Issue Brief

Strengthening the U.S. Semiconductor Manufacturing Workforce

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Executive Summary

Purpose

Over the past decade, the United States has sought to rebuild a larger share of leading-edge domestic production capacity of semiconductors to reduce geographic concentration risk and improve supply chain resilience. However, fabrication facilities (fabs) cannot operate at scale without a steady pipeline of workers with specialized skills, experience, and readiness to work in high-reliability cleanroom environments.

This report focuses on the workforce required to expand and sustain U.S.-based semiconductor fabrication. It is intentionally scoped to front-end manufacturing, where process complexity, equipment intensity, and quality demands make talent constraints especially binding. This focus is motivated by the distinctive workforce profile of fabs: a mix of highly credentialed engineers and scientists, experienced tool and facilities technicians, and production-line roles where the bottleneck is often not formal education alone but job-specific competencies and retention in demanding working conditions.

Methods

To better understand policy issues surrounding the demand for skilled semiconductor workers, this report reviews existing literature produced by semiconductor industry groups, government agencies, academic journals, and news media. The Center for Security and Emerging Technology also hosted a roundtable discussion in May 2025 to ask industry stakeholders for their perspectives on issues raised in the literature review. Attendees represented a wide variety of stakeholders from the semiconductor industry, trade associations, and government agencies. Their comments provided a more current picture of the issues facing the workforce than was available in published literature from recent years.

The report also incorporates summary statistics for skills demands in semiconductor manufacturing from a set of recent U.S. job postings provided by Lightcast. To isolate this sample of job postings, we gathered a list of firms that operated foundries from the Semiconductor Industry Association and a list of semiconductor manufacturing occupations from the U.S. Bureau of Labor Statistics. We then developed a list of keywords that were related to each step of the production process, in order to exclude jobs that were unrelated to semiconductor manufacturing.

Findings

- Our analysis found 3,441 U.S. semiconductor manufacturing job postings in the observation period from January 2023 to April 2025.
- While job postings are concentrated among a few large employers, there are many manufacturers with smaller numbers of job postings. Thirty-one employers were represented in our sample.
- Job postings are concentrated in states where major employers are located, and these states are distributed across the United States. Forty-eight states and the District of Columbia are represented in our sample.
- Engineering and technician roles make up the most common occupations among the 85 separate O*NET occupations covered in job postings, reflecting a wide range of required education and training.
- Semiconductor manufacturing jobs require a mix of soft skills and technical skills, but certain skills like electronics manufacturing and micro manufacturing appear many times more often in our sample than in jobs overall.

Recommendations

Tailor workforce training to skills demands. Based on their frequency in postings, both industry-specific technical skills and soft skills that can be utilized across industries are in high demand. Formal degree programs in relevant fields and work experience programs such as registered apprenticeships should coordinate with employers to ensure that workers receive instruction in necessary skills.

Recruit skilled immigrants and underrepresented talent. One avenue for expanding the semiconductor workforce is through outreach to underrepresented groups, such as female, African American, and Hispanic workers. Establishing mentorship programs at colleges and employers can help retain these workers and advance their careers. Meanwhile, expanding immigration pathways would grow the number of foreign-born skilled workers that are eligible for these roles.

Invest in industry clusters for long-term growth. Building training facilities to offer hands-on experience with manufacturing equipment likely exceeds the budgets of most colleges. Instead, colleges should form partnerships with employers to provide adequate access to training facilities. Physically locating employers near sources of talent also facilitates transfers of knowledge, capital, and talent that pays dividends on long-term investments being made in training, equipment, and construction.

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Introduction

Semiconductors sit at the center of modern economic competitiveness and national security. They are the critical input for advanced computing, telecommunications, energy systems, and defense platforms, and disruptions in their supply can cascade quickly across downstream industries. Over the past decade, the United States has retained global strength in semiconductor research, design, and key segments of the manufacturing supply chain, but it has sought to rebuild a larger share of leading-edge domestic production capacity ("front-end" wafer fabrication) to reduce geographic concentration risk and improve resilience. The CHIPS and Science Act accelerated this shift by pairing industrial incentives with a broader agenda that includes research infrastructure and workforce development. Yet even if fabrication facilities (fabs) are financed and permitted, they cannot operate at scale without a steady pipeline of workers with specialized skills, experience, and readiness to work in high-reliability cleanroom environments.

This report focuses on the workforce required to expand and sustain U.S.-based semiconductor fabrication. It is intentionally scoped to front-end manufacturing where process complexity, equipment intensity, and quality demands make talent constraints especially binding. It does not attempt to cover the full semiconductor labor market (e.g., fabless design, EDA software, equipment, or the full spectrum of back-end assembly, test, and packaging). This focus is motivated by the scale of ongoing and planned investments in domestic fabrication capacity and by the distinctive workforce profile of fabs: a mix of highly credentialed engineers and scientists, experienced tool and facilities technicians, and production-line roles where the bottleneck is often not formal education alone but job-specific competencies and retention in demanding working conditions.

To answer questions about the demand for skilled semiconductor workers, this report reviews existing literature produced by semiconductor industry groups, government agencies, academic journals, and news media. The Center for Security and Emerging Technology also hosted a roundtable discussion in May 2025 to ask industry stakeholders for their perspectives on issues raised in the literature review. Attendees represented a wide variety of stakeholders from the semiconductor industry, trade associations, and government agencies. Their comments provided a more current picture of the issues facing the workforce than was available in published literature from even a few years prior. The report incorporates summary statistics for skills demands in semiconductor manufacturing from current job openings. The literature review and job posting statistics will set up future research on ways to expand the talent pipeline for workers entering the semiconductor industry.

Economic Impact and the CHIPS Act

With the passage of the CHIPS and Science Act of 2022 (CHIPS Act), the United States solidified its commitment to reshoring the fabrication of semiconductors. Microelectronic devices are the foundational technology of the modern digital economy, national security infrastructure, and future technological innovation, but COVID-related supply chain disruptions and other national security considerations brought the need for domestic control over critical chip production front and center.

Reshoring semiconductor manufacturing is not only helpful for supply chain security and economic competitiveness, but it is also a potential driver of economic growth that exceeds its direct employment figures. As of 2023, the United States accounted for only 12% of global activity in front-end fabrication,[1] down from around 37% in 1990.[2] Despite the decrease in market share, in 2023 semiconductor companies still employed 236,000 U.S. workers in either fabrication roles or roles creating the specialized machinery used in fabrication.[3] However, a more comprehensive measure of the industry's economic impact accounts for the number of jobs it creates in adjacent industries. For every individual directly employed in the U.S. semiconductor industry, an estimated additional 5.7 jobs are created across the broader economy. These jobs arise both within the industry's supply chain and from the spending power of semiconductor employees and their suppliers. In 2020, this translated to a total of over 1.85 million American jobs supported by the industry's activities.[4] This outsized impact underscores the industry's role not merely as a source of direct employment but also as a positive force in supporting a broad ecosystem of suppliers, service providers, and local economies.

The incentives contained within the CHIPS Act have brought in substantial investment and a commensurate increase in labor demand.[5] The legislation included $52.7 billion in direct government funding through grants, cooperative agreements, loans, and loan guarantees, and included a 25% manufacturing investment tax credit.[*] The tax credit was later increased to 35% in July 2025 through the One Big Beautiful Bill Act.[6] The government funding also served as a catalyst for private investment. Reflecting the scale of these incentives, companies across the semiconductor ecosystem have announced more than 140 new projects in the United States, totaling more than $640 billion in planned private investment across 30 states as of January 2026.[7]

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[*] $6 billion of the total funding can be allocated to support loans and loan guarantees up to a total of $75 billion in additional capital for covered entities, which is more money than the CHIPS Act directly appropriates. See https://www.nist.gov/system/files/documents/2022/09/13/CHIPS-for-America-Strategy%20%28Sept%206%2C%202022%29.pdf for more details.

Intel, one of the largest beneficiaries of CHIPS Act funding, is especially important to U.S. fabrication efforts because of its scale, domestic manufacturing base, and planned fab investments. As a result, it has received an unusual degree of federal support and attention, including billions of dollars in direct funding, tax credits, and federal loans, as well as an additional $8.9 billion federal equity investment announced in August 2025.[8] Backed by this federal support, Intel has pledged to build and expand fabs in Arizona, Ohio, New Mexico, and Oregon.

As previously noted, the U.S. semiconductor industry has a longstanding domestic presence in the fabrication space, including a sizable workforce and existing relationships with training providers, but the influx of investment is already straining their talent pipelines. In the short term, companies like TSMC and Intel that are constructing new fabs are struggling to find enough skilled construction labor. Major projects in Arizona and Ohio have reportedly faced delays and cost overruns directly attributable to a lack of skilled tradespeople, particularly electricians and pipefitters with experience in cleanroom environments.[9] The skilled construction workforce is not the subject of this report, but this construction labor shortage represents the first major test of the nation's ability to execute on the promise of the CHIPS Act.[*]

[*] The nature of this demand surge also creates a significant long-term policy challenge. The current wave of construction represents a massive, but ultimately temporary, "boom" in demand. Without a predictable, long-term pipeline of future construction projects, the specialized workforce being assembled and trained today is at risk of dispersing once the initial build-out is complete. This creates the potential for a "boom-bust" cycle, where future modernization or expansion projects would face the same costly labor shortages, undermining the long-term cost competitiveness that the CHIPS Act aims to foster.

Composition of the Semiconductor Workforce

To assess the in-demand skills for newly created semiconductor manufacturing jobs, which is a focus of recent legislation like the CHIPS Act, we analyzed a sample of relevant job postings within our set of U.S. job postings provided by Lightcast.[10] To isolate manufacturing jobs within the U.S. manufacturing industry, we employed a similar methodology to a recent NBER paper on the employment effects of the CHIPS Act.[11] We started with the Semiconductor Industry Association's ecosystem map that shows firms in each supply chain segment,[12] then sorted for firms that operated foundries making chips designed by other companies, or integrated device manufacturing (IDM) firms that produce their own chip designs. This yielded a list of firms that we could search for jobs postings in the Lightcast database.

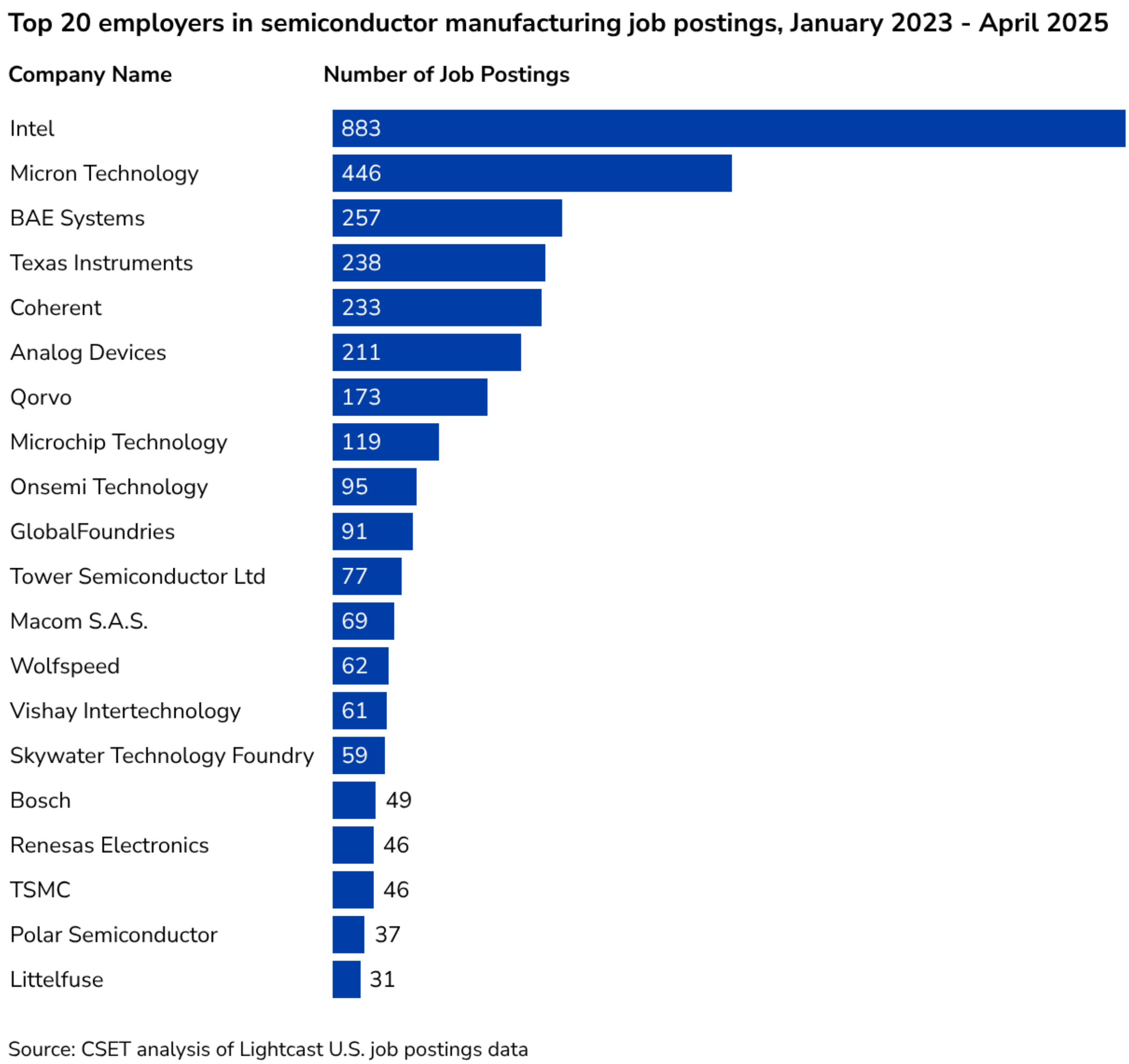
To isolate jobs related to production, we started with a list of production-related standard occupational classification (SOC) code categories from the Bureau of Labor Statistics list of occupations falling under NAICS 3344: Semiconductor and Other Electronic Component Manufacturing.[13] We then developed a list of keywords that were related to each step of the production process (see Appendix 1 for full list).[14] This step was important in order to exclude non-technical roles, technical roles not related to production, and production roles not related to semiconductors. Because many job postings also included a description of the employer, we also needed a way to search for relevant keywords in job descriptions only. We used an LLM-assisted procedure to clean job postings of extraneous information that confounded our ability to filter for relevant job postings.[*] This resulted in a corpus of 3,441 U.S. semiconductor manufacturing job postings from January 2023 to April 2025.

As seen in Figure 1, Intel leads the list of manufacturing jobs by employer during this time period, followed by other major manufacturers including Micron, BAE Systems, and Texas Instruments. While job openings are concentrated among a few large employers, there are many manufacturers with smaller numbers of job postings. TSMC and Samsung did not have many job postings that fit our criteria in the observation period, but they are expected to hire manufacturing positions as their U.S. operations ramp up.[15] The position of TSMC here also suggests that the number of available jobs at other employers may grow over time as fabs come online. The time it takes between

[*] The full text from a job posting often includes a general description of the hiring company, which interferes with keyword search. To extract the subset of text that describes hiring companies from the full "body" text of postings, we used zero- or few-shot prompting with a Gemini model, followed by validation of the generated text against the input. Then we removed the company description from the posting text.

initial investment in fabs and their eventual staffing makes it difficult to align training programs with anticipated demand.

Figure 1: Semiconductor Employers



While new fabs are under construction, the domestic semiconductor industry's main concern is staffing current fabrication facilities while preparing to fill positions in new fabs as they come online. Labor availability, labor cost, and labor quality are three of the highest considerations for semiconductor firms when selecting a location for manufacturing.[16]

The technical workforce required at fabrication facilities can generally be broken down into two categories: scientists and engineers with four-year or advanced degrees (e.g., electrical, chemical, mechanical and process engineers, material scientists, computer scientists) and technicians and operators with less than a four-year degree (e.g., industrial operations specialists, engineering technicians, equipment operators).[17] The distinction between the two segments is fundamental, as each possesses a unique occupational structure, educational profile, and set of talent pipeline challenges.

At the fabrication stage, scientists and engineers with four-year degrees or higher play a central role in making advanced chips possible. While operators and technicians maintain and operate the production line, engineers and scientists design, refine, and troubleshoot the complex steps that turn silicon wafers into advanced microchips. For example, process engineers develop and improve the steps that ensure chips are manufactured consistently and with minimal defects. Another role requiring an advanced degree is a material scientist; many improvements to fabrication processes require making use of new materials or adjusting use of existing materials, such as in transistor miniaturization or new transistor designs. Scientists and engineers make up 39% of the overall domestic fabrication workforce, and producing cutting-edge microchips would not be possible without them.[18]

Our analysis of job postings broken down by O*NET code in Figure 2 reflects a mix of educational and training requirements, from a high school diploma up to advanced degrees.[19] The largest category of manufacturing jobs is engineers, followed by technicians and software developer roles. The technician roles in the middle of the list require less than a four-year college degree, and several employers and community colleges have created training programs targeted at these technician roles. Engineering roles and software developers typically require at least a bachelor's degree. Engineering roles in some specialties may require advanced degrees up to a PhD.

Figure 2: Job Posting O*NET Codes

Top 10 O*NET codes among semiconductor manufacturing job postings, January 2023 - April 2025

O*NET Code	O*NET Occupation	Number of postings
17-2041.00	Chemical Engineers	501
17-2141.00	Mechanical Engineers	321
17-2112.03	Manufacturing Engineers	303
17-2061.00	Computer Hardware Engineers	244
51-9199.00	Production Workers, All Other	208
51-9141.00	Semiconductor Processing Technicians	184
17-2112.00	Industrial Engineers	150
17-3026.00	Industrial Engineering Technologists and Technicians	140
15-1252.00	Software Developers	111
17-2112.02	Validation Engineers	100

Source: CSET analysis of Lightcast U.S. job postings data

When firms hire talent without experience specific to the industry to fill open roles, there is also a lag between the point of hiring and when the new worker becomes fully productive. Industry respondents to a 2023 Bureau of Industry and Security (BIS) survey reported that engineers without prior semiconductor experience typically require one to two years of additional specialized training.[20] The cost of this additional training can be prohibitive for companies thinking of hiring candidates without specific experience to the role.

Figure 3 shows which specialized skills should be offered in training programs, using location quotients. A location quotient (LQ) is a ratio that compares how often a skill appears in one set of job postings to how often it appears in a broader benchmark. Here, we calculated the share of semiconductor manufacturing postings that mention a given skill and divided it by the share of all postings in the Lightcast database that mention that skill. An LQ of 1.0 means the skill appeared at the same rate as in the broader U.S. labor market; an LQ of 3.0 means it showed up three times more often.

Among the skill subcategories in our sample of job postings, Electronics Manufacturing has an LQ of 562 and Micro Manufacturing has an LQ of 429—both appearing hundreds of times more often compared to all job postings. LQ tells a different story from skills frequency; for example, communication appears in many semiconductor postings but has a relatively low LQ because it's required almost everywhere. Skills with high LQs are the core competencies of semiconductor manufacturing: skills workers are unlikely to pick up elsewhere, and that training programs need to teach explicitly.

Figure 3: Top Skills by Location Quotients

Top 10 skill subcategories in semiconductor manufacturing job postings by location quotient, January 2023 - April 2025

Top Skill Subcategories, by Location Quotients
Electronics Manufacturing
Micro Manufacturing
Hardware Description Languages (HDL)
Circuitry
Chemical and Biomedical Engineering
Physics
Optical Engineering
Simulation and Simulation Software
Materials Science and Engineering
Electronics Engineering

Source: CSET analysis of Lightcast U.S. job postings data

Projected Shortages and Reliance on Foreign Talent

Through the years, companies have relied heavily upon foreign nationals to meet their demand for scientists and engineers. International students accounted for six in ten advanced degree graduates in semiconductor-related engineering and computer science disciplines in 2024, supplying a majority of the country's most technically skilled workers.[21] As fewer U.S. citizens pursue graduate-level STEM degrees in relevant academic fields, semiconductor firms increasingly rely on foreign nationals to fill these roles through programs such as the H-1B visa.[22] Reflecting this dependence, CSET estimates from 2022 indicated that 22 percent of engineers and software developers, 11 percent of low-skilled technical workers, and 9 percent of managers employed in the semiconductor industry were non-U.S. citizens.[23]

The other primary group of workers are the technicians that are responsible for installing, maintaining, calibrating, and repairing the highly sophisticated manufacturing equipment that constitutes the bulk of a fab's capital investment. Workers in this category are almost exclusively sourced from local labor pools near fabs, and semiconductor firms and industry associations have longstanding relationships with training providers like local community colleges.[24] Nearly half of all foundry jobs fall within this category, and 82% of those required no more than a high school diploma as of 2022. In fact, it's estimated that approximately one-third of all positions at fabs require no more than a high school diploma or an associate's degree.[25]

As of 2023, the semiconductor industry employed about 345,000 workers but was already facing labor shortages in key roles.[26] In 2022—the same year that CHIPS Act funds were appropriated by Congress—5% of engineering positions were unfilled, and it is estimated that the semiconductor manufacturing industry was understaffed by around 13,000 workers, with the largest gaps in engineering (7,000) and technicians and trades workers (4,000).[27] The aforementioned CHIPS investment is only projected to exacerbate these issues. Depending on the source, future workforce needs are expected to grow by between 70,000 and 120,000 jobs by 2032.[*]

While steps should be taken to increase talent pipelines for technician roles, workshop participants noted that they are less concerned by the technician shortage than they are by the shortage of advanced degree holders due to immigration restrictions. Firms can expand technician training through targeted investments in vocational and community college programs, but advanced R&D roles depend on a much smaller and

[*] Estimates of future workforce need vary from 115,000 new jobs by 2030 (SIA) to 120,000 by 2032 (NSER) to 70,000 by 2032 (BIS).

slower-developing talent base. Creating more domestic PhD-level engineers and scientists is critical but will take sustained funding and years of pipeline development.[28] In the meantime, semiconductor companies continue to identify foreign nationals as the only short-term solution to fill essential research and process-engineering positions.[29]

Industry participants stressed that the problem is longstanding. Semiconductor industry advocates testified in front of Congress to reform high-skill immigration policies as early as 1999, citing the same workforce shortages that persist today.[30] Successive analyses, including CSET's 2022 report on semiconductor reshoring, have echoed those warnings, arguing that restrictive visa policies remain one of the largest structural barriers to domestic capacity growth. Yet despite bipartisan recognition of the issue, reforms have been piecemeal, leaving companies to navigate uncertain and backlogged systems.

As global competition for advanced STEM talent intensifies, the United States now finds itself at a disadvantage. Countries like Canada, the United Kingdom, and Singapore are streamlining visa processes to attract semiconductor professionals, while U.S. policy ambiguity risks deterring international graduates of American universities. Workshop participants noted that such a policy chill could erode the attractiveness of U.S. research institutions and delay the industry's ability to meet the skilled-labor needs created by CHIPS Act investments.

Semiconductor Workforce Pipeline and Pathways

Community and Technical Colleges

Community colleges are the primary institutional vehicle for training technicians who require less than a four-year degree, and they have long served as core training hubs for semiconductor manufacturing. Decades of NSF Advanced Technological Education (ATE) investments and regional employer partnerships have reinforced their role as a primary on-ramp into fab technician careers.

Since the passage of the CHIPS Act, community colleges across the country have stepped up to provide training for the new workers needed at domestic fabrication plants. More than fifty community colleges have announced new or expanded programming for semiconductor training, with programs ranging from ten-day bootcamps to full Associate of Applied Science degrees.[31] They also frequently provide the required classroom instruction of registered apprenticeship programs described in the next section.

On one end of the spectrum is the Semiconductor Technician Quick Start program created at Maricopa County Community Colleges in partnership with Intel and TSMC. It is an inexpensive, ten-day, forty-hour program that covers the basics of cleanroom protocol, safety standards, and basic tooling.[32] The other end of the program spectrum are associate's degree programs tailored to the semiconductor industry, but many of these programs have also built shorter-term credentials into their program structure. For example, Austin Community College has an associate's degree program in advanced manufacturing that features a sequence of four stackable credentials. These credentials each range from four to twelve credits, or about one to four months of coursework.[33]

Short-term programs can be a fast, low-cost way to provide training quickly when companies have immediate hiring needs. They are an efficient avenue for teaching key concepts and they also lower barriers for adult learners. However, their speed and affordability are only benefits for program participants if there are jobs available post-completion, and the impacts on long-term career prospects are uncertain. The Quick Start program in Arizona is a good example of both sides: The program had high demand and over 900 completions, including substantial participation from people of color and first-generation students, yet a sizable share of surveyed graduates reported they were still looking for work amid employer hiring slowdowns and limited communication about near-term demand.[34]

Longer programs are better suited to building durable, transferable skills, especially for technicians who will be expected to adapt to process and tool changes over time. Built-in, stackable credentials create onramps for the program, as well as clearer advancement pathways—both of which can help with continued upskilling and retention.[35] The benefits of a quality program are substantial, but as with most training efforts at community colleges, achieving success requires upfront and sustained investment, institutional capacity, a steady supply of qualified participants, and sufficient labor demand from the targeted industry.

Our analysis of skills frequency job postings in Figure 4 shows a mix of soft skills and technical skills appear most often in requirements for semiconductor manufacturing roles. Soft skills like critical thinking and problem solving, communication, and leadership appear in the largest numbers of job postings, and are more transferable between jobs, employers, and industries. Technical skills include a mix of electrical systems, engineering, and general science and research that are more specific to roles within semiconductor manufacturing and more likely to require specialized training. These findings are a useful reminder that training a high-tech manufacturing workforce should also emphasize soft skills as well as fundamental STEM skills.

Figure 4: Skill Categories in Semiconductor Job Postings

Top 10 skill subcategories in semiconductor manufacturing job postings, January 2023 - April 2025

Skill Subcategory Name	Skill Subcategory Frequency
Critical Thinking and Problem Solving	2,187
Communication	2,000
Initiative and Leadership	1,827
Electrical and Computer Engineering	1,780
Basic Electrical Systems	1,708
Personal Attributes	1,522
Quality Assurance and Control	1,336
General Science and Research	1,314
Process Engineering	1,305
Electronics Manufacturing	1,221

Source: Lightcast U.S. job postings data

Furthermore, community colleges face a number of challenges specific to semiconductor manufacturing training programs. These programs can be capital-intensive, requiring expensive specialized equipment that quickly becomes obsolete due to the rapid pace of technological advancement.[36] Beyond the physical infrastructure, colleges must overcome low public awareness of semiconductor careers and the deterrent of rigorous math and science prerequisites.[37] This is further complicated by administrative friction. Because new programs are often slow to receive official approval, colleges are frequently barred from enrolling students even as industry needs peak.[38] Even when colleges successfully recruit and train students, job availability is not guaranteed in a cyclical industry where timelines can slip and hiring can pause.

In addition to these specific challenges, community colleges also must contend with broader, systemic issues.[39] Operating under low and unpredictable funding levels, these institutions are often tasked with expansive mandates to support low-income and non-traditional learners without the requisite resources to provide deep, individualized wraparound services. This lack of fiscal stability contributes to chronic shortages in qualified faculty and staff, particularly in high-demand technical fields where private sector salaries far outpace academic pay. Students also face structural hurdles, such as significant credit loss upon transfer to four-year institutions and a lack of transparent data on long-term employment outcomes.

Ultimately, while community colleges are uniquely positioned to serve as the backbone of the semiconductor talent pipeline, their success depends on a delicate balance between rapid-response training and long-term technical depth. To fully realize the goals of the CHIPS Act, the sector must bridge the gap between volatile industry demand and the systemic funding and administrative hurdles that currently constrain institutional capacity.

Registered Apprenticeships

Semiconductor companies have also created apprenticeship programs to meet the demand for technicians at their domestic fabs. Registered apprenticeship programs are industry-driven, high-quality career pathways where employers can develop and prepare their future workforce. For companies, these programs offer a scalable method to recruit and retain talent with customized skills; for trainees, they provide a paid work experience, classroom instruction, and a portable, nationally recognized credential without the burden of student debt.[40]

In the United States, apprenticeships have traditionally been concentrated in construction and skilled trades.[41] Apprenticeable roles in these fields are comparable to semiconductor manufacturing technician roles in that they rely heavily on competency-based skills, strict safety protocols, and the practical application of technical knowledge, making them well-suited for registered apprenticeships.[42]

Recognizing the potential of apprenticeships, the U.S. Department of Labor (DOL) awarded grant funding to the National Institute for Industry and Career Advancement (NIICA), formerly known as National Institute for Innovation and Technology (NIIT), to expand their Registered Apprenticeships program. As of 2024, NIICA had helped to develop 85 apprenticeship programs across 17 states.[43] Previously the DOL also funded the Urban Institute to produce detailed occupational frameworks—including ones for semiconductor processing, electrical engineering, and mechanical engineering technicians—that assist employers in developing and registering apprenticeship programs.[44]

The semiconductor industry has taken advantage of these federal initiatives, as well as state and local funding, to create partnerships and apprenticeship programs in many states. In Arizona, TSMC has launched and expanded a multitrack registered apprenticeship system that trains equipment, process, facilities, and manufacturing technicians through partnerships with state universities, community colleges, and city workforce programs, with apprentices hired full-time and progressing toward stackable credentials.[45] Also in Arizona, Intel is piloting its first U.S. registered apprenticeship for facilities technicians, hiring apprentices as full-time employees from day one and delivering a one-year program that blends classroom learning with hands-on training in mechanical, electrical, vacuum, and chemical systems.[46] In California, the SEMI Foundation partnered with the California Apprenticeship Initiative (CAI) to create registered semiconductor industry apprenticeship for technicians at Foothill College, and Nokia, Applied Materials, and Western Digital have all graduated cohorts through this program.[47] Similar efforts are underway in Oregon, New Mexico, Ohio, and New York.[48]

Taken together, these efforts demonstrate that registered apprenticeships provide a mature, effective, and federally supported solution to the industry's workforce shortages. This federal commitment has continued to scale with the Department of Labor's January 2026 announcement of $145 million in funding for a new pay-for-performance incentive program aimed at rapidly expanding the national apprenticeship system.[49] Continued success for both employers and trainees will require sustained employer participation, adequate instructor capacity, and alignment between training providers and rapidly evolving fab technologies, but the foundational infrastructure, funding, and national policy support for apprenticeships position them as a durable solution for meeting the industry's long-term technician workforce needs.

Employee Retention

The industry's talent problems are not limited to training and recruitment; it also faces a significant retention challenge, often described as a "leaky talent pipeline". The historically cyclical nature of the semiconductor market has often led to procyclical hiring and layoff patterns, where companies ramp up hiring during market booms and implement workforce reductions during downturns.[50] This has cultivated a reputation for instability, making it difficult to retain talent for the long term, particularly when competing with the perceived stability of other tech sectors.

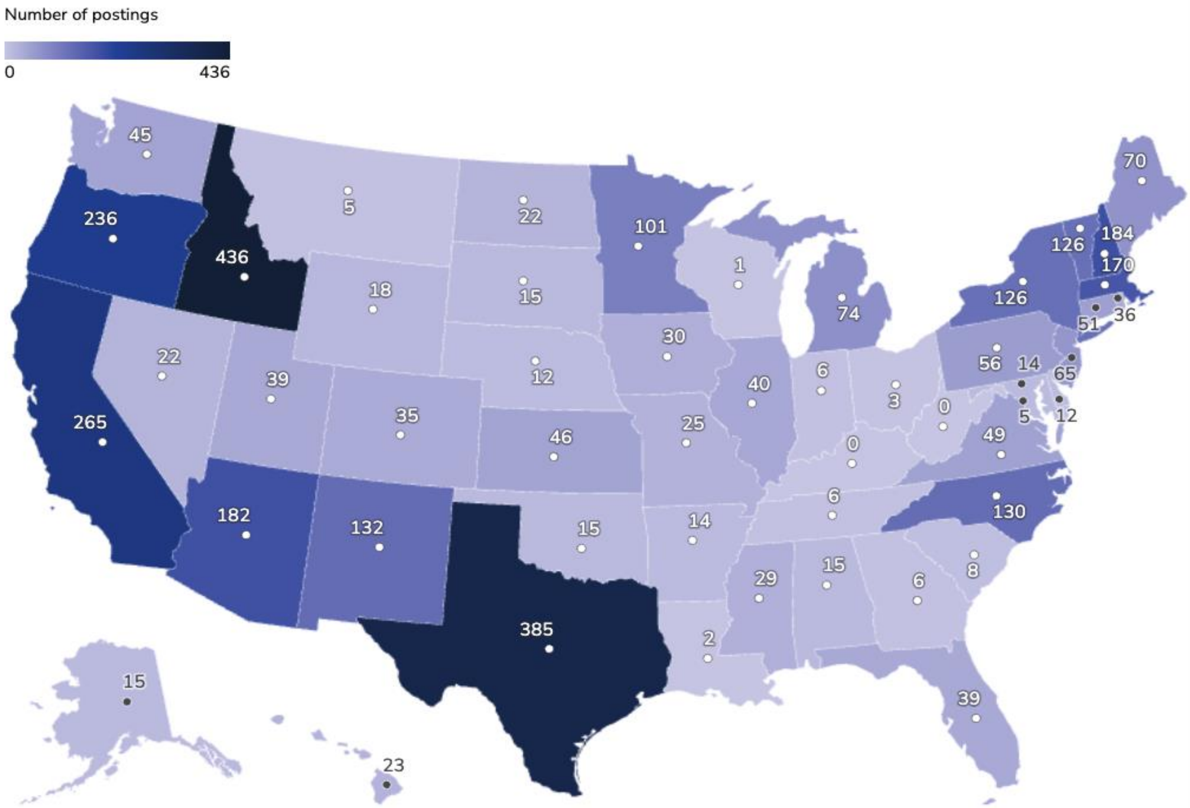
Internal company practices also contribute to attrition. Employees frequently cite a lack of clear and transparent career progression paths, particularly for technical experts who do not wish to move into management roles.[51] Compared to software and other tech industries, the semiconductor sector has been slower to adopt flexible work arrangements and often lags in overall employee satisfaction metrics.[52] These factors combine to make it difficult to retain the experienced workers who are most critical for training the next generation and driving innovation.

Geography of the Semiconductor Workforce

As previously noted, an important part of creating more semiconductor manufacturing jobs in the United States is siting fabrication plants and other facilities near sources of talent. Employers must find a community college, university, or other training provider, as well as policymakers that are willing to coordinate between stakeholders in industry, academia, and the community. Each group's contributions to these local and regional partnerships can lead to broader economic benefits.

By geography, many of the manufacturing jobs in the United States are concentrated along the West coast, Southwest, and Northeast, as shown in Figure 5. These regions have factories from some of the industry's largest employers, such as Texas Instruments, BAE Systems, and Intel. However, there are also pockets of manufacturing activity in the interior of the country: Micron in Idaho and Polar in Minnesota also represent large numbers of jobs. Potential job openings at announced fabrication facilities do not appear on this map, such as a planned factory from Intel in Ohio that would bring more manufacturing jobs to the Midwest. Figure 5 shows existing numbers of semiconductor manufacturing clusters that can be expanded by state, as well as where new industry clusters might be created to take advantage of local talent.

Figure 5: Semiconductor Manufacturing Job Postings by State, January 2023-April 2025



Source: Lightcast U.S. job postings data

Geography and Education

The geographic range of the job market for positions in the semiconductor field can vary widely depending on the educational requirements of a job. The job market for technicians requiring a two-year degree is more localized than that for engineers with four-year degrees.[53] Meanwhile, the prevalence of foreign graduates with advanced degrees in STEM fields means that employers must also compete globally for workers with master's and doctorates in these fields. To fill jobs at each level of educational attainment, employers and policymakers must consider the training programs available locally to produce the necessary talent, and the amenities to attract skilled workers from around the country or internationally. Just as the supply chain for semiconductors stretches across city, state, and national boundaries, so too do pipelines for talent.

Given the differences in education requirements for these roles, many types of training and education programs will need support to fully staff these roles. At the local level, K–12 education can help build the basic math and science skills needed for the semiconductor workforce, and also an awareness of these jobs.[54] Local training programs could consist of two-year degrees or other short-term programs that are specific to semiconductor technician roles, like the examples mentioned in the previous section on community college and technical programs. These schools can also offer programs in skilled trades, like electricians and HVAC technicians, that are needed to build and maintain fabs. At the state level, four-year universities can offer engineering degrees with coursework specific to semiconductor manufacturing. Finally, research universities that draw students from a region, nationally, or internationally can produce master's and doctoral students with graduate degrees that focus on semiconductor manufacturing.

Semiconductor Industry Clusters

To create ecosystems for supplying talent, the U.S. semiconductor industry could look to its past. Silicon Valley got its name from the chip manufacturers that spun off from Fairchild Semiconductor after its founding in 1957.[55] These companies could take advantage of research and graduates produced by nearby universities like Stanford.[56] Forming new industry clusters of employers located near universities can supply additional talent needed for semiconductor manufacturing. There is talent beyond Silicon Valley that can be leveraged to grow semiconductor manufacturing in the United States; the benefits of industry clusters need not be concentrated in one region.

In recent decades, other semiconductor clusters have followed Silicon Valley's example. Upstate New York features several manufacturers with facilities located along the I-90 corridor stretching from Buffalo to Albany, such as GlobalFoundries and Micron.[57] Colleges in the State University of New York system have developed associate's, bachelor's, and graduate degree programs specifically designed for semiconductor manufacturing.[58] Likewise, Phoenix has several chip manufacturers, notably Intel and TSMC, that have partnered with state colleges and universities to provide training facilities for students (see earlier section on community colleges).[59] Students who train in proximity to employers can more readily fill available jobs after they graduate.

Since the passage of the CHIPS and Science Act, Intel announced plans to build a new plant near Columbus, Ohio.[60] The midwestern state has historically been a manufacturing center, but not yet in semiconductors. Meanwhile, the state system of universities and community colleges ensures a steady flow of talent from graduates of programs created in partnership with Intel.[61] A location near the center of the state and its capital also allows for easier coordination with state policymakers and easier commuting for students from other parts of the state. Creating new clusters opens up additional labor markets for workers to join the semiconductor workforce.

One of the benefits of locating many employers in one area is to lower the cost of moving goods, workers, and ideas.[62] Workers with a choice of employers can command higher wages through competition, while employers can hire from a larger pool of prospective employees. More employers and jobs located in a given area also increases knowledge spillovers, as workers can share what they know through collaboration on the job and in informal settings.[63] Some might use their knowledge to start new companies, perpetuating the economic benefits of industry clusters.

Regional Partnerships for Semiconductor Jobs

Launching and growing new industry clusters can become a collective action problem if no stakeholders step up to organize the others. State and local governments often play a coordinating role in forming partnerships among industry and higher education that otherwise compete for limited sources of talent and funding. State and local policymakers can also encourage partnerships with public colleges and universities that enroll students seeking degrees in semiconductor fields, especially through providing funding to get programs started. Once initiated, these partnerships can be mutually beneficial for academic partners that find jobs for graduates, employers that find a source of talent for their work, and governments that expand their tax base.

In semiconductor manufacturing, partnerships are often necessary to provide access to training facilities for students. One major hurdle to training more workers is the cost of building training facilities. The production equipment used to make advanced semiconductors is prohibitively expensive for high schools, community colleges, and universities to afford on their own. The estimated cost to upgrade a university fabrication facility to 200mm is $80 million to start and an additional $80 million per year afterwards.[64] Instead, they will either have to partner with local employers that can provide access to the equipment, or form partnerships with other schools in their region to share this equipment as a consortium. Only one U.S. university, the State University of New York at Albany, currently has a leading-edge 300mm training facility.[65]

So far, we have seen both these models in the United States. In upstate New York, Hudson Valley Community College has built training facilities with support from the state government and GlobalFoundries. Intel has formed partnerships with Ohio's entire state university system to provide training for students that will one day staff their new factory near Columbus. In Phoenix, Arizona, several manufacturers have teamed up with local universities and community colleges to provide everything from 10-day bootcamps to two- and four-year degrees in semiconductor technology. Without this access to equipment for training, students and workers won't have the skills needed to operate them on the job.

Demographics of the Semiconductor Workforce

The demographics of the semiconductor workforce in 2022 were 53% white, 24% Asian, 5% Black, 13% Hispanic, and 4% other.[66] That year, women made up only 28% of the semiconductor workforce.[67] Several workshop participants spoke of framing outreach efforts to underrepresented groups as a "math problem," or casting a wider net to attract a greater number of employees. Meanwhile, semiconductor firms hire large numbers of foreign-born workers with technical skills. Each of these groups require targeted outreach for entering semiconductor jobs and specific needs for staying long-term. Sustaining and growing the semiconductor workforce requires retaining sources of talent already well represented and also reaching out to populations already present in the workforce but not yet working in semiconductor roles.

Underrepresented Groups

Barriers to women in STEM careers are well documented,[68] but removing them is critically important for the semiconductor industry to hire the talent it needs. One barrier is the lack of representation in leadership roles, which leads fewer women to apply for and remain in semiconductor jobs given a lack of career advancement.[69] Increasing representation in leadership roles could not only attract more applicants, but also retain more workers by drawing attention to priorities like flexible work schedules. Workshop participants identified increased mentorship opportunities as one potential solution to increasing the numbers of underrepresented groups. For example, more women in the field could start a virtuous cycle by generating more awareness of these jobs for students and graduates and acting as mentors for new hires.

Reaching underrepresented groups should also involve investment in training facilities and programs in areas where groups targeted for outreach are located. If employers want to reach underrepresented groups, they should partner with community colleges, technical schools, and minority-serving institutions where these groups make up a larger part of the student body. Providing wraparound services, such as childcare or transportation, may also be needed to overcome barriers to workforce participation. Transportation is particularly important for workers in areas without adequate public transportation that are far removed from semiconductor employers.

Veterans

One group where semiconductor manufacturers have had recruiting success is among military veterans. Military training offers a number of technical skills that are readily transferable to semiconductor manufacturing.[70] The distribution of military bases across the country also makes for easier recruiting of veterans, much in the same way that employers would recruit from local colleges. There are several state and federal workforce programs designed to help veterans transition to civilian careers, and these could be used to promote jobs in the semiconductor industry.[71] Furthermore, outreach to veterans could be used as a model for other groups that employers are trying to recruit. Employers should explore which other groups might have transferable technical skills that might not otherwise consider semiconductor jobs.

Citizenship Status

For the foreseeable future, making semiconductors in the United States will require foreign-born workers, which made up 33% of the semiconductor workforce in 2022.[72] This is especially true for jobs requiring advanced degrees: In some semiconductor-related disciplines like computer science and engineering, the majority of workers with PhDs are foreign-born.[73] While U.S. universities attract many international students (over 1 million in 2024),[74] the options for staying and working in the United States after graduation are time-limited. The F-1 optional practical training program allows students and graduates to work jobs related to their field of study, up to 36 months if their degree is in a STEM field.[75] Remaining in the country after that requires applying for another visa category.

Foreign workers with bachelor's degrees can also work in the United States on H-1B visas, which employers apply for to fill specialized jobs. These visas are limited to 85,000 each year, and are distributed to employers by lottery.[76] A new $100,000 fee for new visas[77] and a rule change to favor higher salaries in the lottery[78] may limit the number of employers applying for or the types of jobs that can be filled using H-1B visas. H1-Bs can be renewed for a period of up to six years, which can allow workers to apply for permanent residency with an employment-based green card.[79]

Employment-based green cards are capped by statute at 140,000 annually,[80] and are further limited by caps on the percentage of immigrants coming from any one country.[81] Immigrants from populous countries like India and China can spend decades waiting in their respective green card backlogs to clear. These barriers may discourage foreign graduates with semiconductor degrees from working in the United States, forcing them to take their talents elsewhere.

Citizenship status is critical for some semiconductor jobs with national security applications that require security clearances.[82] These roles will be limited to naturalized citizens or U.S.-born students with advanced STEM degrees. One workshop participant shared that graduate school was viewed as a pathway to citizenship for many foreign students, and without that incentive, few U.S. students in STEM disciplines feel the need to pursue advanced degrees. In addition to expanding pathways for foreign students to remain in the country, some consideration should be given to encouraging more U.S. students to pursue more advanced STEM degrees. This could entail higher funding for STEM advanced degree programs to lower the cost of pursuing advanced degrees.

Conclusion

The importance of training a skilled workforce is underscored by the critical role that semiconductors play as inputs in other industries from telecommunications to weapons systems. The boom in data center construction for running AI models promises to fuel demand for quite some time. By funding the construction of fabrication plants in the United States, the CHIPS and Science Act responded to earlier supply shortages, but also recognized the strategic importance of semiconductors for future uses. Satisfying demand for existing and future uses of semiconductors depends on training a workforce capable of taking on new jobs created at semiconductor fabs. To meet current and future workforce needs, we recommend the following policies:

Recommendation 1: Tailor Workforce Training to Skills Demands

The variety of skills, training needs, and locations for semiconductor manufacturing jobs shows how employers, workers, and policymakers can develop talent to fill these jobs. Based on their frequency in postings, specific technical skills are in high demand within the industry, as are soft skills that can be utilized across industries. Engineering and technician roles make up the most common occupations, reflecting a wide range of required education and training. Formal education such as two-year and four-year degree programs in relevant fields and work experience programs such as registered apprenticeships are both ways to pick up necessary skills. This report highlights several examples of degree and training programs that can serve as models for others.

Recommendation 2: Recruit Skilled Immigrants and Underrepresented Talent

Our literature review and conversations with experts point to several avenues for expanding the semiconductor workforce. One is through outreach to underrepresented groups, such as female, African American, and Hispanic workers, who may not have otherwise considered careers in the industry. Another is by establishing mentorship programs that help retain these workers and advance their careers. Meanwhile, the number of foreign-born workers in the U.S. semiconductor industry suggests that they will continue to be an important source of talent for the foreseeable future. Immigration reforms could expand the number of skilled workers that are eligible for these roles. Strong pipelines for global and domestic talent would allow both groups to join the semiconductor workforce in sufficient numbers.

Recommendation 3: Invest in Industry Clusters for Long-Term Growth

Training a skilled workforce and building new fabrication plants both require significant investments of time and money from employers and colleges. Building training facilities to offer hands-on experience with manufacturing equipment likely exceeds the budgets of most colleges and training providers. Instead, colleges will need to form partnerships within larger systems of higher education or with employers to provide adequate access to training facilities. Besides training, physically locating employers near each other and near sources of talent facilitates transfers of knowledge, capital, and talent that encourages new business formation. The resulting growth from these industry clusters can pay off the long-term investments being made in training and construction.

Appendix: Keywords for Semiconductor Manufacturing Jobs

Assembly
Deposition
Doping
Electromechanical
Etching
Integrated Circuit
Ion Implantation
Manufacturing
Masking
Mechatronics
Metrology
Microelectronics
Packaging
Photolithography
Photoresist
Processing
Production
Semiconductor Fab/Fabrication

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[82] Martin and Rosso, "Chipping Away."