanic-owned suppliers through technical assistance and training (continued).

Procurement technical assistance providers should develop curricula for manufacturers so that Black- or Hispanic-owned companies that already provide goods to OEMs can position themselves as essential suppliers by expanding into adjacent markets.

The MEP centers already support manufacturers trying to expand their operations to seek new customers but do not explicitly focus on businesses from underserved backgrounds and do not specifically orient this assistance to suppliers trying to move into new supply chains.³¹



3 Identify and remove barriers in the advanced manufacturing STEM educational pipeline, which is a source of startup manufacturing companies.

Increase state and federal funding for graduate education at HBCUs and other minority-serving institutions in science and engineering fields that feed into advanced manufacturing.

Graduate education in these fields is a direct source of startup manufacturing companies in high technology supply chains. Evidence suggests that engineering and science students may actually prefer jobs at startups after graduation over employment at large high-tech companies, even at a substantial pay cut.³² In 2021, Black people were slightly less than 6 percent of masters and postdoctoral students in engineering and between 6 and 10 percent in science programs. Hispanic people were between 10 and 13 percent of masters and postdoctoral students in engineering and between 11 and 15 percent of these students in science programs.³³ Although Black and Hispanic people are not as underrepresented in the educational pipelines for high tech manufacturing as they are among business owners in manufacturing, addressing the lack of diversity in

higher education STEM programs is an important first step to identifying and alleviating factors that keep diverse talent from participating in industry.

Provide federal funding for further research into structural or organizational-cultural factors that filter Black and Hispanic students out of STEM education programs or prevent them from starting in those programs, and for implementation of culturally competent program support aimed at increasing retention of Black and Hispanic candidates for advanced degrees in STEM fields.

Students of color earned 19 percent of engineering bachelors' degrees, 17 percent of engineering masters' degrees, and only about 12 percent of engineering doctoral degrees granted in the U.S. between 2009 and 2018. Research suggests that minority student representation can be improved through a combination of individual factors such as identity development and resilience toward discrimination, social/cultural factors such as a sense of belonging and good work/life balance, and institutional factors

3 Identify and remove barriers in the advanced manufacturing STEM educational pipeline, which is a source of startup manufacturing companies (continued).

such as minority role models, social or professional societies, and other support networks.³⁴ Future research should evaluate the success of programs and practices that promote these individual and institutional characteristics and investigate barriers to their widespread adoption. This recommendation complements the CHIPS Act's requirement that the National Science Foundation award grants to universities and research institutions for research on effective practices that HBCUs, tribal colleges and universities, and minority-serving institutions can adopt to promote the recruitment, retention, and advancement of students in STEM fields.³⁵

Strengthen large companies' hiring initiatives with minority serving institutions, such as HBCUs, to help broaden the pool of talent contributing to high-tech and renewable energy innovation and increase representation of minority-owned businesses among startups in these sectors.

In the last several years, high tech companies and other large corporations have invested tens of millions of dollars in STEM higher education, career support programs, and technical infrastructure at HBCUs.³⁶ In addition to broadening the scientific and technical talent pool for the companies that sponsor them, these initiatives can lead to increased Black representation among startup entrepreneurs in high tech manufacturing. However, the work needed to ensure the successful implementation of these programs has just begun.



4 Reform the procurement practices of OEMs and large purchasers in supplier industries to increase access and opportunity for Black- and Hispanic-owned companies.

OEM leadership should emphasize the importance of supplier diversity and incentivize procurement officers to diversify the company’s supplier portfolio.

A more inclusive supplier strategy results in a wider, more flexible purchasing arena, promotes competition among suppliers (which can result in better prices and quality of components), and can improve the reputation of a purchaser’s brand.³⁷

Banks and funders that invest using ESG frameworks should offer financial incentives, such as more favorable short-term loan terms, to large purchasers that enact procurement policies that increase opportunities for minority-owned companies, such as preference for smaller suppliers, shorter payment schedules, or limited-term contracts to increase supplier turnover.

Supply chain finance, which exists to help businesses buy and sell more efficiently, can enable large companies with abundant resources to help smaller companies enact costly but environmentally or socially responsible policies.³⁸ Similarly, impact investors and other ESG-conscious capital providers can create financial incentives for the companies they fund by offering better trade finance terms to businesses that reform their procurement practices to make them more inclusive.

To the extent feasible, large OEMs should unbundle large contracts into smaller ones to make their procurement opportunities accessible to smaller companies.

County and city governments have used unbundling to make their contracts more accessible to small businesses, including manufacturers. To advance its equitable procurement goals, the city of Buckeye, AZ, unbundled procurement contracts for the construction of its new airport in 2023, including contracts for direct city procurement of manufactured goods used in building the airport.³⁹

Unbundling benefits purchasers. By distributing material sourcing between many organizations, it reduces the risk of supply chain interruption.⁴⁰ By awarding contracts to smaller organizations, a purchaser may increase its likelihood of finding local suppliers and reduce its logistics and shipping costs.

Governments should offer OEMs and first-tier suppliers that reform their procurement policies (as specified above) preference for federal, state, and local contracts; funding for state and local pass-throughs of IIJA, CHIPS Act, and IRA funding; and funding under state-level counterparts to these federal laws.

To date, the National Institute of Standards and Technology (NIST) has finalized two funding opportunities under the CHIPS incentives program and one opportunity under the CHIPS research and development (R&D) program. The first CHIPS incentives program Notice of Funding Opportunity (NOFO), which applied to large-scale projects at semiconductor manufacturers, semiconductor materials facilities, and semiconductor manufacturing equipment facilities, required applicants to submit a supplier diversity plan as part of their application.⁴¹ In this first NOFO, NIST specified that applicants should set supplier diversity goals, outline their methods for tracking and reporting on supplier diversity progress, describe how they will coordinate with diverse suppliers (including minority-owned businesses), and describe their existing organizational supplier diversity resources (such as individual staff or supplier diversity offices).

The second CHIPS incentives program NOFO, which applied to smaller-scale projects at semiconductor materials facilities and semiconductor manufacturing equipment facilities, included a similar but less demanding incentive. The document strongly

4 Reform the procurement practices of OEMs and large purchasers in supplier industries to increase access and opportunity for Black- and Hispanic-owned companies (continued).

encouraged applicants to develop a supplier diversity plan and a strategy to engage local stakeholders by supporting local research institutes, educational programs, and community economic development efforts, among others.⁴²

In February 2024, NIST also released a NOFO for research and development funding on advanced packaging manufacturing.⁴³ Advanced packaging is an innovative manufacturing method that semiconductor manufacturers can use to improve chip performance while reducing cost and power consumption.⁴⁴ NIST described investments in advanced packaging as essential for the success of investments in semiconductors.⁴⁵ This NOFO stated that NIST will favorably consider applications that include outreach plans to diverse businesses, institutions such as Historically Black Colleges and Universities, and other Minority Serving Institutions. The NOFO also stated that applications that include training programs to increase the participation of underserved communities would be favorably considered.⁴⁶

Each of these NOFOs presented a unique approach to incentivizing supplier diversity, tailored to each funding opportunity's intended and the kinds of applicants that were likely to bid for funding. Similarly, state and local governments should tailor their incentives to reflect the types of procurement that are required for each contract or funding opportunity and the industry and size of likely applicants.

As they roll out future rounds of funding to supplement IIJA, CHIPS Act, and IRA funds (including funding under state-level counterparts to the CHIPS Act), state and local governments should echo federal policies that give preference to bids that include an actionable, specific supplier diversity plan, such as the provisions attached to federal CHIPS Act funding for manufacturing plants. This should apply to both OEMs and first-tier suppliers.

State and local governments should make the provision of additional support to manufacturers that previously received federal funding under the IIJA, CHIPS Act, and IRA contingent on the successful implementation of their supplier diversity plans.

Although the CHIPS Act and IIJA mention supplier diversity, they discuss diversity initiatives in non-binding terms and do not include specific mandates about how these programs should be developed. The IRA does not include any mention of racial equity or inclusion. President Biden's Executive Order on the Implementation of the CHIPS Act of 2022 orders agencies to prioritize minority-owned businesses (among other priorities) but his executive orders on the IRA and IIJA do not have similar statements.⁴⁷ If the supplier pool of advanced manufacturing is to have more racially and ethnically diverse business owners, future public policies will have to include incentives to change current practices.

Firms that receive funding or incentives through these pieces of legislation should actively seek out minority-owned companies, including Black- and Hispanic-owned manufacturers in the supply chains covered in this report.

5 Collect and disseminate data about advanced manufacturing supply chains, including supply chain mapping and detailed information on the demographics of the companies' owners.

The Census Bureau, Bureau of Labor Statistics, and National Science Foundation should coordinate comprehensive supply chain mapping of advanced manufacturing industries to complement the promising but disconnected efforts that have already begun.

The Department of Energy has begun mapping suppliers for the wind power,⁴⁸ hydroelectric,⁴⁹ and solar power⁵⁰ supply chains. NIST Manufacturing Extension Partnership (NIST MEP) has begun a CHIPS teaming list so that semiconductor OEMs, suppliers, educational programs, and other related organizations can more easily find one another.⁵¹ A centralized public effort to document supply chains would improve on our work by avoiding many of the limitations of proprietary business data, could offer more robust information on business owners' demographics, and could create a data resource that is far more comprehensive than what the scope of our project has allowed.

The Census Bureau should expand its publicly available information to include aggregate business owner demographics for specific supply chains to fill considerable gaps in the data on minority representation in manufacturing.

The lack of public data on the demographic characteristics of manufacturing company owners makes it difficult to assess the extent to which Black and Hispanic owners are underrepresented in supply chains affected by the IIJA, CHIPS Act, and IRA, other than the 13 supply chains included in this report. To monitor the efficacy of policies that are intended to promote racial equity in the revitalization of U.S. manufacturing, more and better data are urgently needed. Fine-grained data on representation by supply chain is especially needed; without

access to such detail, researchers studying this topic may have to continue to resort to time-consuming methods similar to the individual business record verification we used for this report. Such methods have serious drawbacks in efficiency and comprehensiveness. Although we recognize the importance of maintaining the confidentiality of individual businesses' survey responses, the Census Bureau is already able to use synthetic methods to protect business records in much more granular data than the supply chain maps we are proposing.⁵²

For the purposes of both data collection and the distribution of public funding to manufacturers, companies that count as minority-owned should be required to demonstrate that they are producing at least some manufactured products in the U.S.

This recommendation has three benefits. First, in keeping with the intent of the recent industrial policy legislation to promote U.S.-based production, it ensures that public support for manufacturers goes only to firms that actually make goods in the U.S. Second, it guards against the possibility that minority-owned companies that do not make goods in the U.S. will act as "shell" entities for white-owned companies that do manufacture in the U.S. and thereby enable the white-owned companies to benefit from preferences that are intended to benefit minority businesses. Finally, it helps prevent the misclassification of white-owned companies as minority-owned in public data sources; such misclassification artificially inflates the number of minority-owned companies in the data, reducing the usefulness of the data for policymakers and practitioners.



RECOMMENDATIONS

6 Black- and Hispanic-owned manufacturers may have opportunities to operate at lower tiers of their supply chains and hire residents of under-resourced communities.

Black- and Hispanic-owned manufacturers at lower tiers of their supply chains may have more opportunities to benefit from the IIJA, CHIPS Act, and IRA.

Our research shows that there are more Black- and Hispanic-owned first-tier suppliers than OEMs in the large majority of the supply chains we examined. This suggests that there may be more opportunities for minority-owned companies to become first-tier suppliers than to become OEMs. There may be even more opportunities for minority-owned companies, especially in legacy industries, to benefit from the recent industrial policy legislation by becoming suppliers at lower tiers of the relevant supply chains or, if they are already lower-tier suppliers, by expanding to meet the growing demand for their products that could result from the legislation.

Black- and Hispanic-owned manufacturers may be uniquely positioned to hire residents of under-resourced communities.

Despite the small share of companies in impacted supply chains that are located in under-resourced communities, the IIJA, CHIPS Act, and IRA can still benefit the residents of those areas. These pieces of legislation could help existing companies in our supply chains expand. Whether or not those companies are located in URCs, their growth could bring new jobs to URC residents, especially if the companies are Black- or Hispanic-owned. Because URC residents are disproportionately Black and Hispanic compared to the U.S. population,⁵³ and because minority-owned businesses hire minority workers at higher rates than white-owned firms,⁵⁴ Black- and Hispanic-owned manufacturers are well positioned to provide jobs to URC residents even if they are not located in URCs. They are more likely to be able to do so if their locations are accessible to URC residents via public transportation or if the companies themselves provide transportation to their factories from URCs.



“Quick-Win” Policies to Boost Racial Equity in Supply Chains Supported by the IIJA, CHIPS Act, and IRA

Many of the policies and practices we have recommended will take years to implement. Others, even if implemented immediately, will have only limited impact on the rollout of the IIJA, CHIPS Act, and IRA because federal funding has already been committed or it is too late to change the rules governing the distribution of that funding. Such policies will improve opportunities for Black- and Hispanic-owned companies to participate in later stages of America’s new industrial transformation but will do little to increase racial equity in the short term. However, some policies can be implemented more quickly. To ensure that Black and Hispanic owners are not excluded from the immediate benefits of the new legislation and the wealth-building opportunities they create, those policies and strategies are the ones that policymakers and practitioners should prioritize. Among the recommendations we have made, the following are ones that can boost racial equity relatively quickly in the supply chains supported by the recent industrial policy legislation:

- Firms that receive funding or incentives through these pieces of legislation should actively seek out minority-owned companies, including Black- and Hispanic-owned manufacturers in the supply chains covered in this report.
- Encourage financial institutions or technical assistance providers that serve manufacturers to promote the use of supply chain finance in manufacturing supply chains over traditional asset-based lending to help smaller businesses resolve cash flow issues.
- OEM leadership should emphasize the importance of supplier diversity and incentivize procurement officers to diversify the company’s supplier portfolio.
- To the extent feasible, large OEMs should unbundle large contracts into smaller ones to make their procurement opportunities accessible to smaller companies.
- As they roll out future rounds of funding to supplement IIJA, CHIPS Act, and IRA funds (including funding under state-level counterparts to the CHIPS Act), state and local governments should echo federal policies that give preference to bids that include an actionable, specific supplier diversity plan, such as the provisions attached to CHIPS Act funding. This should apply to both OEMs and first-tier suppliers.
- State and local governments should make the provision of additional support to manufacturers that previously received federal funding under the IIJA, CHIPS Act, and IRA contingent on the successful implementation of their supplier diversity plans.
- Black- and Hispanic-owned manufacturers at lower tiers of their supply chains may have more opportunities to benefit from the IIJA, CHIPS Act, and IRA.
- Black- and Hispanic-owned manufacturers benefiting from the IIJA, CHIPS Act, and IRA may be uniquely positioned to hire residents of under-resourced communities.



CONCLUSION

The U.S. is on the cusp of a groundbreaking moment. The IIJA, CHIPS Act, and IRA promise to reshape America's industrial landscape while meeting the nation's critical high technology, clean energy, and infrastructure needs. Although these laws contain some racial equity provisions, they do not by themselves ensure that Black- and Hispanic-owned manufacturers will benefit from or contribute to America's new industrial transformation. This report shows that there are very few Black- and Hispanic-owned OEMs and first-tier suppliers in 13 key supply chains supported by the new legislation. That suggests that the nation's industrial renaissance will not be racially or ethnically inclusive if it relies solely on the existing capabilities of those companies.

However, there is still considerable opportunity for Black- and Hispanic-owned firms to participate in the transformation that the IIJA, CHIPS Act, and IRA are creating. Although many of our recommendations cannot be implemented in time to improve the racial equity impacts of these laws (and so will have only longer-term impacts on racial equity), others can be implemented

more quickly and make a difference over the next several years as funding from the new laws continues to be rolled out. In addition, our findings only scratch the surface of the potential for Black and Hispanic owners to benefit from and contribute to the industrial transformation that is underway. We have examined only OEMs and first-tier suppliers in 13 key supply chains, but the benefits of the recent industrial policy legislation will extend to lower-tier suppliers (where Black and Hispanic ownership may be more common) and to other supply chains. With the help of the right policies, existing Black- and Hispanic-owned firms can expand and new ones can be established in supply chains supported by the legislation, thereby creating jobs, income, and wealth in Black and Hispanic communities.

This report is a call to action for government agencies, OEMs, lenders and investors, technical assistance providers, and foundations. A racially and ethnically inclusive industrial future is possible but not guaranteed. The hour is late but there is still time to act.



APPENDIX

Our research into manufacturing supply chains relied on an iterative process through which we identified the supply chains that are directly affected by recent industrial policy legislation, and then narrowed our selection to a list of priority supply chains for in-depth research and analysis. For the selected priority supply chains, we then conducted company-specific research to identify the OEM and first-tier manufacturers in those supply chains and determine which companies were Black- or Hispanic-owned. This section provides detailed information on our methods.

Identifying and Defining Supply Chains

First, we reviewed the U.S. Congress’s official legislative summaries of the Infrastructure Investment and Jobs Act (IIJA), CHIPS and Science Act (CHIPS Act), and Inflation Reduction Act (IRA) along with guidebooks and fact sheets published by the White House. We used these guidebooks and fact sheets to identify the products and supply chains that are directly supported by these three pieces of legislation. Through this review, we identified 41 supply chains that the legislation directly supports. Appendix Table A1 lists these supply chains.

Appendix Table A1. Supply Chains Directly Supported by Recent Industrial Policy Legislation

IIJA	CHIPS Act	Inflation Reduction Act (IRA)
Transformers	Semiconductors	Electric batteries
Electric vehicle charging stations	Wireless technology	Solar
Caulking		Wind turbines
Weatherstripping		Mineral processing
Furnaces & boilers		Heat pumps
Air conditioning		Clean hydrogen
Nuclear reactors		Fuel cells
Computers & mobile devices		Low-carbon fuels
Road & bridge components		Low-carbon chemicals
Rail track materials		Torque tubes
Railroad cars & components		Inverters
Ferries		Critical minerals
Airport terminals & runways		Electric load service centers
Electric grid control devices & sensors		Electric stoves & ovens
Fiber optic cables		Insulation
Water pipes		High assay low enriched uranium
Water storage		Port equipment
Port infrastructure		Clean vehicles
		Low-carbon building materials
		Carbon capture & storage equipment
		Air quality sensors
		Electric power lines

Note: Each supply chain is shown under one law even if it is supported by more than one.

To prioritize these supply chains, we sought feedback from industry and policy experts. Based on the feedback that we received and our assessment of the relative importance of each supply chain, we reduced our list of supply chains to the set of 13 priority supply chains that are included in this report ([Table 2](#)).

We then referenced the North American Industry Classification System (NAICS) definitions of industries to identify the specific industry codes that correspond to the OEM level of each supply chain. To identify the first-tier supplier industries, we analyzed a U.S. Department of Commerce supply chain report on information and communications technology and a series of U.S. Department of Energy (DOE) supply chain reports on carbon capture materials, energy storage (batteries), fuel cells and electrolyzers, hydropower, nuclear power, platinum group metals (a subset of critical minerals), semiconductors, solar, and wind. These reports describe the OEM level of each industry as well as the upstream and downstream products. For the critical minerals supply chain, we also referenced a DOE report on critical materials.

For the supply chains that did not have government-produced supply chain reports (rail cars, fiber optic cables, and electric vehicles), we analyzed the Bureau of Economic Analysis' (BEA) input-output (I-O) tables to identify the NAICS codes at the first-tier supplier level of the supply chains. We used a variable minimum threshold between one and five percent of the percent of total industry supply (excluding self-supply) to identify the NAICS codes that are most likely to include the first-tier suppliers. This threshold varied from supply chain to supply chain. As first-tier suppliers, we included industries that are extremely general but represent a large percentage of industry supply, and industries that are obviously essential to the OEM industry but may not represent a large percentage of supply. These criteria were also applied to sort the least essential or least relevant NAICS codes from the supplier industry lists constructed from products mentioned in the federal supply chain reports.

In addition to these official supply chain reports and the I-O tables, we referenced industry reports and descriptions of the supply chains found in general publications such as newspapers and books that describe the supply chains.

Semiconductors

Impact of Industrial Policy Legislation

The CHIPS Act funds and expands eligibility for federal financial assistance (grants, direct loans, and loan guarantees) to support domestic production of semiconductors and establishes a tax credit program for investing in semiconductor manufacturing facilities.⁵⁵ The majority of the appropriated funding will enable the Secretary of Commerce to implement federal financial assistance programs that were authorized in the National Defense Authorization Act for Fiscal Year 2021.

Background

Semiconductors are a special class of materials that allow companies to design and manufacture the integrated circuits and microchips that power a vast array of modern devices and equipment. These chips are an

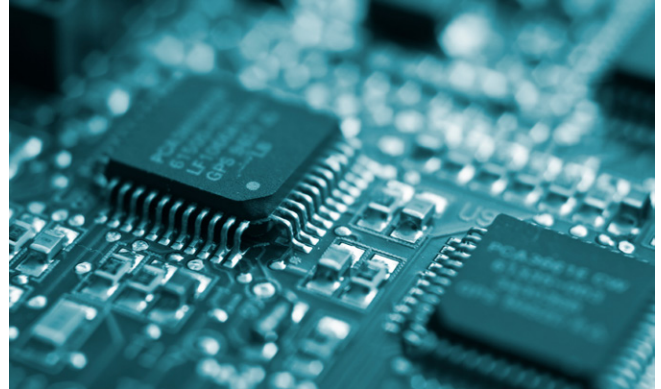
essential component in goods such as cars, smartphones, computers, medical devices, and household appliances.

Manufacturing semiconductors is a long, complex, and highly precise process. The tiny chips that power our devices have hundreds of layers of circuits stacked on top of each other. To create single layer on a chip, manufacturers deposit thin films of semi-conductive materials onto a silicon wafer and then precisely expose the pattern to light, bake and develop the chip (in a process similar to developing an analog photograph), etch a 3D structure onto the chip, and tune the properties of the chip.⁵⁶ This process is repeated up to 100 times to produce a final microchip. This process enables manufacturers to mass produce complex circuitry in a small but dense single component.

Semiconductors (continued)

Identifying OEMs and First-tier Suppliers

We identified OEMs in the semiconductor supply chain as companies that make semiconductors directly. We identified first-tier suppliers as companies that make components of semiconductors or machinery used to make semiconductors, including but not limited to manufacturers of machining equipment designed to work with extreme precision, industrial ovens and furnaces, HVAC technology and janitorial supplies designed for ‘clean rooms’, and photo deposition chemicals.



Wireless Technology

Impact of Industrial Policy Legislation

The CHIPS Act and the IIJA will support the wireless technology supply chain. The CHIPS Act appropriates approximately \$1.5 billion to support the Public Wireless Supply Chain Innovation Fund and creates an advanced communications research program that includes technologies ranging from radio frequency technology to resilient Internet of Things applications for advanced manufacturing.⁵⁷ The IIJA creates a grant program to support the construction of “middle-mile” broadband infrastructure (including wireless broadband, microwave technology, and radio towers), prohibits all new rail cars used in the United States from using wireless technologies developed in “countries of concern” and those developed by foreign state-owned enterprises, and provisions research and development funding on positioning, navigation, and timing capabilities.⁵⁸

Background

The wireless technology supply chain is made up of technology that supports wireless information and communications networks. These systems differ from “wired” technology in that the bulk of information transfer is facilitated through radio, cellular, infrared, or other systems that don’t require a physical connection between two or more devices. Wireless systems also rely on an array of wired technologies to function. The wireless technology supply chain is difficult to define succinctly because it is used in applications ranging

from microscopic measurement technology to global communications infrastructure. However, all wireless technologies essentially depend on a few specific components: transmitters and receivers encode information back and forth from wavelengths to electrical signals; amplifiers, dishes, and towers augment the range of the wireless signals; and cables and controllers (including fiber optics) facilitate the interpretation and input of signals for transmission.⁵⁹

Identifying OEMs and First-tier Suppliers

We identified OEMs in the wireless technology supply chain as companies that make wireless communications products such as cell phones, satellite phones, radio units, and standalone GPS units/personal location devices. We identified first-tier suppliers as companies that make components of these systems or the infrastructure used to directly support such systems, including but not limited to companies that manufacture communications towers, transmitters, antenna and discs, radio frequency amplifiers, receivers, and cables explicitly designed for wireless communications systems.

Electric Vehicles

Impact of Industrial Policy Legislation

Both the IIJA and the IRA will support the electric vehicle supply chain. The IIJA creates a block grant program for installing charging infrastructure, sets standards for electric vehicle charging equipment, creates a grant program to support publicly accessible electric vehicle charging infrastructure, provides grant funding to states to install electric vehicle charging infrastructure, provides grants to other states and entities to build energy transmission and distribution systems to support charging infrastructure, and creates a grant program to support battery manufacturing and recycling.⁶⁰

The IRA creates a rebate program for installing electric vehicle charging infrastructure in multifamily homes in low-income areas, expands a tax credit available for purchasing clean vehicles, creates a tax credit for purchasing previously-owned clean vehicles, creates a tax credit for purchasing qualified commercial electric vehicles, and appropriates funding for the Postal Service to acquire a clean fleet.⁶¹

Background

In most ways, the electric vehicle manufacturing supply chain is very similar to the traditional internal combustion engine vehicle supply chain. Parts manufacturers create components that are found in almost any passenger vehicle, such as seats, steering wheels, seatbelts, interior upholstery, and tires. These components are shipped to first-tier suppliers that carry out the sub-assembly work, which involves processes like welding truck beds to frames, bolting seats into place, installing windows, and other steps.

However, there are some important differences between the supply chains for electric vehicle and internal combustion engine vehicle manufacturing. For example, electric vehicles do not have internal combustion engines, transmissions, and fuel tanks. Electric vehicles also have electric vehicle batteries and electric motors, which internal combustion engine vehicles lack.

Identifying OEMs and First-tier Suppliers

The primary difference between electric and fuel-burning vehicle manufacturing are components related to the engine and the transmission of power from the engine to the wheels. In a vehicle with a combustion engine, a transmission, axles, clutch, and gearbox pass the power of the engine on to the wheels. Most non-hybrid electric vehicles have simplified powertrains that convey electricity from the battery to the motor through a single-speed transmission. Therefore, we selected electric vehicle suppliers from the companies in relevant NAICS industries that manufacture either components that are generally found in every vehicle or components specifically related to electric vehicle powertrains.



Nuclear Power

Impact of Industrial Policy Legislation

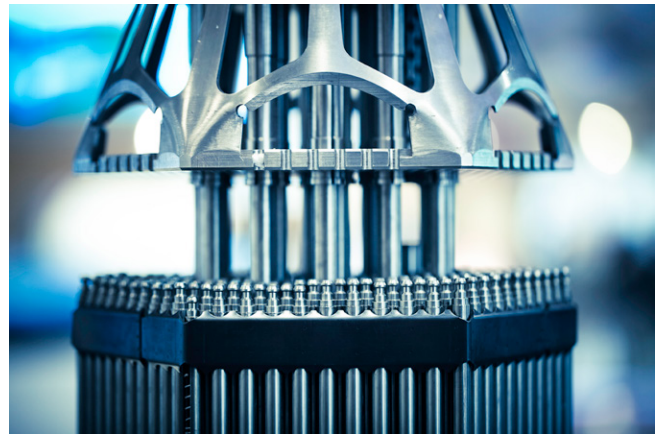
The IIJA and the IRA will support the nuclear power supply chain. The IIJA creates and authorizes funding for a research and development program on technologies that create hydrogen using nuclear power, extends prior legislation and authorizes the Department of Energy to spend \$1.5 billion over five years on clean hydrogen manufacturing (including through nuclear power), authorizes \$6 billion in competitive tax credits for the owners and operators of commercial U.S. reactors, creates a demonstration program for clean energy projects (including nuclear power) on current and former mine land, and authorizes a \$2 billion Department of Energy fund that will provide cost-sharing with the industry to develop advanced reactor models.⁶² The IRA creates a tax credit for nuclear power facilities.⁶³

Background

In many ways, nuclear power plants work very similarly to fossil fuel power plants. A sustained reaction (combustion in conventional plants and fission in nuclear plants) generates an enormous amount of heat energy, which a turbine and generator convert into mechanical and then electrical energy. This energy is then turned into a current that can be transmitted to the electrical grid.⁶⁴ More recently, advancements in technology have made small modular reactors (SMRs) more commonplace. SMRs are designed to be transportable (some are small enough to fit onto a truck) and could offer power generation solutions for industrial purposes or for areas that have historically been unreachable for conventional power grids.

Identifying OEMs and First-tier Suppliers

OEMs in this supply chain are companies responsible for assembling nuclear reactors and building power plants, a process that is a hybrid of construction and manufacturing. Manufacturers of SMRs are also considered OEMs in this supply chain. First-tier suppliers in the nuclear power supply chain include companies that produce components for conventional fossil fuel-burning power plants and those that make products used in fission reactors. These products and components include boilers, high pressure-rated pipes and tubing, concrete, valves, and remote measurement and diagnostic equipment.



Wind Power

Impact of Industrial Policy Legislation

The IIJA and the IRA are the primary pieces of industrial policy legislation that will support the wind power supply chain. The IIJA authorizes funding for wind power projects under the Energy Independence and Security Act of 2007, authorizes funding to support clean energy manufacturing projects in census tracts impacted by coal mine closures or the closures or coal-fired power plants, and creates a demonstration project program for wind projects.⁶⁵ The IRA extends an existing tax credit for renewable energy production, increases a tax credit for solar and wind facilities connected to low-income residential buildings and low-income economic benefit projects, creates a tax credit for producing wind energy components in the U.S., creates a tax credit for clean electricity production, and creates a tax credit for investments made in clean energy production or storage.⁶⁶

Background

To date, most wind power generation systems rely on wind turbines. Wind turbines convert the mechanical energy exerted on propellers into torque, which is transformed into electrical energy.⁶⁷ This energy is centralized in power stations. It is then either converted into alternating current and transmitted directly onto the energy grid or else stored in battery arrays.

Identifying OEMs and First-tier Suppliers

We identified wind power OEMs as any companies that assemble entire wind turbines. First-tier suppliers include but are not limited to any company that manufactures wind turbine blades, dynamos or motors of the sort used in turbines, turbine columns, cables and wire assemblies explicitly made for wind power generation, and power inverters.

Solar Power

Impact of Industrial Policy Legislation

All three pieces of industrial policy legislation will support the solar power supply chain. The CHIPS Act creates a low-emissions steel manufacturing research program that includes heat generation from solar power as a research focus area.⁶⁸ The IIJA authorizes funding for solar energy demonstration projects on current and former mining land, appropriates funding for solar energy projects under the Energy Independence and Security Act, and creates a pilot program for low-emissions ferries, including solar powered ferries.⁶⁹ The IRA creates a tax credit for clean electricity production, creates a tax credit for investments in clean energy production or storage, creates a rebate program that supports the installation of solar in residential land multifamily buildings in low-income areas, creates funding for community solar projects in low-income communities, supports Department of Energy research, development, and demonstration activities on solar power, extends a tax credit for solar projects installed before 2034, extends another 30 percent tax credit for solar projects, and adds low-income residential and low-income economic benefit projects as activities eligible for an energy generation credit.⁷⁰

Background

Solar energy is transformed into electricity in several ways. The most common method uses photovoltaic cells (which make up solar panels) to convert the ultraviolet radiation of the sun into electrical energy.⁷¹ This is then stored in battery arrays or converted into alternating current (AC) power and transmitted to a power grid. Solar power can also be captured as infrared energy, and this heat can convert water into steam and turn turbines in a process similar to what is used in fossil fuel power plants.

Identifying OEMs and First-tier Suppliers

OEMs in the solar power supply chain are companies that assemble complete solar power generation systems. A complete system includes every component necessary to turn solar rays into usable electricity. A first-tier supplier in this supply chain could be any company that manufactures a stand-alone component of these power generation systems, from fully assembled panels to cable arrays. First tier suppliers could also be manufacturers that make parts for the most essential components, such as the photo-voltaic cells that make up solar panels, wiring assemblies to connect the system, or DC/AC power converters.

Hydroelectric Power

Impact of Industrial Policy Legislation

Both the IIJA and the IRA will support the hydroelectric power generation supply chain. The IIJA creates a grant program that funds hydroelectric projects, authorizes funding for hydroelectric and marine energy projects, authorizes funding for hydroelectric energy production tax incentives, authorizes funding for hydroelectric efficiency improvement incentives, directs the Secretary of Energy to provide funding for capital improvements that maintain or enhance hydroelectric generation through improved dam safety, establishes a demonstration for pumped storage hydropower, and establishes a demonstration project for hydropower on current or former mine land.⁷² The IRA creates a tax credit for clean electricity production, creates a tax credit for investments in clean energy production and storage, and extends a tax credit for qualified energy projects, including hydropower.⁷³

Background

Hydroelectric power generation harnesses the power of water and converts the kinetic energy of lakes, rivers, and the sea into electricity.⁷⁴ Hydropower is also a

critical source of energy storage; by using excess energy to pump water into a raised reservoir or behind a dam, pumped hydropower can convert electric energy to kinetic energy and store massive amounts of power for future use. Pumped hydropower storage accounts for a vast majority of utility-scale energy storage in the United States.⁷⁵

Identifying OEMs and First-tier Suppliers

Because they use dams or other means of diverting natural water sources, hydroelectric power generation plants are almost always highly customized and assembled on site. The process of assembling working hydroelectric systems is as much based in construction as it is in manufacturing. However, there are some prefabricated elements that most hydropower plants have in common. We identified first tier suppliers in the hydropower supply chain as companies that manufacture high-volume turbines, high-output generators and generator components, and high tolerance pipes capable of handling the extreme pressures and throughput of a dam.

Fuel Cells and Electrolyzers

Impact of Industrial Policy Legislation

All three pieces of industrial policy legislation will support the fuel cell and electrolyzer supply chain. The CHIPS Act funds research into alternative propulsion systems for airplanes, including fuel cells.⁷⁶ The IIJA creates a grant program for fuel cell manufacturing projects, a research and development program on clean fuel cells, and a Clean Hydrogen Electrolysis program to support research, demonstration, and commercialization of the development of hydrogen energy through electrolysis.⁷⁷ The IRA creates a production credit for clean fuel, extends an energy credit that covers mechanical fuel cells, and modifies the standards for eligible fuel cells.⁷⁸

Background

A fuel cell can be conceptualized as something between an engine and a battery. Fuel cells rely on electrochemical

reactions rather than combustion reactions to generate electricity.⁷⁹ Electrolyzers work in the opposite fashion, using electricity to split inert molecules and produce fuel. Water electrolysis splits water molecules into hydrogen and oxygen gas, which can be used as fuel.

Identifying OEMs and First-tier Suppliers

Fuel cells and electrolyzers can be small, modular, and relatively inexpensive. We identified OEMs in this supply chain as any companies that manufacture fully integrated fuel cells or electrolysis systems. First-tier suppliers include companies that manufacture micro-membranes used in electrolysis, specialized gaskets to seal and contain reactants, and specialized electronic components explicitly designed for these systems.

Carbon Capture and Storage

Impact of Industrial Policy Legislation

The IIJA and the IRA are the primary pieces of industrial policy legislation that will support the carbon capture and storage supply chain. The IIJA creates a clean energy demonstration program (including carbon capture and storage), a grant program to fund advanced energy projects in census tracts that previously had coal mines or coal-fired electricity generation facilities, and a carbon capture demonstration and pilot program. It also modifies an existing research and development program to include carbon capture technologies, funds a federal financial support program (grants, loans, loan guarantees) to support carbon dioxide transportation infrastructure projects, establishes a commercialization program for carbon sequestration, creates a regional direct air capture hub program, creates a regional clean hydrogen hub program that mandates that at least one hub demonstrate clean hydrogen generation using fossil fuels (which will require carbon capture), and classifies carbon dioxide capture facilities as eligible for exempt facility bonds.⁸⁰ The IRA creates a tax credit for clean energy production (defined by low greenhouse gas emissions) and a tax credit for investments in clean energy production equipment (which includes carbon capture).⁸¹

Background

Carbon capture and storage systems have been proposed as one of a host of carbon reduction strategies that could help curtail the increased concentration of greenhouse gases in earth's atmosphere. Although most emission reduction technologies take a preventative approach by reducing the carbon output of polluting agents, carbon capture technologies prevent CO₂ from being emitted into the atmosphere.⁸² "Carbon scrubbing" facilities pass large amounts of air from the ambient environment through a system that



contains carbon dioxide filters or solvents that capture the greenhouse gas and concentrate it. Carbon sequestration often involves chilling or condensing the CO₂, sometimes into liquid form, then storing it in tanks, repurposing it, or injecting it deep into the earth's crust.

Identifying OEMs and First-tier Suppliers

Because carbon capture and storage has not yet been widely implemented, there are no companies that can be considered OEMs in the supply chain. We did not identify any companies that sell turnkey or ready-made carbon capture and storage solutions. However, companies that produce industrial refrigeration and gas compressor systems make products that are analogous to the components of carbon capture systems that condense and transport captured CO₂. First-tier suppliers in the carbon capture and storage supply chain include but are not limited to hydrocarbon refineries capable of producing carbon dioxide solvents, duct and pipeline manufacturers, industrial refrigerant and coolant manufacturers, and conventional oil well machinery manufacturers.

Rail Cars

Impact of Industrial Policy Legislation

The IIJA is the primary piece of industrial policy legislation that will support the rail cars supply chain. The IIJA allocates funding to Amtrak to acquire new rolling stock, prohibits new rail cars used in the United States from using “sensitive technologies” developed in countries of concern or by foreign state-owned enterprises, establishes a grant program to support rail and public transportation projects, funds a grant program that provides operating assistance to intercity rail systems, funds a grant program to support capital projects for intercity rail service, provides funding to support emissions reduction in locomotives, expands a grant program that supports operating costs for rail systems, and establishes a research and development program to support the advancement of rolling stock.⁸⁵

Background

We include both passenger rail cars and freight cars in our definition of the rail car supply chain. These two types of vehicles have differences in equipment

specifications and components but our company-specific research suggested significant overlap in the supply chains. Passenger rail cars, being designed to transport people, are lighter and the components of these cars are designed for faster acceleration and braking and higher top-end speeds.⁸⁴ Additionally, passenger cars can include seating, lighting, luggage storage compartments, and even small rooms that include beds and restroom facilities. Freight cars are designed to profitably transport large quantities of potentially heavy materials and, as such, have components designed to handle heavier loads.

Identifying OEMs and First-tier Suppliers

We identified manufacturers that sell finished entire rail cars as OEMs in the rail car supply chain. First-tier suppliers to rail car OEMs include but are not limited to companies that manufacture seats, interior components, and upholstery for mass transit and other types of passenger cars, including long-distance passenger rail; those that make train car wheels, windows and windshields; and those that do custom fiberglass fabrication.

Critical Minerals

Impact of Industrial Policy Legislation

The CHIPS Act and the IIJA are the primary pieces of industrial policy legislation that will support the critical minerals supply chain. The CHIPS Act creates research and development funds for higher education institutions and nonprofits to conduct research on critical minerals mining technologies.⁸⁵ The IIJA provides funding for facilities that extract critical minerals from recycled batteries, creates a research and development program to support innovation in critical minerals mining, and provides a credit for U.S.-based production of some critical minerals.⁸⁶

Background

Many of the supply chains supported by the IIJA, CHIPS Act, and IRA depend on the supply of minerals such as lithium, silicon, cobalt, copper, and other rare earth metals. The U.S. Geological Survey publishes a list

of critical minerals that its research has identified as important to national security, the economy, renewable energy development, or infrastructure.⁸⁷ Although the extraction of these materials occurs throughout the world at the locations of mineral reserves, these pieces of legislation stress the importance of increasing the domestic refining and enrichment of these ores and decreasing the U.S.’s reliance on foreign production.

Identifying OEMs and First-tier Suppliers

OEMs in the critical minerals supply chain are any companies that sell minerals or rare earth metals in a highly refined state but have not yet incorporated them into other products. We considered companies first-tier suppliers in the critical minerals supply chain if their operations include the primary smelting of ores, but not if they are directly involved in extraction or mining activities.

Fiber Optic Cables

Impact of Industrial Policy Legislation

The IIJA is the primary piece of industrial policy legislation that will support the fiber optic cables supply chain. The IIJA creates grants for states and similar entities to expand high-speed internet infrastructure, grants to support the construction and improvement of “middle-mile” broadband infrastructure, and grants to deploy smart energy grid technology. It also enables states to issue private activity bonds to finance broadband deployment in rural areas, provisions funds for expanding or providing access to broadband at rural schools, and creates the Broadband Equity, Access, and Deployment (BEAD) Program, through which the federal government can make grants to expand broadband access in underserved areas.⁸⁸

Background

Fiber optic cables are an essential part of modernizing the U.S. communications infrastructure. These cables use the optical properties of plastic or glass to transmit information as pulses of light. Because light moves much faster than electrons and is not subject to resistance, it can be used to transmit information faster, further, and with less signal loss than traditional copper wire. Many of the undersea and transcontinental cables that link global communications infrastructure are made of fiber optics. In addition, most of the U.S. broadband infrastructure backbone uses fiber optic cables to connect different regions within the country.⁸⁹

Identifying OEMs and First-tier Suppliers

We identified fiber optics OEMs as any company that manufactures complete fiber optic cables and/or transmitters. First-tier suppliers in the fiber optics industry include optical and high purity glass manufacturers, cable shielding manufacturers, and optical-analog converters.

Batteries

Impact of Industrial Policy Legislation

The IIJA and the IRA are the primary pieces of legislation that will support the batteries supply chain. The IIJA’s impacts on the supply chain include grants for states and tribal entities to purchase storage batteries to enhance the resilience of the electric grid, two grant programs to support battery materials processing and battery manufacturing facilities, and a grant program to support advanced energy projects.⁹⁰ The IRA’s primary impacts on the batteries supply chain include a tax credit for investments in energy storage technology, a tax credit for U.S.-based production of battery components, a rebate program for the purchase of high-capacity storage batteries installed in residential and multifamily properties, and an individual tax credit for expenditures on batteries that are connected to a dwelling and that have at least 3 kilowatt hours of storage.⁹¹

Background

Lithium-ion batteries are used more frequently than other types of battery cells for electric vehicle and high-capacity storage applications. Whole batteries are built of many arrays of smaller cells packed into a completed battery.⁹²

Identifying OEMs and First-tier Suppliers

We classified companies that manufacture and sell complete batteries for use in electric vehicles, or for other high-draw use cases, as OEMs in the batteries supply chain. First-tier suppliers for the supply chain include manufacturers of gaskets to seal the battery assemblies, companies that make cable arrays to connect battery cells, and companies that process rare earth metals.

Identifying Businesses within Supply Chains

Our primary source for identifying individual businesses within our selected supply chains was Dun & Bradstreet’s (D&B) Hoovers database. We downloaded all U.S.-based businesses that Dun & Bradstreet marked as minority-owned in the six-digit NAICS industries that we identified as likely to contain the OEM and first-tier supplier industries. (Appendix Table A2 lists these NAICS codes.) However, these industry categories are overinclusive and contain both manufacturers in the relevant supply chains

and manufacturers in other supply chains. To identify the manufacturers in the supply chains of interest, we conducted company-level research to determine whether each company is operational and which products each company makes. We used our assessment of the products included at both the OEM and first-tier levels of each supply chain along with our assessment of the products that each company makes to determine whether or not each company belongs in a specific supply chain.

Appendix Table A2. NAICS Six-Digit Industries Used for Identification of OEMs and First-Tier Suppliers

Supply Chain	OEM Industries	First-Tier Supplier Industries
Batteries	335910 Battery Manufacturing	325180 Other Basic Inorganic Chemical Manufacturing
		331410 Nonferrous Metal (except Aluminum) Smelting and Refining
		334515 Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
		335910 Battery Manufacturing
		335931 Current Carrying Wiring Device Manufacturing
		335911 Storage Battery Manufacturing
Carbon Capture and Storage	333415 Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	339991 Gasket, Packing, and Sealing Device Manufacturing
		331110 Iron and Steel Mills and Ferroalloy Manufacturing
		324110 Petroleum Refineries
		331210 Iron and Steel Pipe and Tube Manufacturing from Purchased Steel
		333415 Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
		333912 Air and Gas Compressor Manufacturing
Electric Vehicles	336110 Automobile and Light Duty Motor Vehicle Manufacturing	333914 Measuring, Dispensing, and Other Pumping Equipment Manufacturing
	336120 Heavy Duty Truck Manufacturing	326211 Tire Manufacturing (except Retreading)
		334310 Audio and Video Equipment Manufacturing
		335312 Motor and Generator Manufacturing
		335910 Battery Manufacturing
		336211 Motor Vehicle Body Manufacturing
		336212 Truck Trailer Manufacturing
	336320 Motor Vehicle Electrical and Electronic Equipment Manufacturing	

(continued)

Appendix Table A2. NAICS Six-Digit Industries Used for Identification of OEMs and First-Tier Suppliers
(continued)

Supply Chain	OEM Industries	First-Tier Supplier Industries
Electric Vehicles (continued)	336110 Automobile and Light Duty Motor Vehicle Manufacturing	336330 Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
		336340 Motor Vehicle Brake System Manufacturing
	336120 Heavy Duty Truck Manufacturing	336350 Motor Vehicle Transmission and Power Train Parts Manufacturing
		336360 Motor Vehicle Seating and Interior Trim Manufacturing
		336370 Motor Vehicle Metal Stamping
	336390 Other Motor Vehicle Parts Manufacturing	
Rail Cars	336510 Railroad and Rolling Stock Manufacturing	333131 Mining Machinery and Equipment Manufacturing
		332312 Fabricated Structural Metal Manufacturing
		331511 Iron Foundries
		331513 Steel Foundries (except Investment)
		335312 Motor and Generator Manufacturing
		336320 Motor Vehicle Electrical and Electronic Equipment Manufacturing
		336360 Motor Vehicle Seating and Interior Trim Manufacturing
Fuel Cells and Electrolyzers	335910 Battery Manufacturing	325180 Other Basic Inorganic Chemical Manufacturing
		335931 Current-Carrying Wiring Device Manufacturing
		339991 Gasket, Packing, and Sealing Device Manufacturing
		335910 Battery Manufacturing
		335991 Carbon and Graphite Product Manufacturing
		334515 Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
		334413 Semiconductor and Related Device Manufacturing
Hydropower	333611 Turbine and Turbine Generator Set Units Manufacturing	335991 Carbon and Graphite Product Manufacturing
		331221 Rolled Steel Shape Manufacturing
		335999 All Other Miscellaneous Electrical Equipment and Component Manufacturing
		334515 Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
		335991 Carbon and Graphite Product Manufacturing
		334515 Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
Nuclear Energy	332410 Power Boiler and Heat Exchanger Manufacturing	331491 Nonferrous Metal (except Copper and Aluminum), Rolling, Drawing, and Extruding
		332911 Industrial Valve Manufacturing
		334513 Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables

(continued)

Appendix Table A2. NAICS Six-Digit Industries Used for Identification of OEMs and First-Tier Suppliers
(continued)

Supply Chain	OEM Industries	First-Tier Supplier Industries
Solar Power	335999 All Other Miscellaneous Electrical Equipment and Component Manufacturing	334413 Semiconductor and Related Device Manufacturing
		335131 Residential Electric Lighting Fixture Manufacturing
		335132 Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing
		333414 Heating Equipment (except Warm Air Furnaces) Manufacturing
		327992 Ground or Treated Mineral and Earth Manufacturing
		331410 Nonferrous Metal (except Aluminum) Smelting and Refining
		327211 Flat Glass Manufacturing
		325211 Plastics Material and Resin Manufacturing
		326113 Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing
		331314 Secondary Smelting and Alloying of Aluminum
		326112 Plastics Packaging Film and Sheet (including Laminated) Manufacturing
Wind Power	333611 Turbine and Turbine Generator Set Units Manufacturing	331511 Iron Foundries
		335312 Motor and Generator Manufacturing
		335311 Power, Distribution, and Specialty Transformer Manufacturing
Critical Minerals	327992 Ground or Treated Mineral and Earth Manufacturing	325180 Other Basic Inorganic Chemical Manufacturing
	331410 Nonferrous Metal (except Aluminum) Smelting and Refining	
	331313 Alumina Refining and Primary Aluminum Production	
Fiber Optic Cables	335921 Fiber Optic Cable Manufacturing	327212 Other Pressed and Blown Glass and Glassware Manufacturing
		334417 Electronic Connector Manufacturing

APPENDIX

We recorded short descriptions of each company's products and assigned each company to up to two supply chains to which it is most likely to belong. Some companies could feasibly be categorized as suppliers to many supply chains, so we used context from companies' websites to place them in explicitly mentioned supplier industries or the most similar supply chain(s) we researched. Most manufacturers list a set of target industries on their websites. For example, a rubber gasket manufacturer could produce products for the batteries, hydropower, nuclear energy or fuel cells and electrolyzers supply chains, as each of these make products that incorporate rubber seals or gaskets in their OEM product. If the company's website showed a history of business in the energy industry, or high-pressure applications, we would choose the nuclear energy and hydropower supply chains. Using these pieces of context from each company, we classified each business into no more than its two most salient supply chains. We did so because including each company in the full range of possible supply chains would effectively dissolve the distinctions between supply chains and often include suppliers that are much less essential to the OEM product. We also classified each company as either an OEM or a first-tier supplier within each supply chain. It is possible for some companies to be OEMs in one supply chain and first-tier suppliers in another. For example, we classified a manufacturer of electric vehicle batteries as both an OEM in the batteries supply chain and a first-tier supplier in the electric vehicle supply chain.

Once we determined whether or not a company is within a supply chain of interest, we conducted an additional round of research to identify which companies are Black-owned or Hispanic owned. We considered only businesses that Dun & Bradstreet classified as "minority-owned" as eligible to be counted as Black- or Hispanic-owned. To determine whether those businesses are actually Black- or Hispanic-owned, we used publicly available information from a wide variety of reliable websites including Buzzfile, LinkedIn, OpenCorporates, and company websites; OpenGovUS and other online

procurement records; and newspaper articles. If we could not determine definitively whether or not a company is Black- or Hispanic-owned, we assigned that company to an unknown status and did not consider it a Black- or Hispanic-owned company. (We found no individual companies in the relevant supply chains that are both Black- and Hispanic-owned.)

Dun & Bradstreet classifies companies as minority-owned if they are majority owned by an individual who identifies as a racial or ethnic minority. Dun & Bradstreet requires that the company be majority managed by such an individual. In addition to the Dun & Bradstreet data and our inspection of the websites and publicly available information noted above, we also used a proprietary dataset provided by the National Minority Supplier Development Council (NMSDC) to identify business owners' race and ethnicity. This dataset included each company's address, industry, a description of the company's products, and examples of its major customers. The NMSDC dataset also included information on the race and ethnicity of each company's owners. NMSDC uses the same ownership criteria as Dun & Bradstreet.

To estimate the number of privately held companies in each supply chain that are not minority-owned, we took a 3 percent random sample (consisting of 531 businesses) of all the non-minority-owned privately held companies within each NAICS code in the Dun & Bradstreet data. We took this sample at the national level, which did not allow for specific comparisons of representation in smaller geographic areas within the U.S. For each of the companies included in our random sample, we used the research process described above to determine whether the company is operational, what kind of products the company makes, and its supply chain position(s) as an OEM and/or first-tier supplier. Where appropriate, we assigned each company to a primary and a secondary supply chain. We assumed that all privately held companies that Dun & Bradstreet classified as non-minority-owned are white-owned.

Once we constructed our datasets, we analyzed the distribution of companies within each supply chain and compared the Black- and Hispanic-owned companies to the non-minority-owned companies and to the rest of the minority-owned companies. We geocoded all the addresses to assign latitude and longitude coordinates to each company and tallied the number of businesses within each state (as well as the District of Columbia and Puerto Rico) and metropolitan area. We then ranked the top states and metropolitan areas for each supply chain among both Black- and Hispanic-owned businesses.

We used the business revenue and employment data available in the Dun & Bradstreet data to assess whether there were size disparities between Black-, Hispanic-, and white-owned companies within each supply chain. We calculated both mean and median revenue estimates for businesses within each supply chain by race of ownership for Black-owned, Hispanic-owned, and white-owned businesses. We carried out two-tailed t-tests to identify statistically significant differences in mean employment and revenue. We also conducted statistical significance tests of differences in median employment and revenue.

Limitations of the Analysis

Our supply chain categories are based on the products that companies make, not on their business relationships. Therefore, we are unable to say whether a particular company we classified as a first-tier supplier actually sells products to an OEM. This is a limitation in the sense that we are unable to map existing supply chains definitively. However, it is also an advantage because it enables us to identify companies whose current products could enable them to become first-tier suppliers relatively easily as OEMs expand and purchase more components made by first-tier suppliers.

Our analysis is limited to OEMs and first-tier suppliers. It does not include the many lower-tier suppliers that will also expand or come into existence as a result of the recent legislation. Therefore, it understates the number of companies that will benefit from the legislation.

The recent legislation will induce companies that do not currently manufacture in the U.S. to do so. It will also induce existing U.S. manufacturers to expand. As these companies expand, they will create more jobs, and potentially more companies in their supply chains as a result of direct, indirect, and induced impacts of their expansion. Our analysis is a static analysis of businesses as they exist at a point in time rather than an economic impact analysis. Therefore, we are unable to predict any of these changes. As a result, we understate the number of companies that will benefit from the legislation.

Because we limit to two the number of supply chains in which each company may appear, we may understate the number of Black- and Hispanic-owned companies in some supply chains. This limitation may also affect our supply chain-specific estimates of the percentages of companies that are Black- and Hispanic-owned and our supply chain-specific revenue and employment comparisons by owners' demographics, although we cannot know the direction of any biases that may result.

We also may understate the numbers of Black- and Hispanic-owned manufacturers because we classified companies as Black- or Hispanic-owned only if we were able to identify owner race/ethnicity in one of the sources described above. There could be Black- and Hispanic-owned manufacturers that do not disclose, and whose owner(s) do not disclose, owner race/ethnicity in any of those sources.

Because we are interested in counting and comparing companies rather than business establishments, we count each company only once, at the location of its headquarters. Therefore, our geographic analyses are based on headquarters locations, not plant locations. Consequently, there are some states and metropolitan areas that may benefit from the recent legislation because they are the locations of plants but are not counted in our analysis. Because privately held manufacturers are usually small, single-location businesses whose headquarters and production facilities are co-located, this limitation is not likely to be very important.

APPENDIX

The 258 Black- and Hispanic-owned companies included in this report have a total of 293 establishments, so each company has an average of 1.14 establishments.

Some companies are more vertically integrated than others. If a company manufactures a product that we classify as an OEM product for a particular supply chain, then we classify it as an OEM in that supply chain even if also manufactures some of its own components. For example, a firm that assembles complete batteries is an OEM in the batteries supply chain even if it also makes battery components for its own products and even if those components are ones that first-tier suppliers make for other battery OEMs.



REFERENCES

- Atkinson, Robert D. 2021. *The Case for Legislation to Out-Compete China*. Washington: Information Technology and Innovation Foundation.
- Bateman, Alexis, Ashley Barrington, and Katie Date. 2020. "Why You Need a Supplier Diversity Program," *Harvard Business Review*, August 17, <https://hbr.org/2020/08/why-you-need-a-supplier-diversity-program>.
- Briggs, Xavier de Sousa, Charisse Johnson, and Bruce Katz. 2023. "There's an Industrial Revolution Underway. Unless We Act, It Will Make the Racial Wealth Gap Even Worse." Washington: Brookings Institution, <https://www.brookings.edu/articles/theres-an-industrial-revolution-underway-unless-we-act-it-will-make-the-racial-wealth-gap-even-worse/>.
- Broady, Kristen, Mac McComas, and Amine Ouazad. 2021. *An Analysis of Financial Institutions in Black-Majority Communities: Black Borrowers and Depositors Face Considerable Challenges in Accessing Banking Services*. Washington: Brookings Institution, <https://www.brookings.edu/articles/an-analysis-of-financial-institutions-in-black-majority-communities-black-borrowers-and-depositors-face-considerable-challenges-in-accessing-banking-services/>.
- Chandler, Miles and Howard Wial. 2021. *Bridging the Capital Access Gap*. Boston: Initiative for a Competitive Inner City.
- CHIPS Research and Development Office, National Institute of Standards and Technology. 2023. *The Vision for the National Advanced Packaging Manufacturing Program*. Gaithersburg, Maryland, <https://www.nist.gov/system/files/documents/2023/11/19/NAPMP-Vision-Paper-20231120.pdf>.
- Condon, Natasha. n.d. "Incorporating ESG into Supply Chain Finance." New York: J.P. Morgan, <https://www.jpmorgan.com/insights/payments/trade-and-working-capital/incorporating-esg-in-to-supply-chain-finance>.
- Curry, Fantasi, and Jennifer DeBoer. 2020. "A Systematized Literature Review of the Factors that Predict the Retention of Racially Minoritized Students in STEM Graduate Degree Programs," presented at ASEE Virtual Conference, June 22-26, <https://www.purdue.edu/meercat/wp-content/uploads/2020/07/a-systematized-literature-review-of-the-factors-that-predict-the-retention-of-racially-minoritized-students-in-stem-graduate-degree-programs.pdf>.
- Eberhardt, Peter, Howard Wial, and Devon Yee. 2020. *The New Face of Under-resourced Communities*. Boston: Initiative for a Competitive Inner City.
- Eberhardt, Peter, et al. 2023. *Breaking the Glass Bottleneck: The Economic Potential of Black and Hispanic Real Estate Developers and the Constraints They Face*. Washington: Grove Impact.
- Fairlie, Robert. 2020. "COVID-19, Small Business Owners, and Racial Inequality," *NBER Reporter*, no. 4 (December), pp. 12-15, https://live-nber.pantheonsite.io/sites/default/files/2021-01/2020number4_2.pdf.
- Federal Deposit Insurance Corporation. 2019. *2019 Minority Depository Institutions: Structure, Performance and Social Impact*. Washington, <https://www.fdic.gov/regulations/resources/minority/2019-mdi-study/full.pdf>.
- Ganesan, Vasanth, Anil Nathan, and Allen Weinberg. 2023. *Underestimated Start-Up Founders: The Untapped Opportunity*. n.p.: McKinsey & Company, <https://www.mckinsey.com/featured-insights/diversity-and-inclusion/underestimated-start-up-founders-the-untapped-opportunity#/>.
- Helper, Susan, Timothy Krueger, and Howard Wial. 2012. *Why Does Manufacturing Matter? Which Manufacturing Matters? A Policy Framework*. Washington: Brookings Institution.
- National Institute of Standards and Technology. 2013. "Manufacturing Extension Partnership: Making an Impact on U.S. Manufacturing." Gaithersburg, MD, <https://www.nist.gov/system/files/documents/mep/MEP-PARTNERING-IMPACTS-2013-2.pdf>.
- National Institute of Standards and Technology. 2011. *Connecting Small Manufacturers with the Capital Needed to Grow, Compete, and Succeed: Small Manufacturers Capital Access Inventory and Needs Assessment Report*. Gaithersburg, MD, https://www.nist.gov/system/files/documents/ineap/MEP_Capital_Needs_Assessment_Final.pdf.
- National Science Foundation. 2021. *Survey of Graduate Students and Postdoctorates in Science and Engineering*. Alexandria, VA.
- Parker, Melonie. 2021. "\$50 Million for HBCUs to Address the Diversity Gap in Tech," Google Blog, June 17, <https://blog.google/outreach-initiatives/diversity/50-million-hbcus-address-diversity-gap-tech/>.
- Rice, Lisa. 2022. "Fairness in Financial Services: Racial Discrimination in Banking and Lending," testimony before Senate Committee on Banking, Housing, and Urban Affairs, December 1, <https://www.banking.senate.gov/imo/media/doc/Rice%20Testimony%2012-1-222.pdf>.
- Roach, Michael, and Henry Sauermann. 2023. "Can Technology Startups Hire Talented Early Employees? Ability, Preferences, and Employee First Job Choice," *Management Science*, August 8, <https://doi.org/10.1287/mnsc.2023.4868>.
- Roy, Joseph. 2019. "Engineering by the Numbers." n.p.: Applied Advanced Science Exchange, <https://ira.asee.org/wp-content/uploads/2019/07/2018-Engineering-by-Numbers-Engineering-Statistics-UPDATED-15-July-2019.pdf>.

REFERENCES

- Simonite, Tom. 2015. "First Detailed First Detailed Public Map of U.S. Internet Backbone Could Make It Stronger," *MIT Technology Review*, September 15, <https://www.technologyreview.com/2015/09/15/166239/first-detailed-public-map-of-us-internet-backbone-could-make-it-stronger/>.
- Slater, Stanley, Robert Weigand, and Thomas Zwirolein. 2008. "The Business Case for Commitment to Diversity," *Business Horizons*, vol. 51, pp. 201-209.
- Small Business Innovation Research. 2018. "Working with Procurement Technical Assistance Centers." Washington <https://www.sbir.gov/sites/all/themes/sbir/dawnbreaker/img/documents/Course15-Tutorial2.pdf>.
- Steinfeld, Jenn, Phil Berkaw, and Corriane Rice. 2020. *Inclusive Procurement and Contracting: Policies, Programs, and Practices for Local Leaders*. Washington: National League of Cities.
- Stoll, Michael, Stephen Rafael, and Harry Holzer. 2001. "Why Are Black Employers More Likely than White Employers to Hire Blacks?" Discussion Paper 1236-01, Institute for Research on Poverty, University of Wisconsin, <https://www.irp.wisc.edu/publications/dps/pdfs/dp123601.pdf>.
- Sustainable Terms of Trade Initiative. 2022. "White Paper on the Definition and Application of Commercial Compliance," n.p., https://www.iafnet.com/2016_01_22/wp-content/uploads/2021/09/STTI-White-Paper-on-the-Definition-and-Application-of-Commercial-Compliance.pdf.
- U.S. Department of Commerce and U.S. Department of Homeland Security. 2022. *Assessment of the Critical Supply Chains Supporting the U.S. Information and Communications Technology Industry*. Washington, https://www.dhs.gov/sites/default/files/2022-02/ICT%20Supply%20Chain%20Report_2.pdf.
- U.S. Department of Energy. 2023. *Critical Materials Assessment*. Washington, https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf.
- U.S. Department of Energy. 2022. *Carbon Capture, Transport, & Storage: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Carbon%20Capture%20Supply%20Chain%20Report%20-%20Final%202.25.25.pdf>.
- U.S. Department of Energy. 2022. *Grid Energy Storage: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Energy%20Storage%20Supply%20Chain%20Report%20-%20final.pdf>.
- U.S. Department of Energy. 2022. *Water Electrolyzers and Fuel Cells: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Fuel%20Cells%20%26%20Electrolyzers%20Supply%20Chain%20Report%20-%20Final.pdf>.
- U.S. Department of Energy. 2022. *Hydropower: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Hydropower%20Supply%20Chain%20Report%20-%20Final.pdf>.
- U.S. Department of Energy. 2022. *Nuclear Energy: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Nuclear%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf>.
- U.S. Department of Energy. 2022. *Platinum Group Metal Catalysts: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/PGM%20catalyst%20supply%20chain%20report%20-%20final%20draft%202.25.22.pdf>.
- U.S. Department of Energy. 2022. *Semiconductor: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Semiconductor%20Supply%20Chain%20Report%20-%20Final.pdf>.
- U.S. Department of Energy. 2022. *Solar Photovoltaics: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Solar%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf>.
- U.S. Department of Energy. 2022. *Wind Energy: Supply Chain Deep Dive Assessment*. Washington, <https://www.energy.gov/sites/default/files/2022-02/Wind%20Supply%20Chain%20Report%20-%20Final%202.25.22.pdf>.
- U.S. Securities and Exchange Commission, Office of the Advocate for Small Business Capital Formation. 2019. *Annual Report for Fiscal Year 2019*. Washington, https://www.sec.gov/files/2019_OASB_Annual%20Report.pdf.
- Washington State Office of Minority and Women's Business Enterprises. 2019. "Tools for Equity in Public Spending, Unbundling FAQ." Olympia, WA, <https://omwbe.wa.gov/sites/default/files/public/tools-for-equity/Unbundling-FAQ.pdf>.
- White House. 2022. "Fact Sheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China," <https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/>.
- White House. 2022. *A Guidebook to the Bipartisan Infrastructure Law for State, Local, Tribal, and Territorial Governments, and Other Partners*. <https://www.whitehouse.gov/build/guidebook/>.
- White House. 2023. *Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action*. <https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf>.

ENDNOTES

- 1 Authors' analysis of 2021 Annual Business Survey data.
- 2 Susan Helper, Timothy Krueger, and Howard Wial, *Why Does Manufacturing Matter? Which Manufacturing Matters? A Policy Framework* (Washington: Brookings Institution, 2012).
- 3 Robert D. Atkinson, *The Case for Legislation to Out-Compete China* (Washington: Information Technology and Innovation Foundation, 2021), p. 2 (italics in original).
- 4 Infrastructure Investment and Jobs Act, Pub. L. No. 117-58, 135 Stat. 429, November 15, 2021, <https://www.congress.gov/bill/117th-congress/house-bill/3684/text>.
- 5 CHIPS and Science Act, Pub. L. No. 117-167, 136 Stat. 1366, August 9, 2022, <https://www.congress.gov/bill/117th-congress/house-bill/4346/text>.
- 6 Inflation Reduction Act, Pub. L. No. 117-169, 136 Stat. 1818, August 16, 2022, <https://www.congress.gov/bill/117th-congress/house-bill/5376/text>.
- 7 U.S. Department of Commerce and U.S. Department of Homeland Security, *Assessment of the Critical Supply Chains Supporting the U.S. Information and Communications Technology Industry* (Washington, 2022), https://www.dhs.gov/sites/default/files/2022-02/ICT%20Supply%20Chain%20Report_2.pdf; U.S. Department of Energy, *Critical Materials Assessment* (Washington, 2023), https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf; U.S. Department of Energy, *Carbon Capture, Transport, & Storage: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Carbon%20Capture%20Supply%20Chain%20Report%20-%20Final%202.25.22.pdf>; U.S. Department of Energy, *Grid Energy Storage: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Energy%20Storage%20Supply%20Chain%20Report%20-%20final.pdf>; U.S. Department of Energy, *Water Electrolyzers and Fuel Cells: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Fuel%20Cells%20%26%20Electrolyzers%20Supply%20Chain%20Report%20-%20Final.pdf>; U.S. Department of Energy, *Hydropower: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Hydropower%20Supply%20Chain%20Report%20-%20Final.pdf>; U.S. Department of Energy, *Nuclear Energy: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Nuclear%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf>; U.S. Department of Energy, *Platinum Group Metal Catalysts: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/PGM%20catalyst%20supply%20chain%20report%20-%20final%20draft%202.25.22.pdf>; U.S. Department of Energy, *Semiconductor: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Semiconductor%20Supply%20Chain%20Report%20-%20Final.pdf>; U.S. Department of Energy, *Solar Photovoltaics: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Solar%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf>; U.S. Department of Energy, *Wind Energy: Supply Chain Deep Dive Assessment* (Washington, 2022), <https://www.energy.gov/sites/default/files/2022-02/Wind%20Supply%20Chain%20Report%20-%20Final%202.25.22.pdf>.
- 8 Our analysis includes only privately held companies because they are the only ones with owners whose race and ethnicity can be identified. Therefore, we exclude publicly held companies and nonprofit organizations.
- 9 ICIC and Grove Impact used a similar method to identify Black- and Hispanic-owned real estate developers. See Peter Eberhardt et al., *Breaking the Glass Bottleneck: The Economic Potential of Black and Hispanic Real Estate Developers and the Constraints They Face* (Washington: Grove Impact, 2023).
- 10 Because some companies (e.g., electric vehicle battery manufacturers) may be OEMs in one supply chain (e.g., the batteries supply chain) and first-tier suppliers in another (e.g., the electric vehicle supply chain), we are unable to generalize about OEMs and first-tier suppliers at the level of all 13 supply chains combined.
- 11 All differences in median revenue and employment between groups presented in this paragraph are statistically significant at the 5 percent level.
- 12 The differences in median revenue between Black- and white-owned firms and between Hispanic- and white-owned firms are statistically significant at the 5 percent level but the difference between Black- and Hispanic-owned firms is not.
- 13 The differences in median revenue between Black- and white-owned firms and between Hispanic- and white-owned firms are statistically significant at the 5 percent level.
- 14 Authors' analysis of 2021 Annual Business Survey data.
- 15 For ICIC's complete definition of under-resourced communities, see Peter Eberhardt, Howard Wial, and Devon Yee, *The New Face of Under-Resourced Communities* (Boston: Initiative for a Competitive Inner City, 2020), pp. 5-6.
- 16 "Tesla's New Billion-Dollar Gigafactory Opens in Austin on Thursday," NBCDFW website, April 7, 2022, <https://www.nbcdfw.com/news/local/texas-news/teslas-new-billion-dollar-gigafactory-opens-in-austin-on-thursday/2934784/>.

ENDNOTES

- 17 Ericsson website: <https://www.ericsson.com/en/about-us/company-facts/ericsson-worldwide/united-states>; Nokia website: <https://www.nokia.com/about-us/company/worldwide-presence/north-america/>; Satelink Inc. website: <https://satelink.com/>.
- 18 Eberhardt, Wial, and Yee, *New Face*, p. 8.
- 19 Our recommendations expand on those of Xavier de Sousa Briggs, Charisse Johnson, and Bruce Katz, “There’s an Industrial Revolution Underway. Unless We Act, It Will Make the Racial Wealth Gap Even Worse” (Washington: Brookings Institution, 2023), <https://www.brookings.edu/articles/theres-an-industrial-revolution-underway-unless-we-act-it-will-make-the-racial-wealth-gap-even-worse/>.
- 20 National Institute of Standards and Technology. *Connecting Small Manufacturers with the Capital Needed to Grow, Compete, and Succeed: Small Manufacturers Capital Access Inventory and Needs Assessment Report* (Gaithersburg, MD, 2011), https://www.nist.gov/system/files/documents/ineap/MEP_Capital_Needs_Assessment_Final.pdf.
- 21 Sustainable Terms of Trade Initiative, “White Paper on The Definition and Application of Commercial Compliance” (2022), https://www.iafnet.com/2016_01_22/wp-content/uploads/2021/09/STTI-White-Paper-on-the-Definition-and-Application-of-Commercial-Compliance.pdf.
- 22 Miles Chandler and Howard Wial, *Bridging the Capital Access Gap* (Boston: Initiative for a Competitive Inner City, 2021).
- 23 Broady, Kristen, Mac McComas, and Amine Ouazad, *An Analysis of Financial Institutions in Black-Majority Communities: Black Borrowers and Depositors Face Considerable Challenges in Accessing Banking Services* (Washington: Brookings Institution, 2021), <https://www.brookings.edu/articles/an-analysis-of-financial-institutions-in-black-majority-communities-black-borrowers-and-depositors-face-considerable-challenges-in-accessing-banking-services/>.
- 24 Lisa Rice, “Fairness in Financial Services: Racial Discrimination in Banking and Lending,” testimony before Senate Committee on Banking, Housing, and Urban Affairs, December 1, 2022, <https://www.banking.senate.gov/imo/media/doc/Rice%20Testimony%2012-1-222.pdf>.
- 25 Chandler and Wial, *Bridging*.
- 26 U.S. Securities and Exchange Commission, Office of the Advocate for Small Business Capital Formation, *Annual Report for Fiscal Year 2019* (Washington, 2019), https://www.sec.gov/files/2019_OASB_Annual%20Report.pdf.
- 27 Vasanth Ganesan, Anil Nathan, and Allen Weinberg. *Underestimated Start-Up Founders: The Untapped Opportunity* (n.p.: McKinsey & Company, 2023), <https://www.mckinsey.com/featured-insights/diversity-and-inclusion/underestimated-start-up-founders-the-untapped-opportunity#/>.
- 28 Federal Deposit Insurance Corporation, *2019 Minority Depository Institutions: Structure, Performance and Social Impact* (2019), Washington, <https://www.fdic.gov/regulations/resources/minority/2019-mdi-study/full.pdf>.
- 29 Ibid.
- 30 Small Business Innovation Research, “Working with Procurement Technical Assistance Centers” (Washington, 2018), <https://www.sbir.gov/sites/all/themes/sbir/dawnbreaker/img/documents/Course15-Tutorial2.pdf>.
- 31 National Institute of Standards and Technology, “Manufacturing Extension Partnership: Making an Impact on U.S. Manufacturing (Gaithersburg, MD, 2013), <https://www.nist.gov/system/files/documents/mep/MEP-PARTNERING-IMPACTS-2013-2.pdf>.
- 32 Michael Roach and Henry Sauermann, “Can Technology Start-ups Hire Talented Early Employees? Ability, Preferences, and Employee First Job Choice,” *Management Science*, August 8, 2023, <https://doi.org/10.1287/mnsc.2023.4868>.
- 33 National Science Foundation, *Survey of Graduate Students and Postdoctorates in Science and Engineering* (Alexandria, VA, 2021).
- 34 Fantasi Curry and Jennifer DeBoer, “A Systematized Literature Review of the Factors That Predict the Retention of Racially Minoritized Students in STEM Graduate Degree Programs,” presented at ASEE Virtual Conference, June 22-26, 2020, <https://www.purdue.edu/meercat/wp-content/uploads/2020/07/a-systematized-literature-review-of-the-factors-that-predict-the-retention-of-racially-minoritized-students-in-stem-graduate-degree-programs.pdf>; Joseph Roy, “Engineering by the Numbers” (n.p.: Applied Advanced Science Exchange, 2019), <https://ira.asee.org/wp-content/uploads/2019/07/2018-Engineering-by-Numbers-Engineering-Statistics-UPDATED-15-July-2019.pdf>.
- 35 CHIPS and Science Act, section 10523.
- 36 Melonie Parker, “\$50 Million for HBCUs to Address the Diversity Gap in Tech,” Google Blog, June 17, 2021, <https://blog.google/outreach-initiatives/diversity/50-million-hbcus-address-diversity-gap-tech/>.
- 37 Alexis Bateman, Ashley Barrington, and Katie Date, “Why You Need a Supplier Diversity Program,” *Harvard Business Review*, August 17, 2020), <https://hbr.org/2020/08/why-you-need-a-supplier-diversity-program>; Stanley Slater, Robert Weigand, and Thomas Zwirlein, “The Business Case for Commitment to Diversity,” *Business Horizons*, vol. 51 (2008), pp. 201-209.
- 38 Natasha Condon. “Incorporating ESG into Supply Chain Finance” (New York: J.P. Morgan, n.d.), <https://www.jpmorgan.com/insights/payments/trade-and-working-capital/incorporating-esg-into-supply-chain-finance>.
- 39 Jenn Steinfeld, Phil Berkaw, and Corriane Rice, *Inclusive Procurement and Contracting: Policies, Programs, and Practices for Local Leaders* (Washington: National League of Cities, 2020).

ENDNOTES

- 40 Washington State Office of Minority and Women's Business Enterprises, "Tools for Equity in Public Spending, Unbundling FAQ" (Olympia, WA, 2019), <https://omwbe.wa.gov/sites/default/files/public/tools-for-equity/Unbundling-FAQ.pdf>.
- 41 National Institute of Standards and Technology, "Notice of Funding Opportunity, CHIPS Incentives Program - Commercial Fabrication Facilities," Funding Opportunity Number 2023-NIST-CHIPS-CFF-01 (Gaithersburg, MD, 2023) <https://www.nist.gov/system/files/documents/2024/04/19/Amended%20CHIPS-Commercial%20Fabrication%20Facilities%20NOFO%20Amendment.pdf>.
- 42 National Institute of Standards and Technology, "Notice of Funding Opportunity, CHIPS Incentives Program - Facilities for Semiconductor Materials and Manufacturing Equipment" Funding Opportunity Number 2023-NIST-CHIPS-SMME-01 (Gaithersburg, MD, 2023), <https://www.nist.gov/system/files/documents/2023/09/29/CHIPS%20-%20Facilities%20for%20Semiconductor%20Materials%20and%20Manufacturing%20Equipment%20NOFO.pdf>.
- 43 National Institute of Standards and Technology, "Notice of Funding Opportunity (NOFO), National Advanced Packaging Manufacturing Program (NAPMP) Materials & Substrates," Funding Opportunity Number 2024-NIST-CHIPS-NAPMP-01 (Gaithersburg, MD, 2023), <https://www.nist.gov/system/files/documents/noindex/2024/02/27/CHIPS%20NAPMP%20MATERIALS%20AND%20SUBSTRATES%20NOFO%20%281%29-508C.pdf>.
- 44 CHIPS Research and Development Office, National Institute of Standards and Technology, "The Vision for the National Advanced Packaging Manufacturing Program" (Gaithersburg, MD, 2023), <https://www.nist.gov/system/files/documents/2023/11/19/NAPMP-Vision-Paper-20231120.pdf>.
- 45 Ibid.
- 46 Ibid.
- 47 White House, "Executive Order on the Implementation of the CHIPS Act of 2022," <https://www.whitehouse.gov/briefing-room/presidential-actions/2022/08/25/executive-order-on-the-implementation-of-the-chips-act-of-2022/>; "Executive Order on the Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022," <https://www.whitehouse.gov/briefing-room/presidential-actions/2022/09/12/executive-order-on-the-implementation-of-the-energy-and-infrastructure-provisions-of-the-inflation-reduction-act-of-2022/>; "Executive Order on Implementation of the Infrastructure Investment and Jobs Act," <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/11/15/executive-order-on-implementation-of-the-infrastructure-investment-and-jobs-act/>.
- 48 U.S. Department of Energy, "Wind Manufacturing and Supply Chain," <https://www.energy.gov/eere/wind/wind-manufacturing-and-supply-chain>.
- 49 National Hydropower Association, "Supply Chains," <https://www.hydro.org/map/supply-chains/>.
- 50 U.S. Department of Energy, "Solar Manufacturing Map," <https://www.energy.gov/eere/solar/solar-manufacturing-map>.
- 51 National Institute of Standards and Technology, CHIPS for America Teaming Partner List, <https://www.nist.gov/chips/chips-america-teaming-partner-list>.
- 52 U.S. Census Bureau, "OnTheMap: Synthetic Data Protection," <https://lehd.ces.census.gov/doc/help/OTMSyntheticData%2005262009-jma.pdf>.
- 53 Eberhardt, Wial, and Yee, *New Face*, p. 8.
- 54 Michael Stoll, Stephen Rafael, and Harry Holzer, "Why Are Black Employers More Likely than White Employers to Hire Blacks?" Discussion Paper 1236-01, Institute for Research on Poverty, University of Wisconsin, 2001).
- 55 CHIPS and Science Act, sections 102, 103 and 107.
- 56 "How Microchips Are Made: Learn About the Steps in the Chip Fabrication Process and What It's Like Working in a Clean-room," ASML website, <https://www.asml.com/en/technology/all-about-microchips/how-microchips-are-made>.
- 57 CHIPS and Science Act, sections 106 and 10230.
- 58 Infrastructure Investment and Jobs Act, sections 60401 and 22425, Div. J Title V.
- 59 Chuck Moozakis, "What Is Wireless Communications? Everything You Need to Know," TechTarget website, <https://www.techtarget.com/searchmobilecomputing/definition/wireless>.
- 60 Infrastructure Investment and Jobs Act, sections 11109, 11129, 11401, 11403, 25005, and 40207.
- 61 Inflation Reduction Act, sections 50122, 13401, 13402, 13403, and 70002.
- 62 Infrastructure Investment and Jobs Act, sections 40313, 40314, 40323, 40342, and 41002.
- 63 Inflation Reduction Act, section 13105.
- 64 "Nuclear Explained," U.S. Energy Information Administration website, <https://www.eia.gov/energyexplained/nuclear/nuclear-power-plants.php>.
- 65 Infrastructure Investment and Jobs Act, sections 41007, 40209, and 40334.
- 66 Inflation Reduction Act, sections 13101, 13103, 13502, 13701, 13702.
- 67 "How Do Wind Turbines Work?" U.S. Department of Energy Office of Energy Efficiency and Renewable Energy website, <https://www.energy.gov/eere/wind/how-do-wind-turbines-work>.
- 68 CHIPS and Science Act, section 10751.
- 69 Infrastructure Investment and Jobs Act, sections 40341, 40342, 41007, and 71102.

ENDNOTES

- 70 Inflation Reduction Act, sections 13701, 13702, 13502, 50122, 13101, 13102, 13103.
- 71 “How Does Solar Work?” U.S. Department of Energy Office of Energy Efficiency and Renewable Energy website, <https://www.energy.gov/eere/solar/how-does-solar-work>.
- 72 Infrastructure Investment and Jobs Act, sections 40209, 41006, 40331, 40332, 40333, 40334, and 40342.
- 73 Inflation Reduction Act, section 13701, 13702, and 13102.
- 74 “How Hydropower Works,” U.S. Department of Energy Office of Energy Efficiency and Renewable Energy website, <https://www.energy.gov/eere/water/how-hydropower-works>.
- 75 “Hydroelectric Incentives Funding in the Bipartisan Infrastructure Law,” U.S. Department of Energy website, <https://www.energy.gov/gdo/hydro>.
- 76 CHIPS and Science Act, section 10833.
- 77 Infrastructure Investment and Jobs Act, sections 40209, 40313, and 40314.
- 78 Inflation Reduction Act, sections 13704 and 13102.
- 79 “Fuel Cells,” U.S. Department of Energy Office of Energy Efficiency and Renewable Energy website, <https://www.energy.gov/eere/fuelcells/fuel-cells>.
- 80 Infrastructure Investment and Jobs Act, sections 40342, 40209, 41004, 40303, 40304, 40305, 40308, 40314, and 80402.
- 81 Inflation Reduction Act, section 13702.
- 82 “What Is Carbon Capture and Storage?” National Grid website, <https://www.nationalgrid.com/stories/energy-explained/what-is-ccs-how-does-it-work>.
- 83 Infrastructure Investment and Jobs Act, sections 22101, 22425, 21201, 21202, 22105, 22106, 22303, 22304, 22307, 22413, and 30016.
- 84 “Passenger Trains vs. Freight Trains,” Freightera blog, Freightera website, <https://www.freightera.com/blog/passenger-trains-vs-freight-trains/>.
- 85 CHIPS and Science Act, section 10359.
- 86 Infrastructure Investment and Jobs Act, sections 40207, 402010, and 13502.
- 87 “U.S. Geological Survey Releases 2022 List of Critical Minerals,” U.S. Geological Survey website, <https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals>.
- 88 Infrastructure Investment and Jobs Act, sections 60102, 60401, 80401, 40107, and 41202.
- 89 Tom Simonite. “First Detailed First Detailed Public Map of U.S. Internet Backbone Could Make It Stronger.” *MIT Technology Review*, September 15, 2015, <https://www.technologyreview.com/2015/09/15/166239/first-detailed-public-map-of-us-internet-backbone-could-make-it-stronger/>.
- 90 Infrastructure Investment and Jobs Act, sections 40101, 40207, and 40209.
- 91 Inflation Reduction Act, sections 13702, 13502, 50122, 13302.
- 92 “How Lithium-ion Batteries Work,” U.S. Department of Energy website, <https://www.energy.gov/energysaver/articles/how-lithium-ion-batteries-work>.

For More Information

Howard Wial
Senior Vice President and
Director of Research
617.238.3043
hwial@icic.org

For more information about ICIC,
please visit www.icic.org.

