DECEMBER 2023

# ECONOMIC IMPACT OF THE CENTRAL COAST CLEAN TECH AND RENEWABLE ENERGY SECTOR

REACH

Ideas + Action for a Thriving Central Coast

# ACKNOWLEDGMENTS

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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.
reachcentralcoast.org

## 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.

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# CONTENTS



# 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 Technology. The work was commissioned by REACH, an independent 501(c)(3) organization committed to creating a more prosperous and inclusive economy in the Counties of San Luis Obispo and Santa Barbara, 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 Clean Tech and Renewable Energy sector, a cluster of activities that encompasses renewable energy sources such as wind, solar, and biomass, as well as industries ranging from battery manufacturing to materials recovery to specialty trade contractors, like electricians, plumbers, and roofers, which play a key role in supporting electrification and the adoption of clean tech solutions.[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 28) in the appendices for the definition of the sector used in this report.

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 Clean Tech and Renewable Energy 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 28) 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 major energy producer with significant infrastructure and innovative capacity to support the Clean Tech and Renewable Energy sector.

As a long-standing energy hub for the state, the Central Coast's power generation and transmission capabilities are notable and diverse and serve as a vital economic driver for the region. The Diablo Canyon Power Plant, located in the County of San Luis Obispo, is the only remaining nuclear power plant operating in California and one of the region's single largest employers. Onshore and offshore fossil fuel facilities and operations hosted in the region have included the Morro Bay Power Plant (closed in 2014) and the Phillips 66 Santa Maria Refinery (closed in early 2023). Along with these manufactured assets, natural factors including its climate and unique coastal geographic features are among the assets that have positioned the region for renewable energy investment. Abundant sunlight makes the Central Coast conducive to utility-scale solar projects like the Topaz Solar Farm on the Carrizo Plain, one of the largest solar power plants in the world, with the capacity to generate 550 megawatts (MW). The federal government held a landmark auction for three leases in the Morro Bay Wind Energy Area off the Central Coast in December 2022, which will set the stage for the first major offshore wind power generation projects on the West Coast.

The University of California, Santa Barbara (UC Santa Barbara) and California Polytechnic State University, San Luis Obispo (Cal Poly) are part of a growing innovation and entrepreneurship ecosystem. Not only do these top-tier institutions support technological advances across multiple industries, but they also draw STEM talent to the region in the form of students, faculty, and researchers. Along with highly ranked engineering programs, each institution facilitates research relevant to the Clean Tech and Renewable Energy sector. Cal Poly's Electric Power Institute concentrates on sponsor-funded clean energy programs and student research projects, while the Irrigation Training and Research Center focuses on water conservation technologies for agricultural uses. The Center for Polymers and Organic Solids at UC Santa Barbara is at work on cost-effective ways to produce solar cells and photovoltaics. The UC Santa Barbara Institute for Energy Efficiency has contributed to energy-saving applications for LED lighting, data center communications, and energy usage in buildings. REACH, Cal Poly, and other regional partners have also collaborated on a

[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.

clean tech innovation vision centered on the co-use/re-use of Diablo Canyon's industrial parcel and the upcoming development of offshore wind.

Central Coast success stories in this sector include the following companies:

- REC Solar, formed in San Luis Obispo, was acquired by Duke Energy and is part of its new Sustainable Solutions division.
- Santa Barbara-based SunHydrogen is at the cutting edge of producing renewable hydrogen through sunlight and water with nanoparticle-based technologies.
- Goleta-based Bardex develops technologies for maritime industries including offshore wind energy.
- Pearce Services, headquartered in Paso Robles, provides operations, maintenance, and engineering services for utility-scale renewable energy infrastructure.

## The $2.3 billion Clean Tech and Renewable Energy sector employs 9,300 workers and has seen significant job growth over the past two decades.

As defined for this work, the Clean Tech and Renewable Energy sector currently employs about 9,300 workers in the region. Over the last two decades, the sector has experienced an increase of roughly 3,700 jobs, with the majority of the job gains occurring in the County of San Luis Obispo. Projections prepared by Lightcast call for a 4 percent increase in Clean Tech and Renewable Energy jobs over 2022 levels by 2027,[3] a pace that mirrors state and national growth rates during the period. Goods and services provided by businesses in the Clean Tech and Renewable Energy sector industries contributed $2.32 billion to the gross regional product (GRP) of $52.3 billion (4.4 percent) in 2022. Within this figure, nuclear power generation was the largest contributor, accounting for 58 percent of the sector's total GRP.

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 1.75 for the sector, meaning that each Clean Tech and Renewable Energy job supports nearly one additional job in the region.[4] 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 job growth in the sector could result in a total of more than 1,216 jobs, $93.42 million in earnings, and $7.88 million in tax revenues when supply chain and household spending impacts are considered.[5]

## The sector has roles requiring advanced education though many lower-wage jobs do not require a 4-year degree.

The Clean Tech and Renewable Energy sector relies on a range of occupations including sales and management jobs, software developers and engineers, and skilled trades and maintenance workers. Training for this diverse mix of job types encompasses a variety of fields of study ranging from architecture and engineering to construction trades to mechanics and repair. Preparation for the range of positions that support the sector is also varied. Of the awards analyzed in these

[3] Lightcast projections are based on historical patterns and do not capture employment associated with recent and planned offshore wind investments.
[4] The employment multiplier of 1.75 for the Clean Tech and Renewable Energy sector includes the initial gain of one job (1.00), plus the estimated employment generated by that new job, which in this case is nearly one additional job (0.75). See Figure 11 (page 22) for an illustration of the ripple effects of job growth.
[5] See Figure 12 (page 24) for details of the analysis.

categories, two-thirds (67 percent) were granted by Cal Poly at the bachelor's degree level or above and were awarded in architecture and engineering-related program areas.

By contrast, an analysis of job postings found that only about 30 percent of the positions most frequently sought by Clean Tech and Renewable Energy employers required a four-year degree or above. Further, two-thirds of postings analyzed (67 percent) either did not list any minimum level of education or were open to job seekers with a high school diploma or equivalency. This finding highlights the fact that many of the sector's largest in-demand occupations have low barriers to entry, such as administrative workers, warehouse workers, general maintenance workers, and customer service representatives. These occupations are also among the lowest paying of the in-demand occupations, however, falling roughly at or below the median hourly wage for all Central Coast occupations. Seven of the 15 in-demand occupations reviewed for this work have seen employment in the region decline during the last five years, including electricians and electronics workers.

Training for the many skilled trades positions that support the Clean Tech and Renewable Energy sector is available through the region's community college partners: Allan Hancock College, Cuesta College, Santa Barbara City College, and organized labor apprenticeship programs. While the number of for-credit awards in construction-related programs is relatively low, formal credentials are less likely to be obtained by this workforce, which often relies on industry-recognized certification, apprenticeships, or on-the-job training. Initiatives such as SLO Partners that connect incumbent workers with upskilling opportunities and raise awareness of career options among students and residents are essential for this sector.

## Regional strengths and opportunities extend to water conservation, sustainable building practices, and environmental consulting.

The region's sustainability mindset is a key foundation for the Clean Tech and Renewable Energy sector. This mindset contributes to the sector's diversity, which touches on identifying solutions for water conservation, sustainable building practices, green product development, and environmental consulting. While power generation and specialty trades represent the sector's largest sources of employment, the Central Coast is also highly specialized in environmental consulting and water supply systems, meaning that employment in these industries exceeds expected levels based on national employment patterns. Environmental consulting represents a small but growing portion of the Clean Tech and Renewable Energy sector, with employment in the industry projected to increase by nearly 14 percent by 2027.

## 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

On September 14, 2020, Spencer Dale, the chief economist of BP, presented the company's much-anticipated annual outlook to a global webinar audience of energy executives. What unfolded was a scenario forecast in which fossil fuel usage was poised to decline over the next three decades, a prediction that must have been shocking to hear from an industry insider. The only real question remaining, according to Dale, was how fast it would happen. The three scenarios he presented—business-as-usual, rapid, and net zero—each showed successively faster velocities of decline in fossil fuel usage. After years of speculation, the inflection point had finally arrived, it seemed, when traditional energy companies realized that change was inevitable, and if they were to survive, their operating model had to begin shifting.[7]

## TRENDS & DIRECTIONS

Announcements like Dale's ushered in a new era. Photovoltaic and wind power are now being complemented by rapid advances in battery storage technologies which had long been a missing component in clean energy's deployment. Demand for electric grid storage (as well as storage for transportation needs) will encourage battery developers to continue seeking higher capacity with greater longevity and lower costs. The energy transition presents new opportunities for employment, from the manufacture of clean energy hardware and components to the operation and maintenance of power generation sites.

While solar and wind technologies are rapidly being deployed, newer and even more sustainable technologies lie just beyond the horizon, including geothermal and hydrogen. Early investments in hydrogen production, for example, have recently been announced, but future R&D work is needed to develop safe, effective ways to transmit, store, and distribute hydrogen.

## CENTRAL COAST

The Central Coast is advancing various forms of clean and renewable energy technologies through its homegrown companies as well as from far-flung corporations that have sought out the region for their fixed investments. For example, the Strauss Wind Energy project (a 27-turbine development) is currently under construction in Lompoc by BayWa r.e., a German renewable energy developer. More recently, Dallas-based Vistra Energy, a developer of power generation sites, is proposing to build a battery storage facility in Morro Bay that would be among the world's largest. Among local companies, Santa Barbara-based SunHydrogen is at the cutting edge of producing renewable hydrogen through sunlight and water with nanoparticle-based technologies, and Goleta-based Bardex develops technologies for maritime industries including offshore wind energy.

The region's research universities provide an intellectual vigor to the emerging clean energy landscape. UC Santa Barbara's Center for Polymers and Organic Solids is at work on cost-effective ways to produce solar cells and photovoltaics. Research emerging from UC Santa Barbara's Institute for Energy Efficiency has contributed to energy-saving applications for LED lighting, data center communications, and energy usage in buildings. Cal Poly's Electric Power Institute concentrates on sponsor-funded clean energy programs and student research projects, and the Irrigation Training and Research Center, one of the university's centers of excellence, focuses on water conservation technologies for agricultural uses.

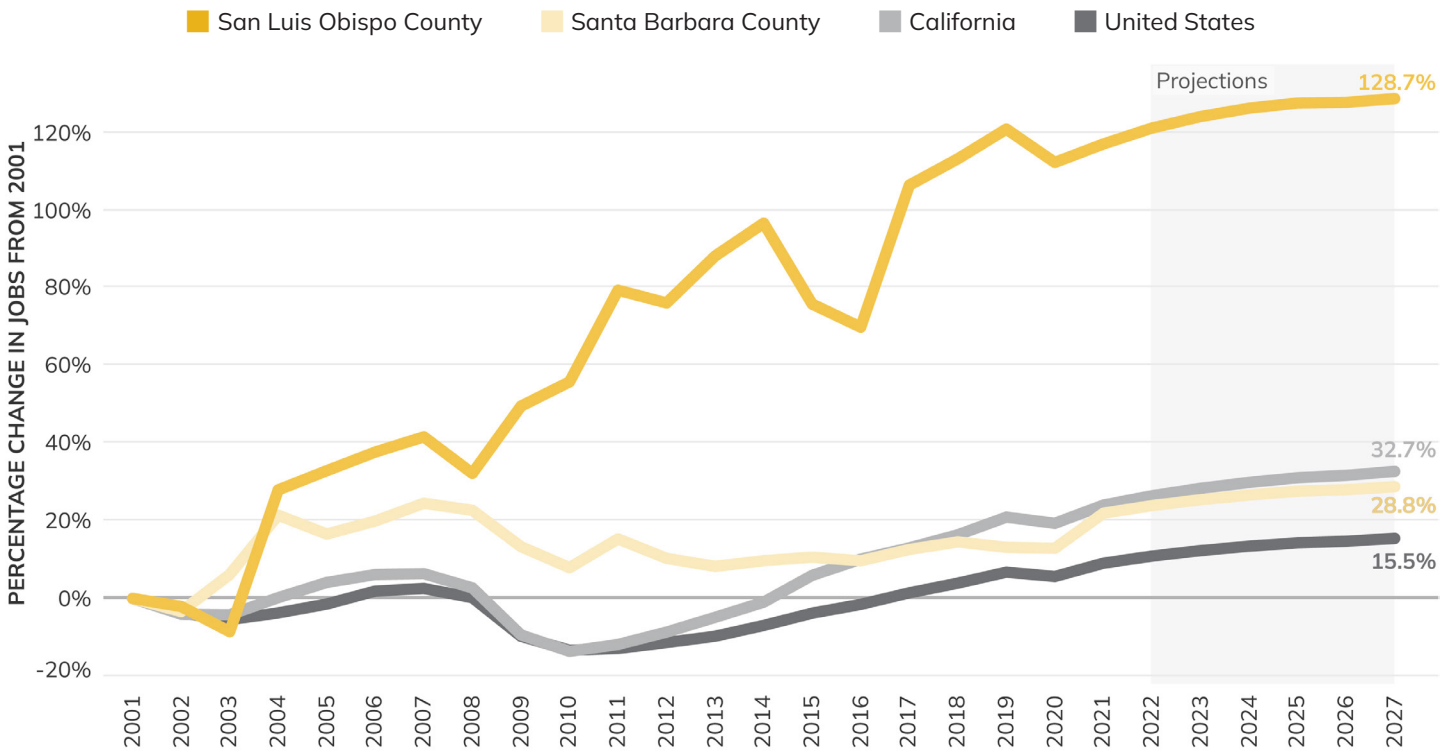
[7] See the appendices for a list of resources that informed this section (Resources, page 41).

# EMPLOYMENT TRENDS

The Clean Tech and Renewable Energy sector accounts for roughly 9,300 jobs in the Central Coast counties, representing nearly 4 percent of the region's total employment. Employment in the sector is roughly evenly divided between the counties, with the County of San Luis Obispo accounting for 59 percent of the total. It encompasses a range of industries, including specialty trades, like plumbing and electrical, and electric power generation from renewable sources.

Over the past two decades, the sector's employment trajectories have differed dramatically between the two Central Coast counties. While employment trends in both counties outpaced the state and US for most of the 2000s, the County of San Luis Obispo diverged sharply from its neighbor around the time of the Great Recession (2007–2009). Over the period analyzed, the County of San Luis Obispo has added three times the number of jobs in this sector as the County of Santa Barbara (roughly 3,000 compared with just under 750). Employment gains in Nuclear Electric Power Generation (NAICS 221113);[8] Power and Communication Line and Related Structures Construction (NAICS 237130); and Plumbing, Heating, and Air-Conditioning Contractors (NAICS 238220) comprised much of the County of San Luis Obispo's growth.

**FIGURE 1. CENTRAL COAST EMPLOYMENT TRENDS IN THE CLEAN TECH AND RENEWABLE ENERGY SECTOR**
WITH COMPARISONS TO THE STATE AND US



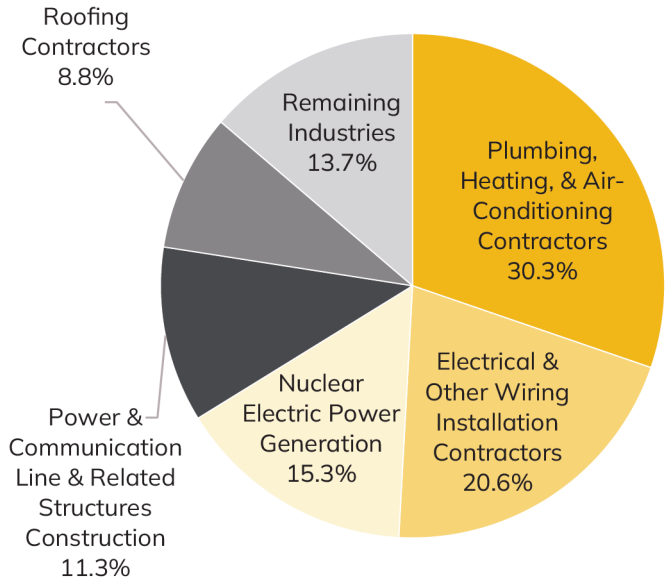

Source(s): US Bureau of Labor Statistics (BLS); Lightcast 2022.4—QCEW Employees, Non-QCEW Employees, and Self-Employed; TIP Strategies, Inc.
Note(s): The Clean Tech and Renewable Energy sector includes 37 detailed industries (6-digit NAICS) which are listed in the appendices.

[8] 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 Clean Tech and Renewable Energy sector, Plumbing, Heating, and Air-Conditioning Contractors (NAICS 238220) and Electrical and Other Wiring Installation Contractors (NAICS 238210) account for roughly one half (51 percent) of the sector's employment. Only two other industries employ more than 10 percent of the sector's workforce in the two counties: Nuclear Electric Power Generation (NAICS 221113) and Power and Communication Line and Related Structures Construction (NAICS 237130), which represent 15 percent and 11 percent, respectively, of total Clean Tech and Renewable Energy employment.

**FIGURE 2. DISTRIBUTION OF CENTRAL COAST EMPLOYMENT IN THE CLEAN TECH AND RENEWABLE ENERGY 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 industries in the sector with at least 100 jobs, the Central Coast is highly specialized in five of them, as shown in Figure 3 (page 11). For this analysis, an LQ of 2.00 or higher was used to denote a very high level of concentration. Only one industry, Nuclear Electric Power Generation (NAICS 221113), met this threshold, with an LQ of 17.45 and just over 1,400 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.

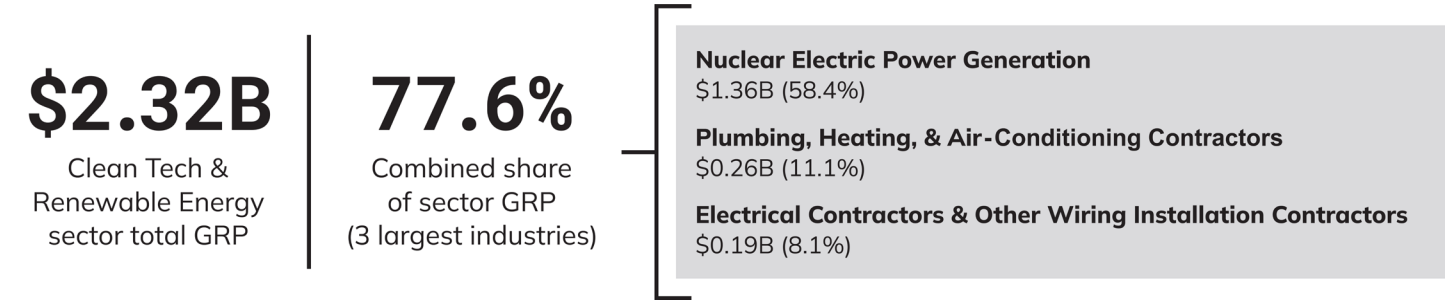
**FIGURE 3. HIGHLY SPECIALIZED INDUSTRIES IN THE CLEAN TECH AND RENEWABLE ENERGY SECTOR**
CENTRAL COAST LQS BY DETAILED INDUSTRY (6-DIGIT NAICS LEVEL)

| NAICS CODE | INDUSTRY | LQ | JOBS |
|---|---|---|---|
| 221113 | Nuclear Electric Power Generation | 17.45 | 1,408 |
| 541620 | Environmental Consulting Services | 1.99 | 404 |
| 221310 | Water Supply & Irrigation Systems | 1.75 | 189 |
| 237130 | Power & Communication Line & Related Structures Construction | 1.69 | 1,035 |
| 238160 | Roofing Contractors | 1.38 | 807 |

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 37 industries that comprise the Clean Tech and Renewable Energy sector contributed $2.32 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, Nuclear Electric Power Generation was by far the largest contributor to Clean Tech and Renewable Energy, representing $1.36 billion or about 58 percent of the sector's total GRP. At the state level, the Clean Tech and Renewable Energy sector as defined for this work added $71.67 billion to the California economy (known as gross state product) in 2022.

**FIGURE 4. GROSS REGIONAL PRODUCT (GRP) IN BILLIONS: CLEAN TECH AND RENEWABLE ENERGY SECTOR**
TOTAL GRP FOR THE SECTOR WITH SHARE REPRESENTED BY TOP THREE INDUSTRIES, 2022

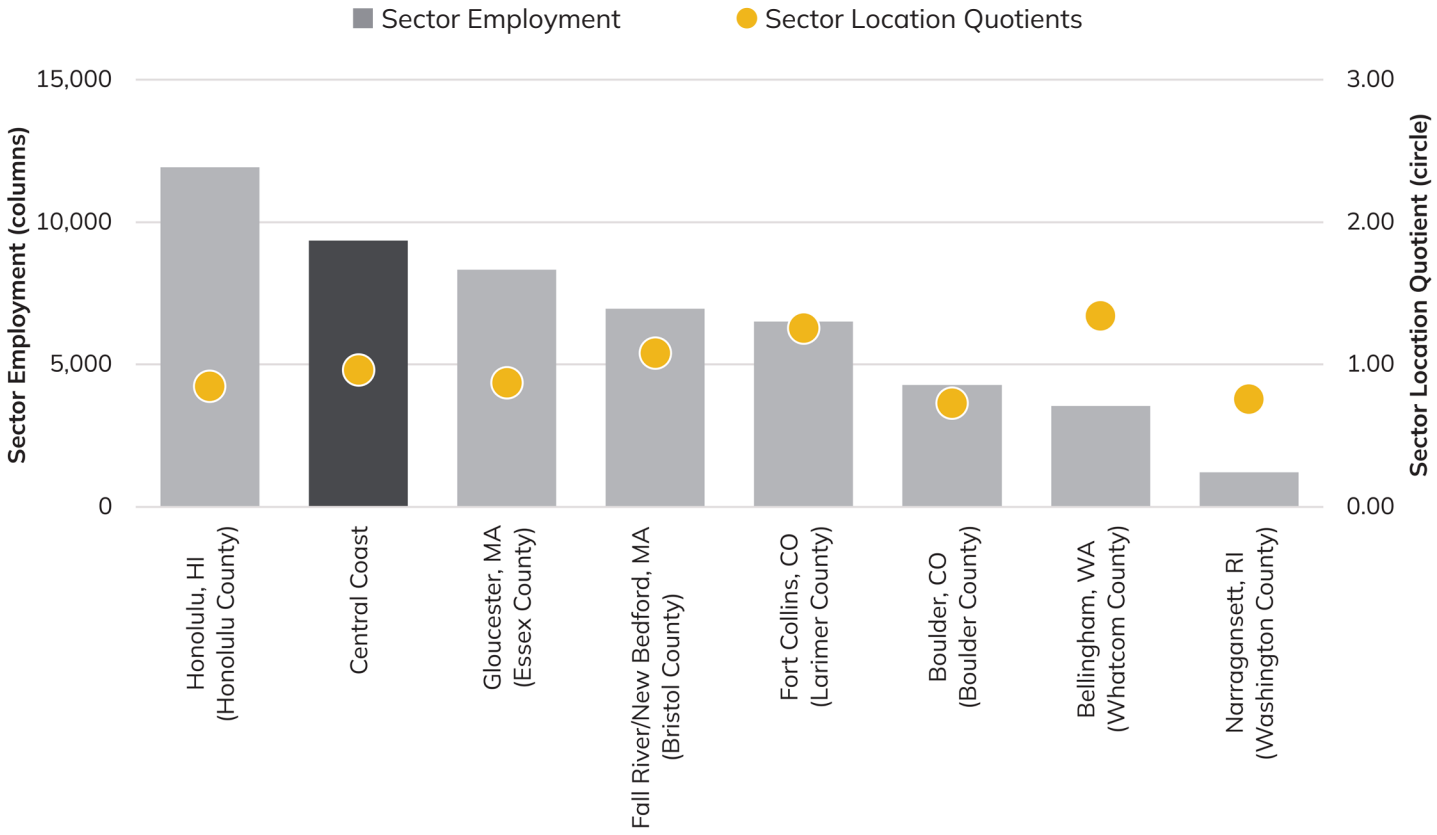



Source(s): Lightcast MR-SAM model, 2022.
Note(s): Total of top three industries may not sum to combined share due to rounding.

# PEER METROS

Jobs created by clean energy R&D, component manufacturing, and deployment for power generation span a wide range of industries, making employment somewhat difficult to measure. By most definitions, however, the Central Coast is a leader in this field. The Central Coast's employment in the nascent clean energy industry exceeds locations where sustainability and the clean tech industry are widely promoted (like Boulder and Fort Collins in Colorado). The region's relatively high levels of employment in the sector are driven by its long history as a center for nuclear power generation. The Central Coast's job levels also exceed coastal locations where offshore wind development and deployment is further advanced, including sites in Massachusetts and Rhode Island. A definition of location quotients (LQs) is featured on page 10.[9]

**FIGURE 5. CLEAN TECH AND RENEWABLE ENERGY 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.

[9] Regional peers were selected by TIP Strategies based on their alignment with business trends, industry development patterns, and academic drivers.

# TALENT PIPELINE

This section examines the current structure of the Clean Tech and Renewable Energy sector workforce, as well as the region's talent pipeline. The latter includes an analysis of recent job postings, a review of relevant degrees awarded by Central Coast postsecondary institutions, and a look at worker migration in associated industry sectors.

## WORKFORCE COMPOSITION

The region's Clean Tech and Renewable Energy sector currently employs roughly 9,300 workers with earnings per job of $113,132.[10] Four out of five workers (81 percent) are male. The age structure of the regional Clean Tech and Renewable Energy workforce largely mirrors the sector's statewide workforce, with roughly two thirds being of prime working age (25 to 54 years old). The racial and ethnic composition of the sector in the Central Coast is significantly less diverse on average than the state. The majority of Clean Tech and Renewable Energy workers in the region are White (58 percent), compared with less than one-half of workers in the sector at the state level (45 percent). A demographic overview is provided in Figure 6 (page 14).

Looking at the composition of the sector's workforce by occupational classification, workers in the Construction and Extraction Occupations group (SOC 47-0000)[11] account for the largest share of Clean Tech and Renewable Energy jobs, representing 39 percent of regional employment in the sector. Workers in this occupational group build homes and other structures, an important point of adoption for clean tech solutions. When viewed at the detailed occupation level, Electricians (SOC 47-2111) represent the largest number of positions, accounting for roughly 1 in 10 jobs in the sector, followed by Plumbers, Pipefitters, and Steamfitters (SOC 47-2152), representing nearly 7 percent. The third largest detailed occupation with 6 percent—Heating, Air Conditioning, and Refrigeration Mechanics and Installers (SOC 49-9021)—is part of the Installation, Maintenance, and Repair Occupations group (SOC 49-0000). Like SOC 47-0000, this group contributes to adoption efforts through the installation and maintenance of clean tech equipment.

Among the sector's 10 largest occupations, all are expected to experience growth in the Central Coast in the coming years based on Lightcast's projections. Electrical Power-Line Installers and Repairers (SOC 49-9051) is set to experience the largest increase, with a 14.2 percent increase projected between 2022 and 2027. Other top 10 occupations projected to see double-digit gains are Heating, Air Conditioning, and Refrigeration Mechanics and Installers (SOC 49-9021), Plumbers, Pipefitters, and Steamfitters (SOC 47-2152) Construction Managers (SOC 11-9021), and Construction Laborers (SOC 11-9021), each of which are anticipated to see between 10 percent and 12 percent growth during the same period.

The majority of the sector's 10 largest occupations require little preparation beyond a high school diploma or equivalency. The exceptions are Construction Managers (SOC 11-9021), which requires a bachelor's degree, and Heating, Air Conditioning, and Refrigeration Mechanics and Installers (SOC 49-9021), which typically requires some postsecondary training, but not a degree.

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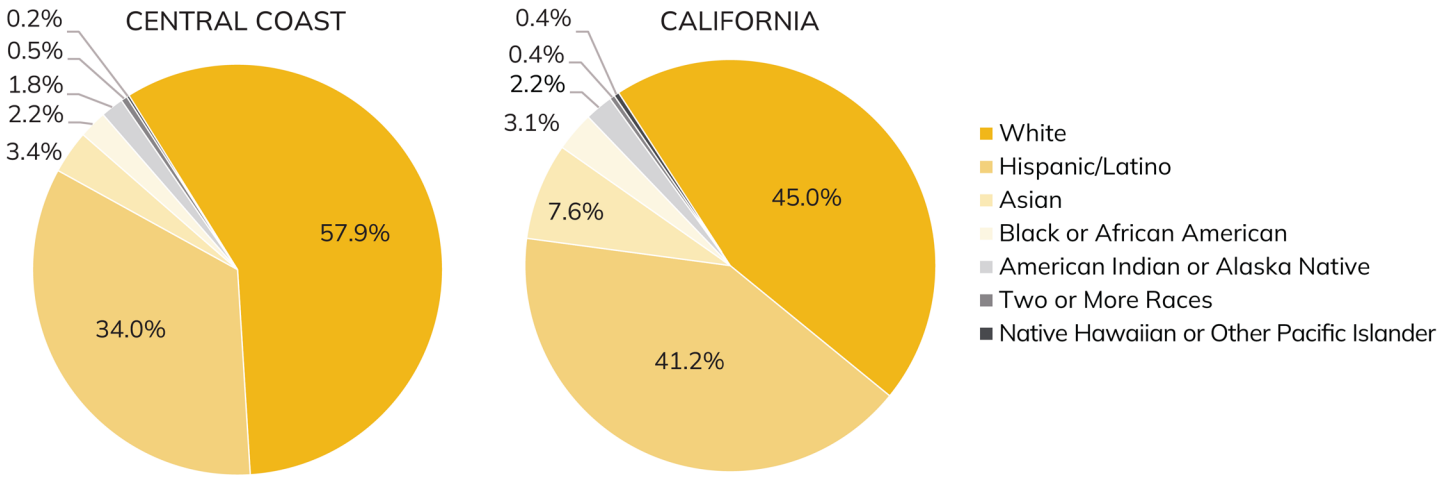
[10] Earnings per jobs is the total industry earnings divided by the number of jobs in the industry. It encompasses a wide range of occupations across all the detailed industries in the sector. As a result, it is not comparable to measures like median hourly earnings, which is calculated for a single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

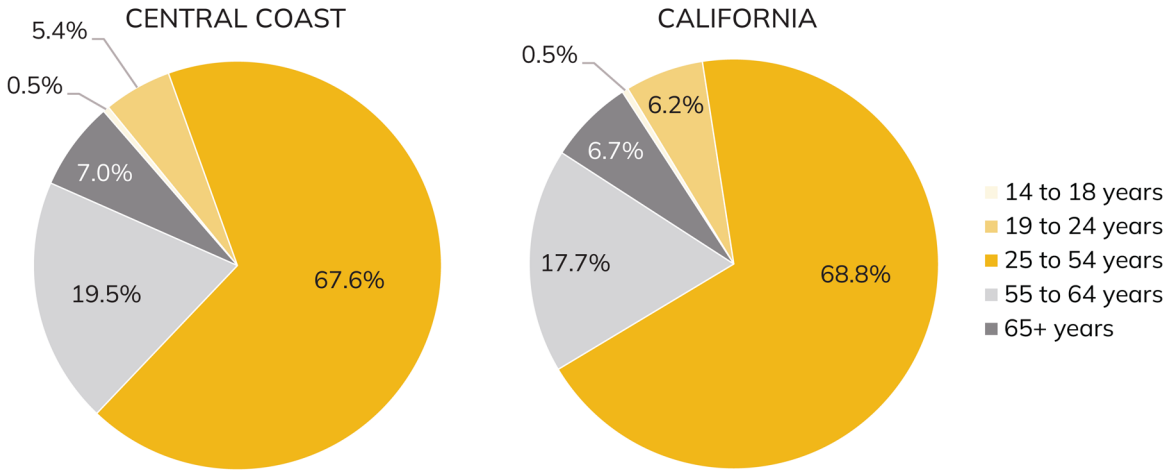
[11] Capitalized occupation names and SOC codes shown in this report refer to the Standard Occupational Classification system, the framework used by federal agencies to classify workers into occupational categories for statistical purposes. See Classification Systems (page 40) for more information.

**FIGURE 6. DEMOGRAPHIC OVERVIEW OF THE CLEAN TECH AND RENEWABLE ENERGY SECTOR**

RACE/ETHNICITY




AGE




GENDER


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 utilities (PG&E and Southern California Edison), environmental and sustainability consultancies (ERM, Dudek, and Endemic Environmental Services), solar installers (Sunrun), facilities services companies (ABM Industries), and industrial waste management service providers (Safety-Kleen).

The roughly 1,300 job postings issued in the Clean Tech and Renewable Energy sector during the period analyzed reflect this mix of employers. The top 15 occupations in the sector's hiring pipeline—the "in-demand" occupations shown in Figure 7 (page 16)—encompass a broad range including sales and management jobs, software developers and engineers, and skilled trades and maintenance workers.

A look at median hourly earnings in Figure 7 reveals the majority of in-demand occupations pay well above the Central Coast median of $20.41, including positions in management, software development, engineering, and science. Among the top 15 occupations (based on their share of total unique postings), just three fell below this threshold: Laborers & Material Movers, Hand (SOC 53-7062), Merchandise Displayers & Window Trimmers (SOC 27-1026), and Customer Service Representatives (SOC 43-4051). When earnings are compared against living wage standards, the majority of advertised occupations at the time of this analysis offered the opportunity to earn enough to sustain a household with two adults and two children.[12]

[12] 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 CLEAN TECH AND RENEWABLE ENERGY 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 |
|---|---|---|---|---|---|
| Sales Reps, Non-Technical & Scientific Products | 3.5% | 2,308 | 2,063 | -10.6% | **$30.11** |
| Managers, All Other | 3.2% | 1,207 | 1,920 | 59.1% | **$54.86** |
| Laborers & Material Movers, Hand | 2.6% | 3,452 | 6,887 | 99.5% | $18.12 |
| Construction Managers | 2.4% | 951 | 1,254 | 31.9% | **$40.20** |
| Software Developers | 2.3% | 2,381 | 2,318 | -2.6% | **$61.28** |
| Customer Service Representatives | 2.2% | 2,737 | 2,607 | -4.7% | $18.54 |
| Secretaries & Administrative Assistants, All Other | 2.0% | 5,661 | 4,115 | -27.3% | **$22.19** |
| Project Management Specialists | 2.0% | 712 | 1,339 | 88.1% | **$42.34** |
| Electrical & Electronic Engineering Technicians | 1.9% | 458 | 334 | -27.1% | **$36.21** |
| First-Line Supervisors, Construction & Extraction | 1.7% | 1,153 | 1,437 | 24.6% | **$36.03** |
| Maintenance & Repair Workers, General | 1.6% | 3,172 | 3,312 | 4.4% | **$22.32** |
| Merchandise Displayers & Window Trimmers | 1.6% | 217 | 257 | 18.4% | $17.26 |
| Biological Scientists, All Other | 1.4% | 104 | 147 | 41.3% | **$42.49** |
| Mechanical Engineers | 1.4% | 554 | 499 | -9.9% | **$45.58** |
| Electricians | 1.3% | 1,266 | 1,178 | -7.0% | **$29.03** |
| *Top Occupations Related to Clean Tech & Renewable Energy* | *31.1%* | *26,333* | *29,667* | *12.7%* | *$35.04* |
| **Central Coast Total Occupations (All Industries)** | | **342,628** | **356,225** | **4.0%** | **$20.41** |

*Share of Central Coast job postings among the 37 detailed industries defining the Clean Tech and Renewable Energy 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 31.1 percent of total job postings define the key occupations for the Clean Tech and Renewable Energy 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.

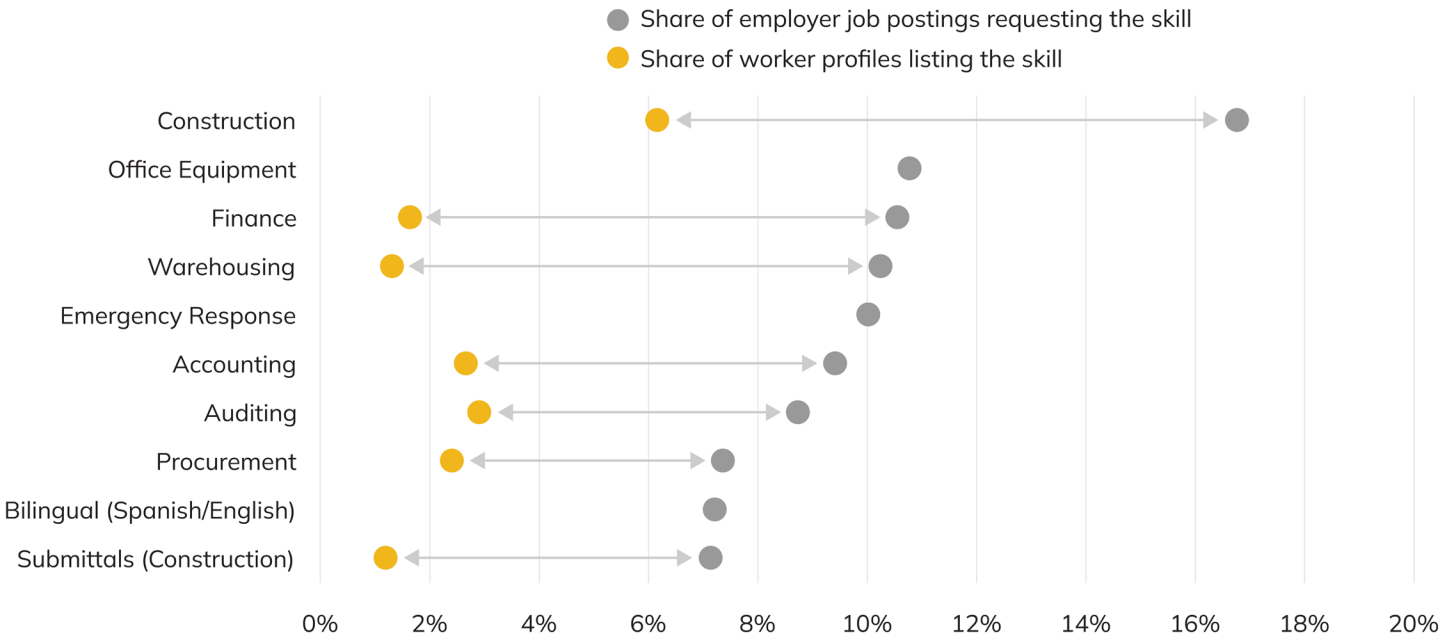
# SKILLS & REQUIREMENTS

The top 10 specialized skills sought by Clean Tech and Renewable Energy employers that are hiring in the region include construction and warehousing, as well as a range of business and financial skills such as accounting, auditing, and procurement. A look at basic skills that are shared across jobs in all sectors reveals a range of traits being requested by employers including communication; management, operations, and planning; leadership and problem-solving; and customer services and sales. After a valid driver's license, the most frequently requested qualifications were a professional engineer (PE) license, cardiopulmonary resuscitation (CPR) certification, and journeyman lineman certification. 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 Clean Tech and Renewable Energy sector's in-demand specialized skills are not well aligned with the availability of those skills among the relevant workforce in the Central Coast (Figure 8). For those skills where profile information is available, the demand for the skill in job postings by Clean Tech and Renewable Energy sector employers exceeds the availability of the skill by a wide margin.

**FIGURE 8. TOP 10 SPECIALIZED SKILLS IN THE CLEAN TECH AND RENEWABLE ENERGY SECTOR RELATIVE TO THEIR AVAILABILITY IN THE WORKFORCE***

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



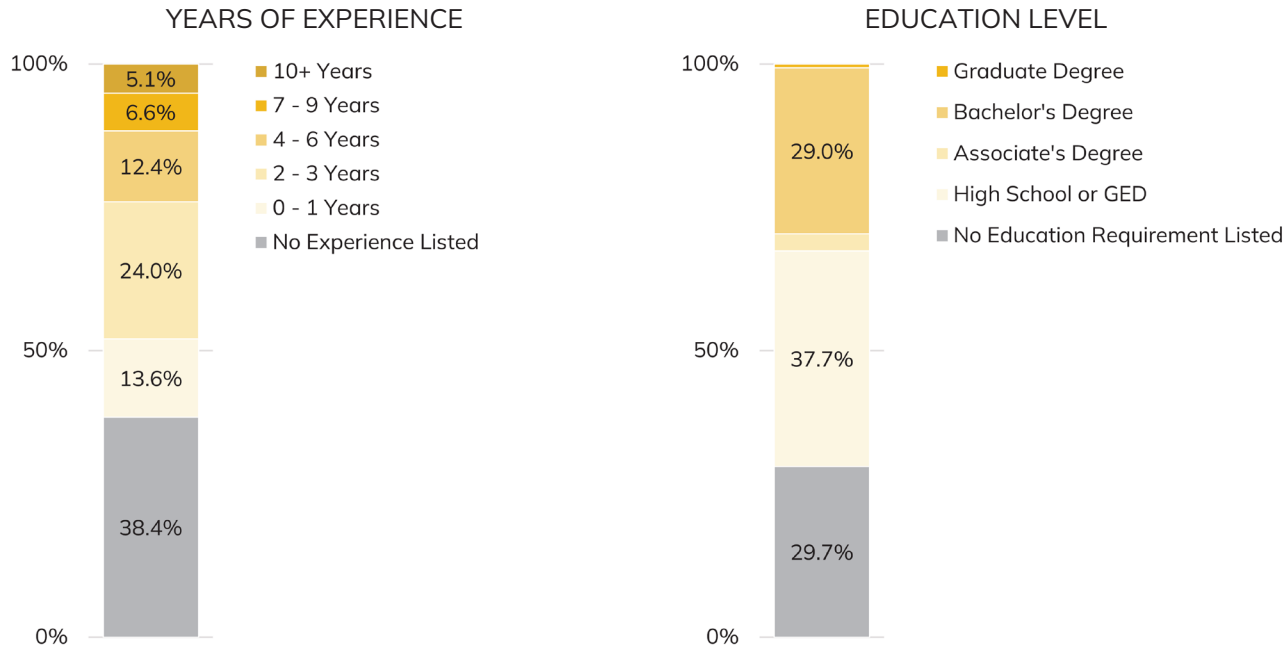

*Worker profile data was not reported for the following skills: office equipment, emergency response, and bilingual (Spanish/English).

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 (38.4 percent) of positions posted by regional employers in the Clean Tech and Renewable Energy sector did not require any experience.[13] Roughly two-thirds of postings analyzed (67.4 percent) either did not list any minimum level of education (29.7 percent) or were open to job seekers with a high school diploma or equivalency (37.7 percent). A bachelor's degree was required for most of the remaining Clean Tech and Renewable Energy positions, representing 29.0 percent of total postings in the sector.

**FIGURE 9. EMPLOYER REQUIREMENTS: CLEAN TECH AND RENEWABLE ENERGY 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): Includes 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.

[13] 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[14] 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 Clean Tech and Renewable Energy sector illustrates the potential supply of talent. Relevant areas include the following:

- Architecture and Related Services (CIP 04)[15]
- Engineering Technologies/Technicians (CIP 15)
- Construction Trades (CIP 46)
- Mechanic and Repair Technologies/Technicians (CIP 47)

The region's postsecondary institutions issued 495 for-credit awards in these four fields of study in 2021. Roughly one-half of this total (52.5 percent) were awarded in Architecture and Related Services (CIP 04) and were almost exclusively at the bachelor's degree level. Slightly more than 100 awards each were granted in Engineering Technologies/Technicians (CIP 15) and Mechanic and Repair Technologies/Technicians (CIP 47) during the same year. Construction Trades (CIP 15) saw the smallest number of completions during 2021, with just 21 awards.

Awards in architecture- and engineering-related fields of study were more likely to be made at the bachelor's degree level; as a result, the majority of awards in these areas were issued by Cal Poly. By contrast, the for-credit awards issued in Construction Trades and Mechanic and Repair Technologies/Technicians consisted entirely of associate's degrees[16] and certificates of less than one year. These completions were awarded by the region's community colleges (Allan Hancock College, Cuesta College, and Santa Barbara City College) and, in the case of Construction Trades, the Center for Employment Training-Santa Maria. None of the awards in the topic areas analyzed were made by UC Santa Barbara.

Figure 10 (page 20) looks at the top five detailed programs within the four broad fields of study bulleted above. Of these detailed programs, Architectural & Building Sciences/Technology (CIP 04.0902), with 156 completions, comprised nearly one-third (31.5 percent) of the awards granted in 2021. Industrial Technology/Technician (CIP 15.0612) was a distant second with 59 awards (11.9 percent).

Occupations related to these program areas include Cost Estimators (SOC 13-1051); Industrial Engineering Technicians (SOC 17-3026); Hazardous Materials Removal Workers (SOC 47-4041); First-Line Supervisors, Construction and Extraction (SOC 47-1011); and First-Line Supervisors, Mechanics and Repairers (SOC 49-1011).

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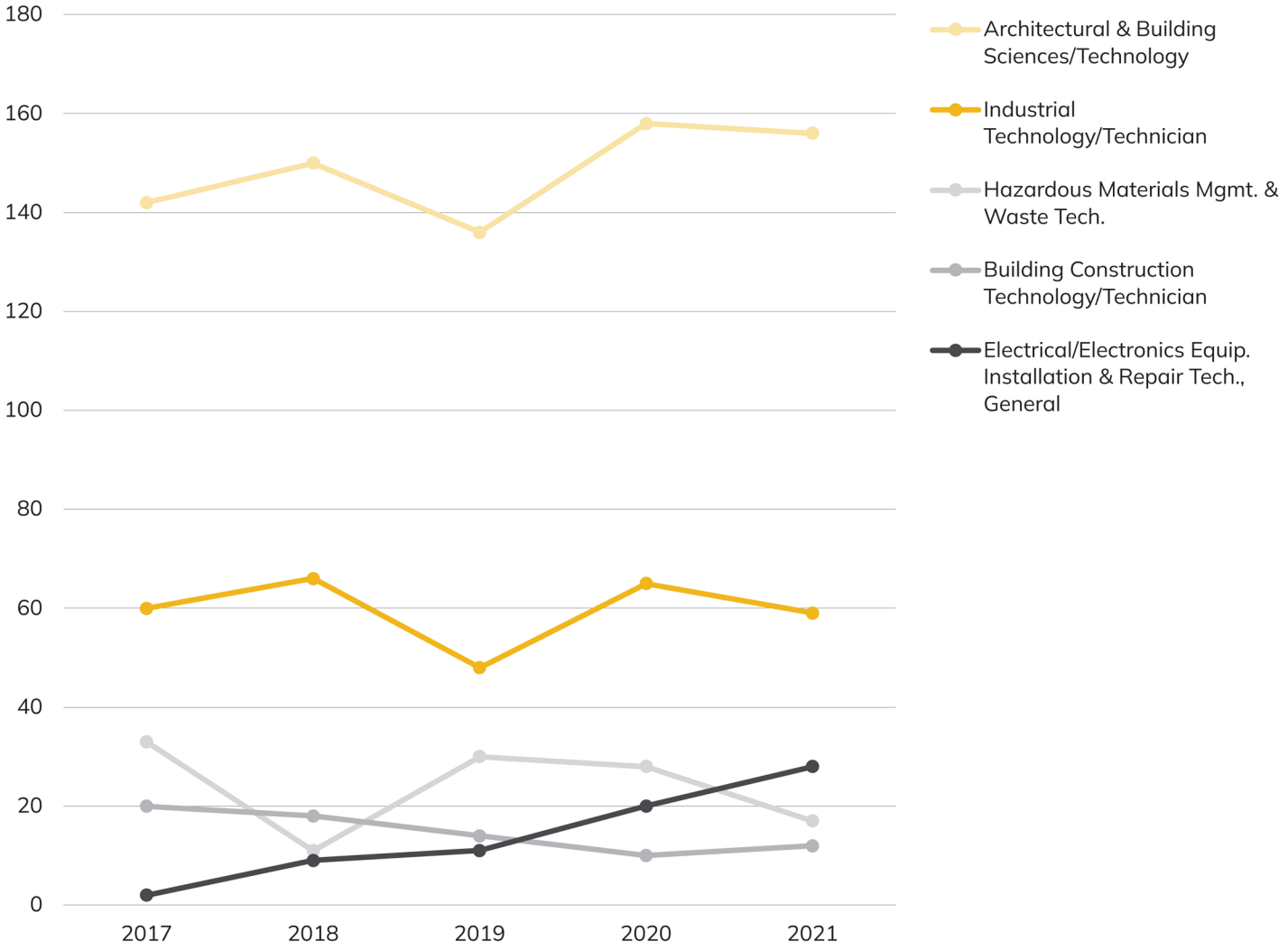
[14] The federal dataset used in this analysis reports on awards and degrees conferred as part of a formal course of study. Recognized postsecondary credentials (typically designated as certificates eligible to be recorded on a transcript) are also included.
[15] CIP codes, shown in parentheses, refer 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).
[16] Associate's degrees include certificates earned in more than one year and less than four.

**FIGURE 10. AWARDS IN SELECTED FIELDS OF STUDY RELEVANT TO THE CLEAN TECH AND RENEWABLE ENERGY SECTOR, 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

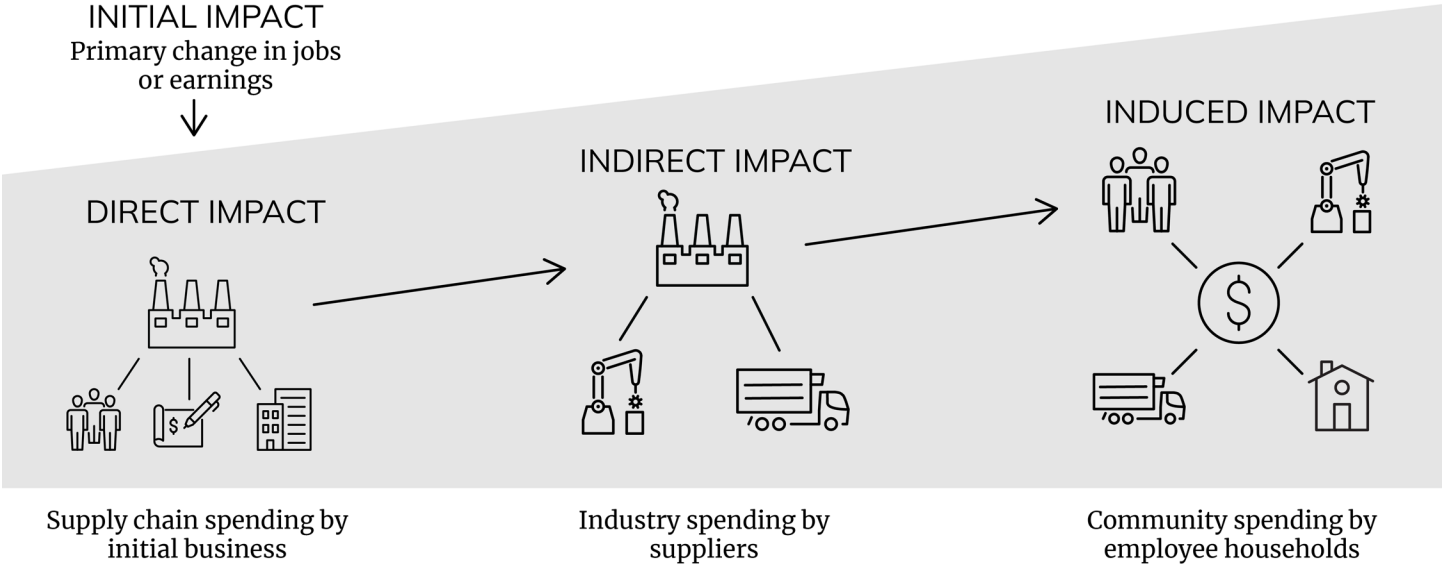
When new businesses are attracted to the Central Coast, or an existing business expands its operations, the regional economy is affected through several mechanisms. These mechanisms include spending on land, buildings, or equipment (capital expenditures); costs associated with hiring workers; revenues 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.[17]

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 22), 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 Clean Tech and Renewable Energy 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.[18]

[17] Estimates of in-region and imported purchases for the Central Coast region are provided in Figure 19 (page 33).
[18] 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 Clean Tech and Renewable Energy sector's economic impact on the Central Coast economy.[19] 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 projection was increased by 10 percent.[20] This approach resulted in a total initial figure of 694 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[21] as well as jobs and earnings multipliers.

# RESULTS

Based on Lightcast's analysis, the addition of 694 jobs in this sector through 2027 (the initial impact) would result in another 522 jobs from direct, indirect, and induced effects, for a total change of 1,216 jobs. The additional employment gain (522 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 Clean Tech and Renewable Energy sector supports nearly 1 additional job on the Central Coast, for a total jobs multiplier of 1.75. Likewise, each dollar earned by workers in the sector generates an additional 46 cents in earnings for workers in other sectors (for an earnings multiplier of 1.46). The remainder of this section presents additional details about the impacts.

**FIGURE 12. ECONOMIC IMPACT OF THE CLEAN TECH AND RENEWABLE ENERGY SECTOR**
SCENARIO: PROJECTED JOB GAINS IN THE SECTOR FROM 2022 TO 2027, PLUS 10 PERCENT

| EMPLOYMENT & EARNINGS | | | | | |
|---|---|---|---|---|---|
| | INITIAL | DIRECT | INDIRECT | INDUCED | TOTAL |
| Jobs (Number) | 694 | 145 | 50 | 327 | 1,216 |
| Jobs (Multiplier) | 1.00 | 0.21 | 0.07 | 0.47 | 1.75 |
| Earnings (in Millions $US) | $63.00 | $8.83 | $2.73 | $18.86 | $93.42 |
| Earnings (Multiplier) | 1.00 | 0.14 | 0.04 | 0.28 | 1.46 |
| **TAX REVENUES** | | | | | |
| | | LOCAL | STATE | FEDERAL | TOTAL |
| Added Tax Revenues (in millions $US) | | $3.47 | $2.91 | $1.51 | $7.88 |

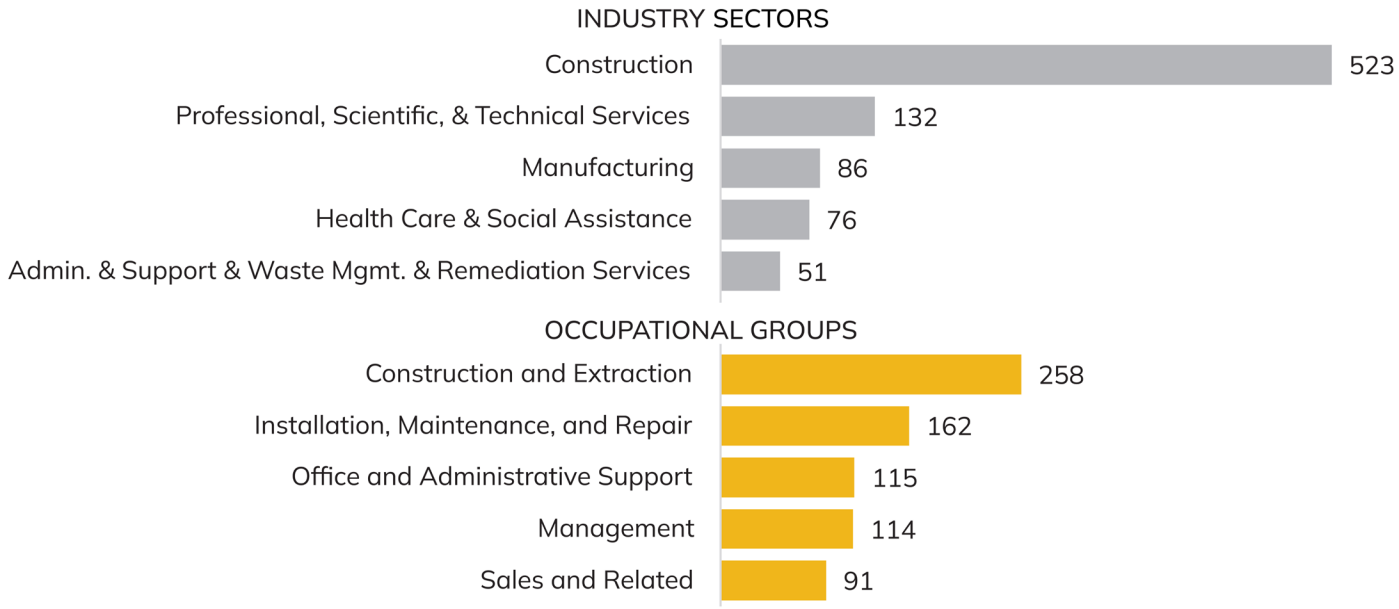
Source(s): Lightcast MR-SAM model, 2022.
Note(s): The model output contains decimal points which are rounded to whole numbers. As a result, figures may not sum to the total shown.

[19] 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 37 industries included in the Clean Tech and Renewable Energy sector definition (see Figure 15, page 28). Where industries were projected to lose jobs, Lightcast assumed that all jobs were retained.
[20] 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.
[21] 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 Clean Tech and Renewable Energy 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 Clean Tech and Renewable Energy employment are seen in the Construction industry sector (NAICS 23). Of the total job impact estimated in Lightcast's analysis, just over 520 jobs (43 percent) are in this sector. The Professional, Scientific, and Technical Services industry sector (NAICS 54), with just over 130 jobs, accounts for the next largest share, at roughly 11 percent of the anticipated jobs impact.

When industry impacts are translated to occupations (using Lightcast's regional staffing patterns data), the largest impacts are seen in the two occupational groups most closely aligned with construction activities: Construction and Extraction (SOC 15) and Installation, Maintenance, and Repair (SOC 49). Impacts on the remaining top five occupational groups are relatively evenly split across administrative, management and sales.

**FIGURE 13. LARGEST IMPACTS FROM CLEAN TECH AND RENEWABLE ENERGY 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 Clean Tech and Renewable Energy jobs in Lightcast's impact scenario would add $93.4 million dollars in earnings to the Central Coast economy. The majority of the earnings impact—nearly $48 million, amounting to 51 percent of the total—would occur in the Construction sector (NAICS 23). Additional earnings in the Professional, Scientific, and Technical Services sector (NAICS 54) and Manufacturing (NAICS 31-33) 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 CLEAN TECH AND RENEWABLE ENERGY SECTOR JOB CREATION SCENARIO**
TOP THREE INDUSTRY SECTORS (2-DIGIT NAICS LEVEL) AFFECTED


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

# APPENDICES

# SUPPORTING DETAIL

## SECTOR DEFINITION

The table below represents the detailed industries that comprise the definition of the Clean Tech and Renewable Energy 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 CLEAN TECH AND RENEWABLE ENERGY SECTOR**
6-DIGIT NAICS LEVEL

| NAICS CODE | INDUSTRY |
|---|---|
| 221111 | Hydroelectric Power Generation |
| 221113 | Nuclear Electric Power Generation |
| 221114 | Solar Electric Power Generation |
| 221115 | Wind Electric Power Generation |
| 221116 | Geothermal Electric Power Generation |
| 221117 | Biomass Electric Power Generation |
| 221118 | Other Electric Power Generation |
| 221121 | Electric Bulk Power Transmission and Control |
| 221122 | Electric Power Distribution |
| 221310 | Water Supply and Irrigation Systems |
| 221320 | Sewage Treatment Facilities |
| 221330 | Steam and Air-Conditioning Supply |
| 237130 | Power and Communication Line and Related Structures Construction |
| 238160 | Roofing Contractors |
| 238210 | Electrical Contractors and Other Wiring Installation Contractors |
| 238220 | Plumbing, Heating and Air-Conditioning Contractors |
| 321113 | Sawmills |
| 321211 | Hardwood Veneer and Plywood Manufacturing |
| 321212 | Softwood Veneer and Plywood Manufacturing |
| 321213 | Engineered Wood Member (except Truss) Manufacturing |
| 321214 | Truss Manufacturing |
| 321219 | Reconstituted Wood Product Manufacturing |
| 321918 | Other Millwork (including Flooring) |
| 321992 | Prefabricated Wood Building Manufacturing |
| 321999 | All Other Miscellaneous Wood Product Manufacturing |

continued next page

**FIGURE 15. INDUSTRIES COMPRISING THE CLEAN TECH AND RENEWABLE ENERGY SECTOR (CONTINUED)**

| NAICS CODE | INDUSTRY |
|---|---|
| 322110 | Pulp Mills |
| 333611 | Turbine and Turbine Generator Set Units Manufacturing |
| 333914 | Measuring, Dispensing, and Other Pumping Equipment Manufacturing |
| 335311 | Power, Distribution, and Specialty Transformer Manufacturing |
| 335911 | Storage Battery Manufacturing |
| 335929 | Other Communication and Energy Wire Manufacturing |
| 423610 | Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers |
| 423930 | Recyclable Material Merchant Wholesalers |
| 541420 | Industrial Design Services |
| 541620 | Environmental Consulting Services |
| 562213 | Solid Waste Combustors and Incinerators |
| 562920 | Materials Recovery Facilities |

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 CLEAN TECH AND RENEWABLE ENERGY JOB CREATION BY INDUSTRY**
2-DIGIT NAICS LEVEL

| NAICS CODE | INDUSTRY SECTOR | CHANGE IN JOBS |
|---|---|---|
| 23 | Construction | 523 |
| 54 | Professional, Scientific, and Technical Services | 132 |
| 31 | Manufacturing | 86 |
| 62 | Health Care and Social Assistance | 76 |
| 56 | Administrative and Support and Waste Management and Remediation Services | 51 |
| 44 | Retail Trade | 47 |
| 81 | Other Services (except Public Administration) | 44 |
| 72 | Accommodation and Food Services | 43 |
| 53 | Real Estate and Rental and Leasing | 40 |
| 42 | Wholesale Trade | 38 |
| 52 | Finance and Insurance | 26 |
| 48 | Transportation and Warehousing | 22 |
| 22 | Utilities | 19 |
| 90 | Government | 18 |
| 61 | Educational Services | 15 |
| 71 | Arts, Entertainment, and Recreation | 12 |
| 51 | Information | 10 |
| 11 | Agriculture, Forestry, Fishing and Hunting | 6 |
| 55 | Management of Companies and Enterprises | 5 |
| 21 | Mining, Quarrying, and Oil and Gas Extraction | 3 |
| | **TOTAL** | **1,216** |

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 24).

**FIGURE 17. IMPACT OF CLEAN TECH AND RENEWABLE ENERGY JOB CREATION BY OCCUPATION**
2-DIGIT SOC LEVEL

| SOC CODE | OCCUPATION | CHANGE IN JOBS |
|---|---|---|
| 47-0000 | Construction and Extraction Occupations | 258 |
| 49-0000 | Installation, Maintenance, and Repair Occupations | 162 |
| 43-0000 | Office and Administrative Support Occupations | 115 |
| 11-0000 | Management Occupations | 114 |
| 41-0000 | Sales and Related Occupations | 91 |
| 13-0000 | Business and Financial Operations Occupations | 87 |
| 53-0000 | Transportation and Material Moving Occupations | 66 |
| 51-0000 | Production Occupations | 60 |
| 35-0000 | Food Preparation and Serving Related Occupations | 39 |
| 31-0000 | Healthcare Support Occupations | 31 |
| 29-0000 | Healthcare Practitioners and Technical Occupations | 30 |
| 37-0000 | Building and Grounds Cleaning and Maintenance Occupations | 28 |
| 27-0000 | Arts, Design, Entertainment, Sports, and Media Occupations | 28 |
| 17-0000 | Architecture and Engineering Occupations | 26 |
| 39-0000 | Personal Care and Service Occupations | 24 |
| 15-0000 | Computer and Mathematical Occupations | 15 |
| 25-0000 | Educational Instruction and Library Occupations | 15 |
| 19-0000 | Life, Physical, and Social Science Occupations | 8 |
| 21-0000 | Community and Social Service Occupations | 7 |
| 45-0000 | Farming, Fishing, and Forestry Occupations | 6 |
| 33-0000 | Protective Service Occupations | 5 |
| 23-0000 | Legal Occupations | 3 |
| 99-0000 | Unclassified Occupations | 1 |
| 55-0000 | Military-only Occupations | 0 |
| | **TOTAL** | **1,216** |

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 24).

**FIGURE 18. IMPACT OF CLEAN TECH AND RENEWABLE ENERGY JOB CREATION ON INDUSTRY EARNINGS (IN MILLIONS)**
2-DIGIT NAICS LEVEL

| NAICS | INDUSTRY SECTOR | INITIAL | DIRECT | INDIRECT | INDUCED | TOTAL |
|---|---|---|---|---|---|---|
| 23 | Construction | $46.46 | $0.05 | $0.08 | $1.23 | $47.82 |
| 54 | Professional, Scientific, and Technical Services | $6.16 | $2.28 | $0.54 | $1.53 | $10.50 |
| 31 | Manufacturing | $5.87 | $0.90 | $0.06 | $0.30 | $7.13 |
| 62 | Health Care and Social Assistance | $0.00 | $0.05 | $0.01 | $5.09 | $5.15 |
| 42 | Wholesale Trade | $2.67 | $0.55 | $0.06 | $0.37 | $3.65 |
| 56 | Administrative and Support and Waste Management and Remediation Services | $0.16 | $0.89 | $0.48 | $0.64 | $2.18 |
| 53 | Real Estate and Rental and Leasing | $0.00 | $0.91 | $0.36 | $0.90 | $2.17 |
| 52 | Finance and Insurance | $0.00 | $0.41 | $0.26 | $1.36 | $2.03 |
| 44 | Retail Trade | $0.00 | $0.70 | $0.03 | $1.19 | $1.92 |
| 22 | Utilities | $1.68 | $0.04 | $0.02 | $0.07 | $1.82 |
| 90 | Government | $0.00 | $0.05 | $0.03 | $1.73 | $1.81 |
| 72 | Accommodation and Food Services | $0.00 | $0.09 | $0.10 | $1.31 | $1.50 |
| 81 | Other Services (except Public Administration) | $0.00 | $0.36 | $0.10 | $0.99 | $1.45 |
| 55 | Management of Companies and Enterprises | $0.00 | $0.51 | $0.24 | $0.34 | $1.09 |
| 51 | Information | $0.00 | $0.23 | $0.12 | $0.65 | $1.00 |
| 48 | Transportation and Warehousing | $0.00 | $0.46 | $0.13 | $0.30 | $0.89 |
| 61 | Educational Services | $0.00 | $0.02 | $0.01 | $0.40 | $0.44 |
| 71 | Arts, Entertainment, and Recreation | $0.00 | $0.04 | $0.05 | $0.29 | $0.38 |
| 11 | Agriculture, Forestry, Fishing and Hunting | $0.00 | $0.09 | $0.06 | $0.12 | $0.26 |
| 21 | Mining, Quarrying, and Oil and Gas Extraction | $0.00 | $0.16 | $0.02 | $0.03 | $0.21 |
| | **TOTAL** | **$63.00** | **$8.83** | **$2.73** | **$18.86** | **$93.42** |

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.
Note(s): 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)[22] shows a trend toward the increased net out-migration[23] of workers in both Central Coast counties. In the San Luis Obispo MSA, 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 MSAs also tend to be those with relatively low wages, such as food services, retail trade, and administrative support. Both areas have seen modest net in-migration of healthcare workers.

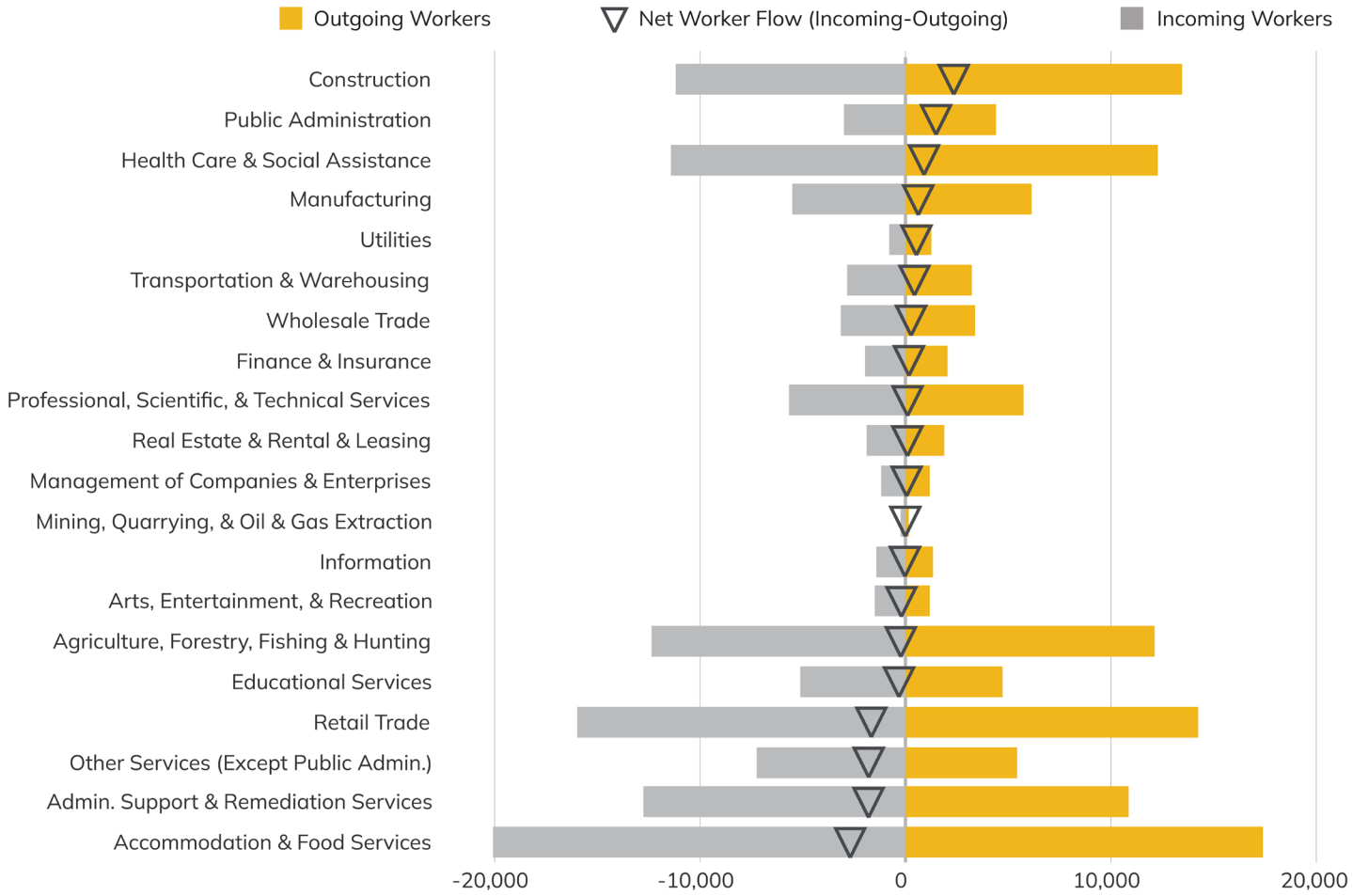
With regards to the Clean Tech and Renewable Energy sector, migration trends in several industry sectors are relevant, including Construction (NAICS 23) and Utilities (NAICS 22). Net migration patterns for workers in the Construction industry differ slightly between the two MSAs. Both counties have experienced largely positive net flows of workers in the sector; however, the San Luis Obispo MSA has seen larger net gains. Migration flows in the Utility industry are much smaller, reflecting the relative size of the workforce. Both MSAs have maintained positive net flows over the past decade, but trends have been flat (San Luis Obispo) or only slightly positive (Santa Barbara).

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.[24]

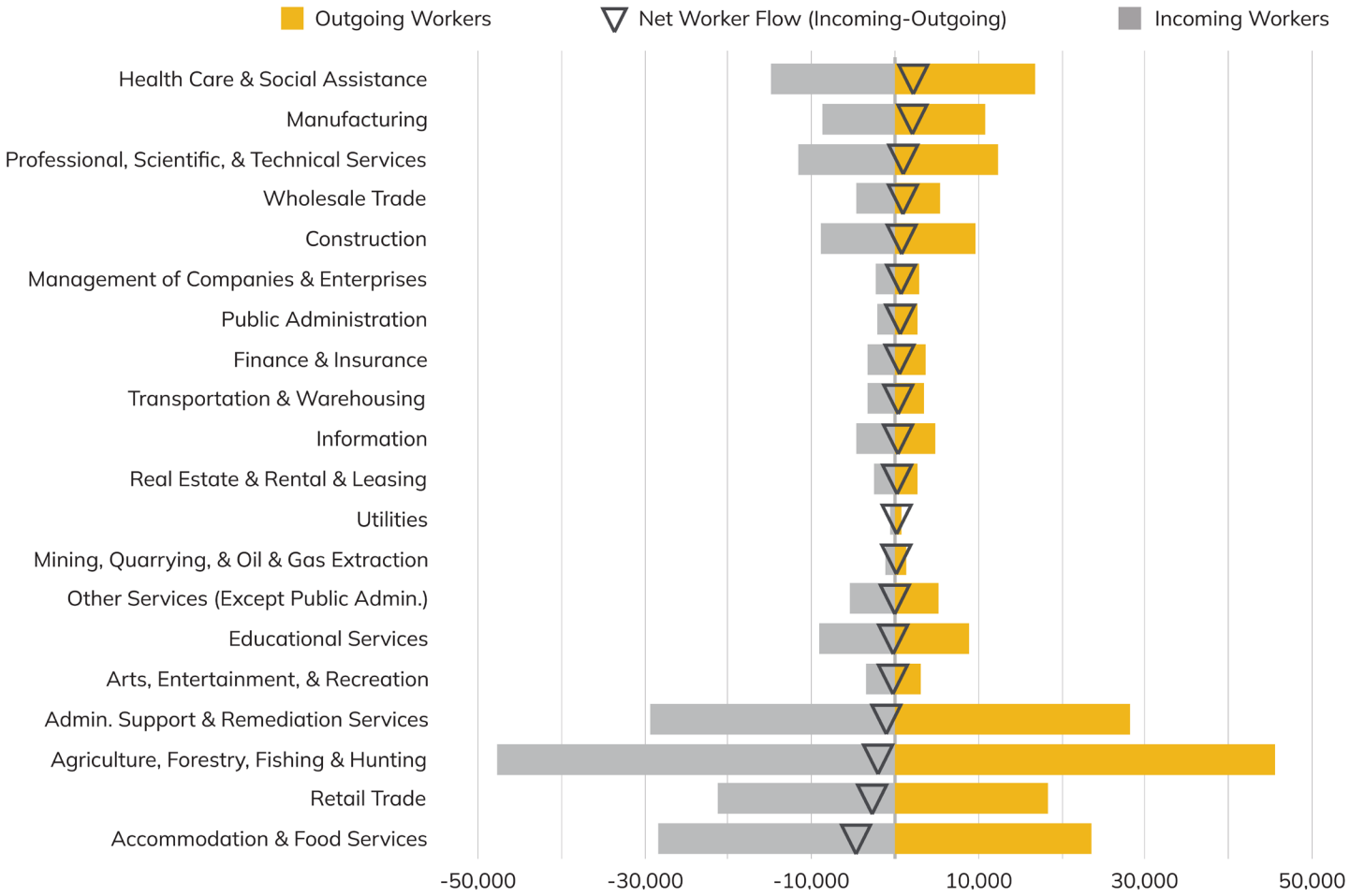
[22] A metropolitan statistical area (MSA) is a designation of the US Office of Management and Budget used by federal statistical agencies. MSAs are composed of one or more counties (or county equivalents, such as parishes) that meet specific thresholds (e.g., population size, share living in urban areas), and which have strong economic ties as illustrated by factors such as employment and commuting. Informal MSA names are used to improve readability..
[23] Net out-migration means more workers left jobs inside the region for jobs outside the region.
[24] 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.<br>*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 22 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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- Office of Management and Budget. "Circular A-94 Appendix C." Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent). Last modified December 2022. https://www.whitehouse.gov/wp-content/uploads/2023/02/M-23-12-Appendix-C-Update_Discount-Rates.pdf.
- 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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- Gül, Timur, "Energy Technology Perspectives 2023," International Energy Agency (IEA), April 2023.
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- Lang, Nikolaus, Maurice Berns, Anders Porsborg-Smith, Jamie Webster, and Tim Figures, "An Inflection Point for the Energy Transition," Boston Consulting Group, July 4, 2022.
- Swiss Re Institute, "De-risking the hydrogen economy," April 2022.


## 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.