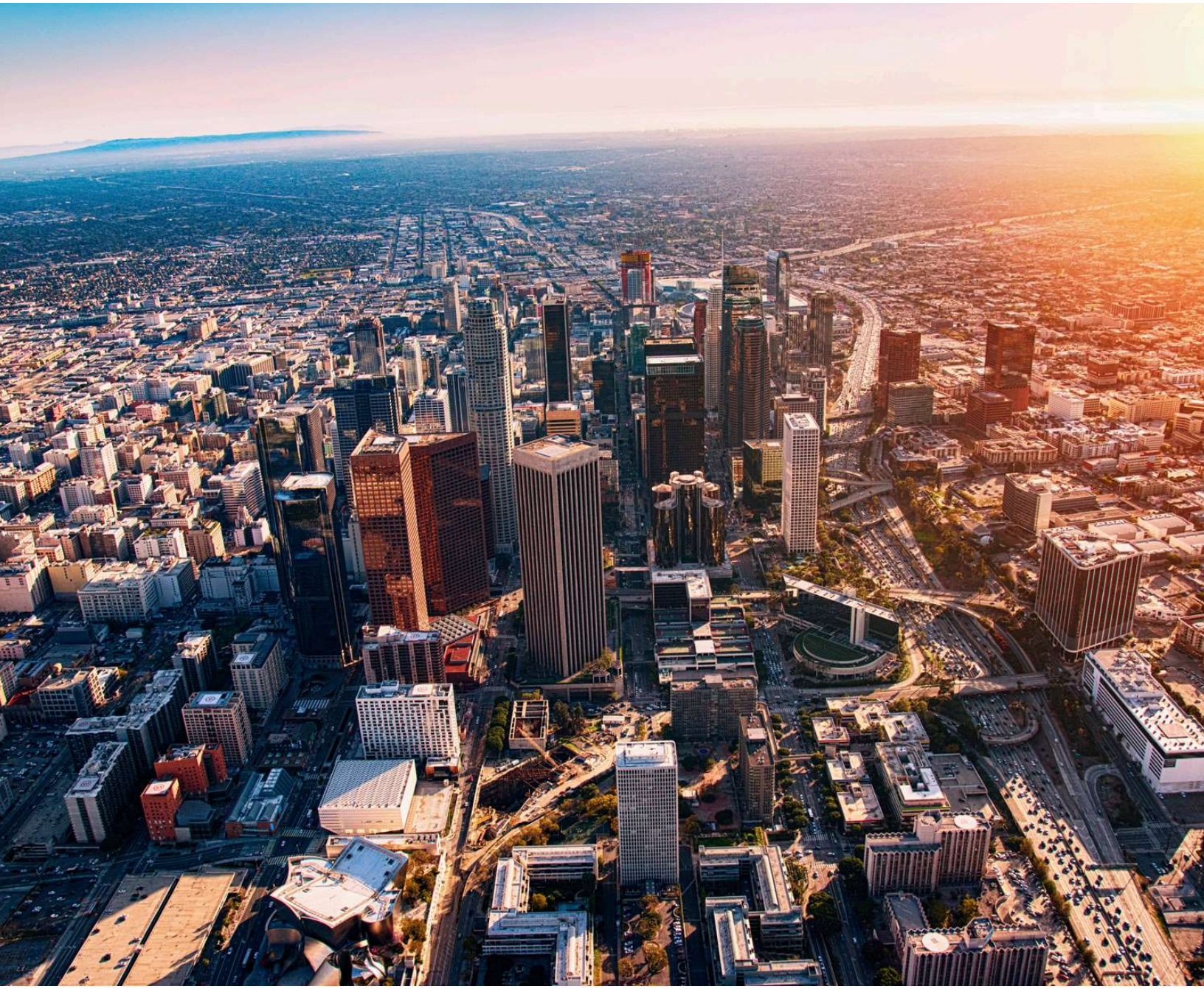
CALIFORNIA BUILDING DECARBONIZATION

WORKFORCE NEEDS AND RECOMMENDATIONS

EXECUTIVE SUMMARY



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INCLUSIVE ECONOMICS

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EXECUTIVE SUMMARY

This study is the first to estimate the potential employment impacts of building decarbonization, which has been identified by the California Energy Commission and California Air Resources Board as a core strategy to achieve California's long-term climate goals. Building decarbonization requires both energy efficiency improvements and reducing the use of fossil fuels in residential and commercial buildings.

Greenhouse gas (GHG) emissions from California's buildings sector account for more than a quarter of the state's total emissions. Direct emissions from building fossil fuel use account for 10–15 percent of the total. These emissions result primarily from both the combustion of gas in buildings for cooking, heating, and water heating as well as from methane leaks throughout the gas distribution system. Reducing building emissions requires reducing the quantity of natural gas delivered to and used in buildings. Replacing gas with efficient electric appliances in existing buildings and constructing new building as all-electric is the primary approach to building decarbonization. This is referred to as building electrification, which is the main focus of this paper.

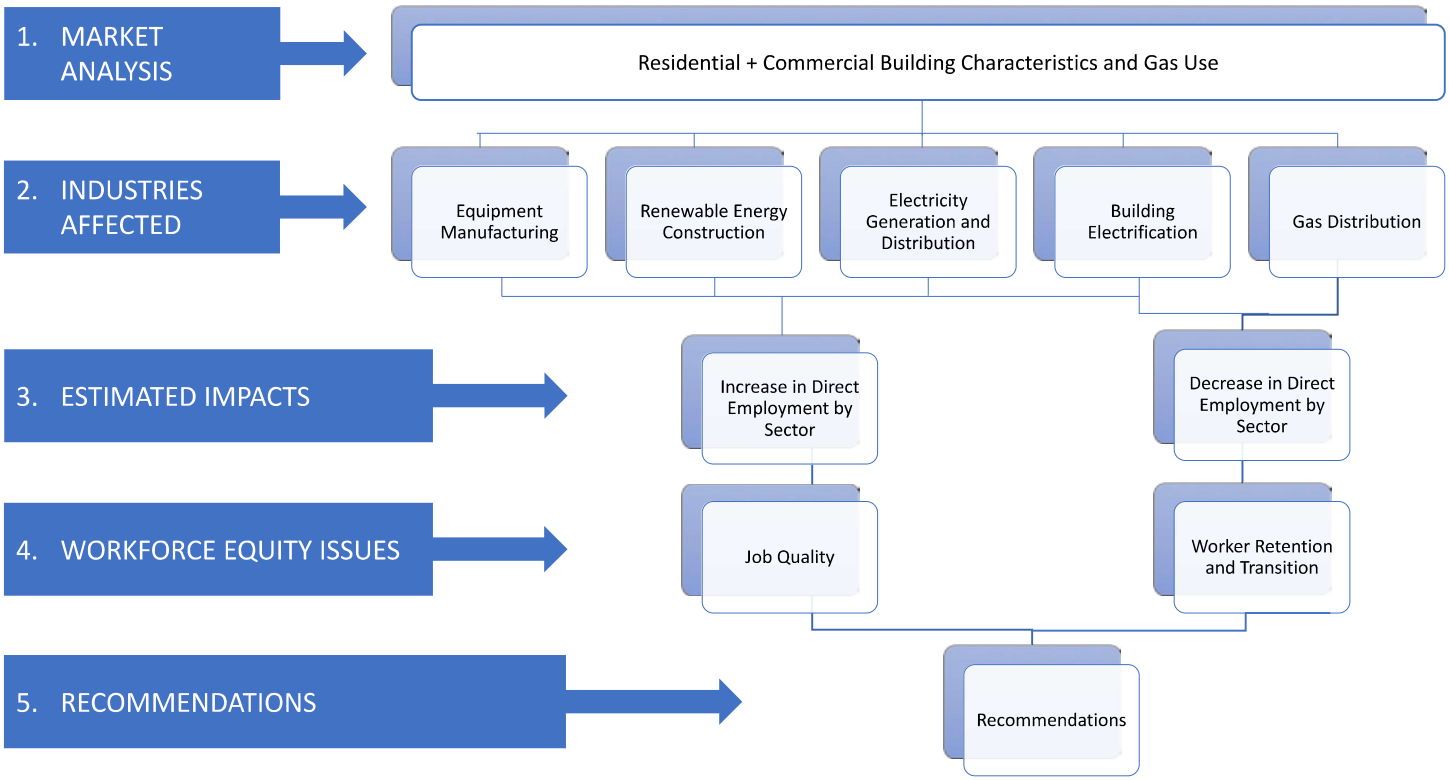
Building electrification will impact several employment sectors. Most obvious is growing the work performed in the process of electrifying more than 14 million homes and more than 8 billion square feet of commercial building space in California; construction jobs associated with efficiency improvements, building modifications, and equipment installations. In addition, there may be jobs in the manufacturing of electrical equipment and appliances needed for installation. There is also work required to ensure that the electricity system can support new demand loads driven by building electrification, which may require new renewable energy and grid infrastructure. Utility jobs to support increased electricity sales represent another area of job growth.

In addition to the increased demand for workers in these areas, there will be a reduced need for workers in other areas. All-electric new construction of buildings eliminates the need for plumbers and pipefitters to extend gas lines and connections; and reduced gas sales could cut the number of utility workers needed to provide gas service to customers, depending on the pattern of reductions. This study assesses all of these impacts.

To guide workforce planning and engagement, this study discusses the distribution of the positive and negative employment effects by market segment and by industry. It provides recommendations for engaging skilled and trained workers in the transition to clean energy generation and electric buildings. Suggestions to minimize and mitigate potential job losses from decreased natural gas consumption are also presented.

ES Figure 1 shows the summary of the study scope. A more detailed graphic on the scope and steps taken to derive employment estimates is provided in Appendix A. Study Scope and Steps.

ES Figure 1. Summary of Study Scope



METHODOLOGY

To estimate the employment effects of building decarbonization, we first calculated market potential by residential and commercial building structure, use, and gas consumption. We identified typical decarbonization pathways for each building type and estimated the cost of each and the total cost of decarbonization based on market potential. We also calculated the change in demand for gas and electricity. Using the economic modeling program IMPLAN, we allocated these cost estimates across relevant industries to determine the direct employment effects from these changes in spending. This allocation is shown in Appendix H. IMPLAN Inputs.

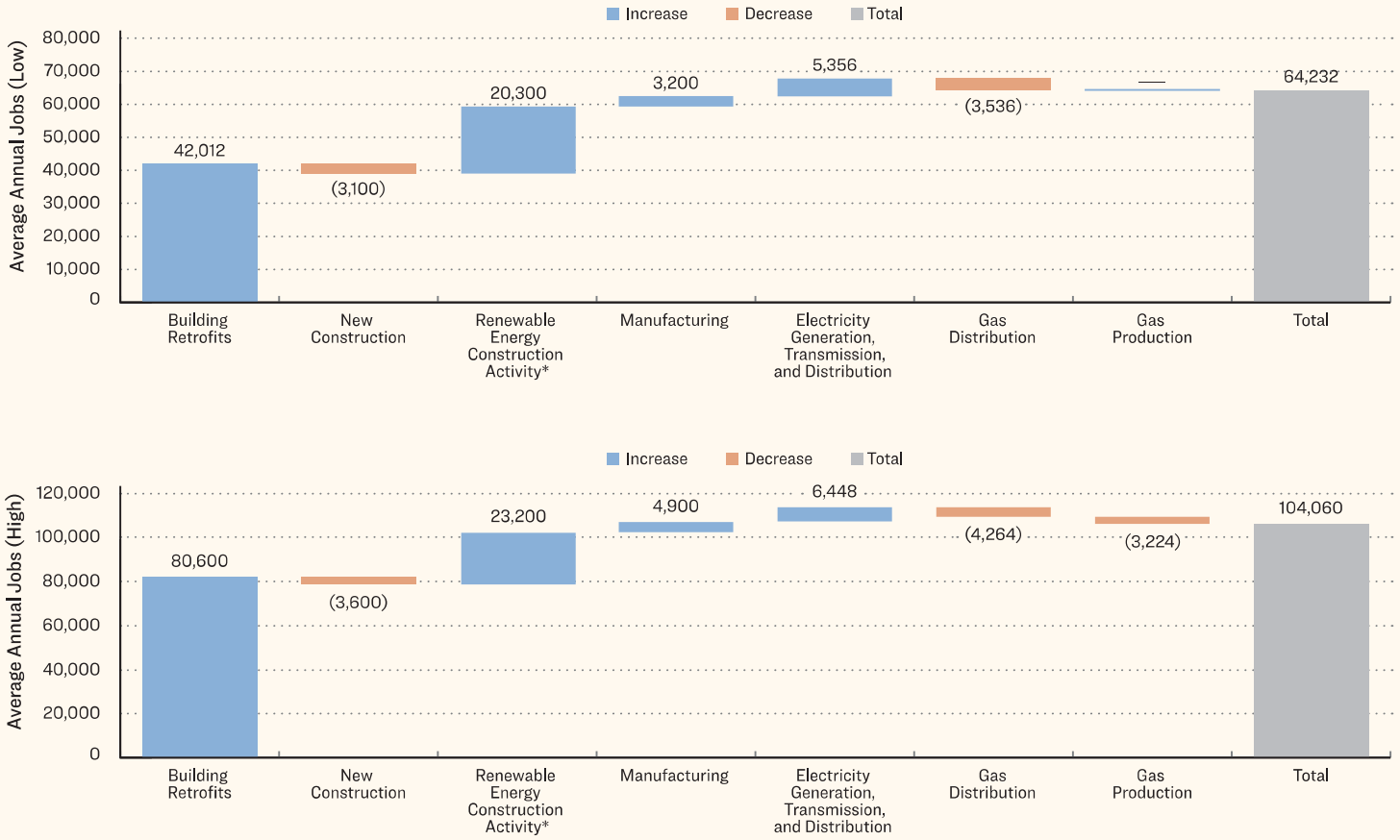
FINDINGS

This analysis reveals that the estimated investments required to electrify 100 percent of California's existing and new buildings — a goal aligned with Governor Brown's 2018 Executive Order B-55-18, which calls for carbon neutrality (zero net GHG emissions) by 2045 — would require over 100,000 full time workers in the construction industry (even after accounting for the labor savings of all-electric new construction) and up to 4,900 full-time manufacturing workers. By 2045, assuming the state has achieved full building electrification, there could be an additional 12,400 full-time electricity generation and distribution jobs and 5,400–6,800 fewer full-time gas distribution jobs.[1]

California imports 90 percent of the natural gas it uses, so the state could eliminate gas in buildings without reducing in-state oil and gas production jobs at all. Eliminating commercial and residential gas use would reduce statewide gas use by only 30 percent, and this could be fully achieved by reducing gas imports. At most, building electrification could result in 6,200 fewer in-state gas extraction jobs.[2]

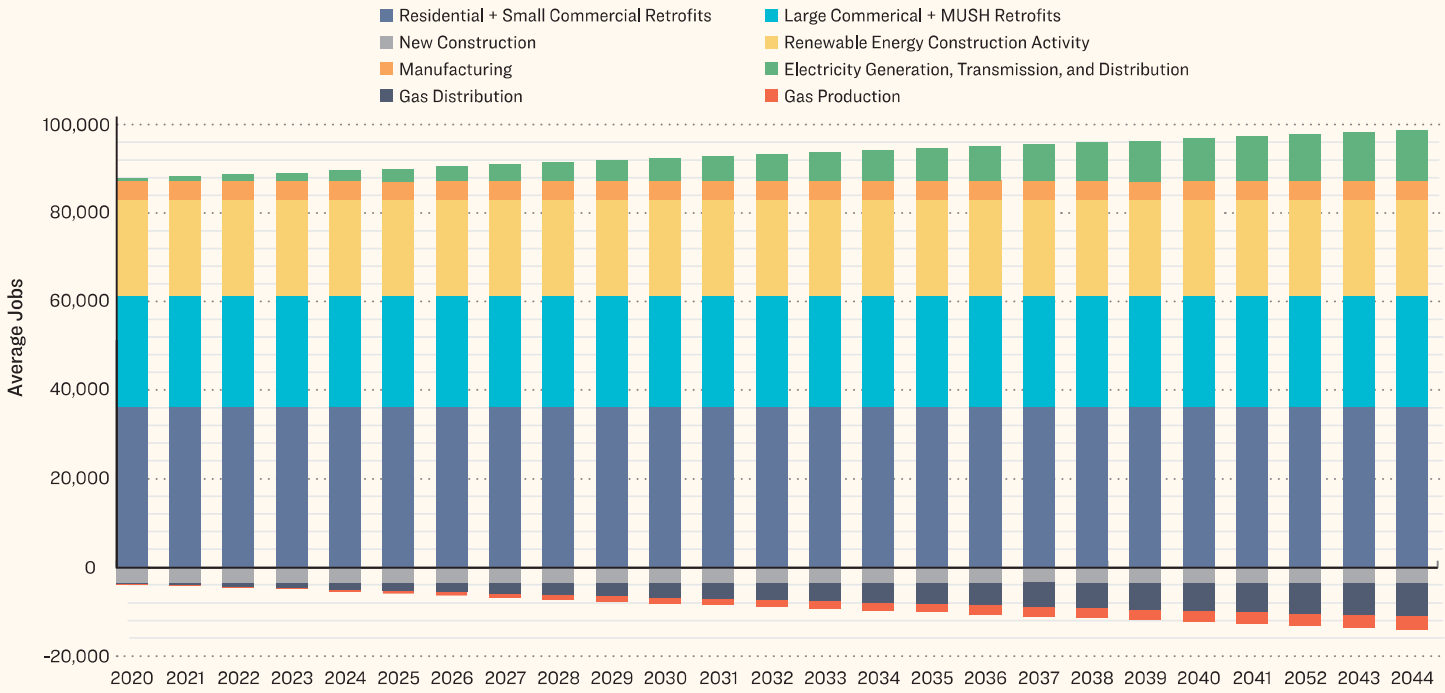
These findings are detailed by sector in the tables below.[3] In total, building electrification in California could support an average of 64,200–104,100 jobs annually, after accounting for losses in the gas industry. *ES Figure 2* shows the average annual employment impacts by industry. The average annual jobs (Figure 2) are slightly different from the total job impacts upon 100% electrification shown in the tables. The areas of greatest increase are building retrofits and renewable energy construction, while the greatest decrease is in gas distribution followed by labor-saving all-electric new construction (but these negative impacts are much smaller than the positive impacts.)

ES Figure 2. Employment Impacts by Industry, Low and High Estimates (Average Annual)



ES Figure 3 shows the average employment impacts by industry, by year. This assumes that the construction activity involved in electrifying buildings takes place at a uniform rate, but that as energy demand shifts from gas to electricity, more workers are required to meet increasing electricity demand and fewer are needed to meeting decreasing gas demand. The majority of the work, shown by the blue sections of the columns, is in building retrofits.

ES Figure 3. Average Annual FTE Jobs Due To Building Electrification



ES Table 1. Potential Employment Impacts — Construction (Excluding Operations and Maintenance)		
Type of Work	**Sector**	**Average Annual Change in Employment (2020–2045)*** **
Existing Building Electrification Construction Activity	Residential Retrofits	26,000–39,300
	Small and Medium Commercial Retrofits	1,700–4,500
	Large Commercial and Municipal, University, School, and Hospital (MUSH) Retrofits **	11,000 –30,900
	District Energy Systems[4],**	3,300–5,900[5]
	Subtotal	**42,000–80,600**
All-Electric New Building Construction Activity	All-Electric New Residential Construction	(3,100)–(3,600) *
Renewable Energy Construction Activity*	Solar Photo Voltaic**	16,400–18,800
	Land-based Wind**	1,000–1,100
	Geothermal**	600–700
	Infrastructure for Grid Connectivity**	2,300–2,600
	Subtotal	**20,300–23,200**
CONSTRUCTION TOTAL		**59,200–100,200**

Note: Construction jobs include both blue- and white-collar workers, in a ratio of approximately 2:1, respectively.

**This study assumes that all-electric new residential construction is less expensive than gas-dependent construction due, in part, to the avoided cost of natural gas piping associated with the service and meter connection. These avoided costs translate to reduced labor requirements. In the commercial sector, the cost difference between mixed-fuel and all-electric buildings is minor, so this study does not project a net change in employment for commercial new construction, although some work would shift from plumbing to electrical work.*

***These are sectors with the greatest opportunity for construction union participation.*

**** In this study, a "job" is a full-time equivalent (FTE). Some jobs in construction and manufacturing are "temporary" resulting from one-time investments, and other jobs in maintenance and energy distribution are "permanent" because they are sustained by ongoing annual spending. In order to use common nomenclature, "temporary" and "permanent" jobs are reported together as average annual jobs from 2020–2045 or annual jobs in 2045.*

The projected increases in employment shown in *ES Table 1* reflect the increased investment needed to fully decarbonize California's residential and commercial buildings. Much of this work involves building construction activity to install new circuits, plumbing, ductwork, and appliances. It also involves construction work to expand electricity generation capacity to meet new electric demands.

In addition to construction jobs, building decarbonization is very technology dependent requiring manufacturing new equipment. In this sector, building decarbonization could support 3,200–4,900 jobs annually as shown in *ES Table 2* or more if in-state manufacturing were to grow.

ES Table 2. Potential Employment Impacts — Manufacturing		
Type of Work	**Sector**	**Average Annual Change in Employment (2020–2045)**
Manufacturing	Large Electric Appliances and Equipment	3,200–4,900

Note: Electrification requires swapping out gas appliances for efficient electric ones. If more electric appliances were manufactured in California, the state could see an increase in jobs.

Adding electricity load and shrinking gas throughput will affect energy production and delivery operations. *ES Table 3* shows that, full building electrification could add 10,400–12,400 direct jobs in electricity generation and distribution. *ES Table 4* shows that this would have a negative effect of 6,800–14,400 jobs in the gas industry, including up to 6,800 gas utility workers.

ES Table 3. Potential Employment Impacts — Electricity Generation and Distribution		
Type of Work	**Sector**	**Change in Employment (2045)***
Electricity Generation, Transmission, and Distribution	Solar	3,800–4,900
	Wind	900–1,000
	Geothermal	500–600
	Out-of-state	NA
	Distribution and Transmission	3,600–4,100
	Public Purpose Charge and Other	1,500–1,800
	Subtotal	**10,400–12,400**

**These jobs are estimated from the annual sales of energy; therefore, they are assumed to be ongoing jobs. The number here, is the total estimated upon reaching 100 percent building electrification.*

ES Table 4. Potential Employment Impacts — Gas Distribution		
Type of Work	**Sector**	**Change in Employment (2045)***
Gas Extraction and Distribution	Core Procurement	0–(6,200) TOTAL** [0–(2200) blue-collar] [0–(4,000) white-collar***]
	Transmission, Distribution, and Storage	(5,400)–(6,800) TOTAL**** [2,200–2,900 blue-collar] [3,200–3,900 white-collar]
	Public Purpose Charge	-1,400
Extraction and Distribution Total	Employment upon full building electrification	(6,800)–(14,400) TOTAL [(2,200)–(5,100) blue-collar] [(3,200)–(7,900) white-collar]

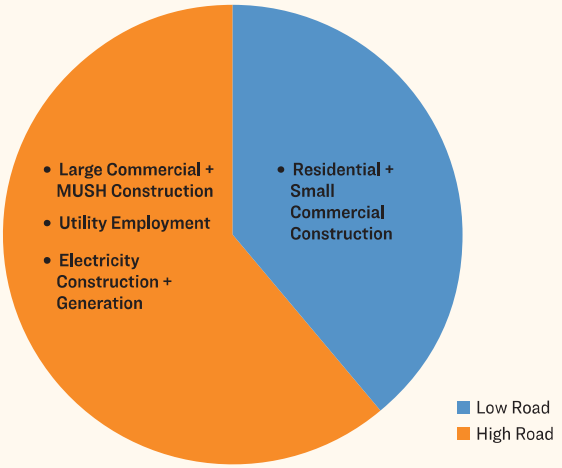
**These jobs are estimated from the annual sales of energy; therefore, they are assumed to be ongoing jobs. The bottom line total, is the total loss of jobs by 2045 upon reaching 100% electrification.*

*** California imports 90 percent of the natural gas it consumes, and could reduce the statewide use of gas by 90 percent without affecting in-state gas extraction jobs. The high end of this range is the current jobs associated with building gas use. Public policy and economics will influence the ratio of fossil fuel imports going forward.*

****This range assumes that a 100% building electrification target would cause a 75–100% reduction in the workforce related to residential and commercial building sales.*

***** The division of blue- and white-collar workers is based on Quarterly Census on Employment and Wages data. Blue-collar workers have skills more specialized to the natural gas industry, while white-collar workers have skills that can be readily deployed in other industries.*[6]

ES Figure 4. Distribution of High-Road and Low-Road Jobs



As *ES Figure 4* shows, three out of five jobs required to meet building electrification goals would be in "high-road" sectors, in which firms compete on the basis of skill, experience, and qualifications and worker pay tends to increase with training and experience. Two out of five jobs would be in traditionally "low-road" sectors in which low cost is the primary driver of competition between firms, and there are low barriers to entry and high turnover of workers.

This is distribution between high-road and low-road jobs is due, in part, to the need for new electricity generation capacity to meet increased demand. The right set of policy interventions can reform the competitive dynamics in in traditionally "low-road" industries like residential and small-commercial construction to improve the quality of jobs and engage more highly skilled workers. Such efforts are not necessarily compatible with lowest upfront cost work, but they do help ensure quality work is performed resulting in satisfied customers, accelerated market transformation, and availability of skilled workers.

Despite the promise of building electrification as a fundamental GHG emission mitigation strategy, there is not yet a clear policy mechanism or plan to achieve the gas reductions needed by 2045. Costs, warmer weather, and climate concerns will continue to nudge consumers to reduce their gas use. This decline in gas sales could raise gas prices further for remaining customers, accelerating further shifts away from gas for consumers able to invest in alternatives. This feedback loop likely will destabilize the gas industry, with severe consequences for the state's businesses, workers, and residential customers. Industry destabilization can, and should, be avoided with sound planning and the right set of policy tools.

RECOMMENDATIONS

California policy makers should aim to expand high-road opportunities that offer family-sustaining wages, benefits, and job security for workers. Because they procure services — climate and energy agencies, utilities, and local governments exert the most influence on the labor market through demand-side strategies. By establishing (or failing to establish) workforce standards, agencies set the bar for the level of skill and training of workers in the labor market, particularly in emerging industries. Agencies can, with deliberate effort, support high-road workforce development, or they run the risk of inadvertently supporting a low-road environment. Often, concerns about project costs lead to decision makers seeking ways to reduce soft costs—especially for labor.[7] But reducing labor expenses has high costs for society, for individual workers, and for businesses that train and employ skilled workers.[8]

The ten recommendations in this study fall into three basic categories: (A) Engage affected workers and unions; **(B)** Prioritize demand-side strategies; and **(C)** Target investments in supply-side (training) strategies. The demand and supply-side strategies can be implemented at the local level, where building decarbonization work is already underway. Transition planning is best managed at the utility or state level.

A) Engage with Affected Unions to Grow Good Jobs and Minimize Job Loss

1. **Create conditions that attract skilled workers.** Engage local building trades councils and Labor Management Cooperation Committees (LMCCs) to identify where goals align. Building electrification is complex work requiring skilled and trained building professionals across a range of occupations. The building trade unions and their signatory contractors co-invest in the best-in-class training for construction professionals: apprenticeship. Working with apprenticeship coordinators to ensure training curriculum covers electrification work and technology presents a solid path to developing a skilled and trained workforce for this work. Furthermore, ensuring work opportunities for apprenticeship-trained workers ensures those skills and knowledge will be deployed in real-world environments.

2. **Plan an orderly transition.** Engage labor, ratepayer advocates, utilities, and other stakeholders and experts in long-term planning process. The goal is to methodically contract and eventually decommission the natural gas distribution system in California in a way that is safe, economical for remaining customers, and minimizes worker displacement. This should include avoiding new investments in gas system expansion that will not be recoverable.

3. **Develop a fund for gas worker retention and transition assistance.** Worker transition assistance should include bridges to retirement for older workers and wage replacement, retraining, and job placement assistance for younger workers. In addition, as California's natural gas system is condensed, it is paramount to retain a skilled and trained workforce to ensure safety and reliability of the system as it contracts.

B) Prioritize Demand-side Strategies

Demand-side interventions to support high-road employment include: investing in high-road sectors and opportunities (those that require and appropriately compensate a skilled and trained workforce), aggregating smaller projects, and establishing workforce standards for programs and policies. Local jurisdictions should:

4. **Pre-qualify contractors.** Agencies can help to stimulate market transformation and improve consumer confidence by pre-qualifying contractors as eligible to receive public or ratepayer incentives for heat pump or other electrification appliances.[9] Ideally, this would be coordinated at the statewide level, but individual jurisdictions could also implement a contractor vetting process.

5. **Condition incentives on skill standards or offer incentives (i.e., accelerated permitting, financial remuneration, etc.) for projects that meet certain workforce criteria.** Condition rebates and incentives for electrification on skill standards and/or responsible contractor criteria to attract high-performing contractors, ensure work quality, and prevent wage and labor law violations common in the residential construction market. Heating, ventilation, and air conditioning (HVAC) skill standards should be applied to building decarbonization policies and programs at all levels (i.e., local government and utility programs, Title 24 building code compliance, state policy, etc.)[10]

6. **Lead with the large commercial and municipal, university, school, and hospital (MUSH) sector.** The large commercial and MUSH sector draws workers from registered apprenticeship programs and the unionized construction workforce. By prioritizing decarbonization and electrification in

this sector, the state can utilize the best-in-class training for skilled construction workers and seed a qualified electrification workforce in California. Through project labor agreements or community workforce agreements, these projects can provide training opportunities for workers facing barriers to employment.

7. **Pursue aggregated community-scale decarbonization.** Targeting projects in regions or neighborhoods planned for new natural gas infrastructure or in need of upgrades is a smart way to "prune" the natural gas distribution system and minimize future stranded assets. Aggregating or bundling small commercial and residential projects can improve the economies of scale, reduce contractor marketing expenses, accelerate market adoption, and enforce skill standards to enhance both the quality of the work performed and the quality of jobs for workers. Geographic pilots should adopt and enforce prevailing wage and targeted hire standards to improve job quality and access for disadvantaged workers.

8. **Invest in decarbonized district energy.** Decarbonization of existing and the expansion of new district energy systems provide a carbon-free pathway to create and sustain good jobs for California's gas workers, plumbers, and pipefitters as well as a new line of business for gas utilities. Like the gas system, district energy systems rely on underground networks of pipes, but instead of moving gas, they move hot water to provide heating and cooling directly to buildings. District energy systems can be powered by a wide array of renewable energy sources, reducing reliance on the electric grid, and their use could be expanded beyond current applications to new residential developments, redevelopment zones, campuses, business parks, and whole neighborhoods. (See Decarbonized District Energy Addendum for more information).

C) Target Investments in Supply-side (Training) Strategies

Most people think about workforce development as a set of training programs and activities, but it is important to recognize that only when training is calibrated to market demand do positive outcomes ensue. Creating stand-alone training programs or over-investing in training, can lead to negative results in the labor market, such as flooding it with more workers than there are jobs, suppressing wages, and diluting the skill of the workforce. Thoughtfully targeted training interventions can avoid these outcomes and more effectively support clean energy goals. Local jurisdictions should:

9. **Support the up-skilling of workers through stackable credentials.** Workforce training is needed to support quality work: however, specialized training should be used in addition to (not instead of) broad occupational training. The trades most needed for building decarbonization are electricians, sheet metal and HVAC workers, and plumbers and pipefitters. Building decarbonization training will be most effective if it is targeted to workers with licenses in these trades rather than to general contractors or other market actors. Programs like California Advanced Lighting Control Program (CALCTP), a training for electricians for advanced lighting controls, or Electric Vehicle Infrastucture Training Program (EVITP) for electric vehicle infrastructure, are good examples of the type of stackable credential training that will likely by most effective for building electrification.

10. **Structure the work to create opportunities for disadvantaged workers.** Support high-road construction careers (HRCCs) for construction and develop high-road training partnerships (HRTPs) for manufacturing and other skills needed for building decarbonization. California's HRCCs and HRTPs work to improve job access for disadvantaged workers and support their career development. Community-based organizations are well-positioned to serve the specific needs of individuals in their communities. When these frontline training organizations have formal agreements with employers, agencies, and apprenticeship programs, better job training and placement outcomes are achieved. Forging stronger partnerships between different facets of the workforce development and support system is key to improving outcomes for disadvantaged workers.

Pursuing a high-road path to building electrification can further demonstrate California's commitment to broadly shared prosperity in a low-carbon future.

ENDNOTES

1 IMPLAN indicates there are 33,500 jobs in natural gas transmission, storage, and distribution in California. The electrification of buildings could affect 16–20% of the transmission and distribution workforce. With a well-planned gas transition, layoffs could be minimized through retention and relocation support for younger workers as older workers transition to retirement.

2 IMPLAN indicates there are 25,300 California workers employed in the natural gas and oil extraction industry. The electrification of buildings could affect 0–25% of the extraction workforce. With a well-planned gas transition, layoffs could be minimized through retention and relocation support for younger workers as older workers transition to retirement.

3 These estimates do not reflect other potential gains or losses of jobs due to other variables, such as the potential increase in gas employment due to pipe replacement and leak repairs even as throughput declines.

4 Building electrification is not restricted to stand-along building retrofits. Some campuses, business parks, and even residential neighborhoods are decarbonizing buildings through a district model, which involves installing centralized energy facilities with a closed loop system of pipes and heat exchangers. Water is heated in the central plant and piped to individual buildings. Heat exchangers allow hot water to be moved to provide space heating or cooling depending on individual building needs. This is highly efficient when buildings with complementary energy heating and cooling loads are located in close proximity.

5 In addition to construction-phase jobs, district energy systems are large enough to require dedicated professional year-round workers, which are not estimated in this study. In Norway, about 25 workers are employed per 1,000 GWh of energy produced for heating. The operations and maintenance jobs and induced jobs from cost savings associated with these systems can be greater than the construction impacts.

6 Zabin, C. and K. Chapple. (2011). California Workforce Education & Training Needs Assessment for Energy Efficiency, Distributed Generation, and Demand Response. University of California (UC) Berkeley Donald Vial Center on Employment in the Green Economy. http://laborcenter.berkeley.edu/california-workforce-education-and-training-needs-assessment-for-energy-efficiency-distributed-generation-and-demand-response/

7 In their "How-To Guide: Net-Zero Retrofit Technical and Cost Benchmark Studies" the Rocky Mountain Institute, states (p.2), "...high labor rates in San Francisco increase the potential for off-site pre-fabrication to significantly reduce project costs." Statements like this are common in clean energy, climate advocacy, and technical assistance documents and presentations, but driving down costs by reducing labor costs has direct negative consequences for skilled workers in the local construction market and may actually slow market adoption.

8 Jacobs, K, I. E. Perry, and J. MacGillvary. (2015). *The High Public Cost of Low Wages.* UC Berkeley Labor Center. April 13, 2015. http://laborcenter.berkeley.edu/the-high-public-cost-of-low-wages/; Mahalia, N. (2008). *Prevailing wages and government contracting costs: A review of the research.* Economic Policy Institute. July 3, 2008. https://www.epi.org/publication/bp215/

9 While many utilities across the country pre-qualify contractors for various programs, California investor-owned utilities (IOUs) and agencies have refrained from undertaking this activity due to concerns of potential legal vulnerability resulting from making contractor recommendations.

10 See discussion about comments and recommendations on pages 7–20 in CPUC (2018). Proposed Decision Addressing Workforce Requirements and Third-Party Contract Terms and Conditions, dated 10/11/2018. The 2018 standard adopted by the CPUC requires that workers installing HVAC systems have completed or are enrolled in an accredited HVAC apprenticeship in HVAC installation; completed at least five years of work experience and all other requirements in the HVAC craft which has workers classified as journeymen in HVAC installation or a related field at the journey level as defined by the California Department of Industrial Relations, passed a practical and written HVAC system installation competency test, and received credentialed training specific to the installation of the technology being installed; or have at least five years of experience as an experienced worker, not a trainee, and is fully qualified and able to perform in the specific HVAC trade without supervision.