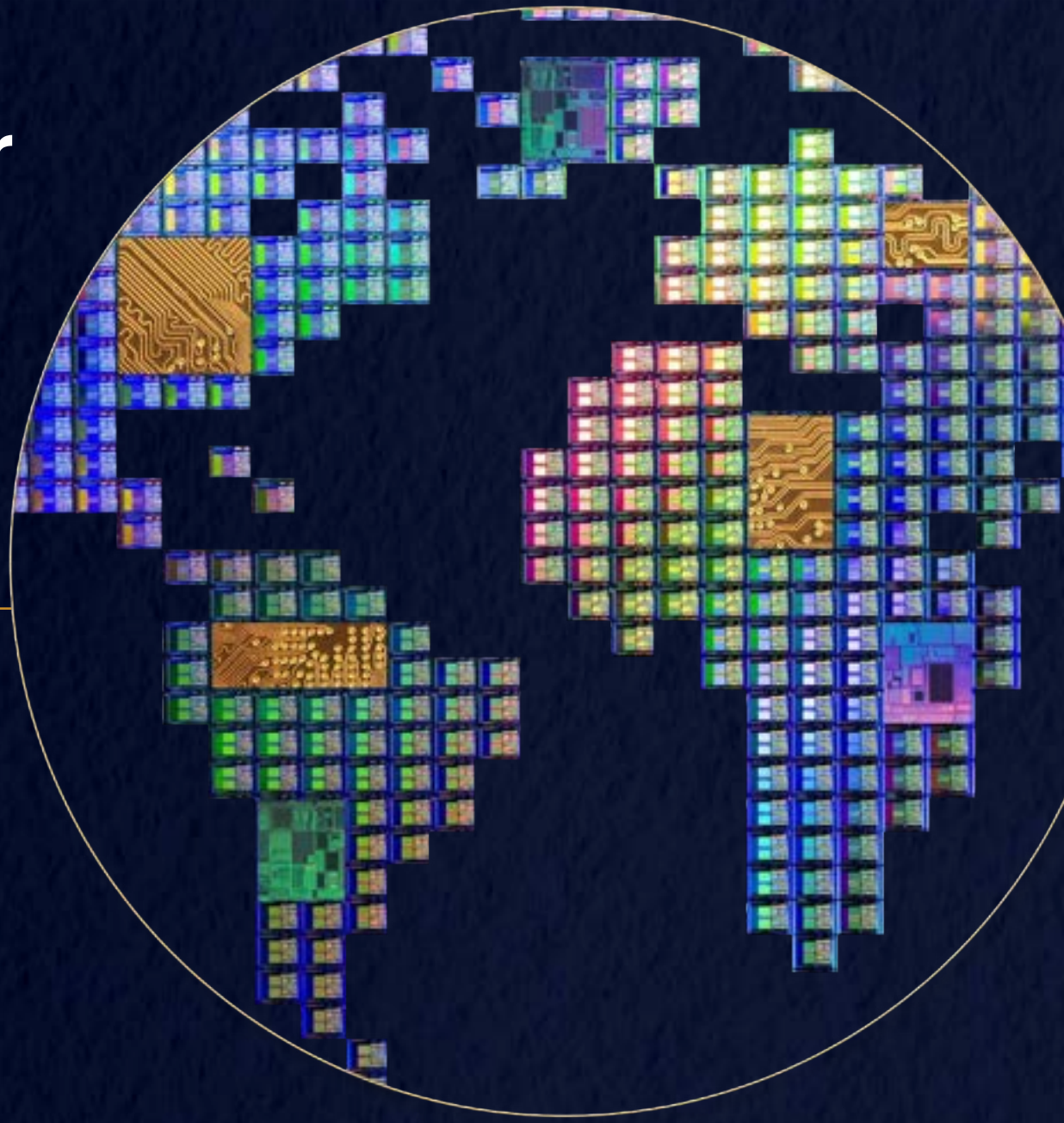
Rebuilding Our Semiconductor Workforce

Making the Most of the CHIPS Act



Lightcast

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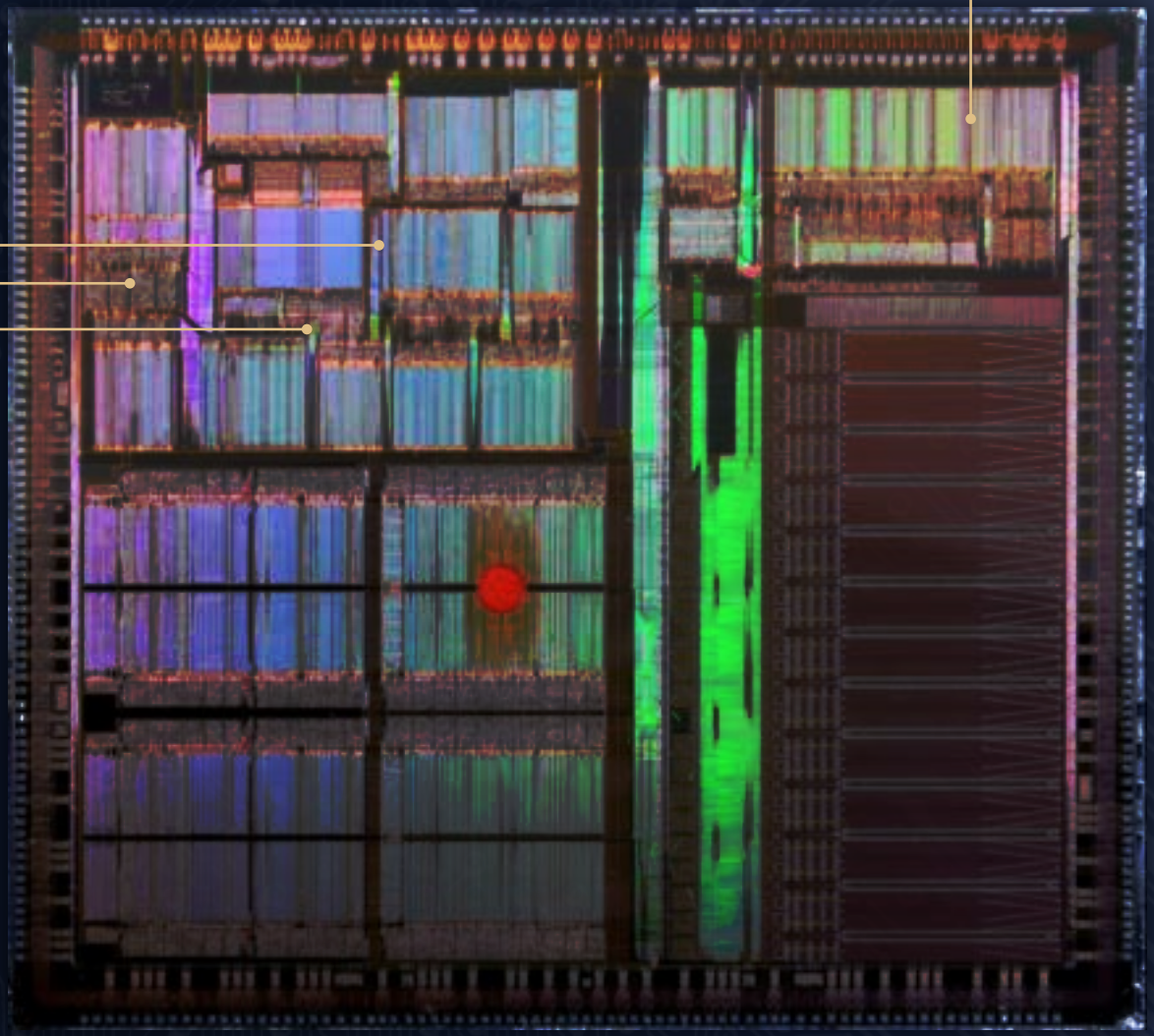

by

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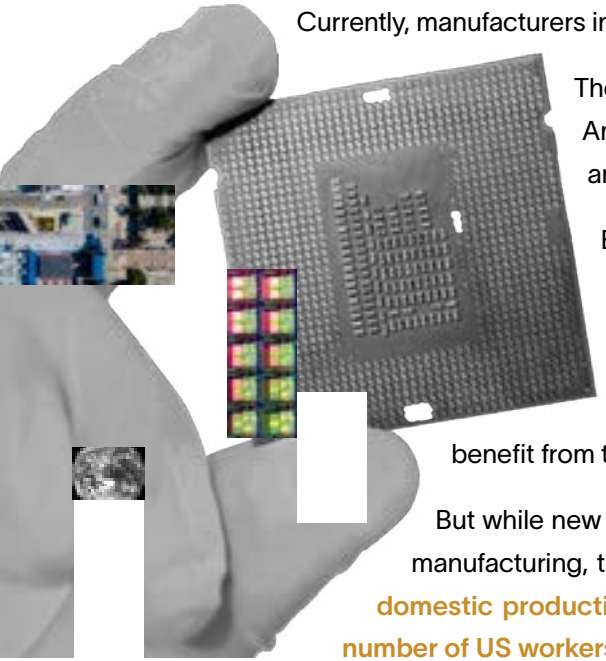
Introduction

THE UNITED STATES IS PREPARING to launch into a new era of resurgent semiconductor manufacturing.

SEMICONDUCTORS ARE CRITICAL TO THE MODERN WORLD. Silicon chips make computers possible, which means they are essential to everything from cars and aircrafts to phones and high-tech weaponry. Semiconductors were invented in the US, but for decades, the American share of semiconductor manufacturing has been in slow decline. From a 37% global share in 1990, we're down to just 12% today, even as greater need for computer chips has led to increasingly high demand for semiconductors. Currently, manufacturers in East Asia supply about 75% of the world's semiconductors.



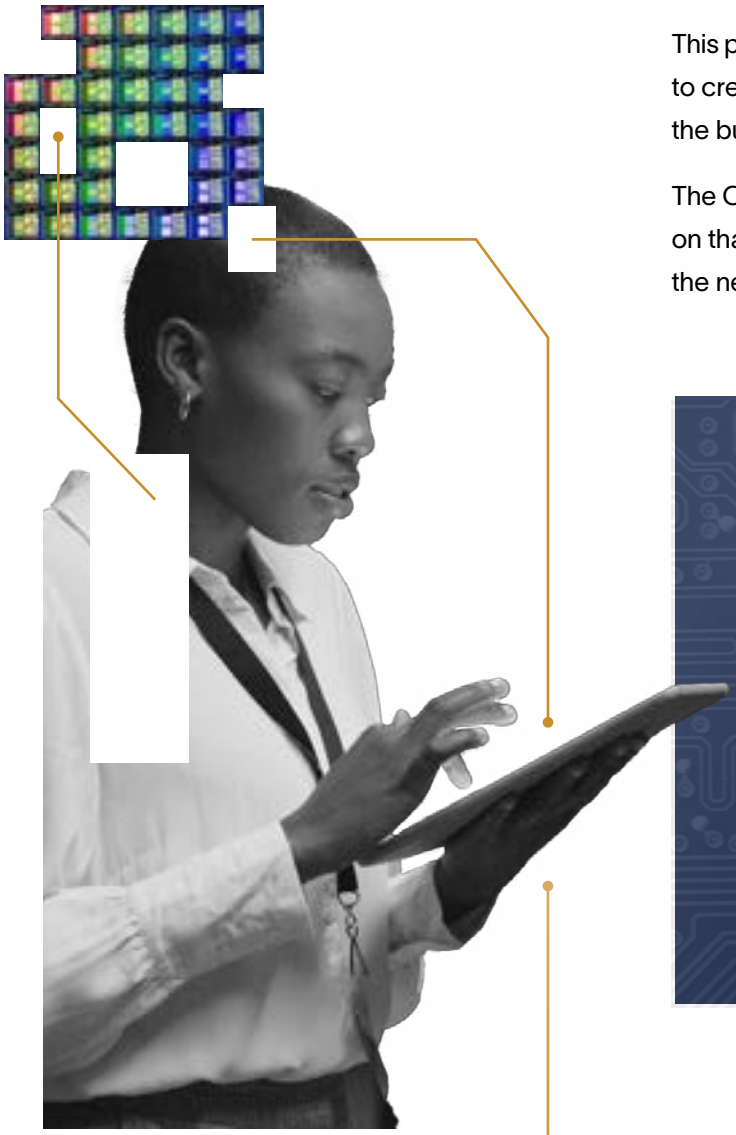
The CHIPS Act, passed in August 2022, sets aside $52.7 billion for American semiconductor research, development, manufacturing, and associated workforce development.

Building up the domestic semiconductor industry is both an economic and a national security issue. Creating these components in the US reduces vulnerability to disruptions in the global supply chain, ensures that US-made products have ready access to the critical components, and enables domestic workers to benefit from the increasing domestic and global demand.

But while new facilities and research are vital for kickstarting a new boom in manufacturing, they are insufficient on their own. **A dramatic increase in the domestic production of semiconductors requires a dramatic increase in the number of US workers producing them.**

WHAT ARE SEMICONDUCTORS?

Most materials either conduct electricity ("conductors") or don't ("resistors"). Semiconductors, such as silicon, fall somewhere in between, and this makes them incredibly useful for building computers and other electronic devices. In discussing semiconductor manufacturing, we're referring to the production of computer chips and similar technological components.



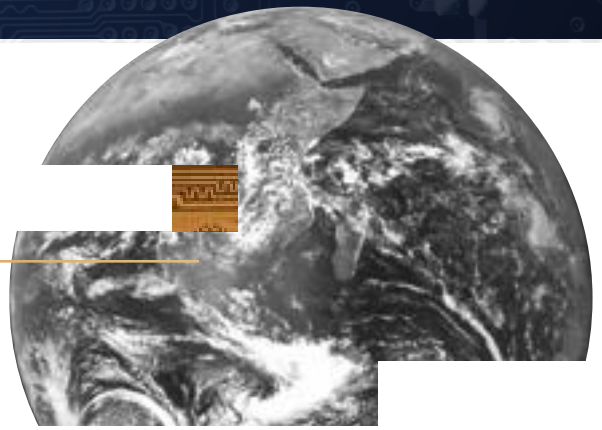
This presents a challenge. In 2022, demographic trends and a complex economic environment combined to create the tightest job market in history, and the impact of that tightness is still being felt throughout the business world. In other words: **we don't have the workers to spare.**

The CHIPS Act represents an immense investment in US manufacturing and technology, but the return on that investment depends on whether enough workers with sufficient skills can be deployed to meet the need and capitalize on the opportunity.

A ROLE AND A BENEFIT FOR EVERY SECTOR

Developing this workforce must be a group effort, and everyone stands to gain by creating a workforce prepared for semiconductor manufacturing:

- **EDUCATION INSTITUTIONS** can teach students the skills needed to work in the semiconductor industry.
- **BUSINESSES** can look beyond their traditional talent pools to fill these new roles.
- **LOCAL LEADERS** can create an environment that attracts new semiconductor investments in their communities.



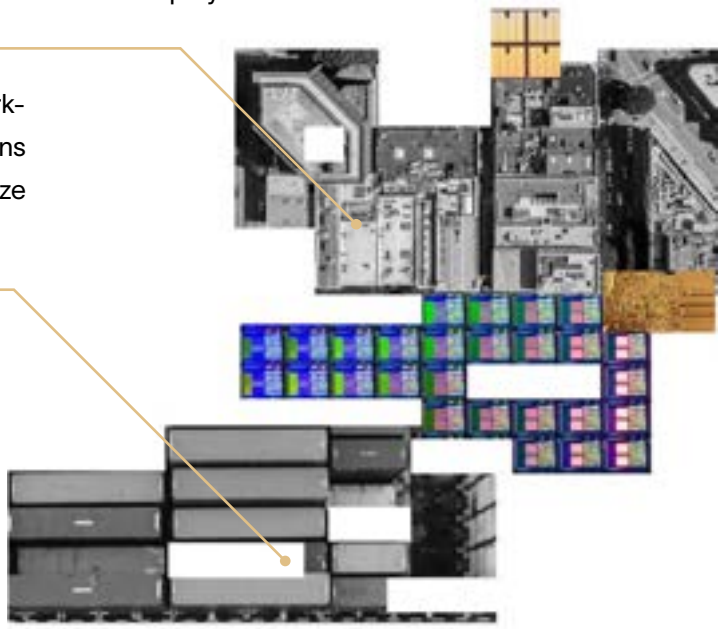
Takeaways

The CHIPS Act presents an opportunity the nation cannot afford to waste. To understand the need, and how to meet it, we need to address four key themes.

1 **UNDERSTANDING THE DEMAND:** to double American semiconductor production, over 230,000 new workers will need to be employed in the industry.

2 **MEETING THE NEED:** in a challenging labor market, semiconductor employers will need to be creative and deliberate in filling these roles. To find the necessary talent, some workers will need to be re-skilled while others will need to be redeployed.

3 **FINDING A PLACE:** we identify the top 10 metro areas with workforces most ready for semiconductor production, to help regions best position themselves for CHIPS Act investment. We also analyze the pool of available diverse workers.



4 **LOOKING AHEAD:** our data show what trends are coming in the future of work in the semiconductor industry, including skills related to AI, data visualization, as well as logistics. In this fast-changing environment, workers, businesses, educators, and communities need to continuously adapt in order to ensure their work stays relevant and future-ready.

Understanding the demand

How many workers will be needed in the semiconductor industry?

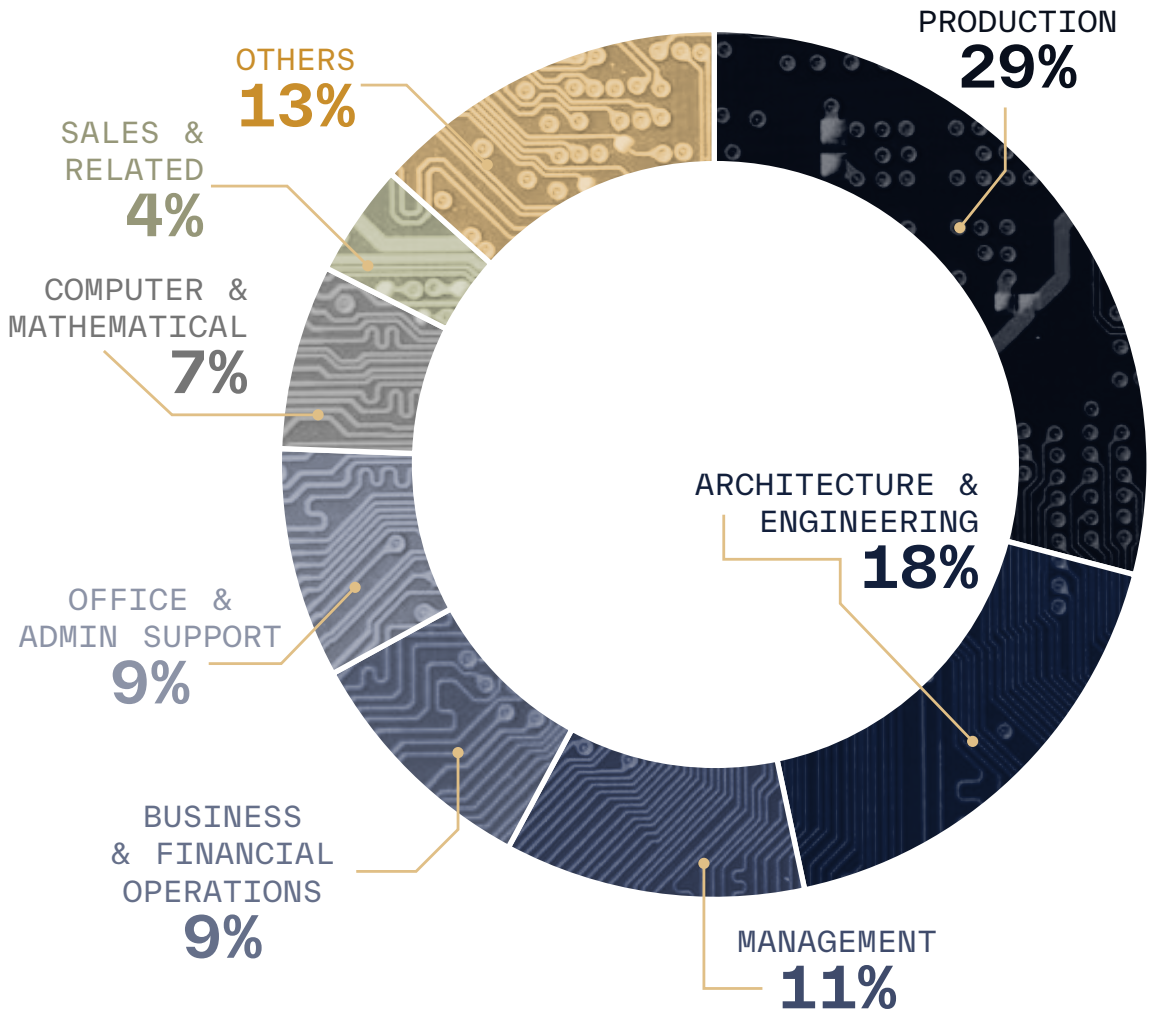
THE SHORT ANSWER:
236,878.

This calculation represents the number of workers needed to double the US share of global semiconductor manufacturing. To be clear, no specific target is stipulated in the CHIPS Act—but we think this is a reasonable one. Moving from 12% of all global production to 24% would be a huge step forward and would dramatically mitigate the vulnerabilities in production, access and security that currently mark semiconductor manufacturing. Significantly, it's also in line with the $52.7 billion investment.

Doubling the US share of global semiconductor production requires more than just production workers. The graph below shows the distribution of those jobs by type of work. The largest shares would be in Production (29%), Architecture and Engineering (18%) and Management (11%).

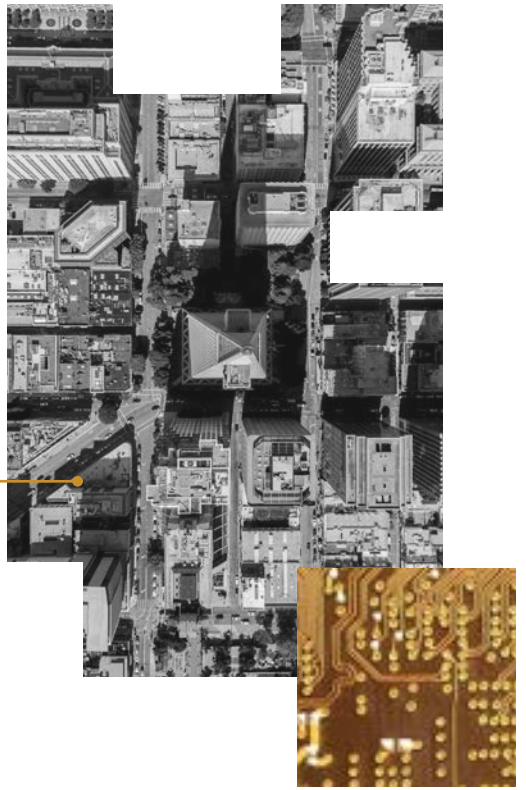
All of these jobs can be considered "semiconductor jobs" because they are all necessary to produce semiconductors, even if they are not all directly involved with manufacturing. Our model determines the proportion of

New Labor Demand by SOC Major Groups



these direct and indirect jobs created based on current employment in the semiconductor industry in the United States.[1] "Direct jobs" includes those working at a manufacturing plant itself, and "indirect jobs" includes those working at suppliers for those plants. Jobs serving lunch at a new restaurant just outside a semiconductor factory, important as they would be, aren't included in this calculation.

These results come from the Lightcast Input-Output Model, which represents the flow of money in an economy, primarily looking at the connection between industries. It can estimate the jobs that will be created by an influx of money in a particular industry or group of industries (semiconductors, in this case). This peer-reviewed model has been used in over 2,200 economic impact studies.[2]

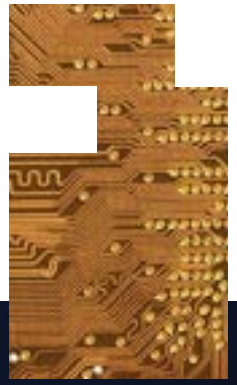


1 Oxford Economics and the Semiconductor Industry Association, in their own assessment of the worker need from the CHIPS Act, estimated an initial need of 185,000 jobs in semiconductor manufacturing. **https://www.semiconductors.org/chipping-in-sia-jobs-report/**

2 **https://lightcast.io/resources/blog/2021-in-review**

Meeting the need

Given the gap between overall need and the current labor supply, what are the most pressing demands in the workforce, and how can they be met?



IN IDENTIFYING THE WORKFORCE NEEDS the semiconductor industry will need to address, we distinguish between two types of undersupplied occupations: **"Reskill"** and **"Redeploy."**

METHODOLOGY

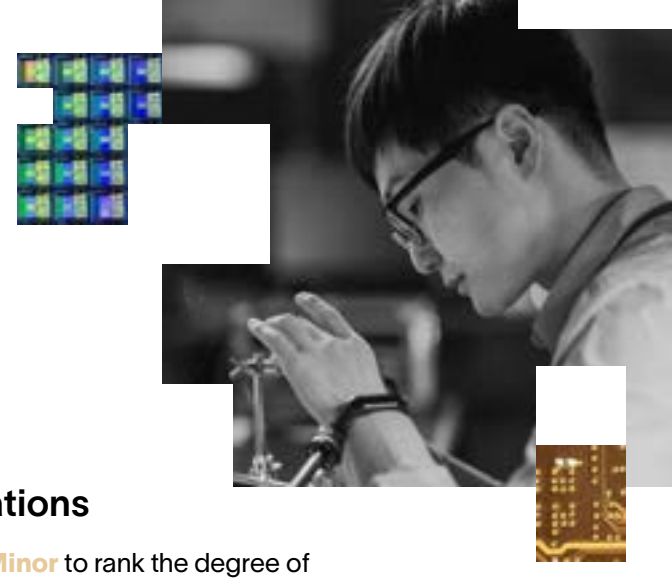
The Lightcast Input-Output Model showed that over 230,000 new jobs need to be filled in order to meet the goal of doubling the American share of global semiconductor production, and also broke out that demand by occupation. To understand what types of occupations would experience the greatest demand, we compared the projected need to the projected supply of new workers into those occupations.

Lightcast job posting data comes from more than 50,000 online sources every day, which together represent the current demand for skills in the labor market and also illuminate trends that show which skills will be needed in the future. The wide-ranging view allows for a much more granular analysis and more accurate forecasting than more general data from government sources or others.

We can estimate the current new annual supply into semiconductor occupations using graduates and workers who return to the labor force in the next 3-5 years. By comparing new supply with new demand, we can calculate which occupations will experience the largest gap between the two, and therefore be undersupplied and suffer a labor shortage.

We are not including those who change jobs in our supply calculations, because we assume that people will continue changing jobs at the same rate unless a targeted effort is made to change that rate.

Reskill Occupations



Reskill occupations are those that are undersupplied across the entire labor market. This means that the United States doesn't have enough workers to fill the openings we have now, and certainly not enough to meet additional demand that new semiconductor production will create.

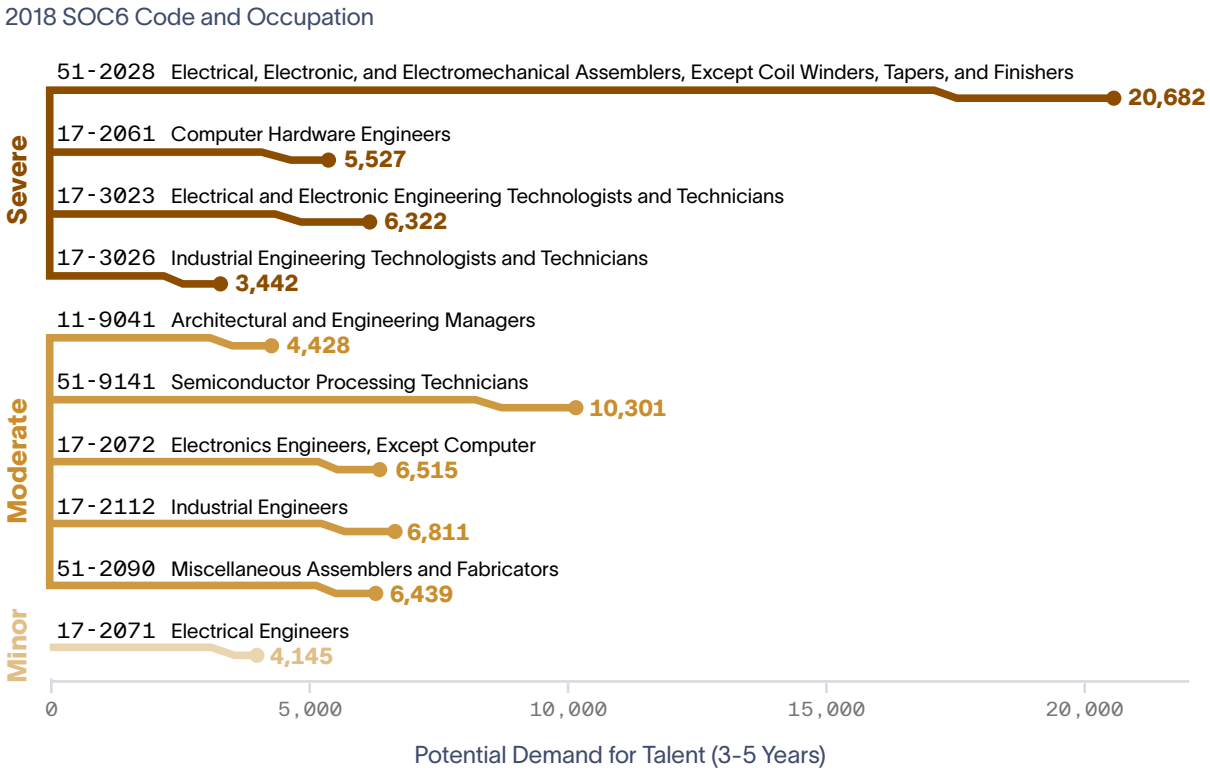
In the long term, building a more robust training pipeline is the solution, and the education system can fill this gap with new graduates. In the meantime, the good news is many of these jobs can be filled by workers at jobs with similar skill profiles, therefore requiring less training than starting from scratch. This is both faster and cheaper than other options. In addition, this makes reskill occupations good primary targets for semiconductor employers and short-term training providers.

The most undersupplied reskill occupations include mostly technical roles at both the engineer and technician levels, including Electrical, Electronic and Electromechanical Assemblers (20,682 additional workers needed in semiconductor manufacturing in the next 3-5 years), Computer Hardware Engineers (5,527), Semiconductor Processing Technicians (10,301) and Industrial Engineers (6,811).

Variations in the anticipated supply of workers helps determine which occupations will be most undersupplied—so even though the potential demand might be smaller for a certain occupation, a lower number of workers expected to fill those roles can still pose a significant challenge. We use the categories of Severe, Moderate and Minor to rank the degree of undersupply.

Top Undersupplied Reskill Occupations

We use the categories of **Severe**, **Moderate**, and **Minor** to rank the degree of undersupply in reskill occupations.[3]



3 An occupation that has a Severe undersupply has a demand that is at least **4 times** greater than the new supply. A Moderate undersupply means that an occupation's new demand is **between 2 and 4 times** greater than the new supply. And a Minor undersupply means that the new demand is **less than 2 times** as great as the new supply.

SOLVING THE UNDERSUPPLY

The fastest and most efficient route to a properly-skilled workforce in these occupations is to draw on workers with similar skills. By building on the skills of current workers and adding the specific skills needed for semiconductors, the industry can quickly get people up to speed and into the jobs that need to be filled. This is known as "reskilling."

For example, the occupation of Calibration Technologist and Technician requires a strong understanding of electronics and the ability to work with a variety of electronic equipment and tools. The semiconductor-affiliated occupation of Electric and Electronic Engineering Technologist and Technician requires all those skills and more, typically requiring additional skills related to electronics and design. Relatively few Calibration Technicians are needed in the semiconductor industry, while demand is much greater and supply is much lower for Electronic Engineering Technologists.

Calibration Technologists and Technicians are well-positioned to be reskilled into becoming Electric and Electronic Engineering Technologists and Technicians. As Calibration Technologists and Technicians, they already possess skills in electronics, maintenance, and instrumentation that are also critical to Electrical and Electronic Engineering Technologists and Technicians. All they need is a little more training in skills like electrical wiring, soldering, and operating programmable logic controllers.

A semiconductor manufacturer in need of Electronic Engineering Technicians doesn't need to look for workers that have all the necessary skills already—instead, they can look for workers, like Calibration Technologists, that already meet many of the requirements, and train them in the last few needed.

Reskilling can be accomplished through various means, such as on-the-job training, in-house training programs, or external lab or classroom professional development courses. But for the process to be successful, it's important to identify the specific skills that are needed for a particular occupation and then determine which workers have those skills, or have the potential to acquire them through additional learning experiences.

So while soldering and operating programmable logic controllers are useful for Calibration Technologists who are transitioning to Electric and Electronic Engineering Technologist and Technicians, teaching everyone at the company how to solder would be wasteful and inefficient.

Beyond just expanding talent pipelines, reskilling has the additional advantage of potentially leading the semiconductor industry to become more diverse. For example, there's substantial skill overlap between the semiconductor-affiliated occupations of Packaging and Filling Machine Operators and Tenders and that of Inspectors, Testers, Sorters, Samplers, and Weighers. In the first job, 62% of all workers come from minority backgrounds, while in the next, 32% do, and the average annual salary is over $12,000 greater. **Increased mobility between the two would help diversify the higher-level occupation while also improving workforce equity and opening new doors for minority workers.**

Redeploy Occupations

Redeploy Occupations are roles where there may be enough trained workers in the broader economy but not enough workers going into the semiconductor industry specifically. Workers in these roles have the necessary skills to work in the semiconductor industry, they just need to be recruited.

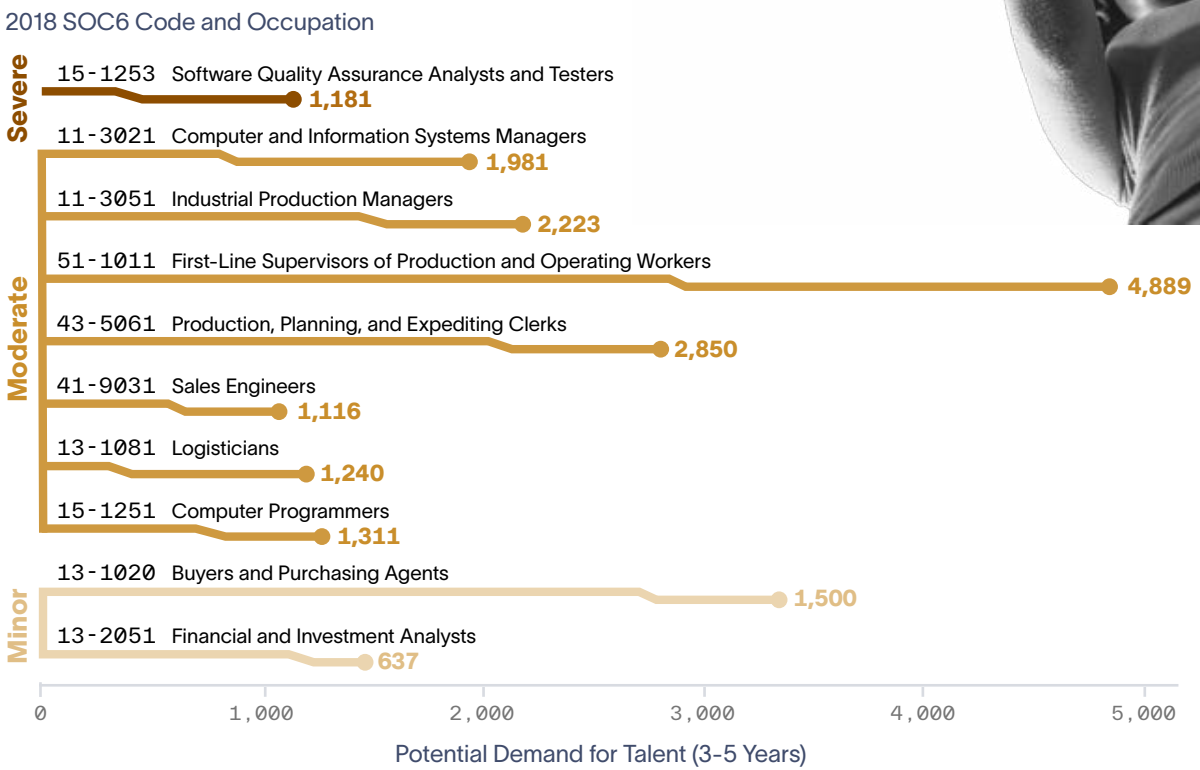
However, this also means new workers will be needed to backfill the positions left behind in other industries, which are just as important to the US economy as resurgent semiconductor production. Education institutions and career service providers, which already train individuals in preparation for careers throughout the economy, will have a large part to play in making sure every industry has the workforce it needs, while also teaching the skills necessary for work in the semiconductor industry.

Redeploy occupations are sorted into two categories, those that require a bachelor's degree and those that do not. When calculating undersupply, we look specifically at the new supply of workers in an occupation within the semiconductor industry as opposed to the new supply overall.[4] As above, the degree of undersupply is dependent on both the potential demand and supply.

Demand is not especially dire in most bachelor's degree occupations. Most of the top undersupplied bachelor's degree redeploy jobs are only moderately undersupplied. Half of the moderate-demand occupations involve managing and supervising production operations,

Top Bachelor's Degree Redeploy Occupations

We use the categories of **Severe**, **Moderate**, and **Minor** to rank the degree of undersupply in reskill occupations.



4 Since we are looking at the degree of undersupply in the industry as opposed to the economy, the thresholds for the Severe, Moderate and Minor undersupply categories are much higher for the redeploy occupations than the reskill occupations.

including Computer and Information Systems Managers (1,981 additional workers needed in 3-5 years), Industrial Production Managers (2,223), First-Line Supervisors of Production and Operating Workers (4,889), Production, Planning, and Expediting Clerks (2,850), while another half requires experience as a technician or engineering, including Sales Engineers (1,116), Logisticians (1,240) and Computer Programmers (1,311).

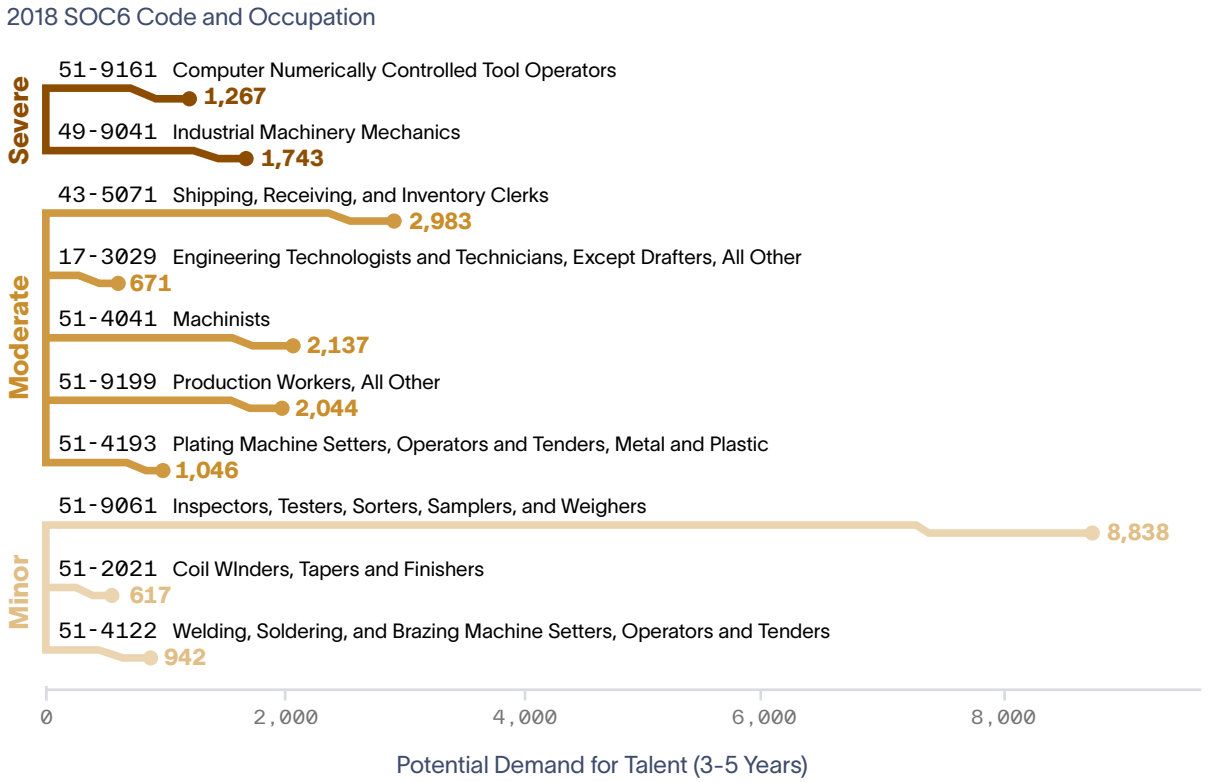
The supply gaps are larger for undersupplied jobs that don't require a bachelor's degree. All of the top undersupplied non-bachelor's degree redeploy occupations involve working in manufacturing, production, or maintenance. This means additional workers could potentially be found in a variety of different industries or fields.

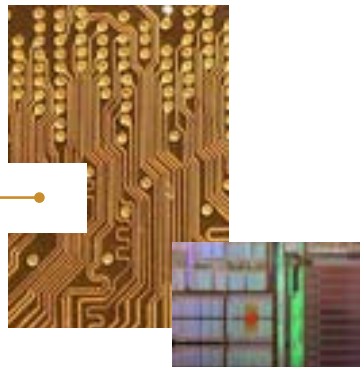
The severely and moderately undersupplied occupations, including Computer Numerically Controlled Tool Operators (1,267 additional workers needed in 3-5 years), Industrial Machinery Mechanics (1,743), and Machinists (2,137), all require a specific set of skills or trades, such as programming or machining, which might be hard for other occupations to reskill to.

Therefore, redeploying workers from other industries is likely to be the most reliable way to fill those jobs, despite the disruption it will bring to those original industries that new semiconductor workers come from.

Top Non-Bachelor's Degree Redeploy Occupations

We use the categories of **Severe**, **Moderate**, and **Minor** to rank the degree of undersupply in reskill occupations.



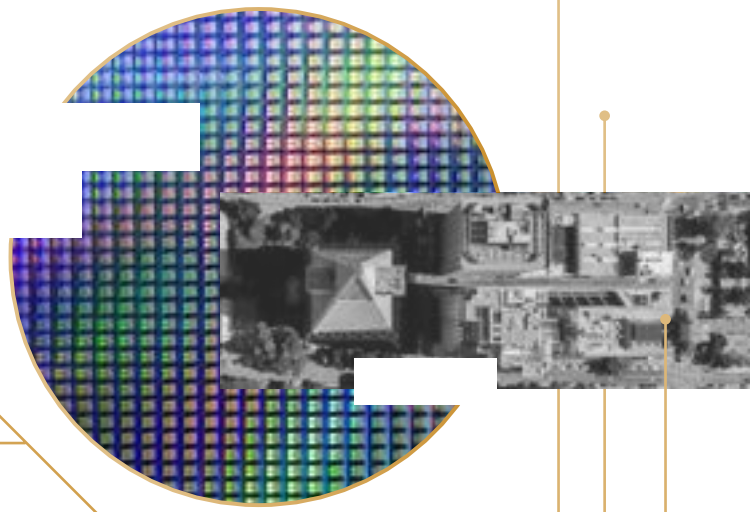


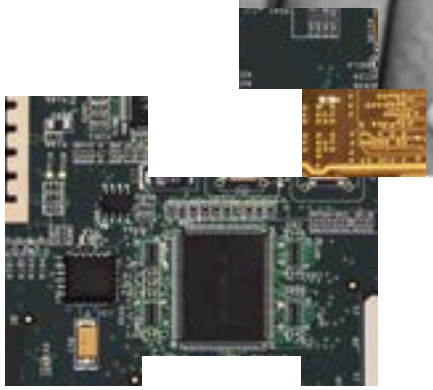
SOLVING THE UNDERSUPPLY

Many job vacancies in the burgeoning semiconductor industry can be filled by workers currently employed in other industries. Workers in roles as diverse as accountants, machine operators, lawyers, computer programmers, salespeople, and mechanics can apply their existing skill sets in a productive way to the semiconductor industry.

At the same time, redeploying workers into the semiconductor industry will leave openings in other sectors. Existing education pipelines are already built to match workers to the jobs that will be opened by backfill, but those pipelines must be expanded so they can supply both existing workforce needs and the emerging semiconductor industry.

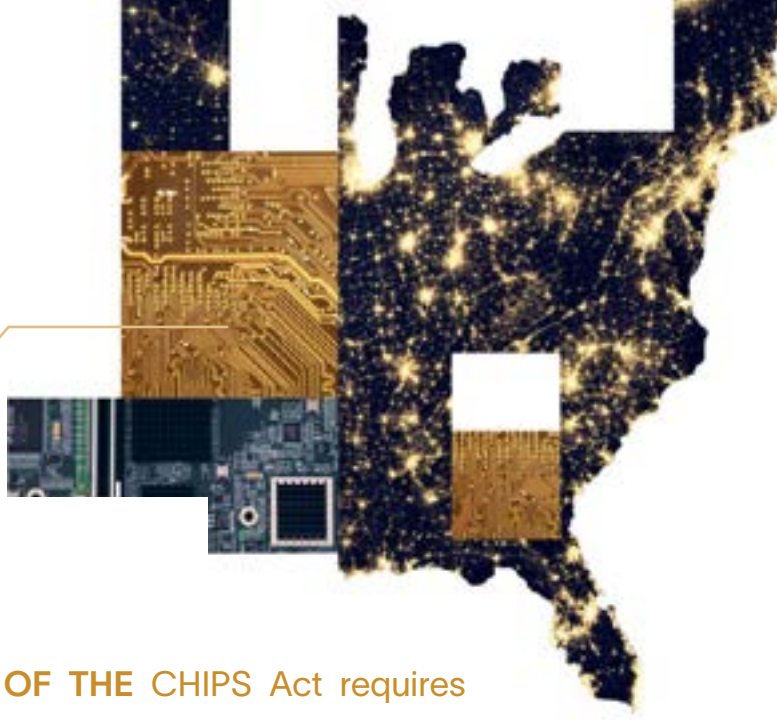
The pipeline includes professional programs in secondary school, postsecondary programs, and training, such as apprenticeships, provided and sponsored by industry groups. Planning for these backfill openings is just as important as workforce planning for the semiconductor industry itself.





Finding a place

Which regions have the local workforces that are best prepared to produce semiconductors?



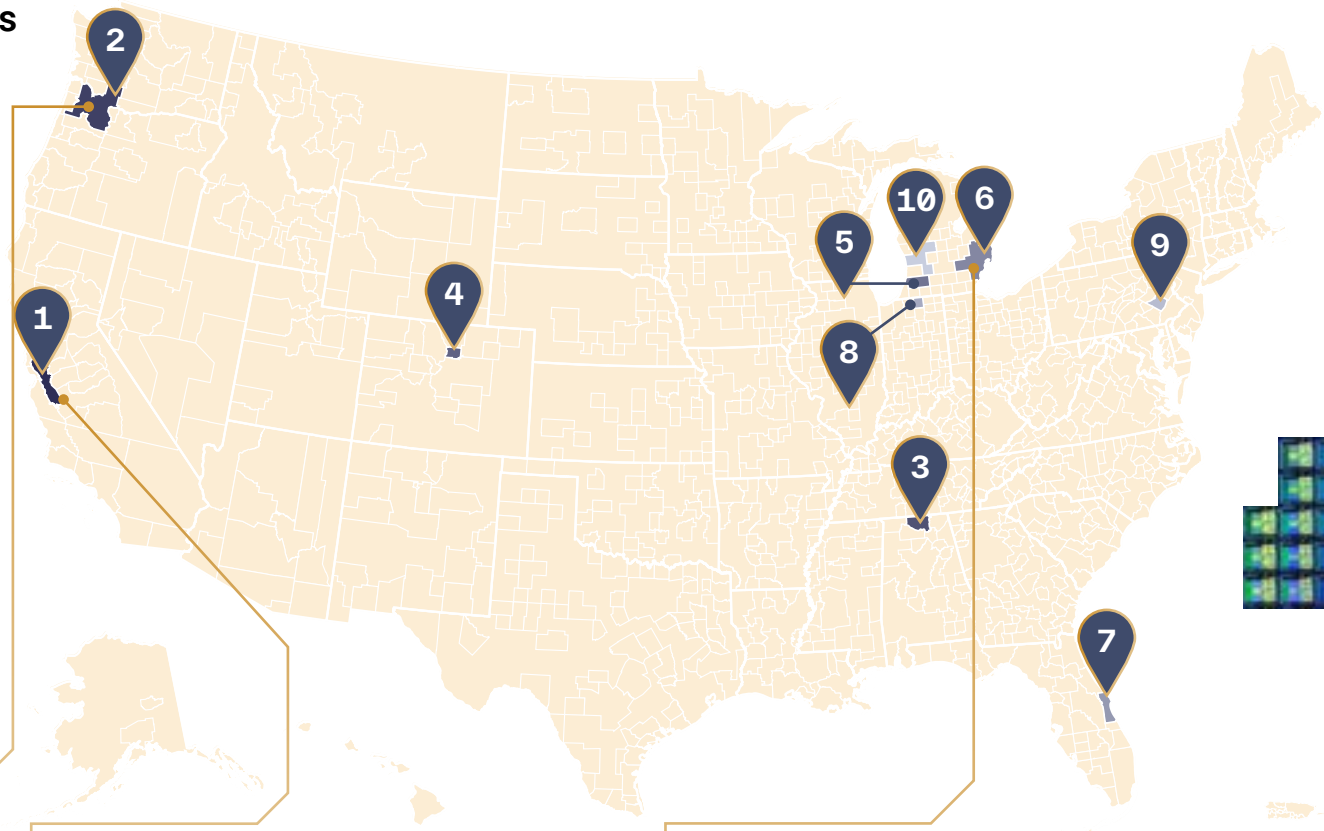
Components of Ranking

MAXIMIZING THE IMPACT OF THE CHIPS Act requires maximizing the impact of each business decision related to new semiconductor production, and no decision is as significant as choosing where to build. Deciding where to establish a new semiconductor plant relies on countless factors, including current industry presence, other nearby plants, or the cost of land.

But as we just saw above, a crucial factor in semiconductor production is the workforce responsible for the the producing. To see which regions are best prepared for semiconductor manufacturing, we created a metric called the **Regional Labor Force Readiness Ranking.** This ranking measures readiness in terms of workers either available now or ready to reskill in the most highly-demanded and undersupplied semiconductor jobs.

The top 10 Metro Statistical Areas (MSAs) with the highest Labor Force Readiness Ranking were:

1. San Jose-Sunnyvale-Santa Clara, CA
2. Portland-Vancouver-Hillsboro, OR-WA
3. Huntsville, AL
4. Boulder, CO
5. Kalamazoo-Portage, MI
6. Detroit-Warren-Dearborn, MI
7. Palm Bay-Melbourne-Titusville, FL
8. Elkhart-Goshen, IN
9. Reading, PA
10. Grand Rapids-Wyoming, MI



While the ranking is calculated on an average within each component, excelling at one aspect can help an MSA rank highly.

THE PORTLAND AREA ranked highly because it has a high concentration of workers in undersupplied semiconductor occupations (including Computer Hardware Engineers, Architectural and Engineering Managers, and Electrical and Electronic Engineering Technologists and Technicians).

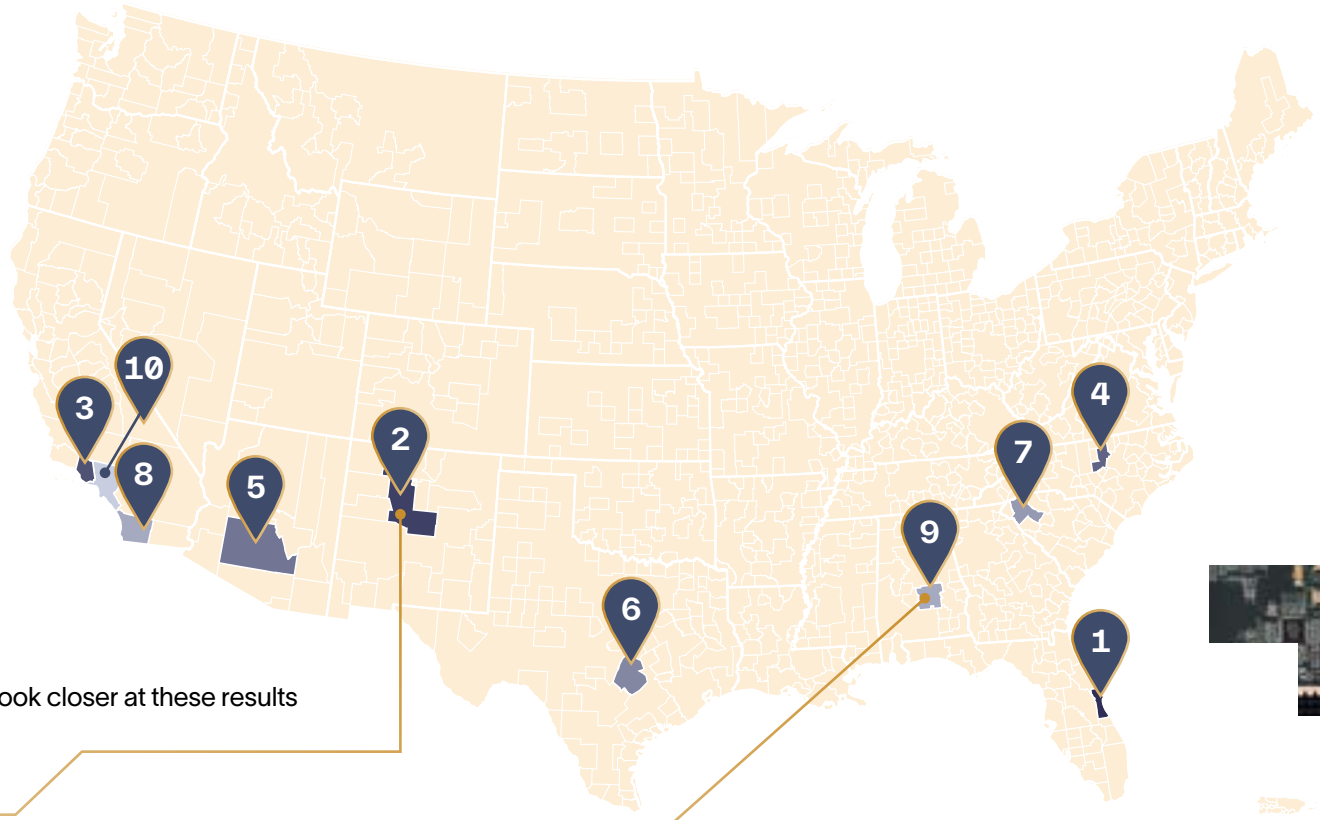
THE SAN JOSE AREA ranked highly because it has a high concentration of workers available for the semiconductor occupations with the greatest demand (including Semiconductor Processing Technicians, Software Developers, and Industrial Engineers).

THE DETROIT AREA ranked highly due to the high concentration of similarly skilled workers that could be reskilled into relevant occupations (including Commercial and Industrial Designers, Mechanical Engineering Technologists, and Calibration Technologists).

When comparing the Labor Force Readiness Ranking to labor market data on underrepresented minority workers, we can also see which MSAs present the greatest opportunity for those groups in semiconductor manufacturing:

The top 10 MSAs for semiconductor production that also promote equity for minority groups are:

1. Palm Bay-Melbourne-Titusville, FL
2. Albuquerque, NM
3. Oxnard-Thousand Oaks-Ventura, CA
4. Durham-Chapel Hill, NC
5. Phoenix-Mesa-Chandler, AZ
6. Austin-Round Rock-Georgetown, TX
7. Greenville-Anderson, SC
8. San Diego-Chula Vista-Carlsbad, CA
9. Montgomery, AL
10. Los Angeles-Long Beach-Anaheim, CA



And just like with the overall rankings, we can also look closer at these results to see the specific strengths of these regions.

IN ALBUQUERQUE, a large percentage of those working in the most-demanded semiconductor occupations are Hispanic (nationwide, 20% of Semiconductor Processing Technicians are Hispanic, while in Albuquerque, 47% are).

MONTGOMERY has a large percentage of Black workers in undersupplied semiconductor occupations (for example, First-Line Supervisors of Production and Operating Workers are 43% Black in Montgomery, compared with national average of 10%).

In the **OXNARD-THOUSAND OAKS-VENTURA** area, a large share of Hispanics work in occupations that could be reskilled into the semiconductor industry (the nationwide average of Electro-Mechanical and Mechatronics Technologists and Technicians who are Hispanic is 12%, while in this area north of Los Angeles, that share is 37%).

EVERY MSA, OF COURSE, HAS ITS OWN ADVANTAGES that can attract new manufacturing opportunities. To take advantage of them, community leaders need the best possible understanding of what workers they have in their regions (and what skills those workers possess), and align that local workforce with the coming semiconductor manufacturing need. Those who have the greatest understanding of employer demand and worker supply will be able to take the greatest advantage of the CHIPS Act.

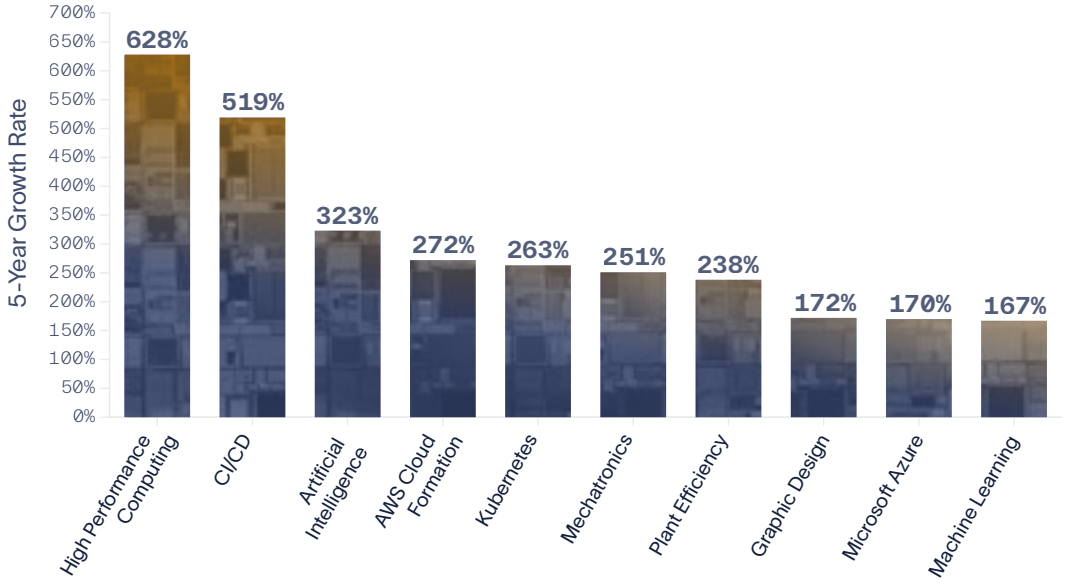
Looking ahead

What trends will shape the future of semiconductor manufacturing, and how can communities, education institutions, and businesses prepare for the future in this fast-changing industry?

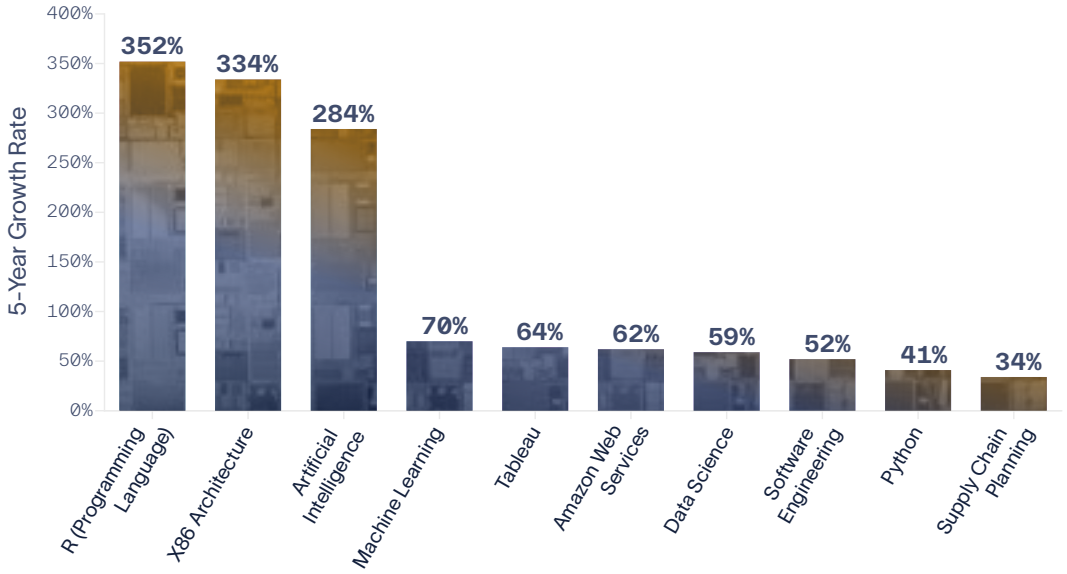
WITHIN SEMICONDUCTOR OCCUPATIONS, there has been an increase in data visualization and analysis skills like Tableau and data science, as well as cloud computing skills like Amazon Web Services (AWS) and Microsoft Azure. Even in positions requiring high school or associate degrees, there is a new focus on artificial intelligence and associated skills like machine learning. While these skills are nascent, their high growth rate indicates they will become increasingly important in the semiconductor industry in the coming years.

The fastest growing titles within our semiconductor occupations include logistics and business positions like Business Analyst and Supply Chain Procurement Specialists. Also seeing fast growth are quality control positions like Clean Room Inspectors, Technical Quality Assurance Analysts, and Verification Specialists.

Skills for Non-Bachelor's Degree Occupations[4]



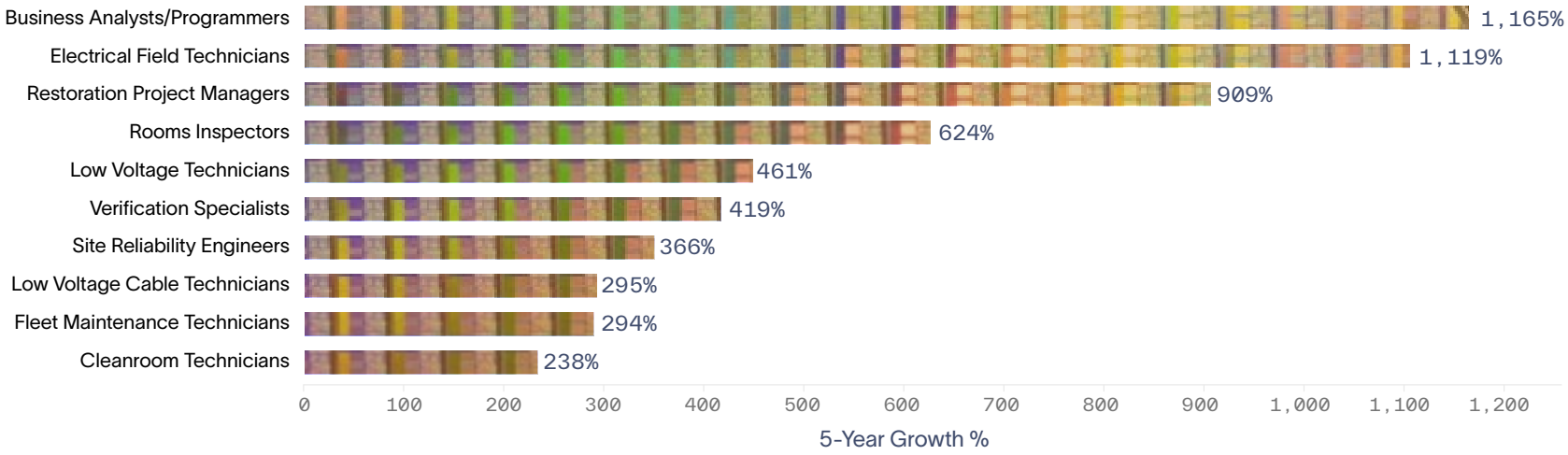
Skills for Bachelor's Degree Occupations



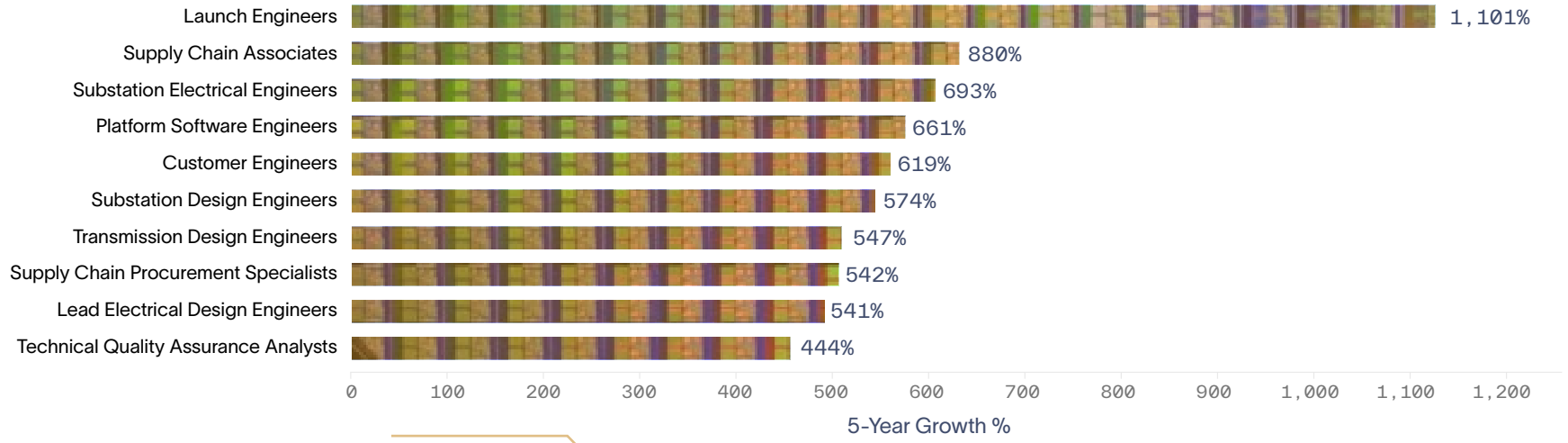
4 We limited our analysis of Bachelor-level occupation postings to the semiconductor industry, and included all postings for non-Bachelor-level occupations due to limitations in sample size.

Forewarned is forearmed, and armed with this knowledge of which skills and jobs will increase in importance in the semiconductor industry, education institutions and other training providers can plan for teaching those skills, businesses can anticipate recruiting needs and prepare their current workforce through professional development, and community leaders can work to connect their local labor force with the training and jobs they will need to be successful moving forward.

Fastest Growing Titles for Non-Bachelor's Degree Occupations



Fastest Growing Titles for Bachelor's Degree Occupations



Conclusion

Taking advantage of the CHIPS Act necessitates a long-term strategy: new projects and developments will be commissioned in the near future, while their economic and labor-market impact will be felt years afterward. This allows us to see into the future, because semiconductor skills and jobs will experience major growth in demand throughout the mid- to late-2020s—and perhaps even longer.

Understanding that reality means now is the time to prepare, especially because the risk is significant and urgent. We live in an era where workers are hard to find, and demographic trends show that this will remain the case for decades to come, all while international semiconductor production continues to grow. Matching workers with these new jobs is possible, but not if businesses, communities, or educators are careless or passive in their approach.

The good news is that these problems have solutions. The findings presented in this report (as well as the greater overall collection of Lightcast data, tools, and insight) show what conditions need to be met for CHIPS Act funding to be spent most effectively, maximizing success not just for the legislation, but for the institutions and individuals who participate in the resulting semiconductor production.

By knowing which jobs and skills will be in demand, and which regions and adjacent occupations have the greatest supply of workers, you can see how they align with the corresponding patterns in your industry—and where the gaps are.

If your organization can meet those conditions, now is the time to press your advantage, because the right data will allow you to make your case for continued and increased investment as the semiconductor industry grows. And if the data show you're not as prepared as you could be, now is the time to fix that, because the window of opportunity is open.

The CHIPS Act represents tremendous possibility for American businesses, education providers, communities, and individuals—and those who will make the most of this opportunity will be those who are most ready for it.

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