DECEMBER 2023

ECONOMIC IMPACT OF THE CENTRAL COAST TECHNOLOGY SECTOR

REACH

Ideas + Action for a Thriving Central Coast

ACKNOWLEDGMENTS

TIP Strategies would like to thank the staff and leadership of REACH and the REACH Technology Industry Council and partners for their input and feedback on this document.

REACH
Ideas + Action for a Thriving Central Coast

REACH is a Regional Economic Action Coalition uniting public, private and civic leaders across the Central Coast of California. REACH's goal is to transform the quality of life on the Central Coast, a region of about 700,000 people in dozens of cities and towns in the Counties of San Luis Obispo and Santa Barbara. The mission of the private sector-led coalition is to increase economic prosperity through big thinking, bold action, and regional collaboration.
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CONSULTING TEAM

TIP STRATEGIES

TIP Strategies, Inc., is a privately held firm providing consulting and advisory services to public and private sector clients. Established in 1995, the firm's core competencies are strategic planning for economic development, talent strategies, organizational development, resiliency planning, and equity initiatives. TIP is headquartered in Austin, Texas, with offices coast-to-coast.

Lightcast

Lightcast is the global leader in labor market analytics. Formerly Emsi Burning Glass, the firm has over two decades of experience providing businesses, communities, and education institutions with the best labor market data possible. Lightcast's data-driven insight enables better, faster decisions. The firm is headquartered in Boston, Massachusetts, and Moscow, Idaho.

This publication was funded in part by the Economic Development Administration. The statements, findings, conclusions, recommendations, and other data in this report are solely those of the author and do not necessarily reflect the views of the Economic Development Administration.

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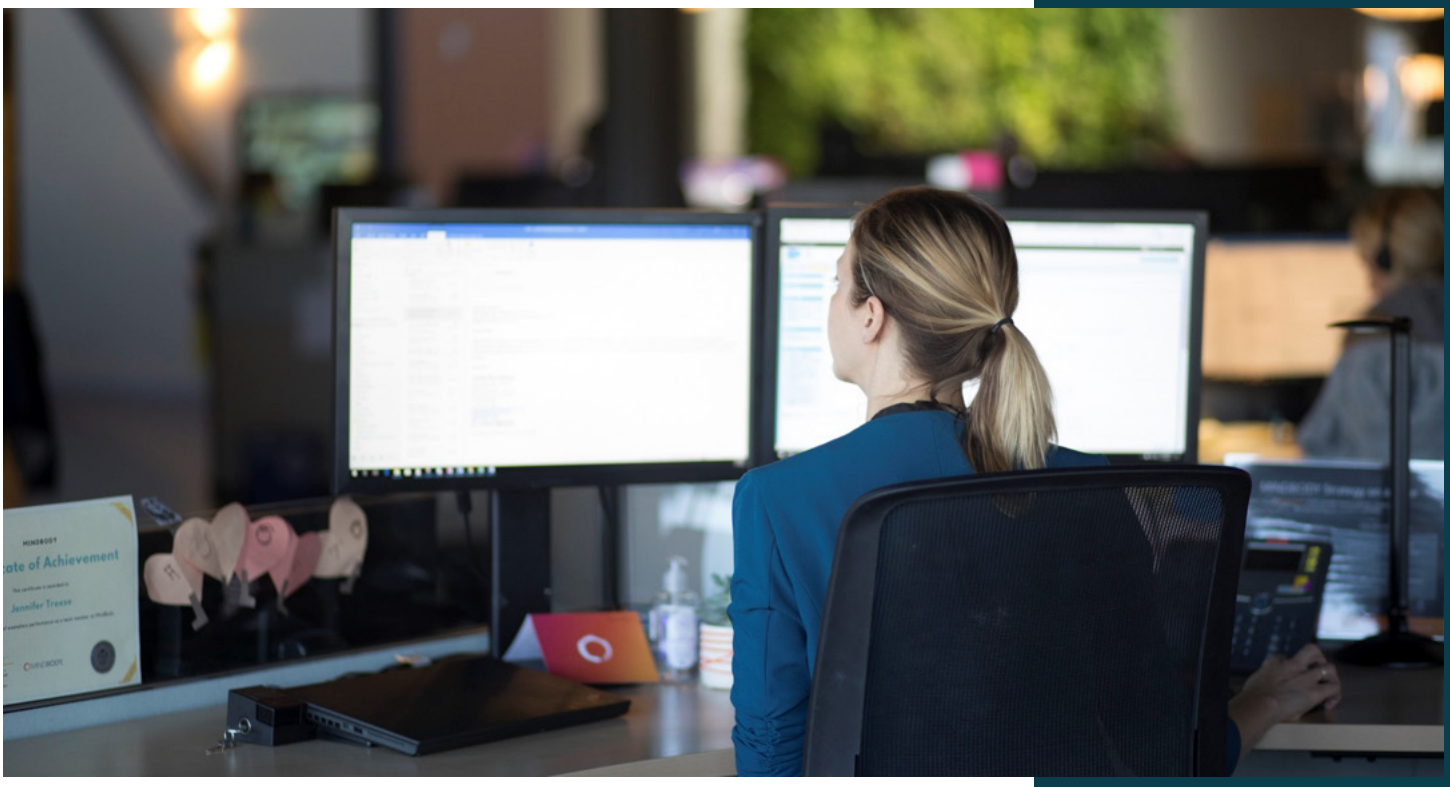


EXECUTIVE SUMMARY

ABOUT THIS WORK

This analysis was completed as a supplement to the preparation of a comprehensive economic development strategy (CEDS) for the Central Coast region of California, which encompasses the Counties of San Luis Obispo and Santa Barbara. It is one of four studies designed to gauge the economic impact of the region's target sectors. The other three are Aerospace, Defense, and Precision Manufacturing; Agriculture and Agtech; and Clean Tech and Renewable Energy. The work was commissioned by REACH, an independent 501(c)(3) organization committed to creating a more prosperous and inclusive economy in San Luis Obispo and Santa Barbara Counties, and supported by funding from the US Economic Development Administration.

CENTRAL COAST TARGET SECTORS

+ Aerospace, Defense, and Precision Manufacturing
+ Agriculture and Agtech
+ Clean Tech and Renewable Energy
+ Technology

This report focuses on the Technology sector, a cluster of cross-cutting activities in areas ranging from information technology to research and development (R&D) to engineering.[1] Insights gained from this work, and from industry roundtables conducted as part of the CEDS planning process, will support the region's growth of this critical sector.

[1] See Figure 15 (page 29) in the appendices for the definition of the sector used in this report. Engineering and related industries were included in the sector to reflect their role in driving technological advances across the economy.

Key findings from the team's research and analysis are summarized in the remainder of this section. It is followed by an exploration of the Technology sector landscape in terms of its assets, employment trends, and talent pipeline. The quantitative analyses presented in this overview draw on an extensive interactive data visualization created by TIP Strategies using proprietary data prepared by national labor market data provider, Lightcast.[2] The final section of the report presents the results of an economic impact analysis—as measured by job creation, earnings, and added tax revenue—conducted by Lightcast. Supporting details, including a list of the industries that were used to define the sector (Figure 15, page 29) and an explanation of the federal classification systems referenced in this work (Classification Systems, page 40), are provided as appendices.

KEY FINDINGS

The Central Coast is a growing technology center with the entrepreneurial assets to support additional expansion.

The Central Coast has attracted attention as a growing center for the formation and expansion of technology-focused companies and facilities. Among the region's many assets are proximity to major markets, including the Bay Area and Los Angeles; highly ranked postsecondary institutions; and a unique quality of place. The ability to connect with key markets is evidenced by the many direct flights available at regional airports as well as digital access to international markets via the Pacific Crossing cable landing station at Grover Beach. Globally recognized brands including Google, Amazon, LinkedIn, PayPal, Sonos, and Zoom have established facilities in the region, along with high-growth startups in areas ranging from consumer products and app developers to cloud computing and artificial intelligence (AI). Growing companies making waves in the region include the following:

- Cognixion, a Santa Barbara-based hardware and software developer that utilizes artificial intelligence, augmented reality, and assistive technology to aid individuals with neurodegenerative conditions.
- Bitwarden, a password management software platform based in Santa Barbara.
- Postal, a San Luis Obispo-headquartered inventory and logistics software company.

A robust entrepreneurial ecosystem is an important foundation in positioning the region for Technology sector growth, including assets associated with University of California, Santa Barbara (UC Santa Barbara) and California Polytechnic State University, San Luis Obispo (Cal Poly). The Cal Poly Center for Innovation & Entrepreneurship plays multiple roles in this ecosystem including offering entrepreneurial programming for students and community members; building a successful community-based incubator, the HotHouse; and providing technical assistance services as the site of the subregion's Small Business Development Center. The Cal Poly Technology Park, which is undergoing a dramatic expansion, offers a strategic location for companies looking to access the university's many resources, including opportunities to collaborate with Cal Poly faculty and access to highly qualified student part-time and temporary workers. Housed within UC Santa Barbara, the California NanoSystems Institute (CNSI) is a cutting-edge research

[2] The quantitative analyses presented throughout this report use proprietary employment data, including five-year projections, prepared by Lightcast. Employment figures reflect Lightcast's complete employment data, which includes both employed and self-employed workers. Projections are based on historical trend lines averaged across three scenarios and, therefore, do not capture employment associated with recent and/or planned investments. More information about Lightcast's data and methodology can be found in their online knowledge base.

facility, incubator, and makerspace dedicated to advancing nanotechnology and interdisciplinary collaboration. The UC Santa Barbara Industry Center, administered by the College of Engineering and the Sciences, facilitates company access to its world-class laboratories and equipment along with offering a number of student-focused initiatives. Initiatives like Silicon Riviera, Ventech, and Softec offer networking and educational events to support entrepreneurs and early-stage companies.

Arguably, the biggest game-changer among the Central Coast's many Technology assets is Google's Quantum AI campus. While Google's Santa Barbara campus is not the nation's only quantum computing facility—Amazon, IBM, Intel, and Microsoft are all working to solve the quantum computing puzzle—advances in this field will benefit a myriad of industries and raise the profile of the region. UC Santa Barbara is also home to the Nanofabrication Facility (a world-class cleanroom accessible to academic researchers and industry partners) and the Quantum Foundry (the nation's first-ever National Science Foundation facility focused on the development of materials for quantum information-based technologies).

The $3.3 billion sector employs 13,000 workers, with significant job growth over the past 20 years.

As defined for this work, the Technology sector currently employs about 13,000 workers in the region, an increase of roughly 5,000 jobs during the last two decades. Most of this growth (around 3,500 jobs) has occurred in the County of Santa Barbara. When viewed in percentage terms, however, the most dramatic growth has occurred in the County of San Luis Obispo, where the number of jobs in Technology sector industries has nearly doubled during this period. These patterns are expected to continue, according to Lightcast's projections, which call for a 4 percent increase in regional Technology jobs over 2022 levels by 2027, a pace that mirrors national growth rates during the period. Goods and services provided by businesses in the Technology sector industries contributed $3.29 billion to the gross regional product (GRP) of $52.3 billion (6.3 percent) in 2022. Within this figure, software, custom programming, and engineering were the three activities with the largest contribution to GRP, together accounting for roughly 60 percent of the sector's total.

Projected expansion in the sector would have additional ripple effects on the economy. An analysis of the sector's economic impact, conducted by Lightcast, identified an employment multiplier of 2.38 for the sector, meaning that each Technology job results in nearly 1.4 additional jobs in the region.[3] Based on a scenario in which focused business development efforts accelerated projected job growth over a five-year period, Lightcast's economic impact analysis found that this growth could result in a total of more than 3,200 jobs, $316 million in earnings, and $18.5 million in tax revenues when the sector's supply chain and household spending impacts are considered.[4]

The region's strengths extend beyond traditional technology to include engineering, testing, and research and development.

The diversity of the Central Coast's Technology sector extends beyond traditional tech-focused companies to include professional services like engineering, testing, and research and development. These industries play a pivotal role in technological advances that drive technological innovation across the economy. Engineering services of all types represents the largest component of the Technology sector job base, accounting for more than one in four positions

[3] The employment multiplier of 2.38 for the Technology sector includes the initial gain of one job (1.00), plus the estimated employment generated by that new job, which in this case is more than one additional job (1.38). See Figure 11 (page 23) for an illustration of the ripple effects of job growth.
[4] See Figure 12 (page 25) for details of the analysis.

(27.5 percent) and $0.53 billion in GRP (16 percent of the sector's total). While it represents a relatively small share of Technology employment, social sciences and humanities research is among the fastest growing of the sector's industries, adding more than 300 jobs between 2017 and 2022. It is also the most specialized of the 17 detailed industries that comprise the sector, meaning that employment in the industry exceeds expected levels based on national employment patterns.[5] Job postings also point to demand among employers in the sector for workers in sales, marketing, and customer services, as well as traditional office functions such as bookkeeping, human resources, and administrative tasks.

There's a robust talent pipeline, with a rising number of relevant degrees, although demand for some occupations has declined in recent years.

The majority of occupations in the Technology sector as defined for this study require postsecondary training, with roughly one-half of the job postings analyzed requiring a bachelor's degree or higher. As a result, the presence of strong engineering and computer science programs at UC Santa Barbara and Cal Poly represents a tremendous asset for the development of the regional Technology sector. Not only do these institutions support innovation across multiple industries, but they also draw STEM talent to the region in the form of students, faculty, and researchers, making them central to the sector's talent pipeline.

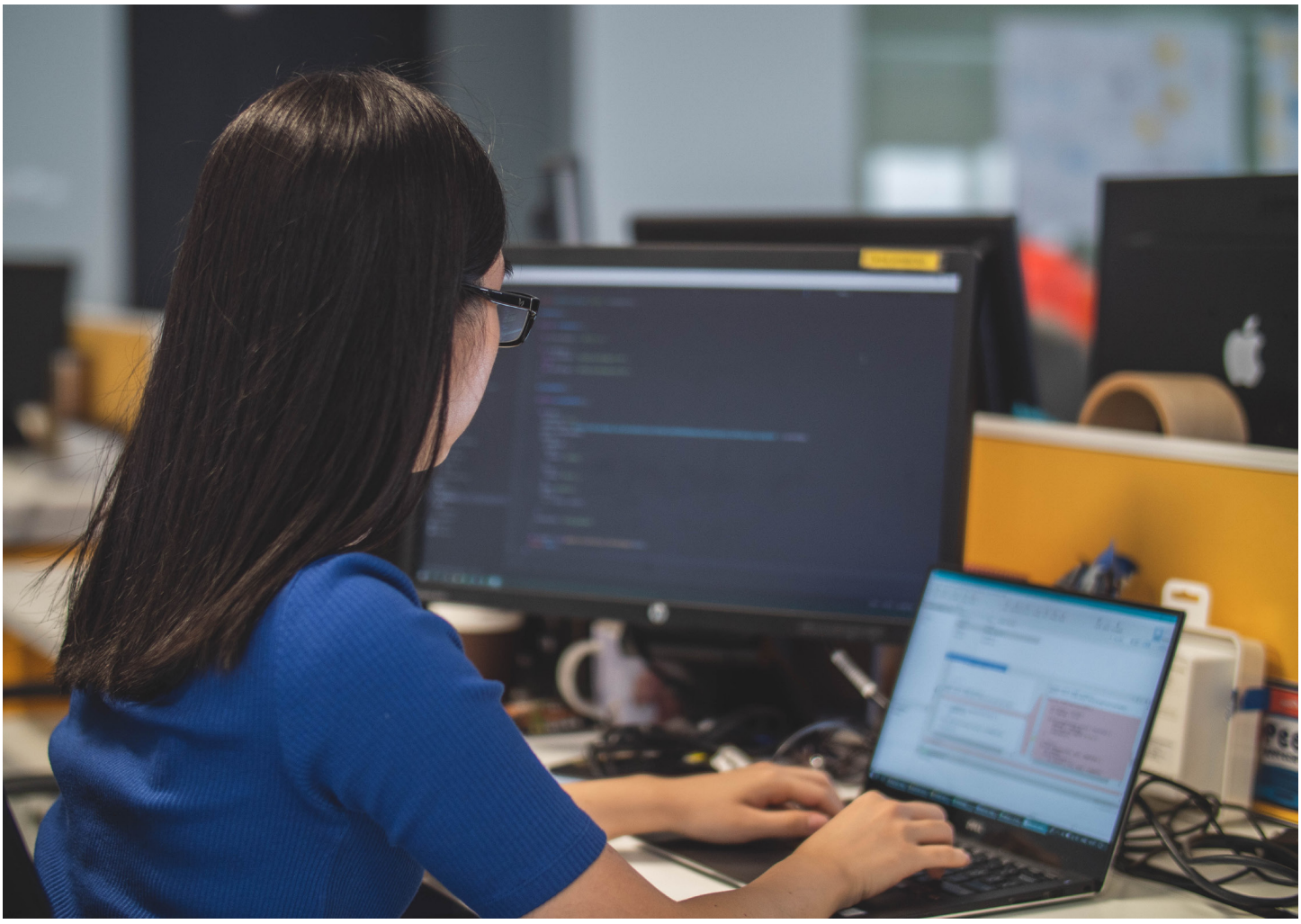
The number of degrees and awards granted across all fields of study by Central Coast institutions as a group has risen steadily over the past 10 years and degrees in computer-related fields have generally followed this upward trajectory. However, for some of the top positions currently being sought by employers (based on a review of real-time job postings data summarized in Figure 7, page 17), the number of jobs in these demand occupations has actually been declining in the region in recent years. Examples of in-demand roles that have experienced declines since 2021 include software developers (-2.6 percent), network administrators (-17.5 percent), and system analysts (-3.7 percent), all of which typically require bachelor's degrees.

The region's community college partners—Allan Hancock College, Cuesta College, and Santa Barbara City College—offer an array of options for positions requiring less than a four-year degree. These core workforce development and career training partners are complemented by initiatives such as SLO Partners that offer upskilling opportunities and bootcamps in high-demand skills such as programming and cybersecurity. The California Cybersecurity Institute at Cal Poly also offers a path for students and incumbent workers to access quality jobs in digital fields with options including industry-recognized certifications in information security and training on Amazon Web Services (AWS) cloud-based data warehousing solutions.

[5] See page 11 for a discussion of location quotients.

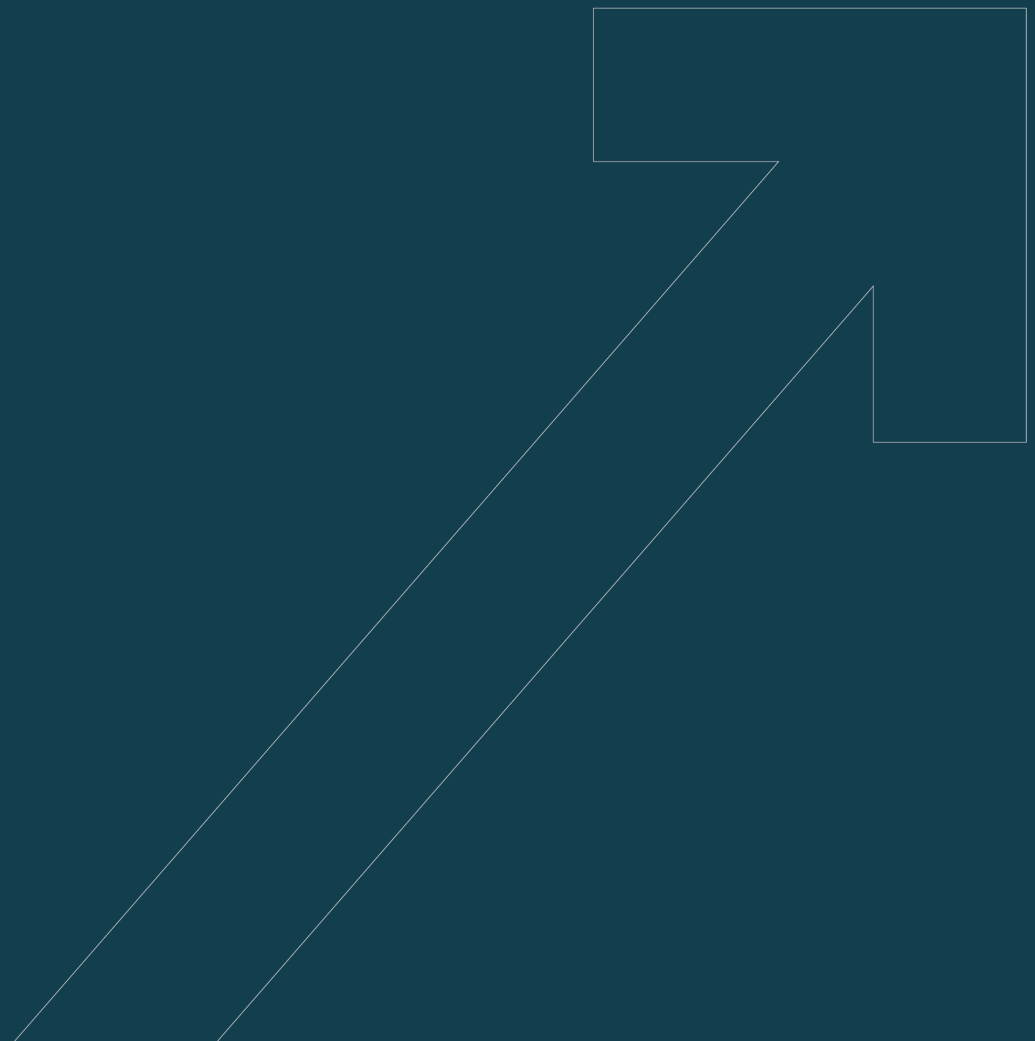
Targeted talent attraction and development efforts will be required to offset regional outmigration of workers.

One significant challenge facing the Central Coast across all sectors is the outmigration of the regional workforce. Data on migration by metropolitan statistical area (MSA)[6] shows a trend toward the increased net out-migration of workers in both Central Coast counties, although there are important differences. Worker outflows in the San Luis Obispo MSA have been largely characterized by the departure of workers under 25 and are likely driven by the movement of college students. The overall trend in the Santa Barbara MSA is similarly downward but appears to be less tied to academic calendars. Following an upward trend in net in-migration of workers between 2017 and 2018, strong net out-migration since late 2019 has culminated in several thousand fewer workers in the region. Reversing this trend will be important to the health of the Central Coast economy.



[6] A metropolitan statistical area (MSA) is a designation of the US Office of Management and Budget used by federal statistical agencies. MSAs are composed of one or more counties (or county equivalents, such as parishes) that meet specific thresholds (e.g., population size, share living in urban areas), and which have strong economic ties as illustrated by factors such as employment and commuting). Informal MSA names are used in this report to improve readability. For example, the San Luis Obispo-Paso Robles, CA, MSA is referred to simply as the San Luis Obispo MSA; Santa Barbara MSA is used rather than Santa Maria-Santa Barbara, CA, MSA.

SECTOR LANDSCAPE



SECTOR OVERVIEW

The early months of 2023 proved to be a bit shaky for the stability of the national tech sector, but most analysts remain bullish on the sector's long-term prospects, especially in certain niches where the outlook for commercialization is exceptional.[7]

TRENDS & DIRECTIONS

The Technology sector encompasses a wide range of innovations beyond just hardware and software. The array of activities that make up "tech" have provided ample opportunities for universities and their surrounding regions to carve out niches of expertise and specialization. For example, UC Santa Barbara has developed a critical mass of expertise in photonics, the science and application of light. It may sound like science fiction, but photonics touches every aspect of daily life, from bar scanners at the grocery store to remote controls for flatscreen televisions to fiber optic cables powering internet services. For the healthcare sector, photonics enables advanced medical instrumentation and complex surgeries. Manufacturers have adapted it for the mundane necessities of cutting and machining. And defense contractors incorporate photonics for the next generation of military uses, like infrared cameras and remote sensing. Daily conveniences, healthcare innovations, even national security, all rely on photonics.

The long-term outlook for companies specializing in optical and photonic components is bright. Photonic technologies are quickly being adapted for driver safety features in the automotive industry, and the use of incandescent light bulbs has rapidly been retired to make way for more efficient light-emitting diode (LED) bulbs. Looking ahead, the demand for optical innovations in gaming, cloud computing, medical, military, and solar technologies will continue to expand, creating continued opportunities for R&D in the sector.

CENTRAL COAST

The Central Coast has an enviable mix of globally recognized companies and locally grown innovators. Google's Quantum AI campus in Santa Barbara offers the prospect of finding collaborative solutions to global problems and establishes the region at the forefront of the technology. Other major players with a presence in the region include Amazon, Zoom, and PayPal. The region has also produced several companies in recent years that are at the leading edge of photonics and other technologies. Among others, these include the following companies:

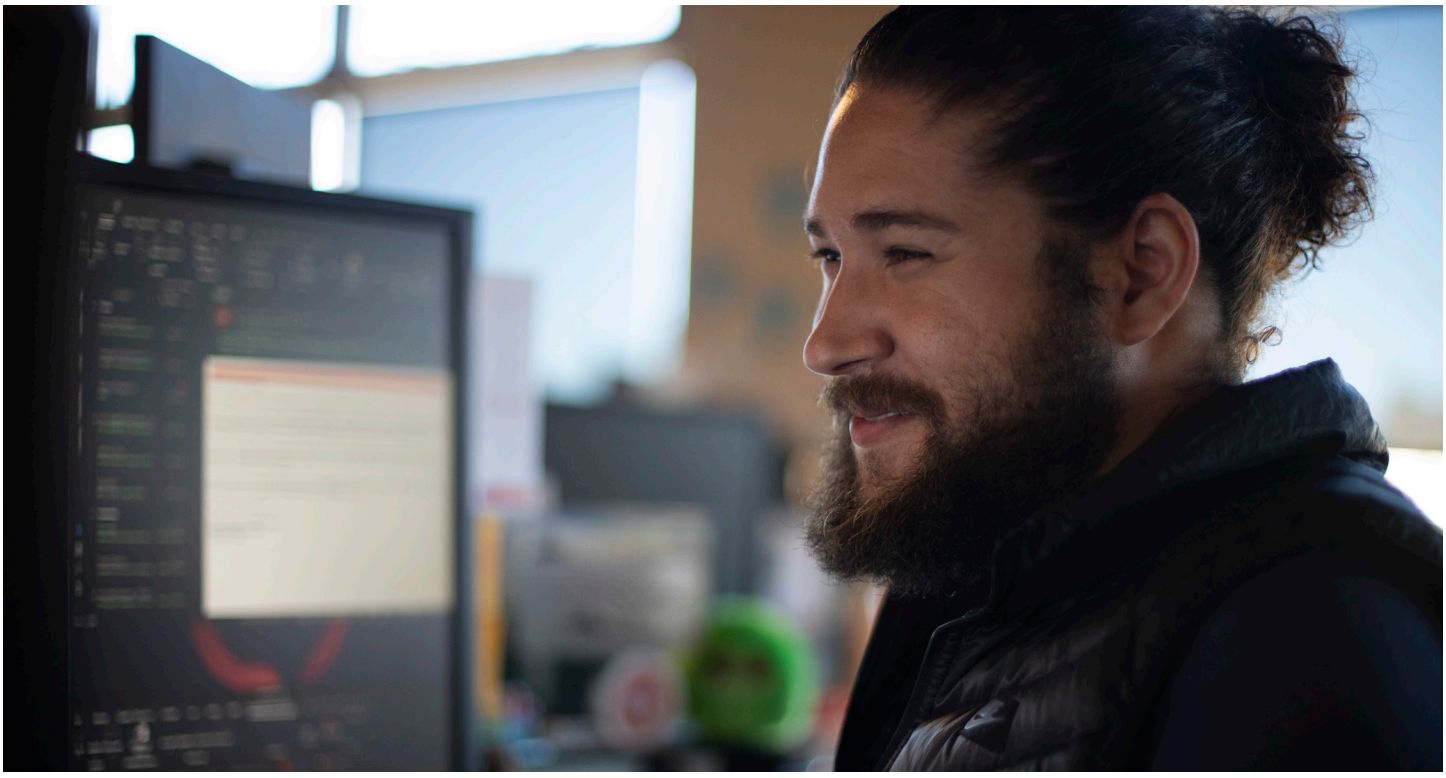
- Goleta-based Nexus Photonics, the developer of enabling techniques for photonic chips to operate in the visible-to-near-infrared spectrum.
- Goleta-based Seek Thermal, a manufacturer of long-wave infrared sensors and thermal imaging products.
- Santa Barbara-based Sonos, a developer of wireless multi-room music systems.
- Goleta-based AppFolio, a provider of cloud business management services for the real estate industry.

[7] See the appendices for a list of resources that informed this section (Resources, page 41).

The pace of merger and acquisition activity in the Central Coast region quickened in 2023, with two Santa Barbara technology companies involved in billion-dollar transactions. Locally based, family-run Wyatt Technology, a company specializing in light-scattering instrumentation and software with more than 200 employees worldwide, was acquired for $1.36 billion by Massachusetts-based Waters Corporation, a specialist in liquid chromatography with a global workforce of more than 8,200. In a separate deal, Santa Barbara-based QAD, a developer of cloud-based enterprise software for manufacturing companies, acquired Miami-based Redzone for $1 billion.[8]

Among the Central Coast's ample intellectual resources for the Technology sector is UC Santa Barbara, which is home to AIM Photonics (AIM), the West Coast headquarters for the American Institute for Manufacturing Integrated Photonics. AIM is a collaborative forum for the convergence of government, industry, and academia as well as an advocate for integrated photonics manufacturing systems. The California NanoSystems Institute, whose work emphasizes applications for energy management, water purification, sustainability, quantum science, healthcare, and robotics, is also located at UC Santa Barbara. The university also hosts extensive nanofabrication cleanroom facilities staffed by trained experts. In San Luis Obispo, Cal Poly's PolyGAIT (Global Automatic Identification Technologies) Center is at the forefront of student education and training in radio-frequency identification (RFID) technologies.

Yet not all intellectual endeavors lead to the immediate gratification of technology commercialization. Great leaps forward in human understanding and development begin with basic research. UC Santa Barbara's Kavli Institute for Theoretical Physics is one of those pioneering institutions on the leading edge of scientific learning. Kavli's discoveries may indeed lead to the technologies of future generations.



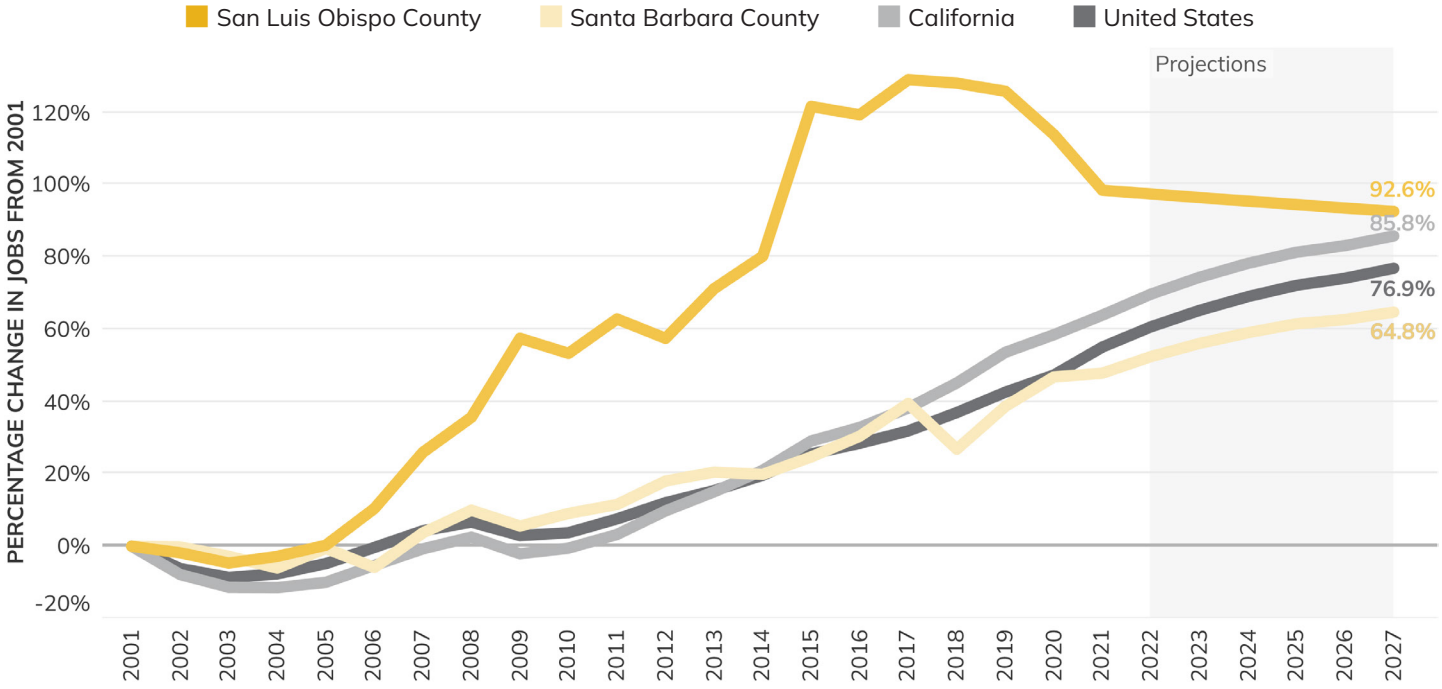
[8] Employment figures are based on a Waters Corporation press release dated 2/15/2023. Employment data for privately held QAD and Redzone could not be confirmed.

EMPLOYMENT TRENDS

The Technology sector accounts for roughly 13,000 jobs in the Central Coast counties, representing nearly 4 percent of the region's total employment. Employment in the sector encompasses a range of industries, including information technology services, R&D activities, testing facilities, engineering firms, and surveying and mapping operations. The majority of employment (78 percent) in the sector as defined is located in the County of Santa Barbara. Engineering Services (NAICS 541330)[9] and Custom Computer Programming Services (NAICS 541511) were the two largest detailed industries within the Technology sector, with each employing more than 3,000 workers in 2022.

As shown in Figure 1, growth trajectories in Technology employment have varied between the two Central Coast counties over the past two decades. While employment trends in the County of Santa Barbara have mirrored or lagged state and US levels, the County of San Luis Obispo has experienced a dramatic increase in Technology jobs in percentage terms. In part, the divergence represents the relative size of the sector in the two counties. When viewed in numeric terms, the County of Santa Barbara has added more jobs (roughly 3,200) than the County of San Luis Obispo (roughly 1,400) during the period analyzed. The uptick in Technology sector employment in the County of San Luis Obispo over the period was driven by gains in Custom Computer Programming (NAICS 541511), which grew from roughly 250 jobs in the early 2000s to a peak of more than 1,500 jobs by 2018, before dipping back to 900 jobs by 2022. Growth rates in the County of San Luis Obispo are projected to slow (a reflection of recent losses in NAICS 541511) yet remain above state and national rates.

FIGURE 1. CENTRAL COAST EMPLOYMENT TRENDS IN THE TECHNOLOGY SECTOR
WITH COMPARISONS TO THE STATE AND US



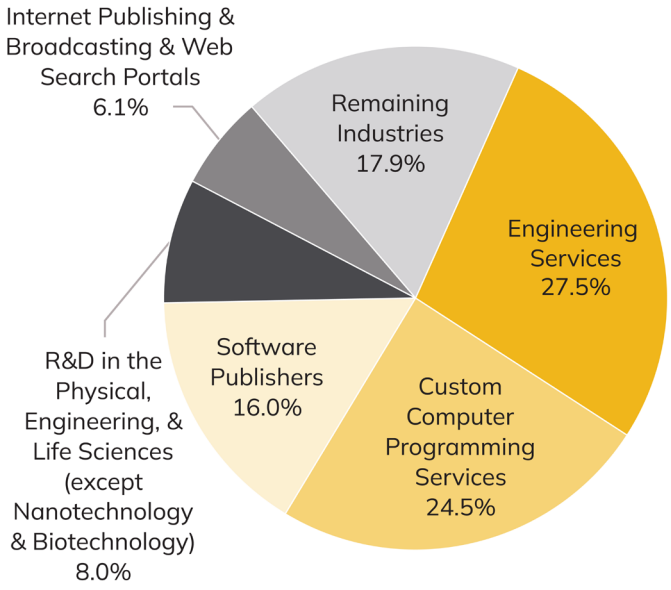
Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): The Technology sector includes 17 detailed industries (6-digit NAICS) which are listed in the appendices.

[9] NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. For additional information, see Classification Systems (page 40).

INDUSTRY DETAIL

Within the Technology sector, Engineering Services (NAICS 541330) and Custom Computer Programming Services (NAICS 541511) each account for roughly 25 percent of employment. Taken together, the two industries represent more than 6,700 jobs, or one-half of the sector's total employment (52.0 percent). Software Publishers (NAICS 511210) represents the next largest industry with nearly 2,100 jobs, or 16 percent of the sector's employment. Only one other industry employs more than 1,000 workers in the two counties: R&D in the Physical, Engineering, & Life Sciences, except Nanotechnology & Biotechnology (NAICS 541715).

FIGURE 2. DISTRIBUTION OF CENTRAL COAST EMPLOYMENT IN THE TECHNOLOGY SECTOR
BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)



Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): Total may not sum to 100 percent due to rounding.

Understanding areas of specialization within the sector can point to areas where industry targeting efforts may be beneficial. Specialization is based on an analysis of location quotients (LQ), a commonly used method for comparing the concentration of employment in an area to national patterns (see box below). Of the 13 industries in the Technology sector with at least 100 jobs, the Central Coast is highly specialized in five of them, as shown in Figure 3 (page 12). For this analysis, an LQ of 2.00 or higher was used to denote a very high level of concentration. One industry met this threshold, R&D in the Social Sciences and Humanities (NAICS 541720), with just over 330 jobs.

LOCATION QUOTIENTS

A location quotient (LQ) analysis is a statistical technique used to highlight areas of relative concentration. LQs are typically calculated as an industry's share of total local employment divided by the same industry's share of employment at the national level. For example, if an industry represents 1 percent of US employment and 5 percent of local employment, its LQ would be 5.00, meaning that employment in the industry in the local area is five times as large as would be expected based on national patterns. An LQ of 1.25 or greater can suggest areas for targeting.

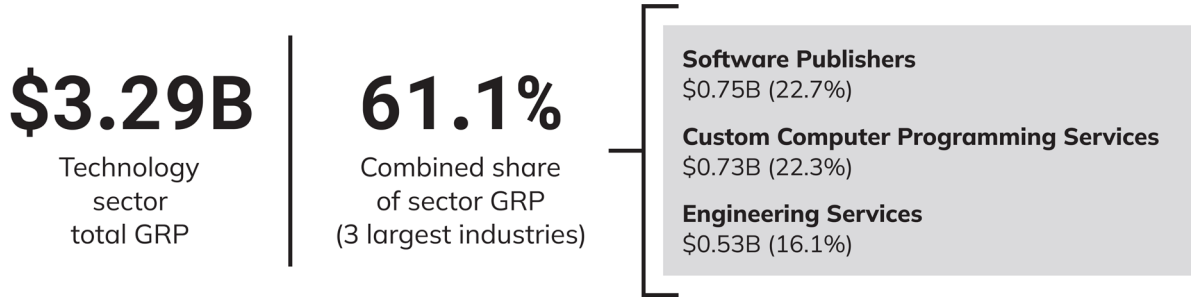
FIGURE 3. HIGHLY SPECIALIZED INDUSTRIES IN THE TECHNOLOGY SECTOR
CENTRAL COAST LQS BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)

NAICS CODE	INDUSTRY	LQ	JOBS
541720	Research & Development in the Social Sciences & Humanities	2.40	334
511210	Software Publishers	1.71	2,071
541330	Engineering Services	1.47	3,548
541511	Custom Computer Programming Services	1.28	3,162
541370	Surveying & Mapping (except Geophysical) Services	1.11	131

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes.

Collectively, the 17 industries that comprise the Technology sector contributed $3.29 billion to the Central Coast economy in 2022. Known as gross regional product (GRP), this metric represents the total market value of goods and services produced in an area and is commonly used to show the size and performance of the economy. When viewed at the industry level, Software Publishers and Custom Computer Programming Services were the sector's largest contributor, with each adding roughly $0.75 billion or about 22 percent of the Technology sector's total GRP. Engineering Services accounted for an additional 16 percent ($0.53 billion). At the state level, the Technology sector as defined for this work added $429.33 billion to the California economy (known as gross state product) in 2022.

FIGURE 4. GROSS REGIONAL PRODUCT (GRP) IN BILLIONS: TECHNOLOGY SECTOR
TOTAL GRP FOR THE SECTOR WITH SHARE REPRESENTED BY TOP THREE INDUSTRIES, 2022

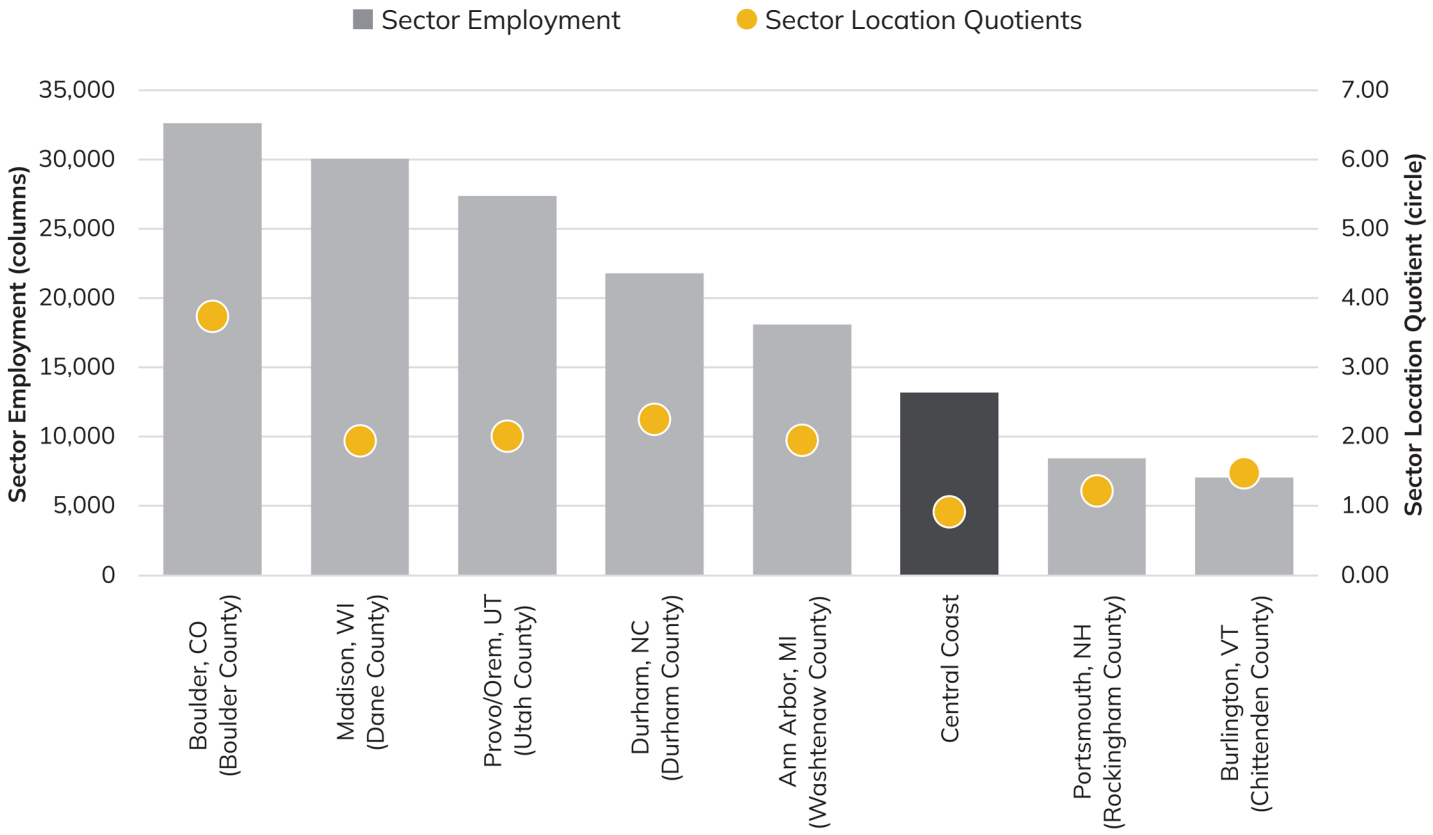


Source(s): Lightcast MR-SAM model, 2022.
Note(s): Total of top three industries may not sum to combined share due to rounding.

PEER METROS

High concentrations of technology jobs often cluster in the regions surrounding major R1 research universities.[10] Examples include Boulder (University of Colorado); Madison (University of Wisconsin); Durham, North Carolina (Duke University); and Ann Arbor (University of Michigan). While the Central Coast is not quite at that same level of technology concentration (yet), the region has all the necessary critical components to follow in this path. One under-the-radar peer to watch is Provo, Utah, home to Brigham Young University (BYU). While BYU's research activities fall under the Carnegie Classification of R2, the region has nonetheless produced a surprising amount of technology jobs over the years and has become an established and recognized hub of US technological activity. A definition of location quotients (LQs) is featured on page 11.[11]

FIGURE 5. TECHNOLOGY SECTOR EMPLOYMENT LEVELS AND CONCENTRATIONS
CENTRAL COAST AND SECTOR COMPARISONS FOR PEER COUNTIES, 2022



Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): The Sector Location Quotients (circle) represent the LQ for total employment in the sector as defined for this analysis. LQs above 1.00 indicate that the peer county's employment in the sector comprises a larger share of its total employment than would be expected based on national patterns.

[10] R1 designation is based on the Carnegie Classification of Institutions of Higher Education. It is reserved for doctoral universities with "very high research activity" based on specific criteria including degrees awarded, research expenditures, and staffing. For more on the Carnegie Classifications, see https://carnegieclassifications.acenet.edu/. UC Santa Barbara is one of eight public universities in California with this designation in the most recent Carnegie Classifications.
[11] Regional peers were selected by TIP Strategies based on their alignment with business trends, industry development patterns, and academic drivers.

TALENT PIPELINE

Ensuring that the Technology workforce is aligned with employer needs and that Central Coast residents are equipped to obtain desirable employment is essential to the health of the sector and the region. This section examines the current structure of the Technology sector workforce, as well as the region's talent pipeline, including an analysis of recent job postings and relevant degrees awarded by Central Coast postsecondary institutions.

WORKFORCE COMPOSITION

The region's Technology sector currently employs nearly 13,000 workers with earnings per job of $151, 861.[12] Just under two-thirds of the workforce (65 percent) is male. The age structure of the regional Technology workforce largely mirrors the sector's statewide workforce, although the share of older workers in the region (those age 55 and above) is slightly higher. The racial and ethnic composition of the sector on the Central Coast is significantly less diverse on average than the state. Roughly 2 out of 3 workers in the sector is White (66 percent), compared with less than one-half of workers in the sector at the state level (47 percent). A demographic overview is provided in Figure 6 (page 15).

Looking at the composition of the sector's workforce by occupational classification, workers in the Computer and Mathematical Occupations group (SOC 15-0000)[13] account for the largest share of Technology jobs, representing 29 percent of regional employment in the sector. When viewed at the detailed occupation level, Software Developers (SOC 15-1252) represent the largest number of positions, accounting for nearly 11 percent of the employment in the sector, followed by Civil Engineers (SOC 17-2051), representing just over 4 percent and Computer and Information System Managers (SOC 11-3021) with roughly 3 percent.

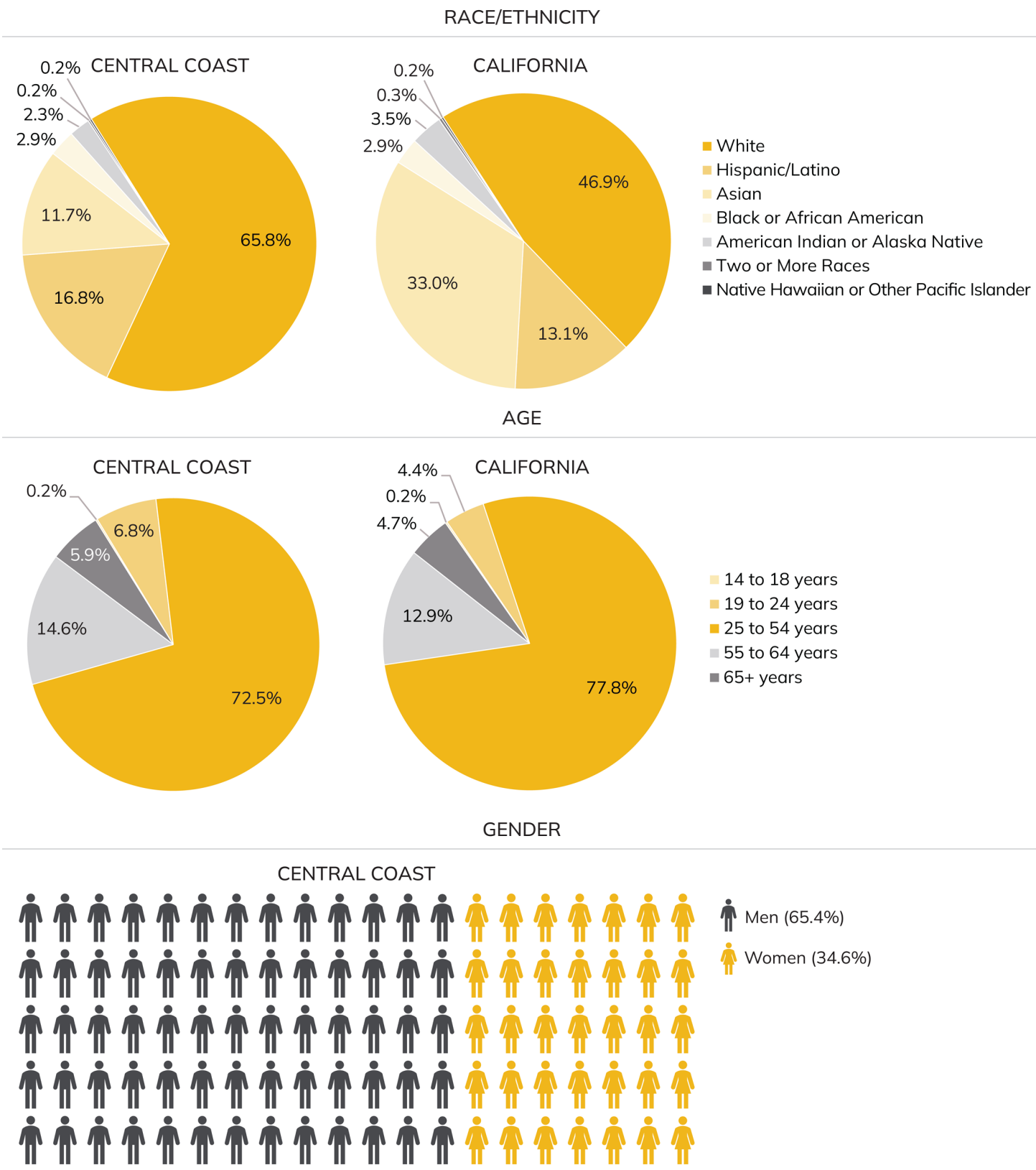
Among the sector's 10 largest occupations, all are expected to experience growth on the Central Coast in the coming years based on Lightcast's projections. Software Developers (SOC 15-1252) is set to experience the largest increase, with a 13.3 percent increase projected between 2022 and 2027. Market Research Analysts and Marketing Specialists (SOC 13-1161) is the only other top 10 occupation projected to see double-digit gains (12.3 percent) during the period.

The majority of the sector's 10 largest occupations require a bachelor's degree as the entry level of education. The exceptions are Computer User Support Specialists (SOC 15-1232), which requires some college, but no degree, and Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel (SOC 41-3091), which typically does not require any formal training beyond a high school diploma or equivalency.

[12] Earnings per jobs is the total industry earnings divided by the number of jobs in the industry. It encompasses a wide range of occupations across all the detailed industries in the sector. As a result, it is not comparable to measures like median hourly earnings, which is calculated for a single occupation or group of related occupations.

[13] Capitalized occupation names and SOC codes shown in this report refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. See Classification Systems (page 40) for more information.

FIGURE 6. DEMOGRAPHIC OVERVIEW OF THE TECHNOLOGY SECTOR



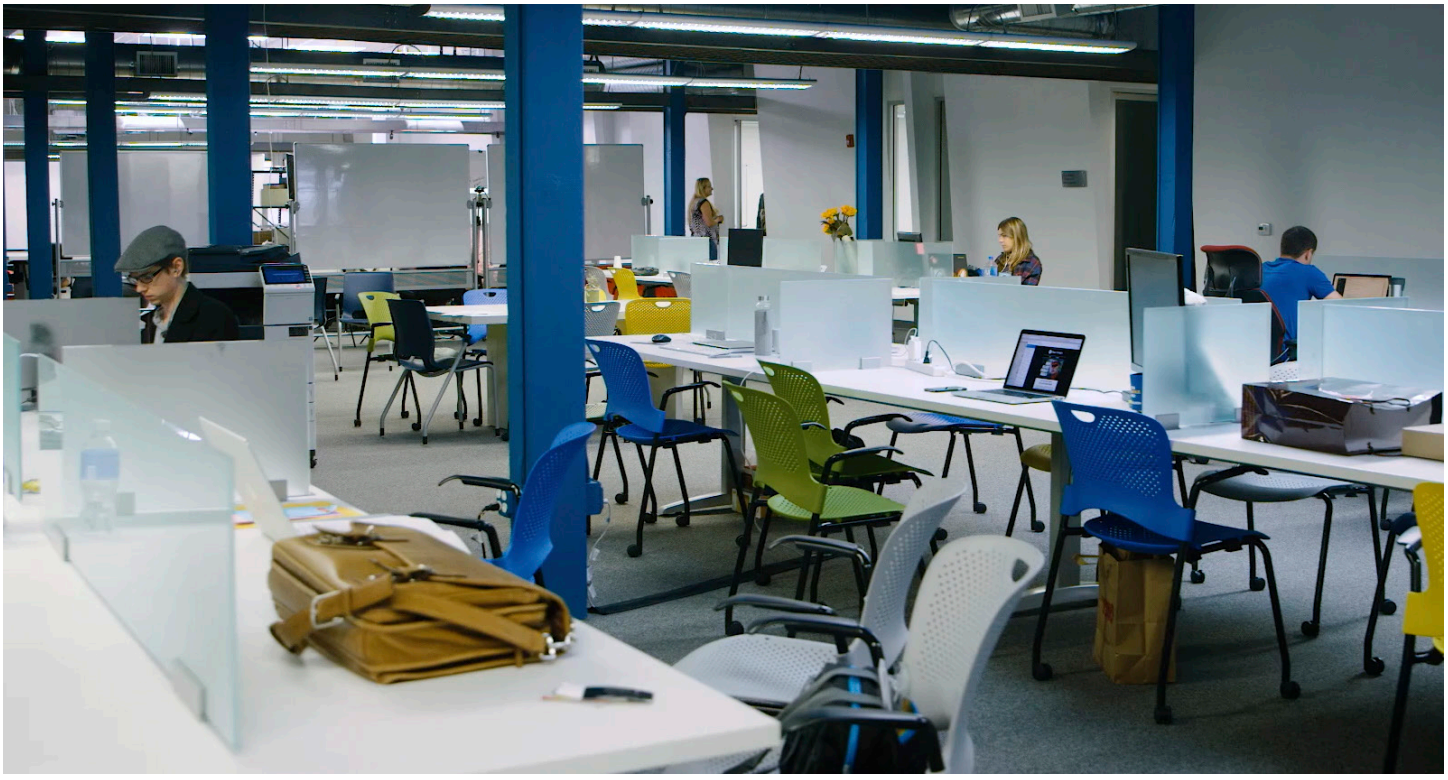
Source(s): Lightcast MR-SAM model, 2022.
Note(s): Totals may not sum to 100 percent due to rounding. Racial and ethnic groups reflect a social interpretation of race or ethnicity based on self-identification.

EMPLOYER DEMAND

An analysis of job postings issued by Central Coast employers over a 12-month period (February 2022 to February 2023) provides a real-time understanding of the skills, qualifications, and educational requirements of the sector. Companies competing for talent in the region based on this analysis include global giants like Google, Intuit, and Stantec as well as locally based successes like AppFolio, Invoca, and Toyon Research Corporation.

Based on the more than 3,500 job postings issued during the period analyzed, demand in the region is largely driven by activities associated with software publishing and computer support services. Among the top 15 occupations in the Technology hiring pipeline—the "in-demand" occupations shown in Figure 7 (page 17)—positions related to software development, sales and marketing, and computer networking and support services dominate.

A look at median hourly earnings in Figure 7 reveals that the majority of the 15 in-demand occupations pay well above the regional median of $20.41, including a variety of management positions. Among the top 15 occupations (based on their share of total unique postings), just three fell below this threshold: Bookkeeping, Accounting, & Auditing Clerks (SOC 43-3031), Secretaries & Administrative Assistants, All Other (SOC 43-6014), and Customer Service Representatives (SOC 43-4051). These three positions are also among the largest of the in-demand occupations in terms of their employment, accounting for more than 10,000 jobs across all industries regionwide. When earnings are compared against living wage standards, the majority of advertised occupations at the time of this analysis paid enough to sustain a household with two adults and two children.[14]



[14] Based on the Living Wage Calculator developed by Dr. Amy K. Glasmeier and the Massachusetts Institute of Technology. At the time of analysis, the living wage on the Central Coast for two adults (one working) with two children was $46.47 per hour.

FIGURE 7. IN-DEMAND OCCUPATIONS IN THE TECHNOLOGY SECTOR
ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023 WITH A COMPARISON TO FIVE-YEAR EMPLOYMENT TRENDS ON THE CENTRAL COAST (2016-2021)

DESCRIPTION	SHARE OF POSTINGS*	2016	2021	PERCENT CHANGE	MEDIAN HOURLY EARNINGS
Software Developers	7.1%	2,381	2,318	-2.6%	**$61.28**
Computer, All Other	3.6%	739	1,058	43.2%	**$43.63**
Sales Reps, Non-Technical & Scientific Products	3.6%	2,308	2,063	-10.6%	**$30.11**
Computer User Support Specialists	3.3%	997	1,015	1.8%	**$28.59**
Marketing Managers	2.7%	379	579	52.8%	**$65.83**
Network & Computer Systems Administrators	2.3%	560	462	-17.5%	**$47.54**
Civil Engineers	2.2%	817	962	17.7%	**$48.28**
Managers, All Other	2.1%	1,207	1,920	59.1%	**$54.86**
Sales Managers	1.9%	1,107	1,491	34.7%	**$51.94**
Human Resources Specialists	1.8%	812	1,369	68.6%	**$34.06**
Information Security Analysts	1.8%	131	222	69.5%	**$51.19**
Bookkeeping, Accounting, & Auditing Clerks	1.7%	4,001	3,729	-6.8%	**$22.80**
Secretaries & Administrative Assistants, All Other	1.7%	5,661	4,115	-27.3%	**$22.19**
Customer Service Representatives	1.5%	2,737	2,607	-4.7%	$18.54
Computer Systems Analysts	1.4%	876	844	-3.7%	**$49.10**
Top Occupations Related to Technology	*38.7%*	*24,713*	*24,754*	*0.2%*	*$44.67*
Central Coast Total Occupations (All Industries)		**342,628**	**356,225**	**4.0%**	**$20.41**

*Share of Central Coast job postings among the 17 detailed industries defining the Technology target in the 12-month period from February 2022 through February 2023.
Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): The top 15 occupations by their share of regional job postings accounting for 38.7 percent of total job postings define the key occupations for the Technology target. Median hourly earnings are in 2021 USD and represent the Central Coast median for the occupation. Shaded values exceed the regional median for all Central Coast occupations.

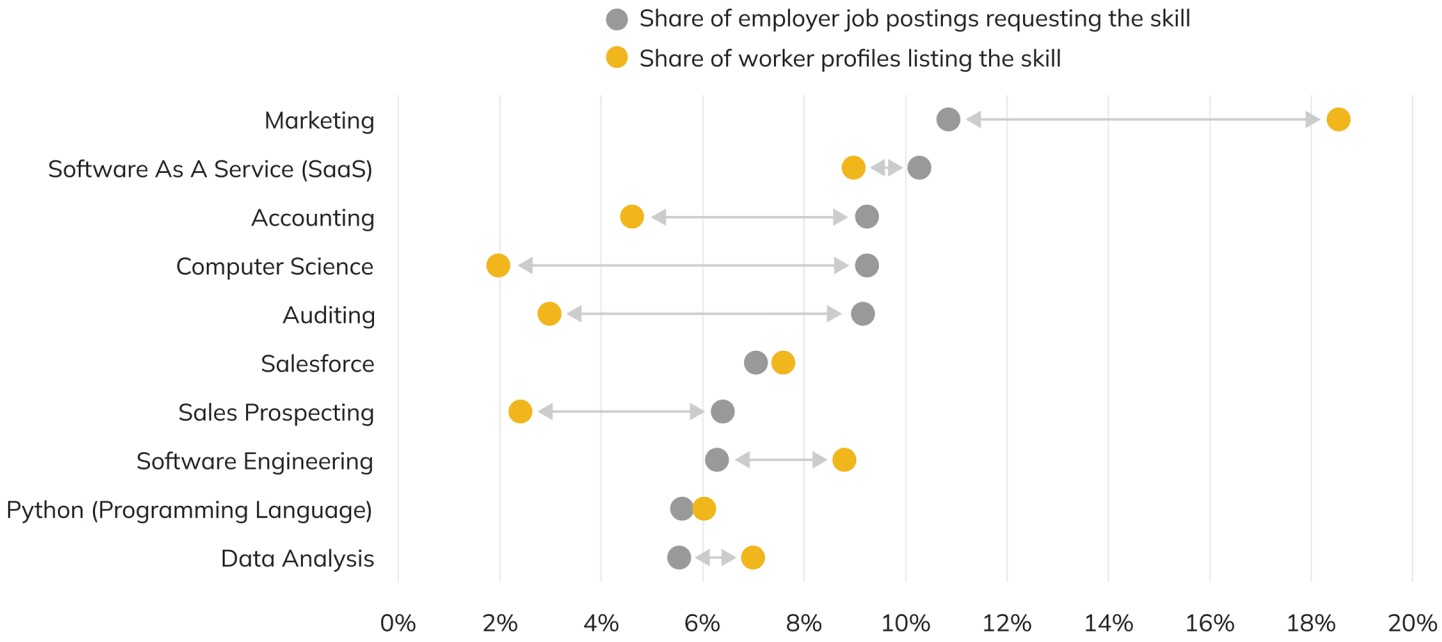
SKILLS & REQUIREMENTS

The top 10 specialized skills sought by Technology employers that are hiring in the region include technology-specific skills like software as a service, software engineering, and Python, along with broad skills such as marketing and sales, accounting, and auditing. A look at skills that are shared across jobs in all sectors reveals a focus on communication skills, problem solving, and time management service, with these and related traits among the most common basic skills listed. After a valid driver's license, the most frequently requested qualifications were linked to security, including various security clearance levels and certifications, such as CompTIA Security. Similar to other sectors, experience with Microsoft Office programs, such as Excel and PowerPoint, were among the general skills requested.

One way to illustrate the gap between the demand for a skill and the supply is to compare job postings (employer demand) with worker profiles (potential workforce). By this measure, several of the Technology sector's in-demand specialized skills are reasonably well aligned with the availability of those skills among the relevant workforce on the Central Coast (Figure 8). Five of the top 10 skills are cited more frequently in relevant workforce profiles than in job postings by Technology sector employers: marketing, Salesforce, software engineering, Python, and data analysis. The remaining comparisons point to gaps between employer demands for specialized skills and the experience of the workforce, with the largest gaps seen in computer science and auditing skills.

FIGURE 8. TOP 10 SPECIALIZED SKILLS IN THE TECHNOLOGY SECTOR RELATIVE TO THEIR AVAILABILITY IN THE WORKFORCE

ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023

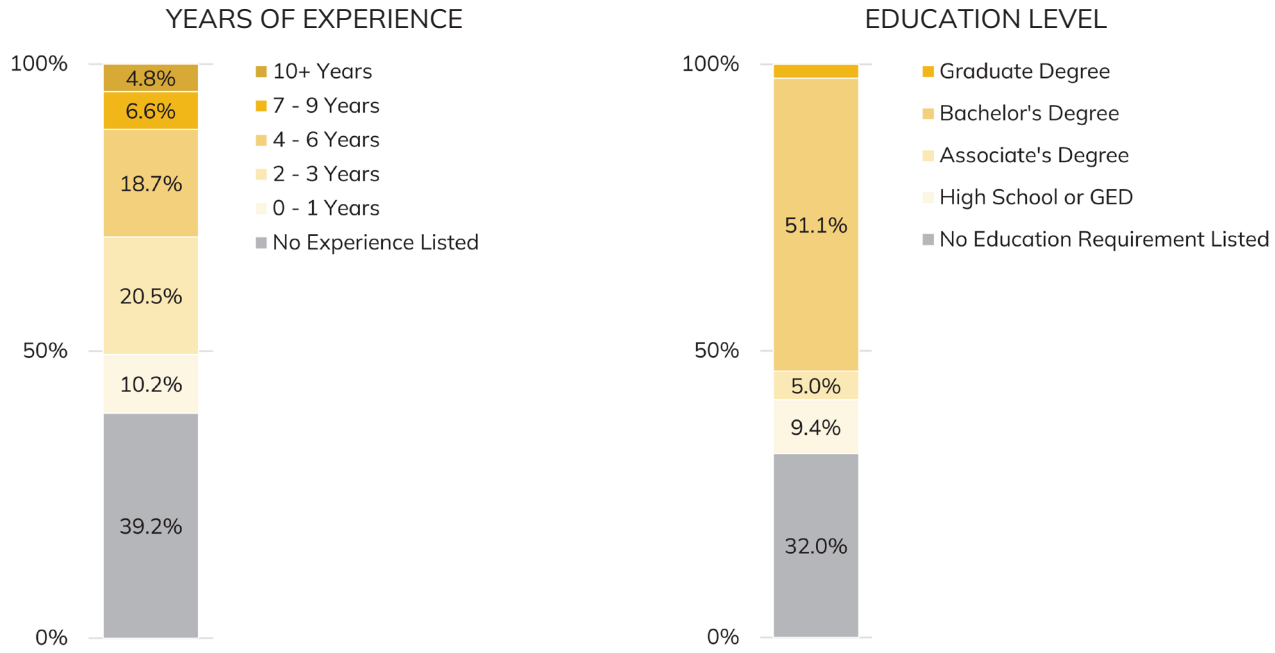


Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

Note(s): Lightcast's worker profiles represent self-reported, publicly available information compiled from sources including third-party resume databases and job boards, the recruiting industry, opt-in data from employers and applicant tracking systems, sales and marketing CRM databases, and various consumer/identity databases. Profiles are standardized, de-duplicated, and normalized by Lightcast to facilitate analysis.

Job postings also provide an understanding of the education and experience levels local employers are seeking. More than one-third (39.2 percent) of positions posted by regional employers in the Technology sector did not require any experience.[15] Slightly less than one-third of postings analyzed did not list any minimum level of education. And roughly one in 10 postings analyzed (9.4 percent) were open to job seekers with a high school diploma or equivalency. However, by far the most common requirement was a bachelor's degree, which was the threshold for entry for slightly more than one-half (51.1 percent) of the Technology sector postings.

FIGURE 9. EMPLOYER REQUIREMENTS: TECHNOLOGY SECTOR
ANALYSIS OF JOB POSTINGS BY SECTOR EMPLOYERS FROM FEBRUARY 2022-FEBRUARY 2023



Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): Incudes non-staffing, unique, active job postings for full-time, part-time, and flexible positions between February 2022 and February 2023. Total may not sum to 100 percent due to rounding.

[15] The lack of stated experience and education requirements in a job posting does not mean that no requirements exist, simply that none were specified.

DEGREES & AWARDS

Central Coast postsecondary institutions granted just over 30,000 degrees and awards for credit[16] in 2021 across all fields of study, with the region's two public universities—UC Santa Barbara and Cal Poly—accounting for nearly one-half (46 percent) of the total. A table showing the full distribution of awards by institution is provided in the appendices (see Figure 20, page 34).

A look at this data for fields of study relevant to the Technology sector illustrates the potential supply of talent. The region's postsecondary institutions issued an average of 550 awards annually in Computer and Information Sciences and Support Services (CIP 11)[17] between 2017 and 2021.[18] Roughly two-thirds of the awards made in this field of study during the most recent academic year were granted by UC Santa Barbara (34.1 percent) and Cal Poly (32.7 percent). The 630 awards granted in this field of study represented just 2 percent of the region's for-credit awards.

Bachelor's degrees and higher comprised the vast majority of Computer and Information Sciences and Support Services awards, accounting for 7 out of every 10 degrees awarded in this field of study during the 2021 academic year. Of the 369 bachelor's degrees awarded during this period, most were issued by either Cal Poly (with 178 bachelor's degrees, or 48 percent of the total awards at this level for CIP 11) or UC Santa Barbara (171 bachelors or 46 percent). Laurus College and Westmont College each issued 10 bachelor's degrees in CIP 11 during the 2021 academic year, representing 3 percent each of the bachelor's degrees in this field of study.

Along with 10 bachelor's degrees, Laurus College awarded 28 associate's degrees[19] in CIP 11 during the 2021 academic year, representing 24 percent of the 116 associate's degrees issued in this field of study during the period. The remaining associate's degrees in CIP 11 granted in academic year 2021 were issued by the region's community colleges: Allan Hancock College (36 associate's degrees), Santa Barbara City College (34), and Cuesta College (18). The three community colleges combined issued 73 awards of less than one year in CIP 11 during the 2021 academic year, distributed as follows: Cuesta College (49 certificates), Allan Hancock College (20), and Santa Barbara City College (4).

Figure 10 (page 21) looks at detailed programs within the broader Computer and Information Sciences and Support Services field of study. These detailed programs include Computer Science (CIP 11.0701), which comprises the majority (69.0 percent) of the awards granted in CIP 11 during the 2021 academic year. Only two other programs—Information Technology (CIP 11.0103) and Computer Support Specialist (CIP 11.1006)—accounted for more than 5 percent of total degrees awarded in the field during the period, representing 6.8 percent and 6.4 percent, respectively.

[16] The federal dataset used in this analysis reports on awards and degrees conferred as part of a formal course of study. Recognized postsecondary credentials (typically designated as certificates eligible to be recorded on a transcript) are also included.
[17] CIP codes, shown in parentheses, refer to the Classification of Instructional Programs (CIP), the framework developed by the National Center for Education Statistics to categorize completions (degrees and awards granted for credit by eligible postsecondary institutions) within broad, generalized categories for tracking and analytical purposes. Additional information on this classification system can be found in the appendices (see Classification Systems, page 40).
[18] Total awards issued in CIP 11 by all Central Coast postsecondary institutions by year with the number shown in parentheses: 2017 (508); 2018 (512); 2019 (539); 2020 (561); 2021 (630).
[19] Associate's degrees include certificates earned in more than one year and less than four.

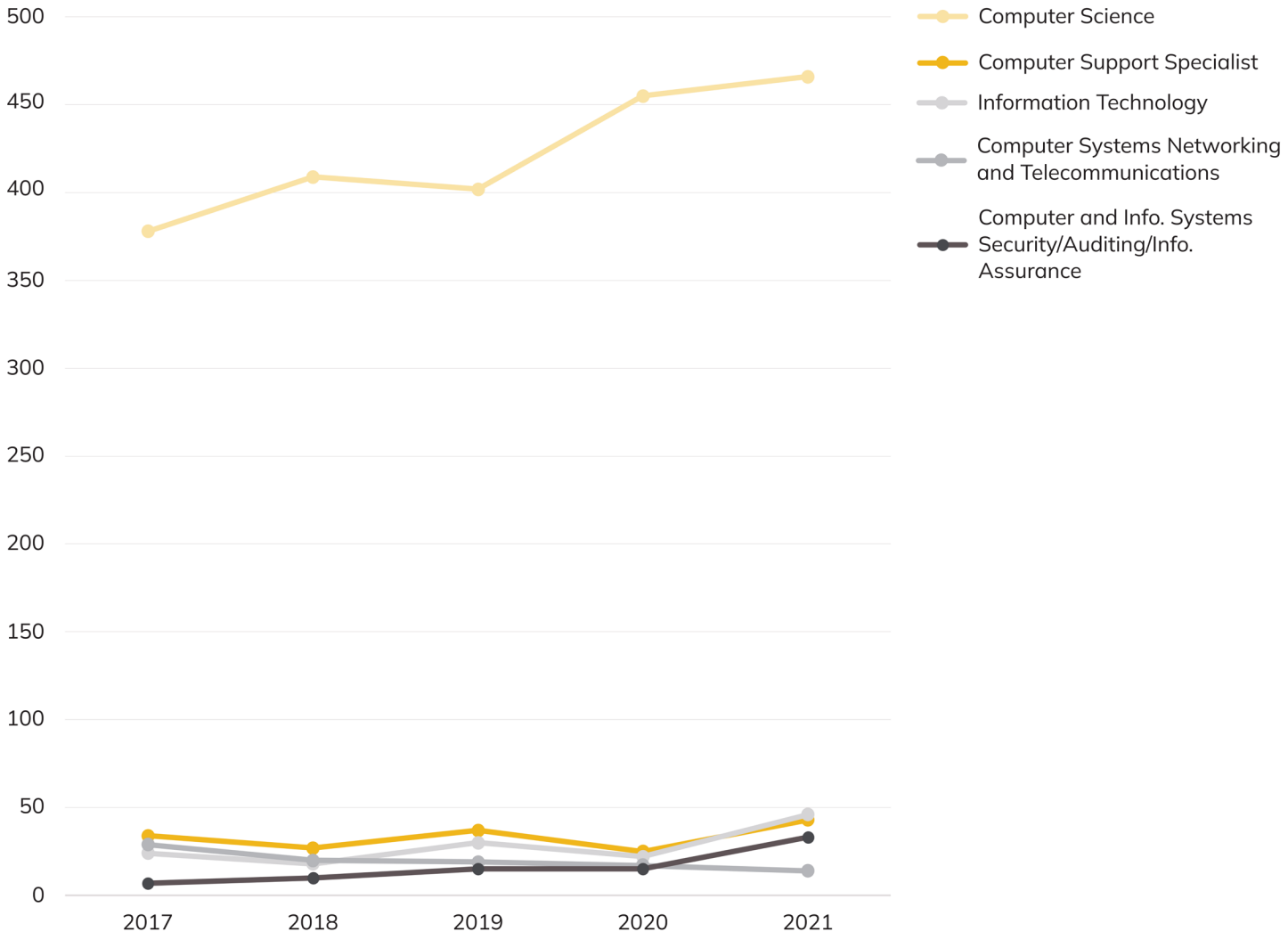
Occupations related to these program areas include the following:

- Computer Occupations, All Other (SOC 15-1299)
- Computer User Support Specialists (SOC 15-1232)
- Computer and Information Systems Managers (SOC 11-3021)
- Computer Systems Analysts (SOC 15-1211)
- Network and Computer Systems Administrators (SOC 15-1244)

Other fields of study that could impact the sector's workforce (with the total number of awards granted in 2021 shown in parenthesis) include Engineering (1,829), Mathematics and Statistics (912), and Physical Sciences (662). Within the broader Engineering classification, awards of particular interest are Computer Engineering, General (152) and Computer Software Engineering (61).

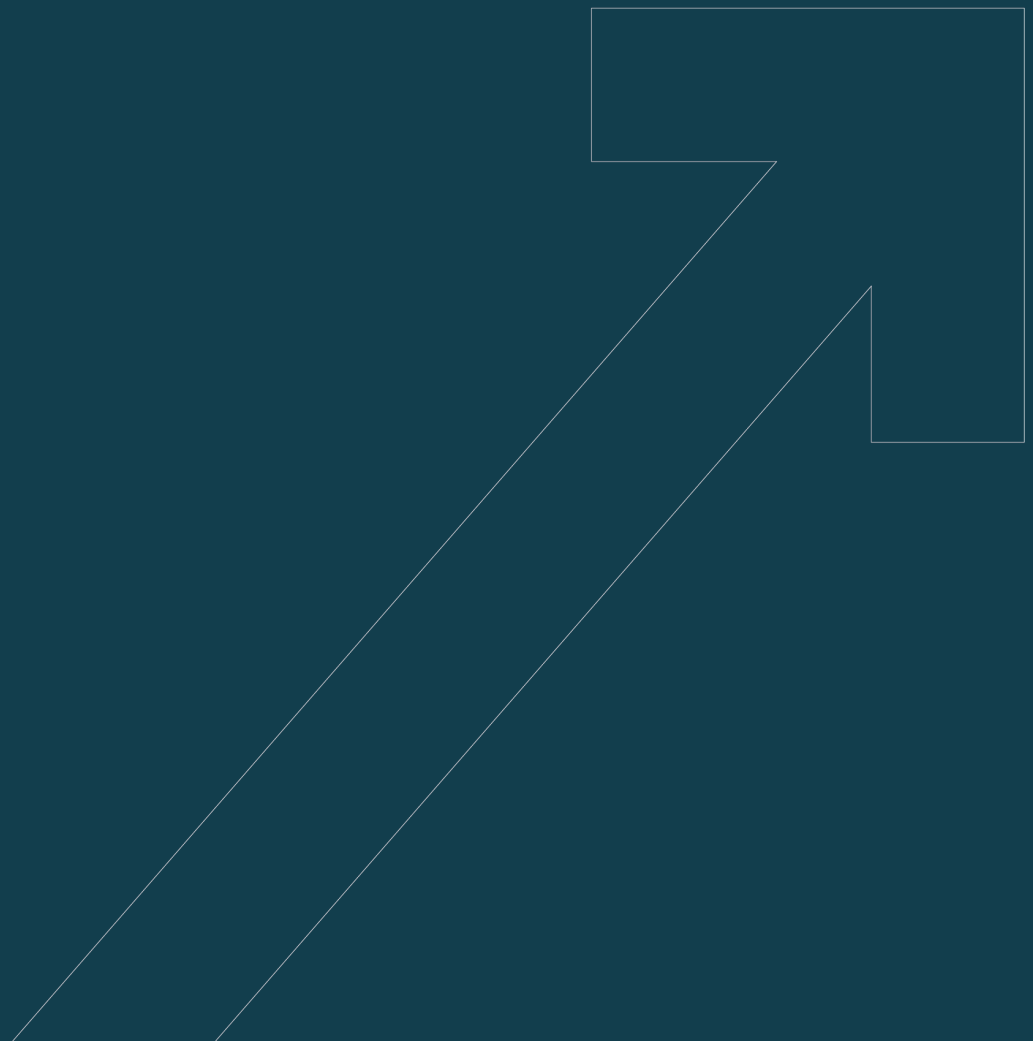
FIGURE 10. AWARDS IN SELECTED COMPUTER AND INFORMATION SCIENCES-RELATED FIELDS OF STUDY, 2017 TO 2021

NUMBER OF AWARDS MADE IN TOP FIVE DETAILED PROGRAM AREAS



Source(s): National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.

ECONOMIC IMPACT



ECONOMIC IMPACT ANALYSIS

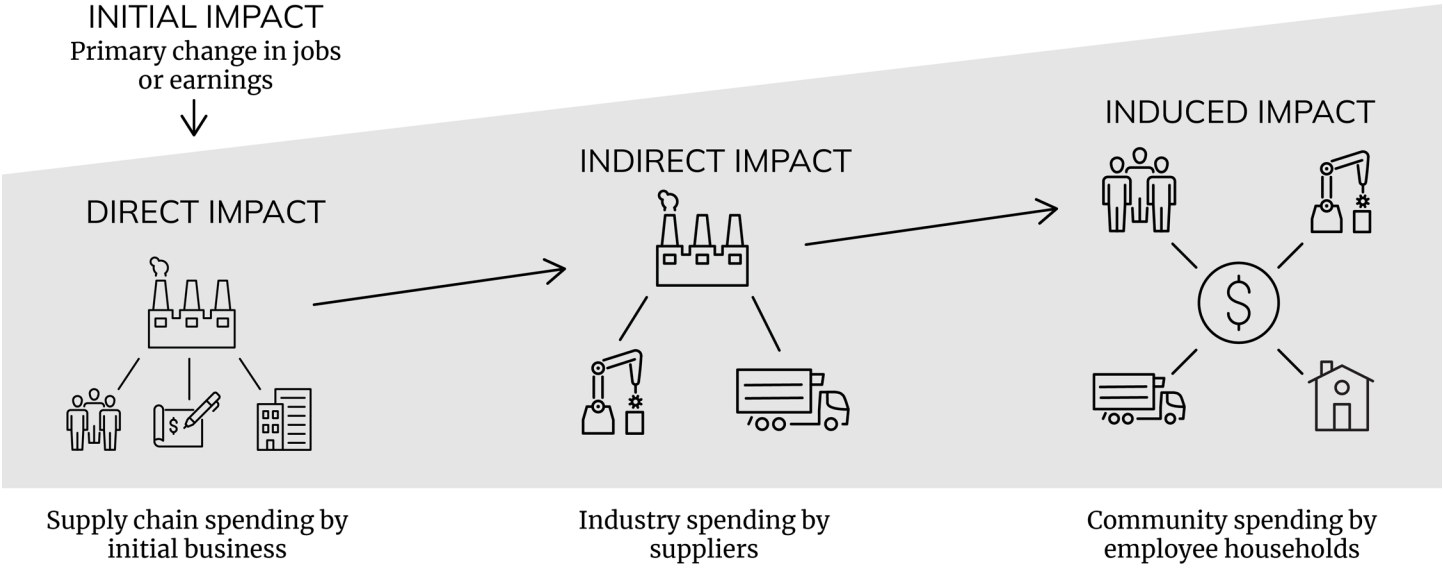
When new businesses are attracted to the Central Coast, or an existing business expands its operations, the regional economy is affected through several mechanisms. These mechanisms include spending on land, buildings, or equipment (capital expenditures); costs associated with hiring workers; revenues generated through the sales of goods and services; and the payment of taxes.

Economic impact analysis provides a tool for understanding how this new economic activity—spending on buildings, equipment, hiring, supplies, materials and so on—ripples through the economy. These ripples occur across all industries in the economy and can be described as one of the following four types of effects:

- **Initial effect.** The initial shock to the economy caused by the initial purchases.
- **Direct effect.** Additional activity that occurs as impacted industries spend money in their supply chain industries.
- **Indirect effect.** Additional shocks as the supply chain industries generate more activity through their inter-industry spending.
- **Induced effect.** Economic activity created by the household sector as businesses raise salaries or hire more people.

Impacts across these four categories can be measured in terms of changes to employment (the number of full- and part-time jobs required to support the change in activity), changes to sales (a measure of the business revenue generated by increased economic activity), and changes to total income (including labor income, or earnings, and non-labor income received from investments). Figure 11 provides an illustration of the types of impacts.

FIGURE 11. ILLUSTRATION OF RIPPLE EFFECTS OF INITIAL ECONOMIC IMPACT
RIPPLE EFFECTS OF INITIAL ECONOMIC IMPACT



Source(s): TIP Strategies, Inc., illustration of Lightcast's economic impact approach.

METHODOLOGY

Economic impact analysis relies on a complex methodology known as input-output (IO) modeling. In simplest terms, IO models use national data on inter-industry relationships to look at how increased demand in one industry translates to economic activity across all industries. Demand is typically stated in terms of increased sales, earnings, or employment in the industry in question. Regardless of the type of demand used in the analysis—sales, earnings, or jobs—the model uses these complex inter-industry relationships to translate the increased demand into economic impacts across those same indicators. In other words, a scenario in which the anticipated demand is stated as an increase in employment can show the estimated impacts in jobs, as well as in sales or earnings. IO analysis also produces multipliers for these indicators that can be used to estimate the potential impact of a future change in economic activity.

IO modeling is often used to run scenarios in order to understand the impact a new employer might have on regional demand for other industries. If an automaker were to build a new manufacturing facility, for example, the affected industries would include inputs from obvious suppliers (like manufacturers of automotive parts, electronic components, and tires) as well as less apparent goods and services (like logistics operators, advertisers, machinery repair services, and property maintenance) along with the purchases made by these suppliers. As might be expected, the extent to which an industry's purchases are made from suppliers in the region or are imported from firms outside the region can have a major influence on its economic impact. As a result, IO models are calibrated to account for this factor.[20]

Each round of spending, first by the automaker (the initial effects), then by its suppliers (the direct effects), and its suppliers' suppliers (the indirect effects) also translates to increased demand for labor, both for the automaker and for companies throughout the supply chain. As illustrated in Figure 11 (page 23), this increased demand for goods, services, and labor ripples across the economy again as workers in all industries spend their earnings at local businesses (the induced effects).

As stated, IO models typically use jobs, earnings, or sales as the starting point for economic impact analysis. In the automotive plant example, the regional economic impact can be modeled based on the number of new jobs created by the automaker, the earnings associated with those new jobs, or the expected sales (calculated from the anticipated number of new vehicles produced annually). Likewise, model results can be reported for those same categories.

Lightcast's analysis of the economic impact of the Technology sector presented in this section measures impacts in terms of the change in jobs and labor income (earnings). While other models focus on sales (or output), Lightcast's IO model, which is described in detail in the appendices, uses income because it provides a more meaningful measure of new economic activity. Unlike sales, which include the costs associated with producing goods and services (such as the cost of labor and materials), income is a net measure that excludes these intermediary costs.[21]

[20] Estimates of in-region and imported purchases for the Central Coast region are provided in Figure 19 (page 33).
[21] The value in this approach is supported by economists' use of gross domestic product when considering the growth of national economies, as this measure represents the final value of goods and services after the costs of goods has been subtracted.

Five-year projections of job growth by detailed industry prepared by Lightcast were used as the starting point to model the Technology sector's economic impact on the Central Coast economy. [22] To reflect the potential contribution that proactive business retention, expansion, and recruitment efforts targeted on the sector could make to regional job growth, Lightcast's proprietary five-year projections were increased by 10 percent.[23] This approach resulted in a total initial figure of 1,353 jobs used to model the sector's direct, indirect, and induced effects on employment and labor income (earnings). Figure 12 provides a summary of the results of this scenario, including an estimate of the change in tax revenues resulting from growth in the sector[24] as well as jobs and earnings multipliers.

RESULTS

Based on Lightcast's analysis, the addition of 1,353 jobs in this sector through 2027 (the initial impact) would result in another 1,872 jobs from direct, indirect, and induced effects, for a total change of 3,224 jobs. The additional employment gain (1,872 jobs) represents the sum of impacts generated by spending in the industry's supply chain (direct), additional purchases in the suppliers' supply chain (indirect), and consumption of goods and services by households of workers in the industry (induced). Stated another way, each job in the Technology sector supports nearly 1.4 additional jobs on the Central Coast, for a total jobs multiplier of 2.38. Likewise, each dollar earned by workers in the sector generates an additional 56 cents in earnings for workers in other sectors (for an earnings multiplier of 1.56). The remainder of this section presents additional details about the impacts.

FIGURE 12. ECONOMIC IMPACT OF THE TECHNOLOGY SECTOR
SCENARIO: PROJECTED JOB GAINS IN THE SECTOR FROM 2022 TO 2027, PLUS 10 PERCENT

EMPLOYMENT & EARNINGS					
	INITIAL	DIRECT	INDIRECT	INDUCED	TOTAL
Jobs (Number)	1,353	610	200	1,062	3,224
Jobs (Multiplier)	1.00	0.45	0.15	0.78	2.38
Earnings (in Millions $US)	$202.59	$38.06	$12.13	$63.36	$316.15
Earnings (Multiplier)	1.00	0.19	0.06	0.31	1.56
TAX REVENUES					
		LOCAL	STATE	FEDERAL	TOTAL
Added Tax Revenues (in Millions $US)		$7.33	$6.40	$4.81	$18.53

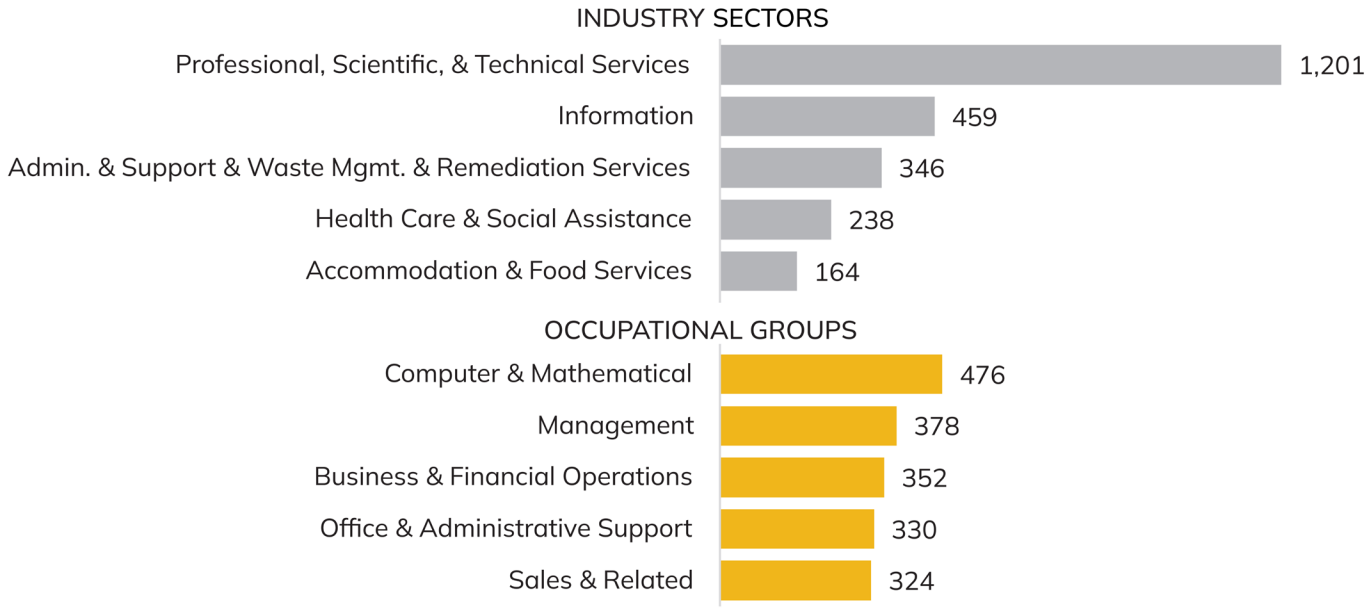
Source(s): Lightcast MR-SAM model, 2022.
Note(s): The model output contains decimal points which are rounded to whole numbers. As a result, figures may not sum to the total shown.

[22] Because Lightcast's IO model captures economic activity at the 6-digit NAICS level, all inputs to the model (jobs, sales, or earnings), must correspond to that industry level. For this work, the initial jobs number represents the sum of the projected job growth, plus 10 percent, for each of the 17 detailed industries included in the Technology sector definition (see Figure 15, page 29). Where industries were projected to lose jobs, Lightcast assumed that all jobs were retained.
[23] Model assumptions, including the 10 percent increase in job growth over initial projections, were determined by Lightcast based on their understanding of economic conditions, expected industry trends, and regional objectives in support of the target sectors.
[24] Data represent taxes on production and imports (TPI). The analysis estimates the tax implications of adding jobs in the sector by measuring the change in local, state, and federal tax revenue through increased industry sales, specifically general sales and property taxes. This change in tax revenue corresponds to the ripple effects of job creation and cannot be tied to a specific timeframe. See the Glossary (page 38) for more information on TPI.

The Technology sector's employment impact stretches across all aspects of the economy. Figure 13 looks at the largest expected change in jobs by industry and occupation. The largest effects from growth in Technology employment are seen in the Professional, Scientific, and Technical Services industry sector (NAICS 54). Of the total job impact estimated in Lightcast's analysis, just over 1,200 jobs (37 percent) are in this sector. The Information sector, with just over 450 jobs, accounts for the next largest share, at roughly 14 percent of the anticipated jobs impact.

When industry impacts are translated to occupations (using Lightcast's regional staffing patterns data), the largest impact is seen in Computer and Mathematical occupations (SOC 15). Impacts on the remaining top five occupational groups are relatively evenly split across a range of business and management occupations. Only about 50 jobs separate the anticipated impacts on Management occupations (SOC 11) and Sales and Related occupations (SOC 41) demonstrating the cross-cutting nature of the sector.

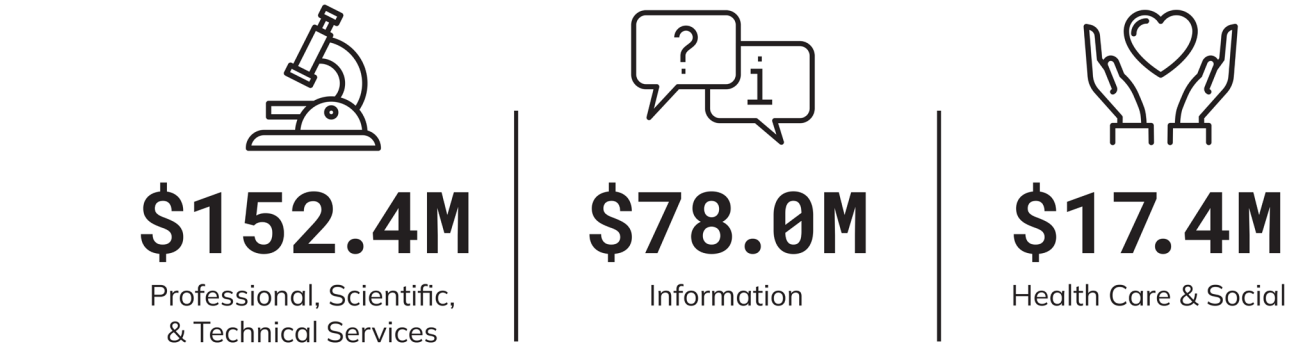
FIGURE 13. LARGEST IMPACTS FROM TECHNOLOGY SECTOR JOB CREATION SCENARIO
TOP FIVE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AND OCCUPATIONAL GROUPS AFFECTED



Source(s): Lightcast MR-SAM model, 2022.

Job growth in the region will also lead to an increase in earnings, thanks to the extra spending of new employees and the ripple effect these purchases create. The increase in Technology jobs in Lightcast's impact scenario would add $316.2 million dollars in earnings to the Central Coast economy. The majority of the earnings impact—more than $152 million, amounting to 48 percent of the total—would occur in the Professional, Scientific, and Technical Services sector (NAICS 54). Additional earnings in Information (NAICS 51) and Health Care and Social Assistance (NAICS 62) round out the three largest contributors to earnings from job creation in the sector. Additional details are provided in the appendices.

FIGURE 14. LARGEST EARNINGS IMPACTS FROM TECHNOLOGY SECTOR JOB CREATION SCENARIO
TOP THREE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AFFECTED



Source(s): Lightcast MR-SAM model, 2022.


Photo courtesy of UC Santa Barbara

APPENDICES

SUPPORTING DETAIL

SECTOR DEFINITION

The table below represents the detailed industries that comprise the definition of the Technology sector agreed upon at the outset of the study. It forms the basis of all analyses and exhibits presented in this report. It is based on the North American Industrial Classification System (NAICS), the framework used by federal agencies to classify business establishments for statistical purposes. The identified industries are mutually exclusive across the sectors analyzed in the four studies (i.e., no detailed industry appears in the definition of more than one sector).

FIGURE 15. INDUSTRIES COMPRISING THE TECHNOLOGY SECTOR
6-DIGIT NAICS LEVEL

NAICS CODE	INDUSTRY
423430	Computer and Computer Peripheral Equipment and Software Merchant Wholesalers
511210	Software Publishers
518210	Data Processing, Hosting, and Related Services
519130	Internet Publishing and Broadcasting & Web Search Portals
519190	All Other Information Services
541330	Engineering Services
541360	Geophysical Surveying and Mapping Services
541370	Surveying and Mapping (except Geophysical) Services
541380	Testing Laboratories
541511	Custom Computer Programming Services
541512	Computer Systems Design Services
541513	Computer Facilities Management Services
541519	Other Computer Related Services
541713	Research and Development in Nanotechnology
541715	Research and Development in the Physical, Engineering, & Life Sciences (except Nanotechnology & Biotechnology)
541720	Research and Development in the Social Sciences & Humanities
541990	All Other Professional, Scientific, and Technical Services

Source(s): REACH; Lightcast; TIP Strategies, Inc.

DETAILED IMPACTS

The following tables provide additional detail regarding the anticipated effects on the Central Coast economy by industry (employment and earnings) and by occupation (employment) associated with Lightcast's economic impact analysis.

FIGURE 16. IMPACT OF TECHNOLOGY JOB CREATION BY INDUSTRY
2-DIGIT NAICS LEVEL

NAICS CODE	INDUSTRY SECTOR	CHANGE IN JOBS
54	Professional, Scientific, and Technical Services	1,201
51	Information	459
56	Administrative and Support and Waste Management and Remediation Services	346
62	Health Care and Social Assistance	238
72	Accommodation and Food Services	164
53	Real Estate and Rental and Leasing	149
81	Other Services (except Public Administration)	125
44	Retail Trade	97
48	Transportation and Warehousing	79
52	Finance and Insurance	77
23	Construction	70
61	Educational Services	50
71	Arts, Entertainment, and Recreation	49
90	Government	44
31	Manufacturing	22
42	Wholesale Trade	21
55	Management of Companies and Enterprises	21
11	Agriculture, Forestry, Fishing and Hunting	9
21	Mining, Quarrying, and Oil and Gas Extraction	2
22	Utilities	2
	TOTAL	**3,225**

Source(s): Lightcast MR-SAM model, 2022.
Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. The model output contains decimal points which were rounded to whole numbers. As a result, figures may not sum to the total shown in Figure 12 (page 25).

FIGURE 17. IMPACT OF TECHNOLOGY JOB CREATION BY OCCUPATION
2-DIGIT SOC LEVEL

SOC CODE	OCCUPATION	CHANGE IN JOBS
15-0000	Computer and Mathematical Occupations	476
11-0000	Management Occupations	378
13-0000	Business and Financial Operations Occupations	352
43-0000	Office and Administrative Support Occupations	330
41-0000	Sales and Related Occupations	324
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	218
35-0000	Food Preparation and Serving Related Occupations	148
53-0000	Transportation and Material Moving Occupations	144
29-0000	Healthcare Practitioners and Technical Occupations	103
31-0000	Healthcare Support Occupations	103
37-0000	Building and Grounds Cleaning and Maintenance Occupations	91
19-0000	Life, Physical, and Social Science Occupations	87
39-0000	Personal Care and Service Occupations	76
17-0000	Architecture and Engineering Occupations	72
25-0000	Educational Instruction and Library Occupations	68
51-0000	Production Occupations	62
47-0000	Construction and Extraction Occupations	60
49-0000	Installation, Maintenance, and Repair Occupations	56
21-0000	Community and Social Service Occupations	25
23-0000	Legal Occupations	20
33-0000	Protective Service Occupations	18
45-0000	Farming, Fishing, and Forestry Occupations	11
99-0000	Unclassified Occupations	2
55-0000	Military-only Occupations	0
	TOTAL	**3,224**

Source(s): Lightcast MR-SAM model, 2022.
Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. SOC codes refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. The model output contains decimal points which were rounded to whole numbers. As a result, figures may not sum to the total shown in Figure 12 (page 25).

FIGURE 18. IMPACT OF TECHNOLOGY JOB CREATION ON INDUSTRY EARNINGS (IN MILLIONS)
2-DIGIT NAICS LEVEL

NAICS	INDUSTRY SECTOR	INITIAL	DIRECT	INDIRECT	INDUCED	TOTAL
54	Professional, Scientific, and Technical Services	$132.41	$11.89	$2.52	$5.56	$152.38
51	Information	$69.82	$4.93	$0.93	$2.30	$77.98
62	Health Care and Social Assistance	$0.00	$0.12	$0.03	$17.24	$17.39
56	Administrative and Support and Waste Management and Remediation Services	$0.00	$10.60	$2.56	$2.22	$15.38
53	Real Estate and Rental and Leasing	$0.00	$3.86	$1.40	$3.18	$8.43
52	Finance and Insurance	$0.00	$0.73	$0.98	$4.65	$6.35
72	Accommodation and Food Services	$0.00	$0.81	$0.52	$4.45	$5.78
23	Construction	$0.00	$0.03	$0.30	$4.59	$4.92
81	Other Services (except Public Administration)	$0.00	$0.74	$0.31	$3.37	$4.42
90	Government	$0.00	$0.26	$0.09	$4.07	$4.41
44	Retail Trade	$0.00	$0.15	$0.08	$4.07	$4.30
55	Management of Companies and Enterprises	$0.00	$1.58	$1.37	$1.17	$4.12
48	Transportation and Warehousing	$0.00	$1.07	$0.35	$1.03	$2.45
42	Wholesale Trade	$0.35	$0.25	$0.11	$1.27	$1.98
31	Manufacturing	$0.00	$0.70	$0.18	$1.05	$1.92
71	Arts, Entertainment, and Recreation	$0.00	$0.22	$0.29	$0.99	$1.51
61	Educational Services	$0.00	$0.09	$0.05	$1.37	$1.51
11	Agriculture, Forestry, Fishing and Hunting	$0.00	$0.02	$0.02	$0.41	$0.45
22	Utilities	$0.00	$0.01	$0.06	$0.25	$0.33
21	Mining, Quarrying, and Oil and Gas Extraction	$0.00	$0.01	$0.01	$0.13	$0.15
	TOTAL	**$202.59**	**$38.06**	**$12.13**	**$63.36**	**$316.15**

Source(s): Lightcast MR-SAM model, 2022.
Note(s): Figures represent detailed outputs from the economic impact modeling process and do not correspond to a specific point in time. NAICS codes refer to the North American Industrial Classification System, the framework used by federal agencies to classify business establishments for statistical purposes. Initial, direct, indirect, and induced impacts may not sum to total due to rounding.

IN-REGION & IMPORTED PURCHASES

In-region and imported purchases are important characteristics of the region's industry composition. In-region purchases describe the purchases a given industry makes from another industry in the region analyzed. Imported purchases describe purchases that occur outside the determined region to meet the local demand. Taken together, these purchases represent the industry's supply chain.

When looking at the Central Coast region, the top three NAICS sectors with the highest percentage of in-region purchases are Real Estate and Rental and Leasing (purchasing 92.3 percent in-region), followed by Accommodation and Food Services (90.7 percent), and Agriculture, Forestry, Fishing and Hunting (83 percent). This level of purchasing indicates the region has the ability to supply most of the demand within those industries. At the other end of the spectrum, sectors with the greatest percentage of imported purchases are Manufacturing, with 81.7 percent of purchases being imported to the region, followed by Utilities (73.9 percent), and Mining, Quarrying, Oil and Gas extraction, (73 percent).

FIGURE 19. IN-REGION AND IMPORTED PURCHASES BY NAICS SECTOR, 2021 (IN MILLIONS)
TOP THREE INDUSTRY SECTORS BY SHARE OF IN-REGION AND IMPORTED PURCHASES ARE **HIGHLIGHTED**

NAICS CODE	PURCHASES FROM	IN-REGION	% IN-REGION	IMPORTED	% IMPORTED	TOTAL
90	Government	$3,849.65	52.1%	$3,545.00	47.9%	$7,394.65
31	Manufacturing	$877.00	18.3%	$3,919.96	**81.7%**	$4,796.96
53	Real Estate and Rental and Leasing	$2,854.07	**92.3%**	$239.29	7.7%	$3,093.35
54	Professional, Scientific, and Technical Services	$1,795.60	62.6%	$1,072.52	37.4%	$2,868.12
52	Finance and Insurance	$1,586.79	56.8%	$1,207.31	43.2%	$2,794.10
56	Administrative and Support and Waste Management and Remediation Services	$1,590.61	69.6%	$693.20	30.4%	$2,283.81
42	Wholesale Trade	$617.53	33.0%	$1,251.67	67.0%	$1,869.20
51	Information	$913.91	51.5%	$860.52	48.5%	$1,774.44
48	Transportation and Warehousing	$441.10	29.6%	$1,050.31	70.4%	$1,491.41
23	Construction	$1,112.68	74.8%	$375.01	25.2%	$1,487.68
55	Management of Companies and Enterprises	$881.68	62.7%	$525.01	37.3%	$1,406.69
22	Utilities	$185.55	26.1%	$525.49	**73.9%**	$711.04
11	Agriculture, Forestry, Fishing and Hunting	$547.39	**83.0%**	$112.10	17.0%	$659.49
44	Retail Trade	$241.49	40.1%	$360.03	59.9%	$601.52
72	Accommodation and Food Services	$383.45	**90.7%**	$39.31	9.3%	$422.76
81	Other Services (except Public Admin.)	$285.46	74.4%	$98.16	25.6%	$383.62
21	Mining, Quarrying, and Oil and Gas Extraction	$100.41	27.0%	$271.48	**73.0%**	$371.90
71	Arts, Entertainment, and Recreation	$96.06	61.6%	$59.77	38.4%	$155.83
62	Health Care and Social Assistance	$92.42	72.8%	$34.62	27.2%	$127.04
61	Educational Services	$46.86	43.6%	$60.63	56.4%	$107.50

Source(s): Lightcast MR-SAM model, 2022.

DEGREES & AWARDS DETAIL

Figure 20 presents the distribution of degrees and awards conferred for credit by the region's institutions of higher education in all fields of study during the 2021 academic year. Roughly one in four awards (26.2 percent) were made by UC Santa Barbara. For Cal Poly, this figure was closer to one in five (19.8 percent). Taken together, the region's three community colleges accounted for nearly one-half (48.7 percent) of all awards.

FIGURE 20. TOTAL AWARDS CONFERRED BY CENTRAL COAST POSTSECONDARY INSTITUTIONS
ALL FIELDS OF STUDY, 2021 ACADEMIC YEAR

INSTITUTION	INSTITUTION (GROUP)	AWARDS	
University of California, Santa Barbara	Public Universities	7,875	26.2%
California Polytechnic State University, San Luis Obispo (Cal Poly)	Public Universities	5,951	19.8%
Cuesta College	Community Colleges	5,408	18.0%
Santa Barbara City College	Community Colleges	4,676	15.5%
Allan Hancock College	Community Colleges	4,577	15.2%
Fielding Graduate University	Specialized Graduate Institutions	356	1.2%
Westmont College	Private Universities	350	1.2%
Pacifica Graduate Institute	Specialized Graduate Institutions	215	0.7%
International Sports Sciences Association	Career & Technical Institutions	142	0.5%
Laurus College	Career & Technical Institutions	129	0.4%
Antioch University-Santa Barbara	Private Universities	127	0.4%
Center for Employment Training-Santa Maria	Career & Technical Institutions	73	0.2%
Design's School of Cosmetology	Career & Technical Institutions	51	0.2%
San Joaquin Valley College-Atascadero	Career & Technical Institutions	47	0.2%
Central California School of Continuing Education	Career & Technical Institutions	41	0.1%
San Joaquin Valley College-Santa Maria	Career & Technical Institutions	38	0.1%
Santa Barbara Business College-Santa Maria	Career & Technical Institutions	32	0.1%
The Santa Barbara and Ventura Colleges of Law at Santa Barbara	Specialized Graduate Institutions	10	0.0%
	TOTAL	**30,098**	**100.0%**

Source(s): National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Only includes general programs with at least 25 average annual completions between 2010 and 2021.

WORKER MIGRATION

A review of migration data by metropolitan statistical area (MSA)[25] shows a trend toward the increased net out-migration[26] of workers in both Central Coast counties. In the San Luis Obispo MSA,[27] this trend is driven by the departure of workers under 25. While this flow is likely skewed by college students, a net flow of nearly 700 workers across education levels departed the county in the second quarter of 2021—the sharpest single-quarter decline in a decade. The overall trend in the Santa Barbara MSA is similarly downward but appears to be less tied to academic calendars. Following an upward trend in net in-migration of workers between 2017 and 2018, strong net out-migration since late 2019 has culminated in several thousand fewer workers in the region.

As shown in Figure 21 (page 36) and Figure 22 (page 37), net flows of workers by industry are fairly balanced in both Central Coast counties. Industry sectors with the strongest net out-migration in both counties also tend to be those with relatively low wages, such as food services, retail trade, and administrative support. Both counties have seen modest net in-migration of healthcare workers.

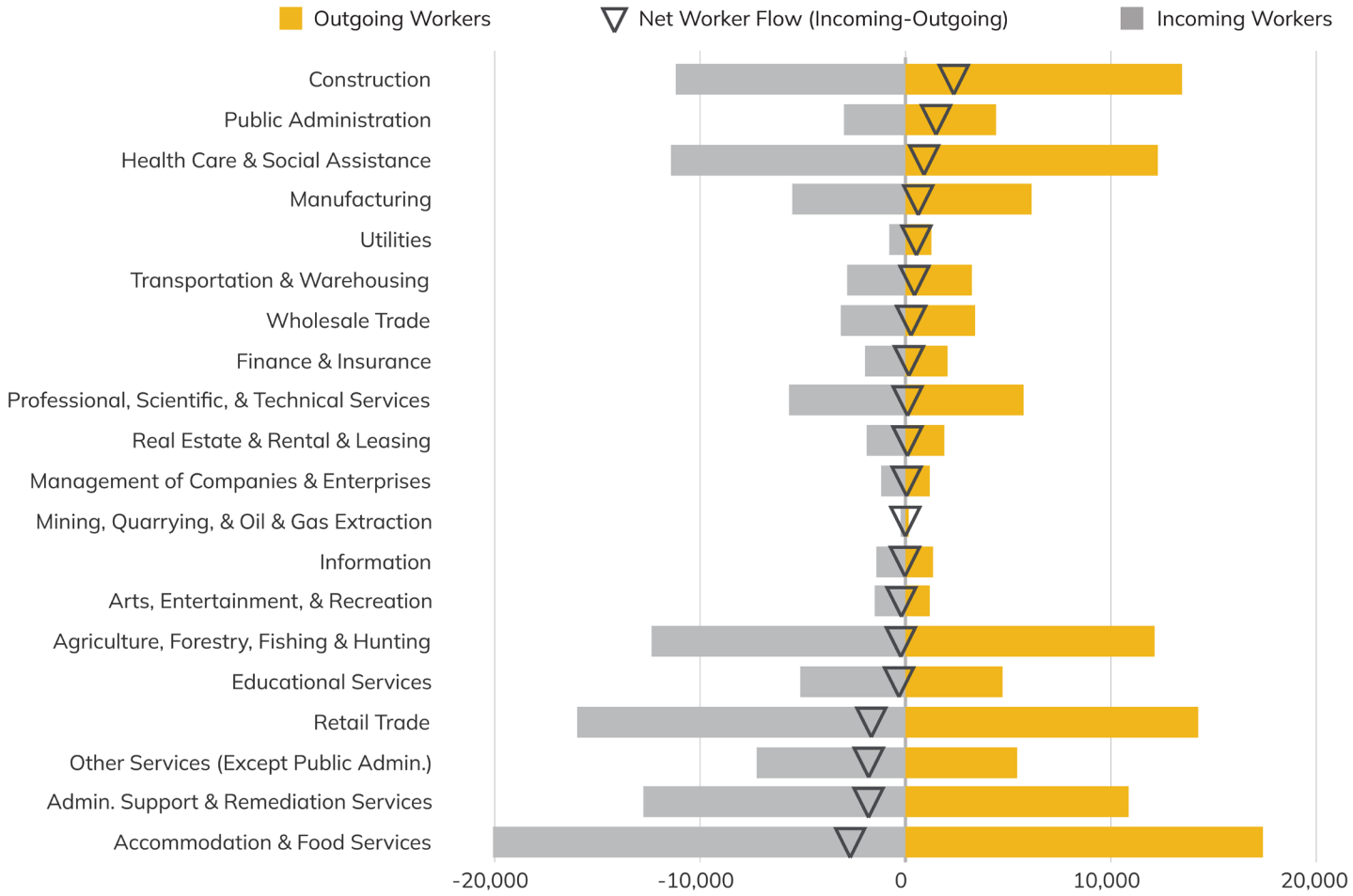
Migration trends in the Information (NAICS 51) and Professional, Scientific and Technical Services (NAICS 54) sectors are instructive for the Technology sector. While trends from quarter to quarter are somewhat volatile, the overall trajectory for the net migration of workers in NAICS 51 has been relatively flat (for the County of San Luis Obispo) or slightly upward (the County of Santa Barbara). With NAICS 54, the opposite pattern is seen. The County of Santa Barbara has experienced largely positive net flows of workers in the sector, while the County of San Luis Obispo has seen a downward trend.

A look at the top destinations for out-migration (regardless of industry) reveals the Central Coast is primarily losing workers to other California locations.

- On balance, the San Luis Obispo MSA tends to lose young workers (those under 25) to San Francisco, San Jose, and San Diego, while gaining workers with less-than-bachelor's education from MSAs including Santa Barbara, Bakersfield, and Los Angeles. Looking at destinations outside California, young workers in the San Luis Obispo MSA are drawn to the Pacific Northwest, Phoenix, or Las Vegas. Young workers from the Santa Barbara MSA migrate to similar areas of California, although Austin and Dallas appear among the top destinations at different points during the period analyzed.
- Migration patterns for young adults in both San Luis Obispo and Santa Barbara are, of course, heavily biased by the presence of Cal Poly and UC Santa Barbara. However, a more even distribution of net out-migration across education levels to San Luis Obispo and San Jose suggests that seasoned workers are leaving the Santa Barbara MSA rather than a trend driven by college-age workers leaving for opportunity, as is seen in San Luis Obispo. Santa Barbara also attracts workers of all education levels from greater Los Angeles.[28]

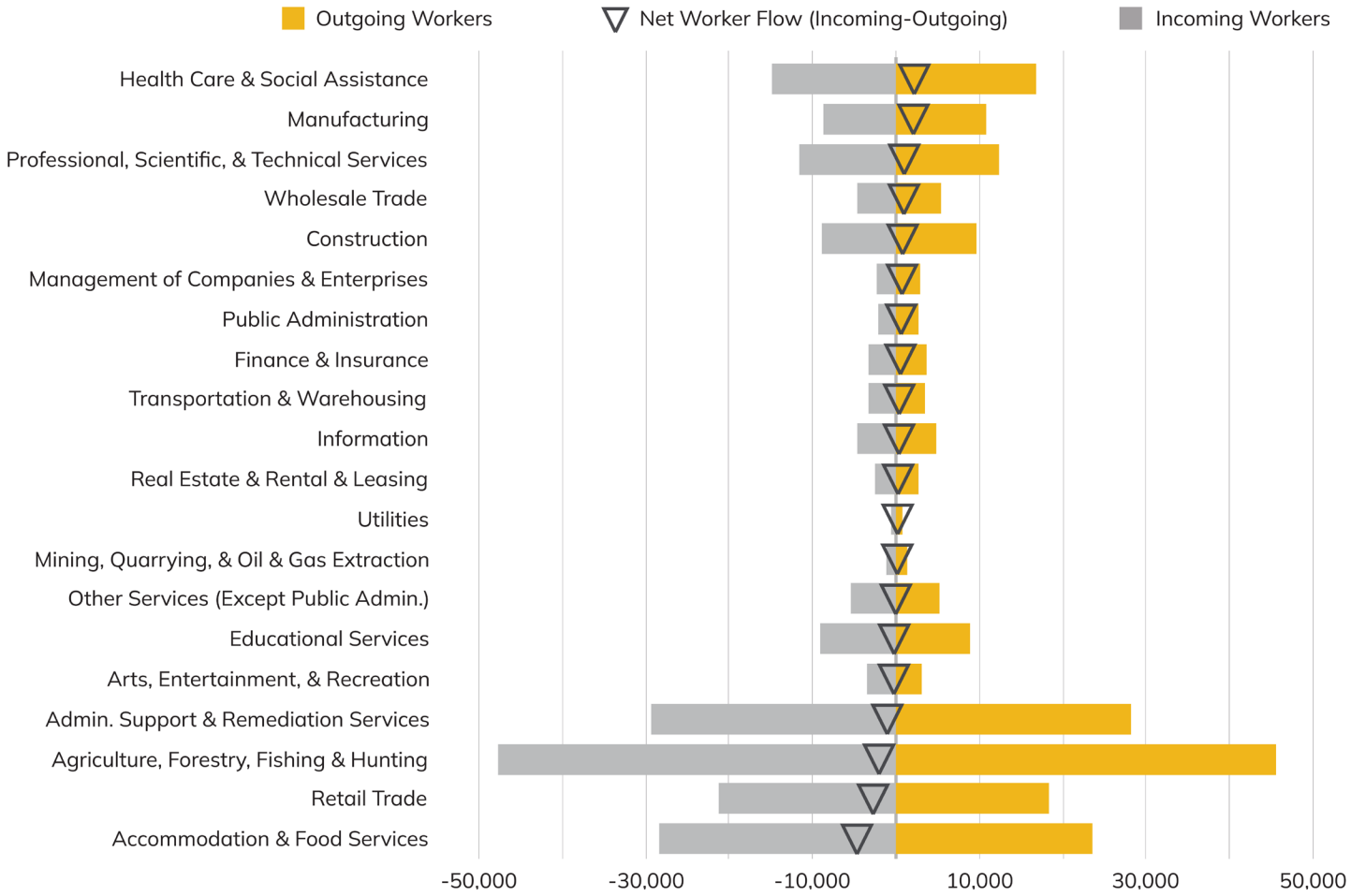
[25] A metropolitan statistical area (MSA) is a designation of the US Office of Management and Budget used by federal statistical agencies. MSAs are composed of one or more counties (or county equivalents, such as parishes) that meet specific thresholds regarding the size of the population and the share living in urban areas, and which have strong economic ties (as illustrated by employment and commuting).
[26] Net out-migration means more workers left jobs inside the region for jobs outside the region.
[27] Informal MSA names are used to improve readability. For example, the San Luis Obispo-Paso Robles, CA, MSA is referred to simply as the San Luis Obispo MSA; Santa Barbara MSA is used rather than Santa Maria-Santa Barbara, CA, MSA.
[28] Including the Oxnard-Thousand Oaks-Ventura, CA, MSA; the Los Angeles-Long Beach-Anaheim, CA, MSA; and the Riverside-San Bernardino-Ontario, CA, MSA.

FIGURE 21. NET FLOW OF WORKERS BY INDUSTRY SECTOR, 2017 Q1 TO 2021 Q4
SAN LUIS OBISPO-PASO ROBLES, CA, MSA



Source(s): US Census Bureau, Longitudinal Employer-Household Dynamics (LEHD), Job-to-Job Flows (J2J); TIP Strategies, Inc.
Note(s): Data include hires and separations of workers between establishments who experienced brief unemployment (one quarter or less). Only establishments with unemployment insurance (UI) covered employees are included. Industry sectors reflect the North American Industry Classification System (NAICS) used by federal agencies to classify businesses.

FIGURE 22. NET FLOW OF WORKERS BY INDUSTRY SECTOR, 2017 Q1 TO 2021 Q4
SANTA MARIA-SANTA BARBARA, CA, MSA



Source(s): US Census Bureau, Longitudinal Employer-Household Dynamics (LEHD), Job-to-Job Flows (J2J); TIP Strategies, Inc.
Note(s): Data include hires and separations of workers between establishments who experienced brief unemployment (one quarter or less). Only establishments with unemployment insurance (UI) covered employees are included. Industry sectors reflect the North American Industry Classification System (NAICS) used by federal agencies to classify businesses.

GLOSSARY

Earnings (labor income)	Income that is received as a result of labor, i.e., wages. It excludes non-work sources of income such as stock dividends or interest, rents, and Social Security.
Earnings per job	Total pre-tax industry earnings divided by the number of jobs in the industry in the same year. Industry earnings consist of two values: wages and salaries (including bonuses, stock options, and severance pay), and supplements (which consists of employer contributions to pension funds; health insurance; and federal, state, and local government programs). Because it is calculated for industries (which encompass a mix of occupations) it is not comparable to occupation-based measures, like median annual wages or median hourly earnings.
Gross state/regional product (GSP/GRP)	Measure of the final value of all goods and services produced in a state after netting out the cost of goods used in production. Alternatively, gross state product (GSP) equals the combined incomes of all factors of production, i.e., labor, land, and capital. These include wages, salaries, proprietors' incomes, profits, rents, and other. GSP is also sometimes called value added or added income. Gross regional product (GRP) represents this same measure for a region.
Imported purchases	The amount of money the selected industry spends on the goods of that industry from suppliers from outside of the selected region.
Income (industry)	Industry income is synonymous with value added gross state product (GSP). Unlike sales, income is a net measure that excludes the cost of production. For this reason, income provides a more meaningful measure of the impact of the sale. *Example:* A bakery sells a loaf of bread for $5.00. The cost of production is $3.00 (i.e., the amount of money spent on ingredients, labor, a portion of space rental and equipment costs, and so on needed to make the loaf of bread), meaning the income derived from the sale is $2.00.
Initial effect	The initial change in jobs or earnings used to model economic impacts. (See page 23 for a discussion of direct, indirect, and induced impacts.)
Input-output analysis	Relationship between a given set of demands for final goods and services and the implied amounts of manufactured inputs, raw materials, and labor that this requires. When institutions pay wages and salaries and spend money for supplies in the state, they also generate earnings in all sectors of the economy, thereby increasing the demand for goods and services and jobs.
In-region purchases	The amount of money the selected industry spends on the goods of that industry from suppliers within the selected region.
Intermediary costs	The costs associated with producing goods and services. Examples include payroll, rent, equipment, and raw materials.

Multiplier effect (earnings)	Additional income created in the economy as employees spend money in the region. It consists of the income created by the supply chain of the industries initially affected by the spending of the employees (i.e., the direct effect), income created by the supply chain of the initial supply chain (i.e., the indirect effect), and the income created by the increased spending of the household sector (i.e., the induced effect).
Multiplier effect (jobs)	Additional employment created in the economy as a result of an initial change in jobs in the sector. It consists of employment created by the supply chain of the industries initially affected by the change in jobs (i.e., the direct effect), employment created by the supply chain of the initial supply chain (i.e., the indirect effect), and employment created by the increased spending of the household sector (i.e., the induced effect).
Net cash flow	Benefits minus costs, i.e., the sum of revenues accruing from an investment minus costs incurred.
Net present value	Net cash flow discounted to the present. All future cash flows are collapsed into one number, which, if positive, indicates feasibility. The result is expressed as a monetary measure.
Non-labor income	Income received from investments, such as rent, interest, and dividends, and other non-work sources (e.g., Social Security).
Sales (or output)	Sales include all the intermediary costs associated with producing goods and services. It differs from income, which nets out (excludes) those costs.
Taxes on production and imports (TPI)	TPI consists of state and local taxes—primarily non-personal property taxes, licenses, and sales and gross receipts taxes—and federal excise taxes on goods and services. Special assessments are also included. It is one of the four components of gross regional product (GRP); the other elements are earnings (labor income), profits/property income, and subsidies.

Source(s): Lightcast; TIP Strategies, Inc.

CLASSIFICATION SYSTEMS

This section provides a brief overview of the three federal classification systems referenced in this report, along with links for more information.

+ The **North American Industry Classification System (NAICS)** is used by federal agencies to classify North American business establishments in order to better collect, analyze, and publish statistical data related to the business economy. The NAICS taxonomy categorizes industries into six levels using codes ranging from 2- to 6-digits as illustrated below. Visit the US Census Bureau NAICS overview page for more information.

  EXAMPLE

  Sector: 23 Construction
  - Subsector: 236 Construction of Buildings
    - Industry Group: 2362 Construction of Nonresidential Buildings
      - NAICS Industry: 23621 Industrial Building Construction
        - National Industry: 236210 Industrial Building Construction

+ The **Standard Occupational Classification System (SOC)** is used by federal agencies to classify workers into occupational categories for statistical purposes. The SOC system classifies occupations at four levels as illustrated in the example below. Visit the US Bureau of Labor Statistics Standard Occupational Classification page to learn more.

  EXAMPLE

  Major group: 51-0000 Production Occupations
  - Minor group: 51-4000 Metal Workers and Plastic Workers
    - Broad occupation: 51-4040 Machinists
      - Detailed occupation: 51-4041 Machinists

+ The **Classification of Instructional Programs (CIP)** was developed by the National Center for Education Statistics (NCES) to categorize completions (degrees and awards granted for credit by eligible postsecondary institutions) within broad, generalized categories for tracking and analytical purposes. It consists of three levels: 1) the two-digit series, 2) the four-digit series, and 3) the six-digit series. As illustrated below, the CIP moves from broad field of study to general instructional area to detailed program area. For more information, visit the NCES CIP User Site.

  EXAMPLE

  14. Engineering
  - 14.09 Computer Engineering
    - 14.0901 Computer Engineering, General
    - 14.0902 Computer Hardware Engineering
    - 14.0903 Computer Software Engineering
    - 14.0999 Computer Engineering, Other

RESOURCES

ECONOMIC IMPACT (LIGHTCAST MODEL)

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- Walczak, Jared, Scott Drenkard. "State and Local Sales Tax Rates, Midyear 2016." Tax Foundation Fiscal Fact no. 515 (July 2016). https://files.taxfoundation.org/legacy/docs/TaxFoundation_FF515.pdf.

BACKGROUND: TRENDS & DIRECTIONS

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- Chang, Andrew, et al., "Industry Top Trends: Technology," S&P Global Ratings, January 2023.
- Fletcher, Ryan, Abhijit Mahindroo, and Jwalit Patel, "Imperatives for photonics companies in the next wave of growth," McKinsey & Company, January 2023.
- National Research Council, *Optics and Photonics: Essential Technologies for Our Nation*, Washington, DC: The National Academies Press, 2013.
- SPIE, "Optics & Photonics Industry Report," Fall 2022 Update.

BACKGROUND: CENTRAL COAST

- General resources for this section include the websites of regional postsecondary institutions (i.e., Cal Poly, UC Santa Barbara, and Cuesta College), Crunchbase, company websites, and local news sources.

LIGHTCAST MR-SAM

Lightcast's Multi-Regional Social Accounting Matrix (MR-SAM) model represents the flow of all economic transactions in a given region. It replaces Lightcast's previous input-output (IO) model, which operated with some 1,000 industries, four layers of government, a single household consumption sector, and an investment sector. The old IO model was used to simulate the ripple effects (i.e., multipliers) in the regional economy as a result of industries entering or exiting the region. The MR-SAM model performs the same tasks as the old IO model, but it also does much more. Along with the same 1,000 industries, government, household and investment sectors embedded in the old IO tool, the MR-SAM exhibits much more functionality, a greater amount of data, and a higher level of detail on the demographic and occupational components of jobs (16 demographic cohorts and about 750 occupations are characterized).

This appendix presents a high-level overview of the MR-SAM. Additional documentation on the technical aspects of the model is available upon request.

DATA SOURCES FOR THE MODEL

The Lightcast MR-SAM model relies on a number of internal and external data sources, mostly compiled by the federal government. What follows is a listing and short explanation of these sources. The use of these data will be covered in more detail later in this appendix.

Lightcast Data are produced from many data sources to produce detailed industry, occupation, and demographic jobs and earnings data at the local level. This information (especially sales-to-jobs ratios derived from jobs and earnings-to-sales ratios) is used to help regionalize the national matrices as well as to disaggregate them into more detailed industries than are normally available.

- **BEA Make and Use Tables** (MUT) are the basis for input-output models in the US. The make table is a matrix that describes the amount of each commodity made by each industry in a given year. Industries are placed in the rows and commodities in the columns. The use table is a matrix that describes the amount of each commodity used by each industry in a given year. In the use table, commodities are placed in the rows and industries in the columns. The BEA produces two different sets of MUTs, the benchmark and the summary. The benchmark set contains about 500 sectors and is released every five years, with a five-year lag time (e.g., 2002 benchmark MUTs were released in 2007). The summary set contains about 80 sectors and is released every year, with a two-year lag (e.g., 2010 summary MUTs were released in late 2011/early 2012). The MUTs are used in the Lightcast MR-SAM model to produce an industry-by-industry matrix describing all industry purchases from all industries.
- **BEA Gross Domestic Product by State** (GSP) describes gross domestic product from the value added (also known as added income) perspective. Value added is equal to employee compensation, gross operating surplus, and taxes on production and imports, less subsidies. Each of these components is reported for each state and an aggregate group of industries. This dataset is updated once per year, with a one-year lag. The Lightcast MR-SAM model makes use of this data as a control and pegs certain pieces of the model to values from this dataset.
- **BEA National Income and Product Accounts** (NIPA) cover a wide variety of economic measures for the nation, including gross domestic product (GDP), sources of output, and distribution of income. This dataset is updated

periodically throughout the year and can be between a month and several years old depending on the specific account. NIPA data are used in many of the Lightcast MR-SAM processes as both controls and seeds.

- **BEA Local Area Income** (LPI) encapsulates multiple tables with geographies down to the county level. The following two tables are specifically used: CA05 (Personal income and earnings by industry) and CA91 (Gross flow of earnings). CA91 is used when creating the commuting submodel and CA05 is used in several processes to help with place-of-work and place-of-residence differences, as well as to calculate personal income, transfers, dividends, interest, and rent.
- **Bureau of Labor Statistics Consumer Expenditure Survey** (CEX) reports on the buying habits of consumers along with some information as to their income, consumer unit, and demographics. Lightcast utilizes this data heavily in the creation of the national demographic by income type consumption on industries.
- **Census of Government's** (CoG) state and local government finance dataset is used specifically to aid breaking out state and local data that is reported in the MUTs. This allows Lightcast to have unique production functions for each of its state and local government sectors.
- **Census' OnTheMap** (OTM) is a collection of three datasets for the census block level for multiple years. All three of these are used in the commuting submodel to gain better estimates of earnings by industry that may be counted as commuting. This dataset has holes for specific years and regions. These holes are filled with Census' Journey-to-Work described later.
  - **Origin-Destination** (OD) offers job totals associated with both home census blocks and a work census block.
  - **Residence Area Characteristics** (RAC) offers jobs totaled by home census block.
  - **Workplace Area Characteristics** (WAC) offers jobs totaled by work census block.
- **Census' Current Population Survey** (CPS) is used as the basis for the demographic breakout data of the MR-SAM model. This set is used to estimate the ratios of demographic cohorts and their income for the three different income categories (i.e., wages, property income, and transfers).
- **Census' Journey-to-Work** (JtW) is part of the 2000 Census and describes the amount of commuting jobs between counties. This set is used to fill in the areas where OTM does not have data.
- **Census' American Community Survey** (ACS) **Public Use Microdata Sample** (PUMS) is the replacement for Census' long form and is used by Lightcast to fill the holes in the CPS data.
- **Oak Ridge National Lab** (ORNL) **County-to-County Distance Matrix** (Skim Tree) contains a matrix of distances and network impedances between each county via various modes of transportation such as highway, railroad, water, and combined highway-rail. Also included in this set are minimum impedances utilizing the best combination of paths. The ORNL distance matrix is used in Lightcast's gravitational flows model that estimates the amount of trade between counties in the country.

OVERVIEW OF THE MR-SAM MODEL

Lightcast's MR-SAM modeling system is a comparative static model in the same general class as RIMS II (Bureau of Economic Analysis) and IMPLAN (Minnesota Implan Group). The MR-SAM model is thus not an econometric model, the primary example of which is PolicyInsight by REMI. It relies on a matrix representation of industry-to-industry purchasing patterns originally based on national data which are regionalized with the use of local data and mathematical

manipulation (i.e., non-survey methods). Models of this type estimate the ripple effects of changes in jobs, earnings, or sales in one or more industries upon other industries in a region.

The Lightcast MR-SAM model shows final equilibrium impacts—that is, the user enters a change that perturbs the economy, and the model shows the changes required to establish a new equilibrium. As such, it is not a dynamic model that shows year-by-year changes over time (as REMI's does).

NATIONAL SAM

Following standard practice, the SAM model appears as a square matrix, with each row sum exactly equaling the corresponding column sum. Reflecting its kinship with the standard Leontief input-output framework, individual SAM elements show accounting flows between row and column sectors during a chosen base year. Read across rows, SAM entries show the flow of funds into column accounts (also known as receipts or the appropriation of funds by those column accounts). Read down columns, SAM entries show the flow of funds into row accounts (also known as expenditures or the dispersal of funds to those row accounts).

The SAM may be broken into three different aggregation layers: broad accounts, sub-accounts, and detailed accounts. The broad layer is the most aggregate and will be covered first. Broad accounts cover between one and four sub-accounts, which in turn cover many detailed accounts. This appendix will not discuss detailed accounts directly because of their number. For example, in the industry broad account, there are two sub-accounts and over 1,000 detailed accounts.

MULTI-REGIONAL ASPECT OF THE MR-SAM

Multi-regional (MR) describes a non-survey model that has the ability to analyze the transactions and ripple effects (i.e., multipliers) of not just a single region, but multiple regions interacting with each other. Regions in this case are made up of a collection of counties.

Lightcast's multi-regional model is built off of gravitational flows, assuming that the larger a county's economy, the more influence it will have on the surrounding counties' purchases and sales. The equation behind this model is essentially the same that Isaac Newton used to calculate the gravitational pull between planets and stars. In Newton's equation, the masses of both objects are multiplied, then divided by the distance separating them and multiplied by a constant. In Lightcast's model, the masses are replaced with the supply of a sector for one county and the demand for that same sector from another county. The distance is replaced with an impedance value that takes into account the distance, type of roads, rail lines, and other modes of transportation. Once this is calculated for every county-to-county pair, a set of mathematical operations is performed to make sure all counties absorb the correct amount of supply from every county and the correct amount of demand from every county. These operations produce more than 200 million data points.

COMPONENTS OF THE LIGHTCAST MR-SAM MODEL

The Lightcast MR-SAM is built from a number of different components that are gathered together to display information whenever a user selects a region. What follows is a description of each of these components and how each is created. Lightcast's internally created data are used to a great extent throughout the processes described below, but its creation is not described in this appendix.

COUNTY EARNINGS DISTRIBUTION MATRIX

The county earnings distribution matrices describe the earnings spent by every industry on every occupation for a year—i.e., earnings by occupation. The matrices are built utilizing Lightcast's industry earnings, occupational average earnings, and staffing patterns.

Each matrix starts with a region's staffing pattern matrix which is multiplied by the industry jobs vector. This produces the number of occupational jobs in each industry for the region. Next, the occupational average hourly earnings per job are multiplied by 2,080 hours, which converts the average hourly earnings into a yearly estimate. Then the matrix of occupational jobs is multiplied by the occupational annual earnings per job, converting it into earnings values. Last, all earnings are adjusted to match the known industry totals. This is a fairly simple process, but one that is very important. These matrices describe the place-of-work earnings used by the MR-SAM.

COMMUTING MODEL

The commuting sub-model is an integral part of Lightcast's MR-SAM model. It allows the regional and multi-regional models to know what amount of the earnings can be attributed to place-of-residence vs. place-of-work. The commuting data describe the flow of earnings from any county to any other county (including within the counties themselves). For this situation, the commuted earnings are not just a single value describing total earnings flows over a complete year but are broken out by occupation and demographic. Breaking out the earnings allows for analysis of place-of-residence and place-of-work earnings. These data are created using Bureau of Labor Statistics' OnTheMap dataset, Census' Journey-to-Work, BEA's LPI CA91 and CA05 tables, and some of Lightcast's data. The process incorporates the cleanup and disaggregation of the OnTheMap data, the estimation of a closed system of county inflows and outflows of earnings, and the creation of finalized commuting data.

NATIONAL SAM

The national SAM as described above is made up of several different components. Many of the elements discussed are filled in with values from the national Z matrix—or industry-to-industry transaction matrix. This matrix is built from BEA data that describe which industries make and use what commodities at the national level. These data are manipulated with some industry standard equations to produce the national Z matrix. The data in the Z matrix act as the basis for the majority of the data in the national SAM. The rest of the values are filled in with data from the county earnings distribution matrices, the commuting data, and the BEA's National Income and Product Accounts.

One of the major issues that affect any SAM project is the combination of data from multiple sources that may not be consistent with one another. Matrix balancing is the broad name for the techniques used to correct this problem. Lightcast uses a modification of the "diagonal similarity scaling" algorithm to balance the national SAM.

GRAVITATIONAL FLOWS MODEL

The most important piece of the Lightcast MR-SAM model is the gravitational flows model that produces county-by-county regional purchasing coefficients (RPCs). RPCs estimate how much an industry purchases from other industries inside and outside of the defined region. This information is critical for calculating all IO models.

Gravity modeling starts with the creation of an impedance matrix that values the difficulty of moving a product from county to county. For each sector, an impedance matrix is created based on a set of distance impedance methods for that sector. A distance impedance method is one of the measurements reported in the Oak Ridge National Laboratory's County-to-County Distance Matrix. In this matrix, every county-to-county relationship is accounted for in six measures: great-circle distance, highway impedance, rail miles, rail impedance, water impedance, and highway-rail-highway impedance. Next, using the impedance information, the trade flows for each industry in every county are solved for. The result is an estimate of multi-regional flows from every county to every county. These flows are divided by each respective county's demand to produce multi-regional RPCs.