DECEMBER 2021

NET EMPLOYMENT BENEFITS OF DEEP DECARBONIZATION IN COLORADO

REGIONAL, SECTORAL, AND OCCUPATIONAL ANALYSIS AND RECOMMENDATIONS FOR QUALITY JOBS AND AND ECONOMIC INCLUSION

BY INCLUSIVE ECONOMICS

IN PARTNERSHIP WITH GRIDLAB, NRDC, SIERRA CLUB, EVOLVED ENERGY, AND PSE HEALTHY ENERGY

CONTENTS

Suggested Citation: Betony Jones and Maggie Jones, "Net Employment Benefits of Deep Decarbonization in Colorado," (Inclusive Economics, December 2021).

EXECUTIVE SUMMARY

This research paper is the third in a series looking at pathways to deep decarbonization in Colorado. The first paper analyzes the technologically and economically feasible pathways to deep decarbonization in Colorado, and the second assesses equity impacts and suggests recommendations for an equitable transition.[1, 2] This paper models and examines the employment effects associated with three different decarbonization pathways and a reference case. In addition to statewide modeling, it parses these effects across nine regions, across industrial sectors, and by occupation. The results are provided in terms of direct jobs which are those that will be required to decarbonize, and total jobs, which include all jobs created from the ripple effects of the investments required to decarbonize, including both in-state supply chain jobs and the jobs created when workers spend their income on in-state goods and services. Job loss associated with reduced expenditures on fossil fuels is also factored into this analysis.

The employment modeling accounts for the increase in employment resulting from the investments required to decarbonize and the decrease in employment resulting from reduced use of fossil fuels in Colorado. These job gains and job losses are aggregated into the results shown in Figure ES-1, thus providing a measure of the net employment effects, which are generally positive. The fossil fuel segments of some industries and specific occupations see small net-negative effects, but they are dwarfed by the significant gains in the broader industry or occupational category.[3] The analysis clearly shows that decarbonization will result in gains in economic activity and employment (see Figure ES-1). Renewable energy development, building retrofits, and distributed solar provide the greatest contributions to jobs in the state, but ensuring that these are good, stable, career-track jobs and that they are accessible to under-represented workers will require intentional policies and efforts, suggested in the recommendations section.

Each of the three decarbonization pathways results in a net increase in direct jobs, starting immediately. The central and slow electricity cases show higher job growth in the earlier years, while the 100-percent renewables

1 Arjun Krishnaswami, Ariana Gonzalez, and Matthew Gerhart, "Committing to Climate Action: Equitable Pathways for Meeting Colorado's Climate Goals" (Evolved Energy, GridLab, NRDC, and Sierra Club, September 2020), https://gridlab.org/wp-content/uploads/2020/09/GridLab_Committing-to-Climate-Action.pdf.

2 Elena Krieger, PhD, Boris Lukanov, PhD, Ana McPhail, PhD, Audrey Smith, MPH, and Annelise Dillon, MS, "Equity-Focused Climate Strategies for Colorado: Socioeconomic and Environmental Health Dimensions of Decarbonization" (Physicians, Scientists, and Engineers for Healthy Energy [PSE], August 2021), https://www.psehealthyenergy.org/wp-content/uploads/2020/12/Equity-Focused-Climate-Strategies-for-Colorado-Report.pdf.

3 It is possible that the job loss modeled is conservative because this analysis is not based on assumptions regarding the in-state effects of other states' decarbonization activities. Because Colorado is a net exporter of fossil fuels, the state's oil and gas industry and its workforce are vulnerable to the decarbonization activities of neighboring states.

case sees job growth between 2045 and 2050. The constraints in the decarbonization modeling pushes the renewable investment out to 2045, but the actual deployment could and should be smoother and steadier over time. From a workforce perspective, condensing renewables development into a few years could be hampered by labor shortages, lead to intermittent work, and trigger high job loss after the investment period, whereas long-term, sustained investment can support new apprenticeship and other training programs and ensure stable and continuous employment.

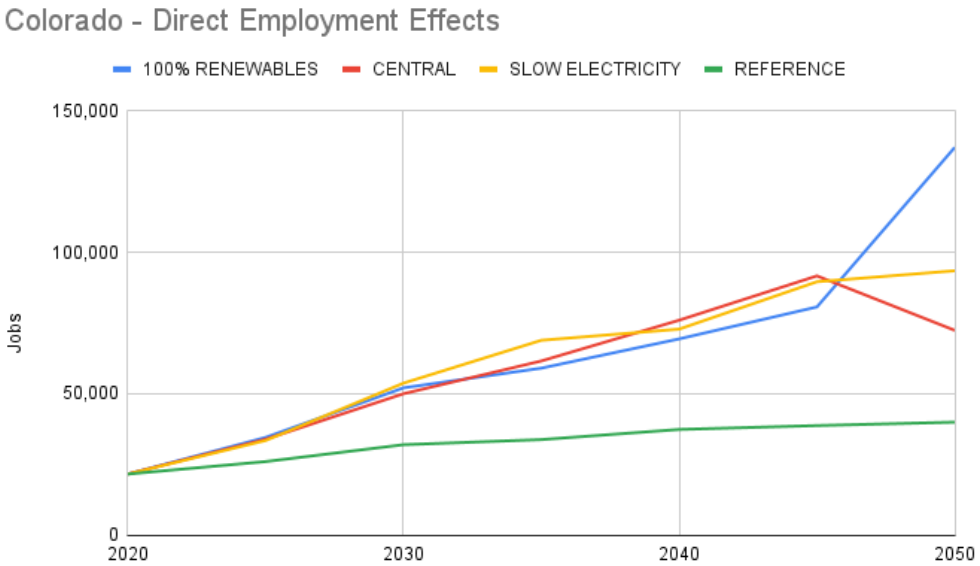


Figure ES-1. Colorado Jobs From Different Decarbonization Pathways

The 100-percent renewables scenario shows the largest increase in jobs by 2050. This large, late increase in jobs is a result of the model's optimized decision to delay large fossil-fuel-replacing investments until the model's last time step. This late increase in jobs differentiates the fossil free scenario from the others that were modeled; it should be considered somewhat separately rather than directly compared to the other scenarios.

Relative to the reference scenario, all nine regions of Colorado would benefit from decarbonization activities. Under each decarbonization pathway, the Denver metropolitan (Metro Denver) and eastern regions see high job growth, due mainly to large investments in building retrofits and distributed solar in the case of Metro Denver and high renewable development in the eastern region. Figure ES-2 shows decarbonization job growth by region for the central scenario.

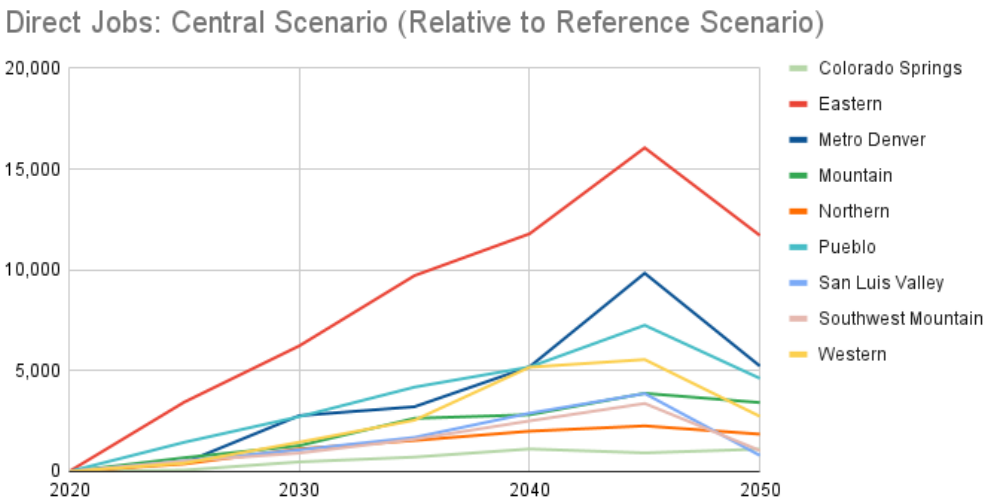


Figure ES-2. Direct Employment Effects due to Decarbonization Activities, by Region: Central Scenario

Table ES-1. Percent Increase in Regional Employment by Year 2030, Relative to 2019

REGION	100% RENEWABLES	CENTRAL	LOW DEMAND	REFERENCE
Colorado Springs	1.9%	1.8%	2.4%	1.6%
Eastern	14.6%	14.0%	23.5%	5.9%
Metro Denver	2.2%	2.1%	2.6%	1.9%
Mountain	3.7%	3.6%	5.4%	2.8%
Northern	2.4%	2.3%	3.0%	1.9%
Pueblo	5.8%	5.5%	8.6%	3.1%
San Luis Valley	8.1%	7.4%	10.8%	3.2%
Southwest Mountain	4.7%	4.4%	6.3%	3.0%
Western	3.5%	3.3%	4.4%	2.5%
TOTAL	2.8%	2.6%	3.6%	2.1%

Table ES-1 shows the percent increase in jobs by region by the year 2030 relative to regional employment in 2019. Each region will see an increase in total employment relative to a 2019 baseline. This effect is particularly pronounced in the eastern region, where jobs grow more than 14 percent relative to 2019.

In terms of industrial sectors, the largest impacts, by far, are in the construction industry, which accounts for more than 90 percent of the new decarbonization jobs in each scenario. Construction activities include building new renewable energy facilities, transmission infrastructure expansion, building and home energy retrofits, electric vehicle charging infrastructure, building new manufacturing facilities to produce clean energy equipment, and the installation or replacement of equipment like HVAC systems, heat pump water heaters, or induction stoves in buildings. Most "clean energy" jobs in the State of Colorado will be in the construction sector.

Figure ES-3 shows the change in direct decarbonization jobs for the central scenario. Because of the scale of job growth, the small categories of job loss are difficult to discern. While the model shows a loss of fossil-fuel-related utility jobs of 1,281 by 2050 in the central scenario, there is an increase in clean energy utility jobs of 1,719 by 2050, a net gain of more than 400 utility jobs. Similarly, we show a decrease of 542 fossil fuel extraction and manufacturing jobs by 2050, but an increase of 924 clean manufacturing jobs in Colorado that year.

As expected from the industrial impacts, construction- and maintenance-related occupations see the greatest growth. Other occupations, including administrative and office support, sales, and service jobs, also grow significantly. The high-growth occupations are represented by stars in Figure ES-4. These are middle-income occupations, many of which do not require a four-year or college degree.

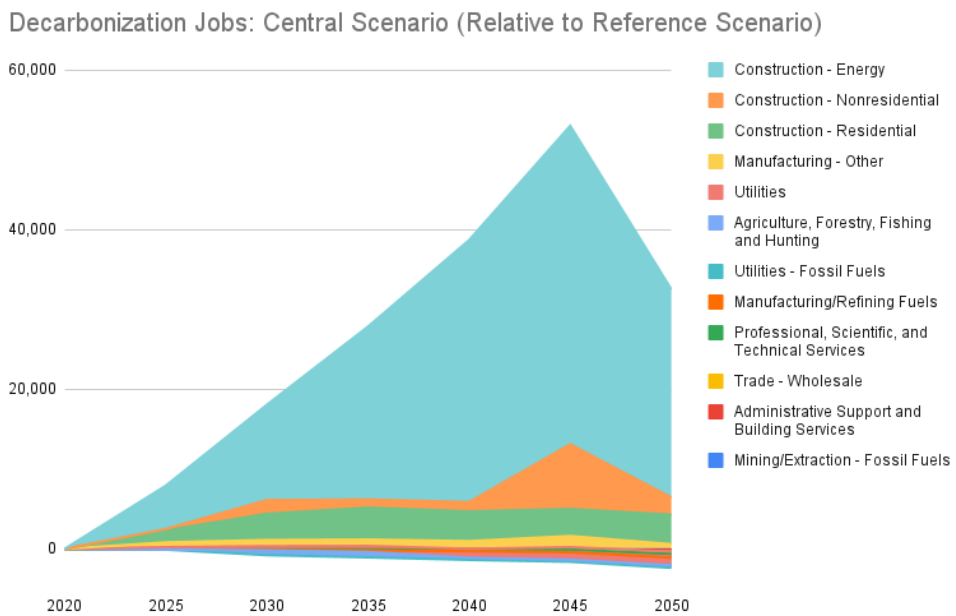
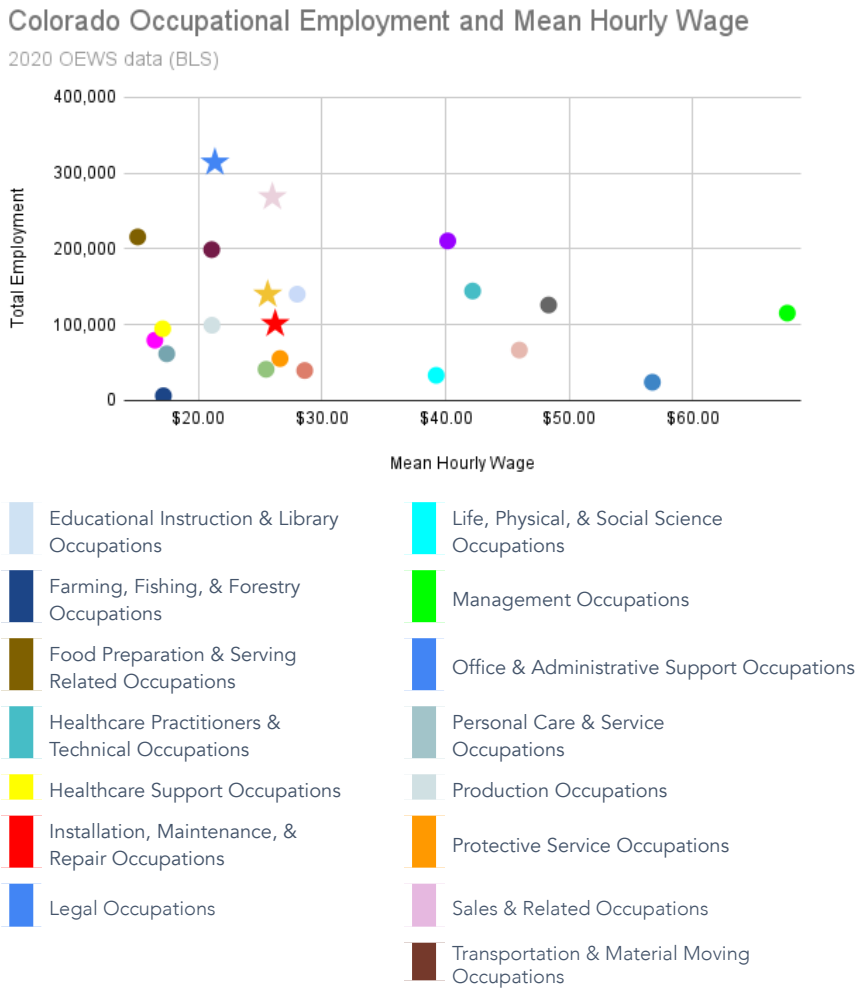


Figure ES-3. Direct Employment Effects, by Industrial Sector: Central Scenario

With the construction occupations, the expansion of registered apprenticeship programs and use of registered apprentices on projects are good ways to ensure that there is skilled and trained worker availability to meet growing labor market demand and that new investments are supporting career-track, family sustaining jobs. The last section of this report provides detailed data on Colorado's apprenticeship programs for the in-demand occupations. The data show higher participation by women and workers of color, as well as higher graduation rates among the union apprenticeship programs, but there is still much room for improvement in this regard. Continuing to improve diversity, equity, and inclusion can be supported with targeted hire standards, contractor diversity programs, and pre-apprenticeship programs with wrap-around services. This paper provides detailed data and recommendations to support improved job quality and job access in the energy transition.

Figure ES4. Colorado Employment and Mean Hourly Wage, by Occupational Category



Due to the regional, sectoral, and occupational aggregation used in this paper, it is possible that acute job losses in single counties, industries, and occupations have been missed. This is not to gloss over the challenge of job loss or the particular hardship faced by displaced workers. Even when job loss is small, it must be mitigated and managed. The geographic and occupational distribution of employment effects provided in this paper shed light on where growth in clean-energy-related occupations will occur. It details how to ensure that new investments support high-quality, family-sustaining jobs that are accessible to workers facing transition and populations traditionally excluded from career-track employment. Recommendations regarding job quality and job access are provided so policymakers and advocates can design and adopt policies to ensure that no one is left behind.

Decarbonization can be an engine of good job creation and equitable economic development. Developing domestic manufacturing—and clean energy supply chains, specifically—would result in considerably more jobs than shown here, since our modeling is constrained by current in-state activities and industry relationships. In addition to creating good career-track local jobs, decarbonization activities will save consumers money over the long haul, thus increasing household income for non-energy goods and services. The long-term cost savings of decarbonization, as well as the cleaner air and reduced health expenditures, can also support broader economic development and diversification beyond clean energy, which are not captured in this paper. Economic diversification will continue to be important, particularly in regions currently dependent on fossil fuel activity.

INTRODUCTION

The adverse effects of climate change are already apparent in Colorado, creating hotter, drier conditions responsible for disrupting its ecosystems, natural resources, water supply, and human health and prosperity. Average temperatures in the state have increased two degrees Fahrenheit over the past 30 years, with an additional five-degree increase projected by 2050.[4] The snowpack has decreased since the 1950s and is melting 15 to 30 days earlier than 30 years ago.[5] The state has been plagued by persistent drought over the past two decades, with a continued rise expected in extreme heat days, air pollution, and the frequency and intensity of wildfires, which broke records in acreage burned in 2020. To combat the climate crisis driving these perilous trends, Colorado has set ambitious targets to decarbonize its economy, transition to clean energy, and increase its climate resiliency. As the state embarks on this transition, it must work to improve health, equity, and economic opportunities for communities across the state.

4 "Colorado's Climate and Colorado's Health: Examining the Connection" (Colorado Health Institute, June 2017), https://www.coloradohealthinstitute.org/research/colorados-climate-and-colorados-health.

5 "Climate Change in Colorado," 350 Colorado, accessed January 22, 2021. https://350colorado.org/climate-change-in-colorado/.

POLICY CONTEXT

Passed in May 2019, House Bill 19-1261 committed Colorado to reductions in greenhouse gas (GHG) emissions of at least 26 percent by 2025, 50 percent by 2030, and 90 percent by 2050 as compared to 2005 levels. The same month, Governor Jared Polis laid out additional goals in his administration's *Roadmap to 100% Clean Energy by 2040 and Bold Climate Action*.[6]

The state's pathway to achieving its climate targets has since been updated and laid out in detail in Governor Polis's *Colorado Greenhouse Gas Pollution Reduction Roadmap*,[7] published in January 2021. Notably, this roadmap includes certain utilities' commitment to reducing GHG pollution at least 80 percent by 2030, reaffirms the state's commitment to bold climate action through a just and equitable transition, and acknowledges the renewed urgency of building a resilient and sustainable economy in the face of the COVID-19 pandemic. Based on modeling, the governor's plan charts progress and presents different scenarios for reaching decarbonization targets.

A project initiated by Sierra Club, GridLab, and the National Resources Defense Council (NRDC) used expert analysts to examine detailed technology and policy roadmaps for Colorado's decarbonization, analyzing energy system changes and health and equity implications. This project resulted in a paper from Evolved Energy, *Committing to Climate Action: Equitable Pathways for Meeting Colorado's Climate Goals*, published in September 2020, and a companion paper by PSE Healthy Energy, *Equity-Focused Climate Strategies for Colorado,* published in December 2020. [8, 9]

The research presented herein examines the employment and economic impacts of the decarbonization modeling by Evolved Energy Research. To enable data-driven impact assessments, this report sheds light on the associated job impacts by providing granular analysis by industry and by region. It examines the distributional effects of these outcomes, including measures of job quality such as occupational breakdowns, compensation, demographic trends, and training pathways. Lastly, it provides policy and program recommendations focused on job quality and job access to harness the momentum of large-scale change to create a more equitable low-carbon economy.

6 Jared Polis, "Roadmap to 100% Renewable Energy and Bold Climate Action" (Administration of Colorado Governor Jared Polis), accessed January 22, 2021, https://drive.google.com/file/d/1K_anGQpEf-edqhjz5b6D3LJIsfFV3mI3/view.

7 Jared Polis, "Colorado Greenhouse Gas Pollution Reduction Roadmap," January 14, 2021, https://drive.google.com/file/d/1jzLvFcrDryhhs9ZkT_UXkQM_0LiiYZfq/view.

8 Arjun Krishnaswami, Ariana Gonzalez, and Matthew Gerhart, "Committing to Climate Action: Equitable Pathways for Meeting Colorado's Climate Goals"

9 Elena Krieger, PhD, Boris Lukanov, PhD, Ana McPhail, PhD, Audrey Smith, MPH, and Annelise Dillon, MS, "Equity-Focused Climate Strategies for Colorado: Socioeconomic and Environmental Health Dimensions of Decarbonization"

ECONOMIC CONTEXT

In 2016, 27.4 percent of Colorado households with at least one adult between the ages of 18 and 64 with no work-limiting disability did not have enough income to cover county-specific costs of living.[15]

Colorado has a diversified economy, and its unemployment rate is often among the lowest in the nation. In 2019, the poverty rate in Colorado was 9.3 percent, below the national average of 10.5 percent.[10, 11] However, even before the COVID-19 pandemic, there were significant disparities in this economic picture, including growing racial wealth gaps and a growing wage gap, with earnings in the top 10 percent rising while the remaining 90 percent have largely stagnated. There are also significantly higher poverty rates among people of color—with Native Americans and Alaska Natives experiencing poverty at nearly twice the rate of the overall population, at 18 and 18.7 percent respectively—and disproportionate concentrations of the labor force in urban areas, contributing to poverty and joblessness in rural areas.[12]

While Colorado has fared better than some states since the start of the COVID-19 pandemic, job losses and economic recovery have reinforced existing disparities in the state. Job losses in 2020 were greatest among low-wage workers, most dramatically in leisure and hospitality, which showed a 12-month loss of 26.4 percent at year's end, compared to the state's overall decrease of 5.4 percent.[13] The mining and logging sector was the second hardest hit, with jobs down 12.9 percent for 2020 at year's end, primarily affecting rural areas.[14]

There is also evidence that poverty and unemployment rates do not accurately reflect income insecurity in Colorado. A measure called the "self-sufficiency standard," developed by a researcher at the University of Washington, revealed that in 2016, 27.4 percent of Colorado households that included at least one adult between the ages of 18 and 64 with no work-limiting disability did not have enough income to cover county-specific costs of living for the household composition. This figure represents more than three times the number of households counted as experiencing poverty that year. For households of color, the gap between actual income insecurity and the official poverty measure was significantly greater (by 13 percent or more).[15]

In Colorado, 500,000 jobs in outdoor recreation represent 18.7 percent of employment statewide,[16] leaving some jobs vulnerable to weather conditions in ways that climate change exacerbates, such as decreased snowpack and early melt reducing the number of skiable days. While this type of job impact is not reflected in our decarbonization modeling—which looks at the employment impacts of climate *policies* and not the impacts of climate change itself—it only strengthens the argument for an energy and economic transition that effectively addresses climate change.

10 "U.S. Census Bureau QuickFacts: Colorado," accessed July 15, 2021, https://www.census.gov/quickfacts/CO.

11 Jessica Semega et al., "Income and Poverty in the United States: 2019" (U.S. Census Bureau, September 15, 2020), https://www.census.gov/library/publications/2020/demo/p60-270.html.

12 Charlie Brennan and Lauren Contorno, "State of Working Colorado: 2020 Edition" (Colorado Center on Law and Policy, 2020), https://cclponline.org/wp-content/uploads/2020/12/SWCO_Final_122820_SM.pdf/.

13 These figures (26.4 percent and 5.4 percent) refer to "nonfarm employment," the general labor classification used by the U.S. Bureau of Labor Statistics for annual statistics (not seasonally adjusted).

14 U.S. Bureau of Labor Statistics, "Colorado: Mountain–Plains Information Office," accessed July 15, 2021, https://www.bls.gov/regions/mountain-plains/colorado.htm#eag.

15 Brennan and Contorno, "State of Working Colorado: 2020 Edition."

16 Polis, "Colorado Greenhouse Gas Pollution Reduction Roadmap."

SCOPE OF THIS ANALYSIS

Our economic modeling reflects the ways in which this transition will affect the Colorado economy and employment across sectors and geographies, accounting for both increases and decreases in economic activity due to decarbonization. This is not to suggest that balancing the job equation is a simple tally of gains and losses. Job access and job quality need to be considered broadly, over the long term and in terms of who is benefitting.

For Colorado's decarbonization effort to avoid perpetuating the same practices that led to current inequality and job precarity, the state needs policies and programs that protect not only jobs, but job quality across industries. This approach means making sure that job growth outpaces job loss, but also that the jobs created are stable, secure, safe, and good-paying, and that they are accessible and accessed by people traditionally excluded from career-track work opportunities. Beyond ensuring good quality and accessible clean energy jobs, new economic diversification will be key. The analysis presented here is constrained by the technology and policy pathways identified to dramatically reduce emissions by 2050.

Colorado's future economic and climate resilience will depend on how the energy transition is carried out and how effective the state is in developing low-carbon livelihoods that allow workers to make a good living. The transition to a low-carbon economy is an opportunity to address historic inequities. With policies to make sure traditionally underserved populations are well represented in high-quality employment as the economy evolves, Colorado can forge a just and sustainable future.

With policies to support displaced workers and make sure traditionally underserved populations are well represented in high-quality employment, Colorado can forge a just and sustainable future.

METHODOLOGY

This analysis uses the IMPLAN Input-Output model to ascertain the macroeconomic and employment effects of the deep-decarbonization scenarios.

Decarbonization Scenarios

The analysis herein is based on the following scenarios from Evolved Energy's September 2020 report.[17]

- **REFERENCE:** "Represents business as usual. No emissions reductions are required, and Colorado does not meet its HB-1261 goals."
- **CENTRAL:** The central pathway recommended by Evolved Energy "[i]ncludes a mix of achievable but aggressive demand-side transformations paired with rapid electricity decarbonization to achieve 2030 goals. [...] The model selects the most cost-effective energy supply portfolio for achieving the emission reduction goals in HB-1261. The 2050 goals are achieved with almost complete electrification of on-road transportation, heating, and the limited deployment of low-carbon fuels."
- **SLOW ELECTRICITY:** Differs from the central scenario in the delayed closure of coal plants that do not have confirmed retirement dates. Electrification is accelerated to make up for smaller emission reductions in the power sector. The modeling shows this pathway to be the most expensive, "demonstrating the high costs of a slow pace of decarbonizing the power sector."

In the central and slow electricity models, "[o]il and gas production declines 25 percent by 2030 and 75 percent by 2050, and methane leakage rates in the oil and gas industry decline by 57 percent by 2030 and 71 percent by 2050, compared to today's levels."

Evolved Energy also considered a more ambitious scenario, the 100-percent renewables (fossil-free) model, which completely phases out oil and gas use and production across the country by 2050, resulting in an emissions reduction in Colorado surpassing the 90-percent target specified in HB-1261. This scenario is presented separately from the others because it emphasizes the build-out of renewable energy, without necessarily considering the full range of interactive effects. In-state fossil fuel businesses' response to a fossil-free domestic economy will have an influence on jobs that would require additional analysis.

- **100-PERCENT RENEWABLES (FOSSIL FREE):** "Focuses on a full transition to zero fossil fuel production and use across the country by 2050. Emphasis is on the infrastructure necessary to support such a future and implications for siting, economic development, and the pace of expansion of clean electricity."[18]

17 Arjun Krishnaswami, Ariana Gonzalez, and Matthew Gerhart, "Committing to Climate Action: Equitable Pathways for Meeting Colorado's Climate Goals." 18, 19, 32-35.

18 Arjun Krishnaswami, Ariana Gonzalez, and Matthew Gerhart, "Committing to Climate Action: Equitable Pathways for Meeting Colorado's Climate Goals" . 14, 16, 32.

IMPLAN Model and Limitations

The economic and employment impact analysis below is based on converting outputs from the Evolved Energy Research (EER) deep decarbonization scenario modeling into inputs for IMPLAN. IMPLAN is an input-output (I-O) model that maps how changes in spending circulate throughout the economy, based on existing industry relationships and spending patterns in a local economy. The IMPLAN model has 544 industry sectors for which it maps the upstream and downstream relationships. I-O modeling is typically used to analyze how a change in economic activity in one sector of the economy affects that sector as well as activities, employment, and labor income in other sectors of the economy. When you model an impact (e.g., change in spending, change in output, change in employment, etc.) to a particular industry, it uses preset industry spending patterns to discern the indirect and induced impacts resulting from the initial impact. IMPLAN is not dynamic, which means that it does not account for any feedback (such as price adjustments or business, worker, and consumer activity adjustments) in response to changing prices.

For this analysis, we used as inputs the non-levelized increases and decreases in economic activity across the industries directly affected by the decarbonization scenarios. If these changes result in higher costs for households and businesses, they are reflected as a reduction in household and business income, and when changes result in reduced costs, they are reflected as an increase in household and business income. The impacts of these direct increases and decreases in spending ripple out across the economy, affecting other industries and jobs, and ultimately, they result in additional changes in spending on local goods and services.

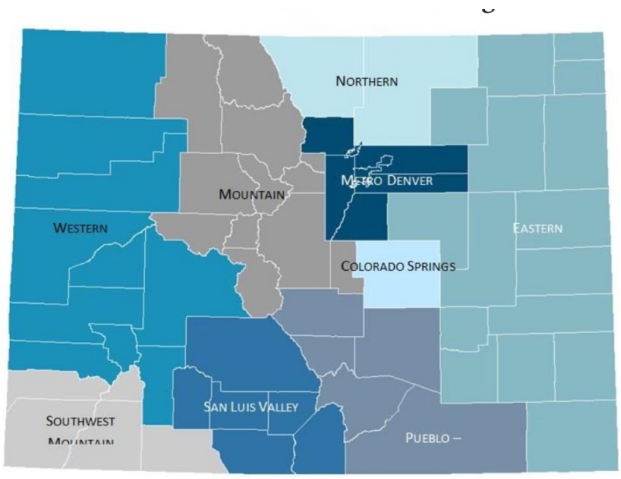
The analysis provides the "direct" and "total" macroeconomic and employment effects. The direct effects are those created directly from the activity modeled (e.g., investments in expansion of transmission infrastructure or the construction of a wind farm), while the total impacts include the indirect effects that result from intermediate (supply chain) expenditures and the induced effects created by the spending of worker and business earnings.

Technology and policy pathways account for in-state changes in demand. As a result, the consumption of fossil fuels for power generation, transportation, buildings, and other uses declines over time as the investment required to replace fossil fuels with clean energy increases. However, while the new investments required to decarbonize are captured in the energy systems modeling, the negative consequences for existing fossil fuel industries are difficult to predict and not in the scope of this paper. The IMPLAN model has captured the loss of jobs and economic activity associated with Evolved's modeled changes in energy demand, but by excluding assumptions about how fossil fuel industries will respond to reduced demand, the job loss estimates may be conservative. More detail on the specific methodology can be found in Appendix A, with the mapping on Evolved's modeling outputs to IMPLAN inputs in Appendix B.

Regions

For ease of conveying distributional impacts across the state, we allocated 64 county-level impacts to nine regions, following the map of economic regions provided by the Colorado Legislature.[19] Appendix C provides the county names by region.

Figure 1. Colorado's Economic Regions



Sectors and Occupations

For ease of conveying distributional impacts across IMPLAN's 544 industrial sectors and 823 occupations, we allocated impacts to the higher-level groupings of sectoral and occupational categories. The sectoral and occupational aggregations are shown in Appendix D, Tables A1 and A2.

19 "Colorado's Economy | Colorado General Assembly," accessed July 15, 2021, https://leg.colorado.gov/agencies/legislative-council-staff/colorados-economy.

EMPLOYMENT RESULTS

The "direct" jobs are those directly affected from the activity modeled (e.g., investments in expansion of transmission infrastructure or the construction of a wind farm). The "total" jobs include the the direct jobs plus the "indirect" jobs that result from intermediate (supply chain) expenditures and the "induced" jobs resulting from the spending of worker earnings.

STATEWIDE IMPACTS

In each decarbonization pathway modeled, the State of Colorado would see an increase in direct employment relative to the business-as-usual reference case and relative to pre-pandemic 2019 as the reference year. The direct employment impacts are shown in Figure 2. The reference scenario is graphed as the yellow line. These figures represent jobs in the industries directly affected by the decarbonization scenarios; they are mostly clean energy job growth (e.g., construction of renewable energy, manufacturing clean fuels and products, performing energy retrofits, etc.) as well as reduction in jobs in fossil fuel industries.

Figure 3 shows the economy-wide job effects of the decarbonization scenarios. Mainly these totals follow the same trend as direct job growth, differing only in the number of jobs (i.e., the total number of jobs are about double the direct jobs). The greater the intermediate spending in an industry, and the stronger the in-state supply chains, the greater the indirect and induced employment ripple effects, measured as a multiplier. For every 100 direct jobs created due to decarbonization activities, another 92 to 97 jobs will be created in the state economy. This multiplier will increase as in-state supply chains for clean energy equipment develop.

The indirect and induced job multipliers are shown in Table 1. Relative to the reference case, the indirect and induced multipliers for the decarbonization scenarios are lower, likely because in-state supply chains for decarbonization activities have not yet been well developed in Colorado. As more in-state businesses develop to meet changing energy needs and if Colorado workers and households shift more spending of income and energy cost savings to in-state businesses, these multipliers will increase.

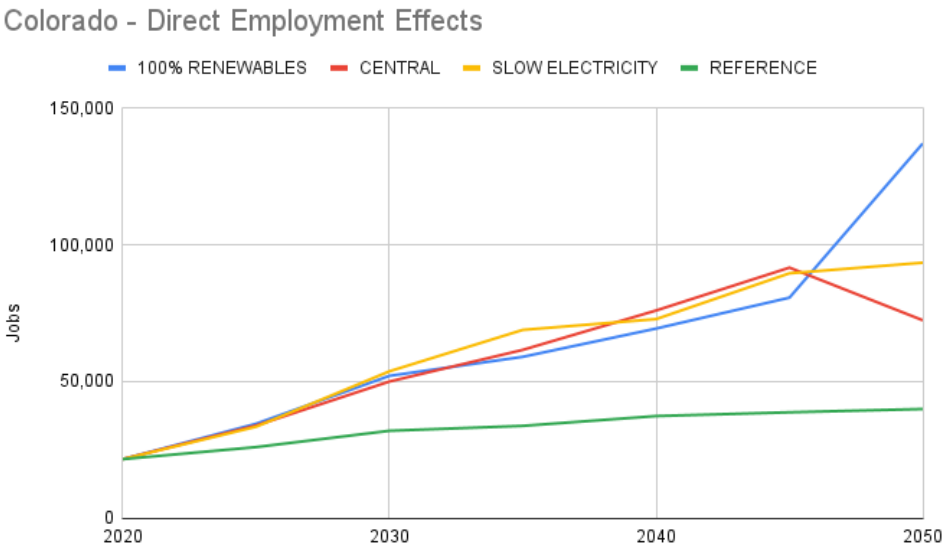


Figure 2. Statewide Direct Employment Effects of Decarbonization Scenarios

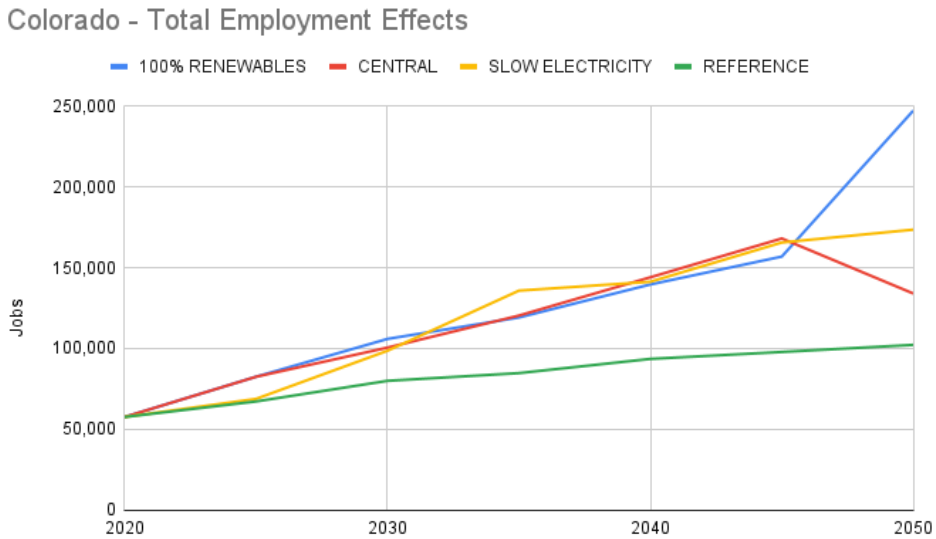


Figure 3. Statewide Total Employment Effects of Decarbonization Scenarios

Table 1. Employment Multipliers (Indirect and Induced Jobs/Direct Jobs), by Scenario

	100% RENEWABLES	CENTRAL	SLOW ELECTRICITY	REFERENCE
Indirect and Induced Employment Multiplier	0.97	0.94	0.92	1.54

A summary of the total macroeconomic impacts by scenario is presented in Table 2. All three decarbonization pathways support greater job growth and economic activity relative to the reference scenario. The slow electricity scenario creates the highest economic benefits in 2030, while the 100-percent renewables scenario creates the highest economic benefits in 2050. In the year 2040, the macroeconomic effects of all the decarbonization scenarios are similar and about 50-percent higher than the reference scenario.

Table 2. Total (Direct, Indirect, and Induced) Macroeconomic Effects, by Scenario (Dollars Reported in $ Billion)

Scenario/ Year	Employment	Output	GDP	Labor Income	State & Local Taxes	Federal Taxes
100% RENEWABLES						
2030	106,000	$26.29	$12.90	$7.21	$0.92	$1.50
2040	140,000	$31.81	$16.22	$9.21	$1.15	$1.92
2050	247,000	$52.17	$27.34	$16.21	$1.80	$3.33
CENTRAL						
2030	101,000	$25.22	$12.33	$6.88	$0.88	$1.43
2040	144,000	$32.69	$16.81	$9.57	$1.15	$1.98
2050	134,000	$29.29	$15.17	$8.74	$1.07	$1.82
SLOW ELECTRICITY						
2030	136,000	$31.26	$16.00	$9.04	$1.11	$1.88
2040	141,000	$31.66	$16.33	$9.32	$1.13	$1.93
2050	174,000	$37.24	$19.41	$11.33	$1.34	$2.34
REFERENCE						
2030	80,000	$21.46	$10.20	$5.56	$0.78	$1.17
2040	93,000	$25.08	$11.86	$6.47	$0.90	$1.36
2050	102,000	$28.02	$13.19	$7.11	$1.01	$1.50

REGIONAL IMPACTS

The direct job effects across regions are largely driven by two factors: population and renewable resource potential. Regions with large populations will see more building retrofit and distributed solar jobs, while rural areas with more solar potential will see more large-scale renewable energy development. Figure 4 below shows the direct clean-energy-related jobs by region for the three decarbonization scenarios relative to the reference scenario.

Immediately striking is the distribution of employment benefits across regions. The employment impacts are based on the pace of investments outputted by Evolved Energy's decarbonization modeling, which operates under constrained optimization. In the real world, investment may happen more smoothly. A steady path of decarbonization through 2050 can support consistent career-track employment for Colorado's workers. If decarbonization follows a path of fits and starts, job stability will suffer, and it will be difficult to secure trained and qualified workers to implement climate solutions. A strong policy signal and commitment to decarbonize by 2050, with a regulatory framework to support strong and steady private sector and ratepayer investments as well as a committed source of public revenue to build the infrastructure necessary to support those investment can ensure a stable source of jobs for tens of thousands of Coloradans over the next 30 years.

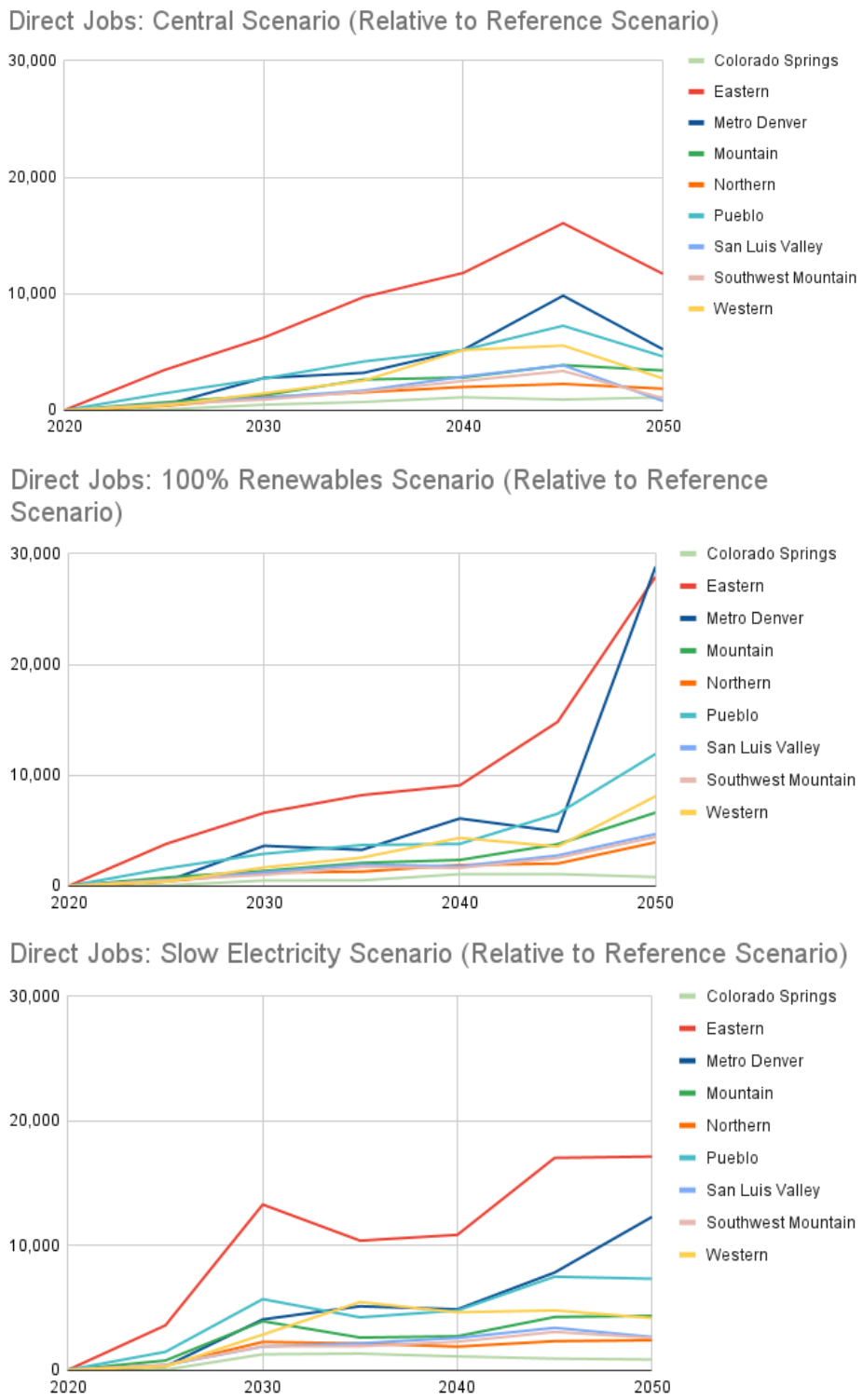
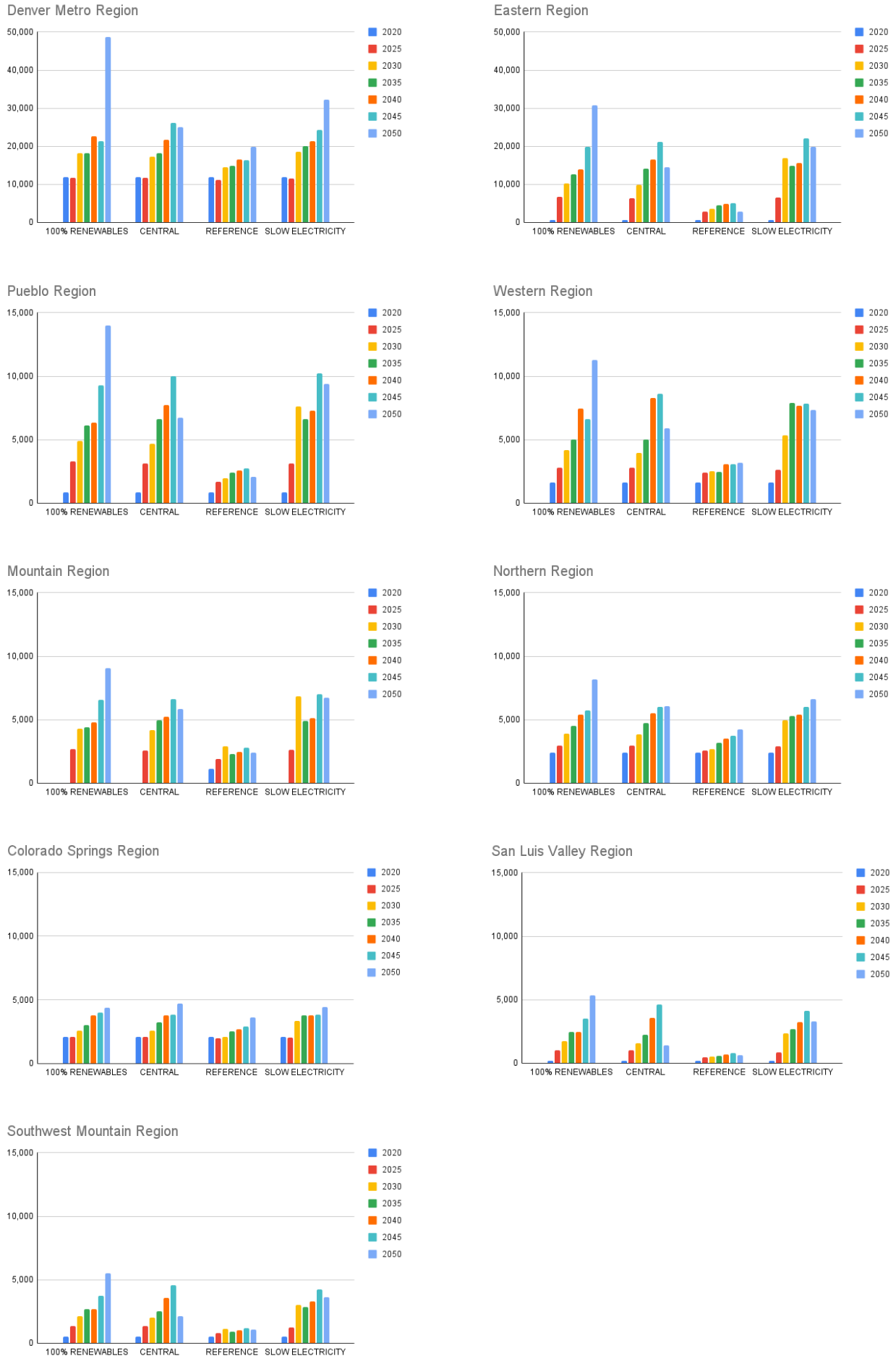


Figure 4. Decarbonization Jobs (Direct Effects), by Region

The regional results shown in these line graphs are reproduced in Figure 5, which shows regional snapshots of the total annual jobs (including those in the reference scenario). Note that the Denver metropolitan (Metro Denver) and eastern regions are shown on a different scale than the others in order to best portray the differences across scenarios within each region. The direct effects capture the jobs required to decarbonize the state economy and support a clean energy transition. These include those required to build renewable energy facilities, retrofit buildings, and manufacture equipment (e.g., vehicles, clean fuels, appliances, etc.) to meet Colorado consumer demand (to the extent such manufacturing capacity is located in Colorado). Detailed sectoral breakdowns of these jobs are provided in the next section.

Figure 5. Regional Direct Employment Effects (i.e., jobs related to decarbonization and clean energy transition)



The different-sized impacts across regions are partially explained by the decarbonization potential in different sectors. For example, rural regions with high wind or solar potential will see greater job gains than rural regions without such resources. Urban regions will see higher impacts than rural regions because of the population: more houses and buildings to retrofit, more rooftop solar potential, etc. To help make sense of these differences, we compare 2019 employment to the total job growth by decarbonization scenario by 2030. Table 3 shows this comparison, and Table 4 represents regional job growth as a percent of 2019 employment.

As with Figures 2 and 3, the data show that total employment effects by region are about double the direct employment effects. For every job created from the investment required to decarbonize, another job is created in the local supply chain and from local spending of labor income. These effects take into account the higher costs or higher savings to businesses and households related to decarbonization (e.g., higher or lower energy costs, fuel purchases, investments in cars or appliances, etc.).

While the Denver metropolitan area will see the greatest increase in jobs in each scenario, the more-rural regions will see a greater-percentage change relative to current (2019) employment. The eastern and San Luis Valley regions see particularly high job growth. By 2030, decarbonization investments could grow jobs in eastern Colorado by 23.5 percent; however, a slower and smoother rate of growth will ensure that decarbonization investments provide a stable source of employment over time, which is better for workers and easier to prepare for. Long-term, sustained investment can support new apprenticeship and other training programs and ensure stable and continuous work for workers and employers who invest in training.

Table 3. Change in Total Employment in Year 2030 Compared to 2019 Employment

REGION	2019 EMPLOYMENT	100% RENEWABLES	CENTRAL	SLOW ELECTRICITY	REFERENCE
Colorado Springs	418,987	7,767	7,422	9,876	6,701
Eastern	76,947	11,242	10,804	18,113	4,517
Metro Denver	2,329,159	51,708	48,801	60,322	44,563
Mountain	182,447	6,776	6,541	9,929	5,152
Northern	393,770	9,301	8,888	11,620	7,453
Pueblo	114,591	6,643	6,355	9,811	3,528
San Luis Valley	26,847	2,176	1,979	2,887	867
Southwest Mountain	66,790	3,107	2,953	4,212	1,990
Western	206,912	7,173	6,768	9,030	5,140
Statewide Total	3,816,451	105,893	100,510	135,798	79,911

Table 4. Percent Increase in Regional Employment by Year 2030 (Relative to 2019)

REGION	100% RENEWABLES	CENTRAL	SLOW ELECTRICITY	REFERENCE
Colorado Springs	1.9%	1.8%	2.4%	1.6%
Eastern	14.6%	14.0%	23.5%	5.9%
Metro Denver	2.2%	2.1%	2.6%	1.9%
Mountain	3.7%	3.6%	5.4%	2.8%
Northern	2.4%	2.3%	3.0%	1.9%
Pueblo	5.8%	5.5%	8.6%	3.1%
San Luis Valley	8.1%	7.4%	10.8%	3.2%
Southwest Mountain	4.7%	4.4%	6.3%	3.0%
Western	3.5%	3.3%	4.4%	2.5%
Statewide Total	2.8%	2.6%	3.6%	2.1%

Photo Credit: Catherine Werner, City of St. Louis, IBEW Training Center

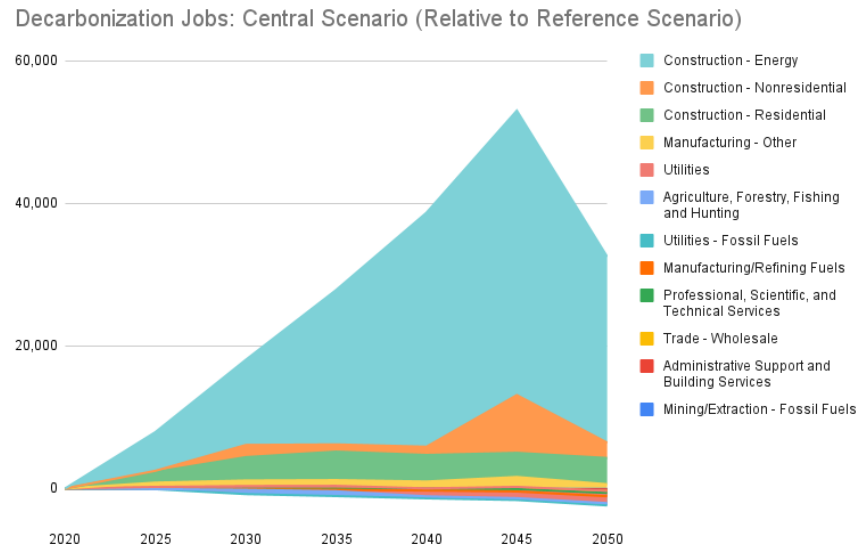
INDUSTRY IMPACTS

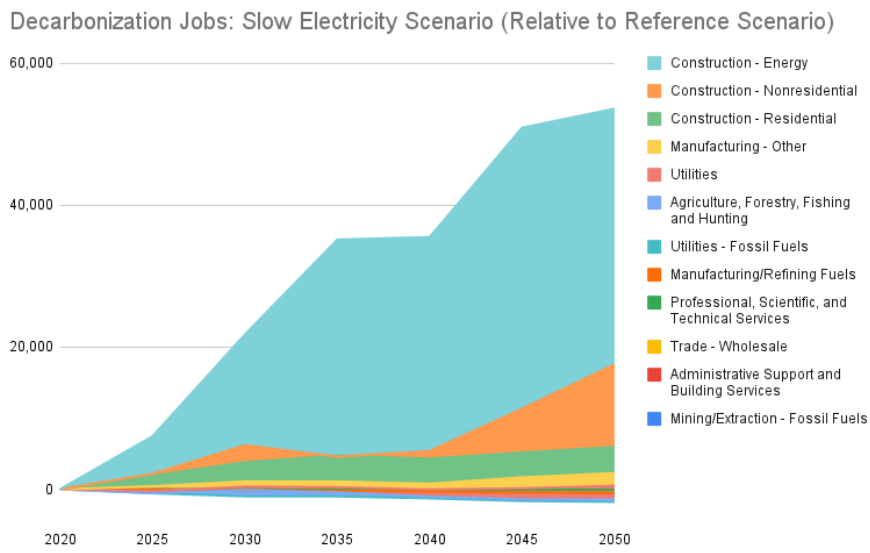
The largest impacts, by far, are in the construction industry, which accounts for roughly 90 percent of the new decarbonization jobs. Construction activities include building new renewable energy facilities, transmission infrastructure expansion, building and home energy retrofits, electric vehicle (EV) charging infrastructure, building new manufacturing facilities to produce clean energy equipment, and the installation or replacement of equipment like HVAC systems, heat pump water heaters, or induction stoves in buildings. The distribution of decarbonization jobs across industries is shown in Figure 6. Most clean energy jobs in the State of Colorado will be in the construction sector. If Colorado had a stronger clean-energy-related manufacturing industry, the state would see higher job numbers there, but the modeling for this project was constrained by the extent to which in-state demand for particular products (e.g., vehicles, HVAC systems, household appliances, etc.) is currently met by in-state manufacturers.

In this analysis, the construction-related employment is distributed by sector, the sectors being residential, non-residential, and energy. Residential construction includes energy efficiency retrofits, electrification activities, and rooftop solar. Non-residential construction will include commercial building retrofits, commercial solar, electrification activities, and the construction of new manufacturing facilities. Energy construction includes utility-scale renewable energy facilities, transmission and distribution infrastructure, and EV charging infrastructure.

The intermediate expenditures within these directly affected industries impact some other industries, and the change in labor income associated with decarbonization activities affect yet another set of industries. Thus, most industrial sectors across the Colorado economy experience ripple effects of decarbonization investments.

Occupations and industries are different. For example, not all of the jobs in the construction industry are construction occupations. There are finance professionals, business managers, and accountants employed in the construction industry, just as there are electricians, pipefitters, or construction laborers employed in the utility, extraction, and other industries. When people train for occupations, they can move between industries that require those occupational skills. When people are trained for a very specific industry or a very specialized occupation, whether it be coal mining or solar installation, they are more vulnerable to ebbs and flows in industrial investment due to policy changes. The distribution of the jobs across occupations associated with decarbonization in Colorado is shown in the next section.





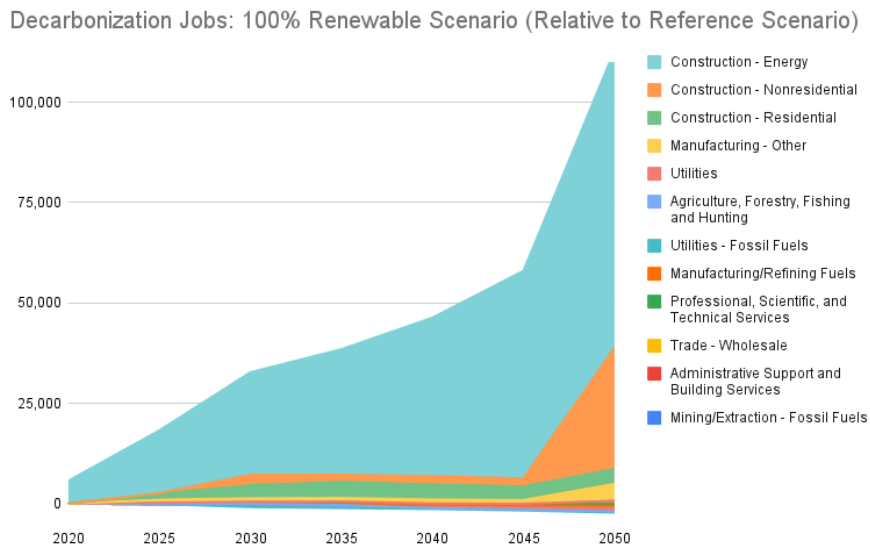


Figure 6. Decarbonization Jobs (Direct Effects), by Industrial Sector


Photo Credit: Catherine Werner, City of St. Louis, IBEW Training Center

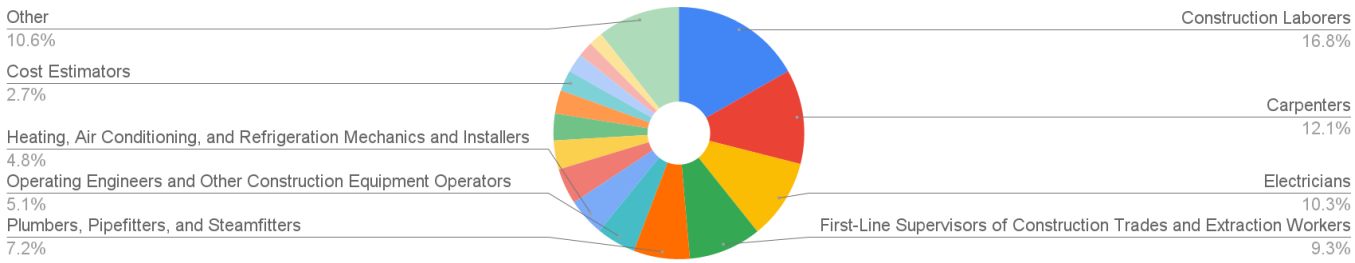
OCCUPATIONAL IMPACTS

The main difference between the decarbonization scenarios and the reference scenario is the higher percentage of construction jobs in the decarbonization scenarios. While the number of jobs in each occupational category differs by scenario, the distribution of jobs across occupations is consistent across the three decarbonization scenarios.

The top construction occupations are shown in Figure 7. IMPLAN's assignment of occupations to industries is based on federal employment surveys, and the categorization does not perfectly represent nuanced differences between general energy-related construction and renewable energy construction. The occupations required to install wind turbines and solar photovoltaic (PV) farms differ from those required to install new transmission lines. In addition, the jurisdictional boundaries of different work tasks can vary by trade. That said, most of the jobs in wind and solar construction and installation fall within traditional construction occupations (i.e. laborers, carpenters, electricians, etc.).

The key take-away for workforce development is to focus on broad occupational training leading to industry-recognized credentials, rather than investing in technology-specific training. This will allow greater transferability of skills across clean energy industries, provide workers more stable employment and job security, and ensure the State of Colorado has the qualified workers needed to implement the full range of decarbonization activities.

Figure 7. Distribution of Jobs, by Clean Energy Construction, Operations, and Building Retrofit Occupations: Decarbonization Scenarios



The top eight clean energy construction- and building-retrofit-related occupations are provided by region in Appendix E. The charts in Figure 8 show these for the Metro Denver and eastern regions, which see the largest need, and the Pueblo and San Luis Valley regions, which see the largest increase in jobs relative to their current labor force. The results for the central scenario are shown below, but the data for all regions, all scenarios, all years are shown in Appendix E. The data should inform workforce development staff and apprenticeship coordinators to expand education and training programs across regions, calibrated to growing demand for particular occupations. Toward that end, these bars represent single-year snapshots of labor market demand due to decarbonization.

Figure 12. Top Eight Clean Energy Construction and Building Retrofit Occupations, Central Scenario for Four Most-Affected Regions

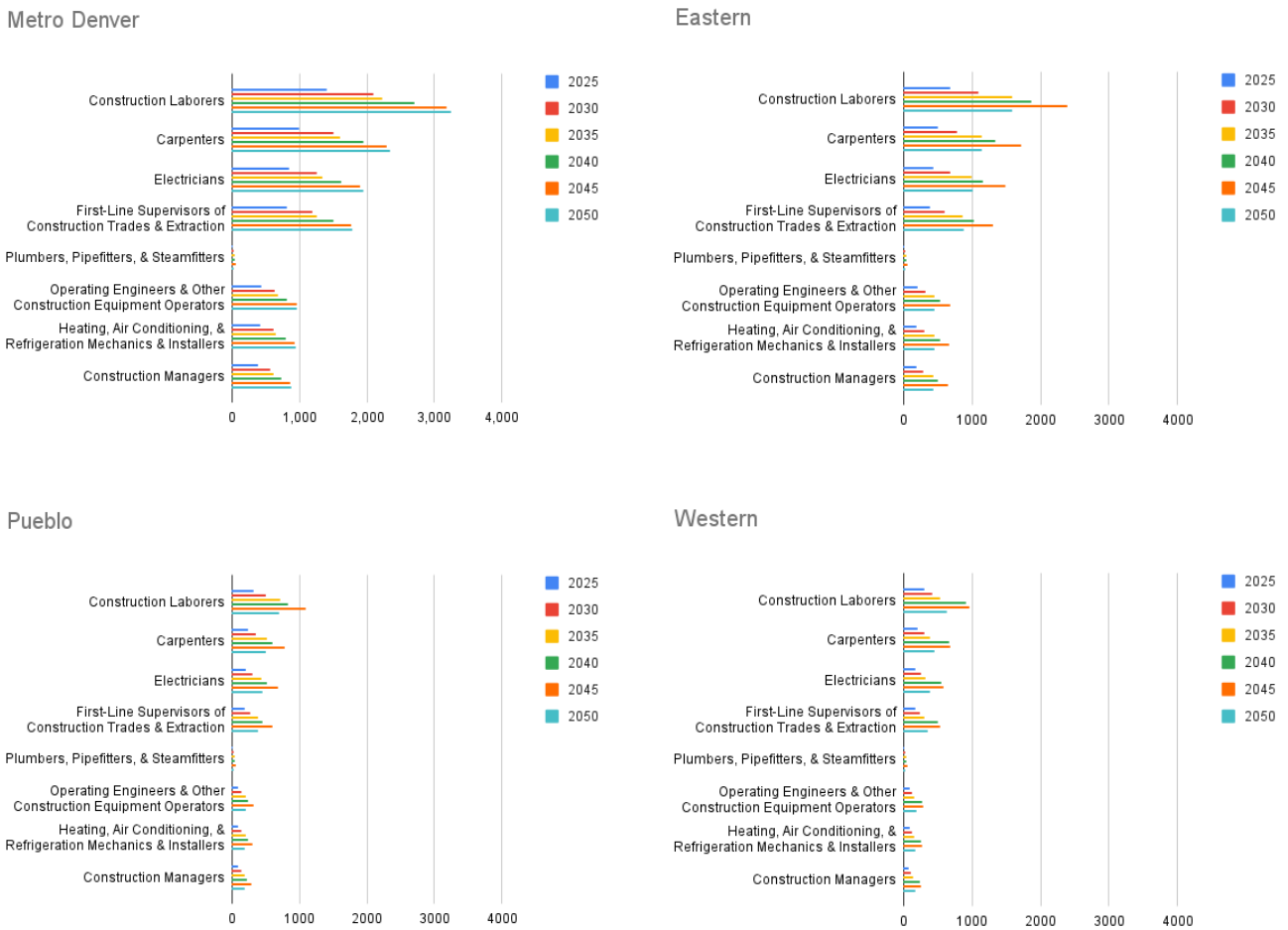


Table 5 provides the most-recent wage data and educational and licensing requirements for the top clean energy occupations in Colorado. All of these occupations are apprenticeable, and registered apprenticeship programs exist for these occupations throughout Colorado. Appendix F provides information on the registered apprenticeship programs in Colorado. Some apprenticeships are offered by single employers, while others are offered through joint labor–management apprenticeship training councils. Even among registered apprenticeships, quality can vary. More information on quality apprenticeships, including journey-level wages for the occupations in Table 5, is provided in the next section.

Table 5. Wages, Educational and Licensing Requirements for Top Clean Energy Occupations[20]

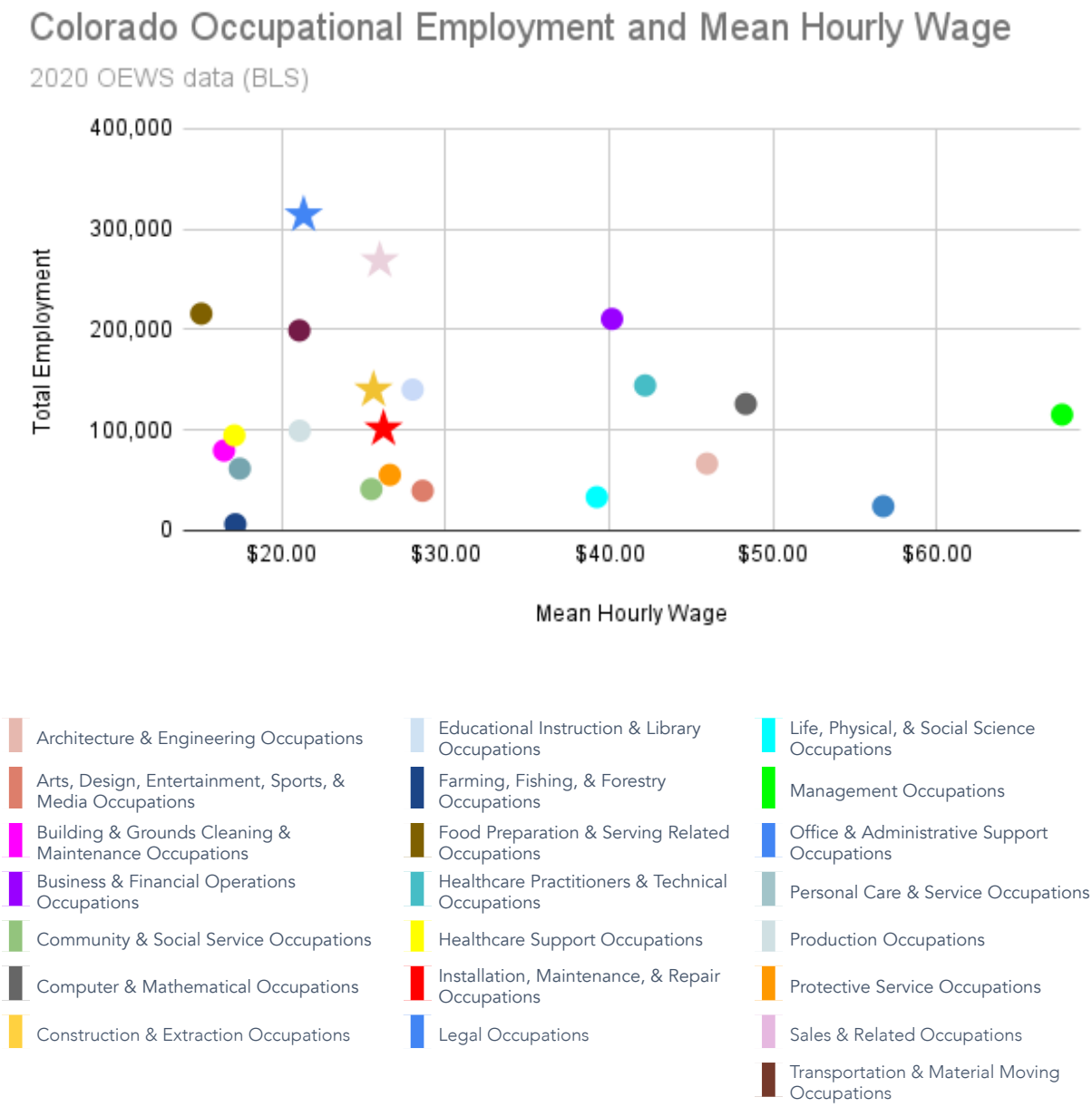
Occupation	Total employment	Average wage per hour	10th percentile wage per hour	90th percentile wage per hour	Educational requirements	License or Certification[21]
Construction Laborer	21,210	$18.80	$12.64	$24.82	Usually less than high school	No
Carpenter	13,600	$24.99	$16.41	$32.24	Usually at least high school diploma or equivalent	No
Electrician	17,930	$27.07	$16.18	$39.09	Usually at least high school diploma or equivalent	Master Electrician Journeyman Electrician Electrical Contractor Electrician Apprentice
First-line Supervisor of Construction Trades Workers	17, 440	$36.15	$22.63	$52.66	Usually at least high school diploma or equivalent	No
Plumbers, Pipefitters, & Steamfitters	10,460	$27.14	$16.64	$39.74	Usually at least high school diploma or equivalent	Master Plumber Journeyman Plumber Plumbing Contractor Plumbing Apprentice Residential Plumber
Operating Engineers & Other Construction Equipment Operators	12,110	$24.81	$17.79	$31.68	Usually at least high school diploma or equivalent	Not specified
Heating, Air Conditioning, & Refrigeration Mechanics & Installers	6,850	$26.75	$17.14	$38.22	Usually at least postsecondary non-degree award	Not specified
Construction Managers	10,460	$51.44	$30.44	$77.57	Usually at least associate degree	Not specified, except for "Electrical Contractor" (annual license required)

20 Bureau of Labor Statistics, Department of Labor, "May 2020 OEWS Estimates," accessed August 13, 2021, http://www.bls.gov/oes.

21 "Licensed and Certified Occupations," LMI Gateway | Colorado Department of Labor and Employment, accessed July 22, 2021, https://www.colmigateway.com/vosnet/analyzer/resultsNew.aspx?session=occlicense&pu=1&plang=E.

Figure 9 provides the most recent statewide employment numbers and mean hourly wages by occupational category. The occupations depicted by stars represent those with the highest job growth due to decarbonization. While these are not the highest-paid occupations in the state, the data indicate that decarbonization activities have the potential to create living wage jobs for workers without a four-year or professional degree. There is always room to improve worker compensation, and doing so may be necessary to ensure an adequate supply of workers.

Figure 9. Colorado Employment and Mean Hourly Wage, by Occupational Category



JOB QUALITY AND INCLUSION

Good jobs can broadly be defined as those offering family-sustaining compensation, job security, and career mobility. Improving economic inclusion requires not only that good jobs exist (job quality), but that the diverse population of workers has equitable access to them (job access).

A pathway to a secure career in clean energy involves equipping workers with the skills they need to succeed in the in-demand occupations and calibrating training programs to market demands with a view to long-term job security. In the construction sector, quality pre-apprenticeship and apprenticeship programs strike this balance, providing established pathways to secure, family-sustaining jobs during and beyond the energy transition.

JOB QUALITY

Many clean energy training programs focus on a narrow set of skills that prepare workers for a narrow set of work tasks. This exposes them to excessive market volatility compared with workers who receive broad occupational training.

The significant growth in demand for construction workers in both the basic and specialty trades is apt to raise concerns about labor shortages and a need for investments in workforce training. Indeed, meeting aggressive climate goals will require massive infrastructure investments and significant growth in construction occupations. However, labor shortages cannot be adequately addressed with training or other "supply-side" strategies alone; wage standards, skill requirements, and other "demand-side" levers are necessary to attract and retain a qualified workforce.

Since the 1970s, construction has shifted dramatically toward a "gig economy" model of self-employment, cutting costs for employers by stripping workers of benefits and protections. As a result, poor conditions for workers play a large part in the perceived "labor shortage." With only 20 percent of construction projects in the United States today completed by unionized firms—compared to 80 percent in the 1970s—workers have increasingly lost leverage to combat low wages, job insecurity, lack of benefits and mobility, and abuses such as wage theft, which are all widespread today.[22] Moreover, as union-coordinated apprenticeship programs declined in response to this trend, the nonunion sector failed to organize an alternative system for training workers. The "skills gap" decried for decades by homebuilders, homeowners, and construction firms has made plain the importance of organized training in maintaining a robust pool of skilled labor. Training requires time and money. Unless the acquisition of credentials is tied to increased wages and better benefits, neither workers nor employers will make this investment.

Moreover, workforce development programs that focus on the *supply side* of the labor market can flood the market with new trainees ready to work when jobs for them do not exist. Excessive supply of trained workers relative to demand can drive down wages, which hurts incumbent workers as well as trainees, destabilizing and de-skilling the industry as retention of skilled and experienced workers becomes more challenging under these conditions. Furthermore, many supply-side training programs in the clean energy sector focus on a narrow set of skills that prepare workers for a narrow set of work tasks. Solar installation and wind technician programs are two examples of training that focuses on narrowly defined skills, education, and competencies of workers, which exposes them to excessive market volatility.

22 For historical analysis of the "labor shortage" phenomenon in construction, driven by anti-union agendas since the 1960s and 19070s, see Andrew Yamakawa Elrod, "Built Trades," Phenomenal World, August 11, 2021, https://phenomenalworld.org/analysis/construction-labor-shortage.

Registered Apprenticeship

Broad occupational training, such as registered apprenticeships, can insulate against such volatility by strengthening workers' attachment to their occupations, thereby stabilizing the industry. Apprenticeship is an earn-as-you-learn training model with articulated wage progressions as trainees acquire skills and experience. Apprentices engage in both on-the-job training and classroom-based education, learning the theoretical and practical knowledge and skills to successfully complete a broad range of occupational tasks, including those required for a clean energy transition.

Construction union apprenticeships are overseen by joint labor–management–apprenticeship training committees (JATCs), ensuring that the training meets the needs of workers as well as employers. Union apprenticeships are carefully calibrated to labor market demand. JATCs estimate how much work is coming up and how many new apprentices need to be recruited to fill the positions. This demand-driven model helps ensure that individuals who invest time in their skills development and training and employers who support them will see a return on their investment, while also ensuring that employers will have access to sufficiently skilled and trained labor to complete contracted jobs.

While apprenticeship training is expanding acrossmany industries, the quality of apprenticeship programs varies significantly. Registered apprenticeships are vetted by either the U.S. Department of Labor, in the case of federally-registered apprenticeships, or the Colorado Apprenticeship Council, in the case of state-registeredapprenticeships. In both cases, key elements of registered apprenticeships is that they provide pathways to certification by completing a specified number of on-the-job training hours and related technical instruction, and involve a demonstration of competency in defined subject areas. Even for registered apprenticeships, graduation rates are indicative the quality of the program. An effective program should be able to graduate about 50 percent of its apprentices. JATC programs are responsible for the majority of apprentices, and, perhaps even more importantly, apprenticeship graduates.

Rather than investing public resources soley in education and training, decarbonization investments should be tied to workforce standards that can "pull" trained workers into jobs. Project labor agreements, project stabilization requirements, community workforce agreements, responsible contractor pre-qualification, best-value contracting, prevailing wage requirements, and skill standards are all demand-side levers that create the market conditions to address labor shortages and expand opportunities for career-track training. Labor standards on public, ratepayer, and private investments will create more openings in quality apprenticeship programs.

Apprentices receive both on-the-job training and classroom-based education, learning the theoretical and practical knowledge and skills to successfully complete a broad range of occupational tasks, including those required for a clean energy transition.

As more apprenticeship openings and programs are created, investments must also be made in creating more inclusive access to these opportunities. Barriers can be addressed through quality pre-apprenticeship or apprenticeship readiness programs that provide a range of individualized support services during and after program completion to foster skills that workers need to enter and succeed in construction careers. Training programs can provide soft skills, professional development, and math tutoring to help applicants meet common criteria,23 as well as transportation and childcare support to reduce and remove barriers to success, disproportionately affecting women and workers of color. Diversity and cultural competency training and practices among program staff and peers can likewise foster more inclusive and welcoming environments.

23 North America's Building Trades Unions, "Requirements Matrix," (North America's Building Trades Unions, March 2017), https://nabtu.org/wp-content/uploads/2017/03/Requirements-Matrix.pdf, quoted in Frank Manzo, Betony Jones, and Katherine Luke, "How to Achieve Economic Justice in Illinois' Clean Energy Transition" (Sierra Club and Inclusive Economics, January 2021), https://drive.google.com/file/d/1gEE1zRgg17YAsEvR-ngAgMTQuSRlYl4l/view.

Colorado Job Quality Legislation

In 2019, Colorado passed an apprenticeship and prevailing wage law (SB 19-196) that took effect in July 2021.[24, 25] This legislation is an important measure for ensuring that public investments support good jobs and access to career-track training. Such thresholds and standards could also be adopted for clean energy development, grid investments, and other infrastructure projects. For public projects anticipated to cost more than $500,000, SB 19-196 requires all contractors and subcontractors to pay local prevailing wages and benefits to employees weekly. The prevailing wage rate includes regular, holiday, and overtime wages, plus payments to welfare, pension, vacation, apprenticeship training, and education funds for each employee working on the project. For public projects costing $1 million or more, the contractors or subcontractors used for mechanical, electrical, plumbing, fire suppression and sprinkler-fitting work must also participate in registered apprenticeship programs that have a proven record of graduating apprentices at specified rates. Specified wage and benefits contributions for apprentices are also required. This law will work to create more opportunities in the unionized construction trades.

Colorado's recent labor-backed beneficial electrification bill (SB 21-246), passed in June 2021, exemplifies climate policy that supports high-quality, family-sustaining local jobs. The bill makes it more affordable for households and businesses to upgrade to efficient electric appliances, thereby also spurring demand for local contractors qualified to install them. "Because this legislation ensures that Coloradans participating in new upgrade programs work with licensed contractors who adhere to strong workforce standards like good training programs and livable wages, we can create new union jobs and new work for our existing union members at the same time," said Colorado AFL-CIO Executive Director Dennis Dougherty.[26]

24 Pete Lee et al., "Colorado Quality Apprenticeship Training Act Of 2019," Pub. L. No. SB 19-196 (2019), https://leg.colorado.gov/sites/default/files/2019a_196_signed.pdf.

25 Pete Lee et al., "SB 19-196: Revised Fiscal Note," April 18, 2019, https://leg.colorado.gov/sites/default/files/documents/2019A/bills/fn/2019a_sb196_r2.pdf.

26 "Colorado First State to Pass Labor-Backed Electrification Policy," NRDC, June 21, 2021, https://www.nrdc.org/media/2021/210621-1.

Prevailing Wage

Prevailing wage laws work to recruit and retain skilled workers in the construction industry. While concerns that prevailing wage rules increase project costs abound, the vast majority of peer-reviewed studies have concluded that prevailing wage laws have no impact on public construction costs.[27] Labor costs represent a low percentage of total costs on construction projects, generally, and an even lower percentage of total costs on clean energy projects. Nationwide, in 2012, labor costs accounted for approximately 23 percent of total costs in construction, while the most-recent federal data indicate that labor costs were just 11 percent of total solar project costs.[28, 29] Even wage increases of 20 percent would have minimal impact on construction costs, even before accounting for improved productivity, which tends to offset the potential impact.30 When wages increase in construction, higher-skilled workers substitute in for less-productive workers.[31] Studies show that worksite productivity improves 14 to 33 percent as a result.[32, 33] Prevailing wage laws, therefore, increase worker efficiency, stabilize costs, and help to retain a skilled workforce.[34]

27 Frank Manzo and Kevin Duncan, "An Examination of Minnesota's Prevailing Wage Law: Effects on Costs, Training, and Economic Development" (Midwest Economic Policy Institute, 2018). An analysis of 335 school construction projects built before and after the 2015 repeal of prevailing wage in Indiana reveals that repeal had no statistical impact on the average cost per public school project. See: Frank Manzo and Kevin Duncan, "The Effects of Repealing Common Construction Wage in Indiana: Impacts on Ten Construction Market Outcomes" (Midwest Economic Policy Institute, 2018), https://midwestepi.files.wordpress.com/2018/01/mepi-csu-effects-of-repealing-common-construction-wage-in-indiana-final.pdf.

28 U.S. Census Bureau, "2012 Construction (NAICS Sector 23)" (2016), https://www.census.gov/data/tables/2012/econ/census/construction.html.

29 Feldman, David, Vignesh Ramasamy, Ran Fu, Ashwin Ramdas, Jal Desai, and Robert Margolis. 2021. U.S. Solar Photovoltaic System Cost Benchmark: Q1 2020. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-77324. https://www.nrel.gov/docs/fy21osti/77324.pdf. (p.45)

30 Furthermore, by promoting the use of higher-skilled workers, prevailing wage laws reduce expenditures on materials, fuels, and rental equipment. See: Kevin Duncan and Alex Lantsberg, "How Weakening Wisconsin's Prevailing Wage Policy Would Affect Public Construction Costs and Economic Activity" (National Alliance for Fair Contracting, 2015).

31 William Blankenau and Steven Cassou, "Industry Estimates of the Elasticity of Substitution and the Rate of Biased Technological Change between Skilled and Unskilled Labor," Applied Economics 43, no. 23 (2011): 3129–42.

32 Peter Philips, "Environmental and Economic Benefits of Building Solar in California: Quality Careers, Cleaner Lives" (Donald Vial Center on Employment in the Green Economy, Institute for Research on Labor and Employment University of California, Berkeley, 2014), http://laborcenter.berkeley.edu/pdf/2014/building-solar-ca14.pdf.

33 Other important factors to consider include apprenticeship enrollment, which is 6- to 8-percent higher, and apprentice completion of on-the-job and classroom training, which occurs at faster rates in states with prevailing wage laws. See: Cihan Bilginsoy, "Wage Regulation and Training: The Impact of State Prevailing Wage Laws on Apprenticeship" (Working Paper Series, Department of Economics, University of Utah, 2003), https://ideas.repec.org/p/uta/papers/2003_08.html; Cihan Bilginsoy, "The Performance of ABC-Sponsored Registered Apprenticeship Programs in Michigan: 2000-2016" (Illinois Economic Policy Institute, 2017).

34 Frank Manzo, Betony Jones, and Katherine Luke, "How to Achieve Economic Justice in Illinois' Clean Energy Transition" (Sierra Club and Inclusive Economics, January 2021), https://drive.google.com/file/d/1gEE1zRgg17YAsEvR-ngAgMTQuSRlYl4l/view.

Apprentices engage in both on-the-job training and classroom-based education, learning the theoretical and practical knowledge and skills to successfully complete a broad range of occupational tasks, including those required for a clean energy transition.

Colorado Apprenticeship Data

Table 6 and 7 present the U.S. Department of Labor's record of Colorado apprentices and programs for Q3 2020.

Table 6. Colorado Apprentices and Apprenticeship Graduates, by Industry

Industry	Active Apprentices	Journey Employees[35]	Female Employees	Employees of Color
Construction	4,800	29,432	5,600	8,893
Non-Construction	474	4,436	1,352	1,013
Utilities	624	2,426	823	613
Grand Total	5,896	36,294	7,775	10,519

Many of Colorado's registered apprenticeship programs provide on-the-job training for jobs critical for decarbonization. Surveying the most-recent apprenticeship data for the state in Registered Apprenticeship Partners Information Database System (RAPIDS) for 2020 Q3, there were 5,896 active apprentices, 4,800 of whom were in construction and industry-related occupations most relevant to decarbonization needs.[36]

Table 7. Colorado Construction Apprentices and Apprenticeship Graduates, by Program Type

Union/ Non-Union	Active Apprentices	Journey Employees	Female Employees	Employees of Color
Non-Union	2,375	11,854	4,699	2,994
Public	264	3,119	364	777
Union	2,160	14,459	537	5,122

In Colorado, 2,160 apprentices were in joint labor–management apprenticeship (JATC) programs. These programs have higher completion rates than non-union programs in Colorado. Of registered construction apprentices in Colorado, 38 percent of apprentices in joint labor–management programs have graduated versus 24 percent in the non-union programs. The registered apprenticeship programs for the most in-demand occupations are shown in Table 8.

35 A journeyman, or journeyperson, is a worker who has successfully completed an apprenticeship program, qualifying them to be employed in a specific trade.

36 "Employment and Training Administration | Registered Apprenticeship Partners Information Database System (RAPIDS)," Data and Statistics | U.S. Department of Labor, accessed July 23, 2021, https://www.dol.gov/agencies/eta/apprenticeship/about/statistics/2020.

The vast majority of construction apprentices in Colorado are in the specialty trades (mechanical, electrical, plumbing, and sheet metal). The JATC programs lead to higher wages. The average journeyperson wage for JATC program graduates was $31.96, compared to an average of $23.11 for the construction and industrial occupations generally. From an equity/job access perspective, the JATC programs have higher-than-average participation for both women and workers of color, i.e., 5-percent women employees and 40-percent employees of color, compared to 3 percent and 31 percent, respectively, in construction and industry apprenticeships overall. The data show that higher unionization rates in Colorado not only serve workers through improved job quality, but provide better access to good-paying careers for women and workers of color, as well. Appendix F provides detailed data on wages and demographic characteristics of apprenticeships. The joint labor–management programs (JATCs) are highlighted in yellow.

Table 8. Colorado Federally Registered Apprenticeship Program, Highest-Growth Occupations

Program Name	Region	County	Occupation	Journey-level Wage
COLORADO LABORERS & CONTRACTORS JATC	Metro Denver	Adams County	CONSTRUCTION CRAFT LABORER	$17.00
COLORADO CARPENTERS & AFFILIATED TRADES JATC	Metro Denver	Denver County	CARPENTER	$25.00
COLORADO SPRINGS ELECTRICAL INDUSTRY JATC	Colorado Springs	El Paso County	ELECTRICIAN (Alternate Title: Interior Electrician)	$32.60
PUEBLO ELECTRICAL JATC	Pueblo	Pueblo County		$27.55
WESTERN COLORADO ELECTRICAL JATC	Western	Mesa County		$25.20
DELTA-MONTROSE ELECTRIC ASSN JATC	Western	Montrose County	LINE REPAIRER	$40.25
SAN ISABEL ELECTRIC ASSOCIATION JATC	Pueblo	Pueblo County		$42.53
POUDRE VALLEY REA JATC	Northern	Larimer County		$36.00
SOUTHEAST COLORADO POWER ASSN JATC	Eastern	Otero County		$40.14
TRI-STATE G&T ASSOCIATION INC. JATC TRANSMISSION (WEST)	Northern	Weld County	LINE INSTALLER-REPAIRER	$43.00
EMPIRE ELECTRIC ASSN INC. JATC	Southwest Mountain	Montezuma County	LINE MAINTAINER (Alternate Title: High Voltage Electrician)	$33.00
TRI-STATE G&T ASSOCIATION INC. JATC TRANSMISSION (WEST)	Northern	Weld County		$45.18
DENVER PLUMBERS JATC	Metro Denver	Adams County	PLUMBER	$33.18
COLORADO SPRINGS PLUMBERS/ PIPEFITTERS JATC	Colorado Springs	El Paso County		$33.85
TRI-STATE G&T JATC CRAIG	Western	Moffat County	OPERATING ENGINEER (Alternate Title: Heavy Construction Equipment Mechanic)	$39.29
COLORADO SPRINGS PLUMBERS/ PIPEFITTERS JATC	Colorado Springs	El Paso County	HEATING & AIR-CONDITIONER INSTALLER	$33.85

Table 9 lists the total number of employees who are journey level, female, workers of color, and active apprentices for these apprenticeships. While participation by women and workers of color may seem low, there is value in programs that track actual data in this regard. As the adage goes —what gets measured, improves.

Of the Colorado apprenticeship data reported in the RAPIDS system, about half of recent apprentices were in the electrical trades and another 20 percent were plumbers and pipefitters. The basic construction crafts are sorely under-represented in the RAPIDS data: for example, carpenter crafts were only 8 percent, which is significantly lower than other states. Openings to and expansion of joint labor–management apprenticeship programs are determined by labor market demand. As work for skilled and trained construction workers grows, apprenticeships can expand to accept and support more apprentices, including individuals from groups still under-represented in the construction- and clean-energy-related trades. If more unionized firms win bids in clean energy and decarbonization work, it is likely that basic craft apprenticeships could expand.

Table 9. Demographics of Colorado Federally Registered Apprenticeship Program, Highest-Growth Occupations

Program Name	Region	Journey Employee Count	Female Employee Count	Employees of Color Count	Active Apprentice Count
COLORADO LABORERS AND CONTRACTORS JATC	Metro Denver	1886	132	1304	49
COLORADO CARPENTERS & AFFILIATED TRADES JATC	Metro Denver	774	3	271	187
COLORADO SPRINGS ELECTRICAL INDUSTRY JATC	Colorado Springs	459	10	119	65
PUEBLO ELECTRICAL JATC	Pueblo	73	3	16	37
WESTERN COLORADO ELECTRICAL JATC	Western	88	1	8	18
DELTA-MONTROSE ELECTRIC ASSN JATC	Western	21	0	1	3
SAN ISABEL ELECTRIC ASSOCIATION JATC	Pueblo	20	0	7	6
POUDRE VALLEY REA JATC	Northern	38	0	0	3
SOUTHEAST COLORADO POWER ASSN JATC	Eastern	20	0	2	7
TRI-STATE G&T ASSOCIATION INC. JATC TRANSMISSION (WEST)	Northern	14	0	2	2
EMPIRE ELECTRIC ASSN. INC JATC	Southwest Mountain	20	0	0	4
DENVER PLUMBERS JATC	Metro Denver	1,207	11	239	113
COLORADO SPRINGS PLUMBERS/ PIPEFITTERS JATC	Colorado Springs	204	3	39	48
TRI-STATE G&T JATC CRAIG	Western	9	2	2	0

It should be noted that looking at average wages by occupation can hide wage differences between industries. According to the Economic Census of Construction (2017), Colorado construction workers' average hourly earnings in the oil and gas pipeline industry ($28.37) were 19 percent higher than the average for the power and communications lines and related structures industry ($23.75). A just transition could address this disparity so that workers facing job loss in one industry could transition to work in a new industry without accepting a large pay cut.

EQUITY AND INCLUSION

Photo Credit: Ujamaa Place, St. Paul, MN

Non-discrimination policies are meant to support equity and inclusion, but their real-world effectiveness is limited if they are unenforced or out of date. United States Federal Executive Order 11246 stipulates that federal contractors and contractors who receive federal assistance for construction projects must adhere to specified non-discrimination policies. These measures include participation goals of 6.9 percent for female workers nationwide and geographically specific goals for workers who are Black, Indigenous, and People of Color (BIPOC), which includes workers of Hispanic or Latinx ethnicity who do not identify as white.

While these federal standards are available and calculated to represent the demographic and geographic diversity of Colorado, the BIPOC inclusion goals are based on the 1970 Census and are out of date with the current racial and ethnic composition of some regions.[37, 38] For example, the targets for BIPOC inclusion in Colorado range from 6.9 percent in Fort Collins (Larimer County), to 13.8 percent in the Denver-Boulder metropolitan area, and 27.5 percent in Pueblo,[39] whereas the U.S. Census Bureau's 2019 American Community Survey estimates that, collectively, the BIPOC population and people of Hispanic/Latinx ethnicity who identify as white make up 21.3 percent of the population in Larimer County, 25.8 percent in Boulder, 45.7 percent in Denver, and 49 percent in Pueblo County.[40, 41, 42, 43]

Furthermore, federal standards require that contractors "engage in outreach and other good faith efforts to broaden the pool of qualified candidates to include minorities and women," meaning that if contractors fail to meet the participation goals, they are not in violation of the Executive Order.[44] State and local funding agencies could adopt more-stringent requirements that trigger penalties when contractors fail to meet the established criteria for participation.[45]

37 "Technical Assistance Guide for Federal Construction Contractors: Participation Goals for Minorities and Females" (U.S. Department of Labor, n.d.), https://www.dol.gov/ofccp/taguides/tac_fedcontractors_jrf_qa_508c.pdf.

38 "Nondiscrimination in the Construction Trades - Frequently Asked Questions" (U.S. Department of Labor - Office of Federal Contract Compliance Programs, August 4, 2009), https://www.dol.gov/agencies/ofccp/faqs/construction-trades#Q14.

39 "Technical Assistance Guide for Federal Construction Contractors" (U.S. Department of Labor - Employment Standards Administration Office of Federal Contract Compliance Programs, n.d.), http://federalconstruction.phslegal.com/wp-content/uploads/sites/116/2006/11/Construction_Contractor_Guide.pdf.

40 For each county, calculated as the difference between "Total Population" and "White alone, not Hispanic or Latino." 2019 American Community Survey 5-Year Estimates, "U.S. Census Bureau - Geography Profile: Larimer County, Colorado | People and Population | Race and Ethnicity" (2019), https://data.census.gov/cedsci/profile?g=0500000US08069.

41 2019 American Community Survey 5-Year Estimates, "U.S. Census Bureau - Geography Profile: Boulder County, Colorado | People and Population | Race and Ethnicity" (2019), https://data.census.gov/cedsci/profile?g=0500000US08013.

42 2019 American Community Survey 5-Year Estimates, "U.S. Census Bureau - Geography Profile: Denver County, Colorado | People and Population | Race and Ethnicity" (2019), https://data.census.gov/cedsci/profile?g=0500000US08031.

43 2019 American Community Survey 5-Year Estimates, "U.S. Census Bureau - Geography Profile: Pueblo County, Colorado | People and Population | Race and Ethnicity" (2019), https://data.census.gov/cedsci/profile?g=0500000US08101.

44 "Nondiscrimination in the Construction Trades - FAQ," U.S. Department of Labor.

45 Julian Gross and PolicyLink, "Local and Targeted Hiring" (Policy Brief, Local Progress: The National Municipal Policy Network), accessed February 1, 2021, https://www.policylink.org/find-resources/library/local-and-targeted-hiring.

In 2019, according to the Solar Foundation's Solar Jobs Census, 22.5 percent of solar jobs in Colorado were held by women. This figure falls below the national average of 26 percent. Hispanic or Latinx workers held 13 percent of solar jobs, up from 7.7 percent in 2015.[46, 47] As the clean energy economy matures, inclusion and equitable participation of women and people of color at all levels of employment across all industries (not only solar) must be a guiding principle.

A related national study, *U.S. Solar Industry Diversity Study 2019: New Resources on Diversity and Inclusion in the Solar Workforce*, surveyed 377 solar industry firms and 398 employees (72.5-percent men and 27.2-percent women). The responses indicate that people of color were less likely to be in manager, director, or president (MDP) positions: 37 percent of white solar workers held MDP positions, compared to 35 percent of Black solar workers and 25 percent of workers of other races. While white workers made up 73.3 percent of the solar workforce overall, they held 88 percent of top executive positions. Although around 6 percent of both men and women respondents fell in the highest wage bracket of $75 or more per hour, the overall gender wage gap in solar stood at 26 percent, i.e., women earning 74 cents on the dollar compared to men. Only 26 percent of women reported being "very satisfied" with their wage and position, compared to 40 percent of men.

In terms of career advancement, the study finds the gender gap endures and is significantly greater for women of color: only 60 Black women for every 100 men receive promotions to a manager position, compared to a ratio of 84 to 100 for white women.[48] The previous edition of the study in 2017 reported that "women of color were grossly excluded from the highest wage category, with only 4 percent of women of color earning wages above $75 per hour."[49]

Many industries lack the clear metrics needed to define and pursue equity goals. Tracking diversity trends through regular studies is an important tool that should be implemented for all industries, with at least state-level granularity. In the case of solar, the 2019 study showed some improvement in job satisfaction and wages for Hispanic/Latinx and Black respondents compared to 2017.[50, 51] Overall, the findings illustrate the need to continue improving diversity and equity in compensation and promotion at all levels of employment, particularly with regards to gender and especially for women of color.

The organization Young Invincibles makes the following recommendations for achieving gender parity in apprenticeship participation in Colorado over the next 15 years: set a gender equity target for the state's apprenticeships; fund diversity, equity, and inclusion (DEI) consultants to support the recruiting and retaining of women, particularly in male-dominated fields; release annual data on apprenticeship participation to track the state's progress toward gender equity; increase access to affordable childcare; and employ best practices for recruiting women.[52] Tracking diversity metrics and pay parity isn't enough; in order to achieve real gender equity, the culture of construction needs to significantly shift to one that is truly inclusive. This transformation requires deep work that not only addresses the systematic and historical issues around gender and racial discrimination, but changes of processes, behaviors, and expectations for workers from top to bottom.

In the construction sector—the industry sector into which solar, wind, and grid infrastructure fall— there are significant compensation differentials between union and non-union workers. Published analyses show that unions boost hourly wages for all construction and extraction workers, regardless of race or gender.[53] A case-study of wage premiums for construction and extraction occupations in Illinois, for example, found that unions raise wages by 49 percent for white workers and 56 percent for African American workers, and by 55 percent for men and 67 percent for women.[54]

46 "Solar Jobs Census 2019: Colorado" (The Solar Foundation, 2019), https://www.solarstates.org/#states/solar-jobs/2019.

47 The Solar Foundation, "Colorado Solar Jobs Census 2015" (2015), https://www.thesolarfoundation.org/solar-jobs-census/CO-2015/.

48 "U.S. Solar Industry Diversity Study 2019: New Resources on Diversity and Inclusion in the Solar Workforce" (The Solar Foundation, Solar Energy Industries Association [SEIA], 2019), https://www.thesolarfoundation.org/diversity/.

49 "U.S. Solar Industry Diversity Study 2017: Current Trends, Best Practices, and Recommendations," (The Solar Foundation, 2017), https://irecusa.org/resources/2017-solar-industry-diversity-study/.

50 "U.S. Solar Industry Diversity Study 2017."

51 "U.S. Solar Industry Diversity Study 2019."

52 Christina Postolowski and Erin Steva, "Achieving Gender Equity in Colorado Apprenticeships" (Young Invincibles [YI], October 2018), https://younginvincibles.org/wp-content/uploads/2018/10/YI_CO_ApprenticeshipsFactSheet.pdf.

53 "Construction Job Quality Across the US Energy Industries" (North America's Building Trades Union [NABTU], July 2020), https://nabtu.org/press_releases/two-new-energy-construction-studies/; based on study by Peter Philips, "The Quality of Jobs in Construction and Oil-and-Gas for High School Graduates" (ICERES, 2020), http://iceres.org/wp-content/uploads/2020/07/ICERES-Quality-of-Jobs-in-Construction-and-Oil-and-Gas.pdf.

54 "How to Achieve Economic Justice in Illinois' Clean Energy Transition" (Inclusive Economics, ILEPI, and Sierra Club, March 2019), https://drive.google.com/file/d/1gEE1zRgg17YAsEvR-ngAgMTQuSRlYl4l/view.

RECOMMENDATIONS

Photo Credit: Rising Sun Center for Opportunity

Both climate change and the energy transition will affect workers—workers in the fossil fuel and energy-intensive industries, workers subject to the vagaries of harsh weather, workers dependent on natural resources threatened by climate change, and workers who have never had access to secure employment. The energy transition will create new jobs but could also threaten long-established jobs. Shifting to a carbon-neutral economy will change the composition of the state's occupations and industries.

Colorado's 2019 Public Utilities Commission Reauthorization (PUC) Act has laid important groundwork, pairing climate targets with just transition and workforce measures, such as best value metrics and project labor agreements (PLAs), as well as prevailing wage, local hire, and apprenticeship utilization provisions.[55] To maximize benefits and minimize costs on its path to decarbonization, Colorado should continue investing in just transition tools and resources, support the growth of high-quality jobs, and improve access to jobs and contracting opportunities for women, people of color, and other marginalized people.

55 Cited from this comprehensive review of just transition measures adopted by various states: "State-Based Policies to Build a Cleaner, Safer, More Equitable Economy – A Policy Toolkit" (BlueGreen Alliance, July 24, 2020), https://www.bluegreenalliance.org/resources/state-based-policies-to-build-a-cleaner-safer-more-equitable-economy-a-policy-toolkit/.

1. Just Transition

If industries shutter, individual workers—and in some cases, entire communities—will require support to avoid excessive hardship. Workers may need retraining, wage guarantees, or bridges to retirement. Communities may require economic diversification and development investments. These are the elements of a just transition, but the need for transition support is best averted by minimizing industry destabilization that leads to abrupt layoffs.

Minimizing transition risks requires long-term planning. There are uncertainties as to the future of fossil fuel extraction and use, but when uncertainty leads to inaction, there is real risk for workers. Setting targets and engaging in long-term planning are essential to avoid industry death spirals and disorderly worker displacement. Avoiding layoffs requires managing fossil fuel decline to avoid—or at least plan for—the disruption to existing industries. By looking ahead, the state can negotiate retention bonuses to retain skilled workers even as an industry contracts, align industry contraction with retirements, and minimize or avoid layoffs. Long-term planning is also required for comprehensive industrial strategy that is compatible with and supportive of a decarbonized economy as well as forward-looking economic diversification in and across all of Colorado's unique regions.

Figure 13. Components of a Just Transition for Fossil Fuel Workers

2. Support High-Road Jobs

Creating secure family-sustaining jobs means both supporting responsible "high-road" employers and closing off the "low road" whereby firms gain a competitive advantage by skirting laws and regulations. High-road employers are those who invest in: reduction of pollution, emissions, and other environmental impacts; workplace health and safety; and employee benefits, compensation, and training. High-road firms cannot compete in an economy (or energy plan) that prioritizes low cost. Growing responsible businesses requires adopting and enforcing robust rules so that all participants in an industry meet threshold responsible employer criteria. In a global economy, Colorado must align different facets of labor, economic, and industrial policy to explicitly support the high-road path to decarbonization.

PUBLIC PROCUREMENT: JOB-QUALITY STANDARDS

In order to firmly counter a "race to the bottom," labor standards, inclusive hiring practices, and environmental standards need to be embedded in RFPs and contracts whenever the state is spending money on goods or services. In general, public procurement is an underutilized lever for meeting climate, equity, and workforce goals. It is through the procurement of both goods and services that the state government signals its policy priorities. Prevailing wage laws establish criteria for the utilization of registered apprentices as well as a threshold for worker pay and benefits.

These laws ensure that firms employing skilled workers are not underbid, that public works construction can attract and retain a skilled workforce, that industry account for the full costs of doing business (i.e., not passing costs on to taxpayers by paying sub-standard wages that require welfare subsidies), and that public dollars will support the training of the next generation of skilled workers through apprenticeship.

Beyond construction, public contracting for other services is also a lever for job quality and job access. When a public contracting process prioritizes lowest cost over best value, it actually undermines the goals of developing a skilled, stable, and diverse workforce. Colorado procures a wide range of products and services, many of which are related to its energy goals. Energy service contracts, transit vehicle purchases, and other public contracts are opportunities to ensure that the jobs the state is supporting are high-quality jobs accessible to workers of color and other marginalized individuals.

The U.S. Employment Plan (USEP) developed by the Jobs to Move America Coalition is a customizable tool to encourage companies competing for public procurement contracts to disclose information on job creation, job quality, and plans to recruit and train historically marginalized workers. It provides public agencies with guidance on building good jobs and equity into their bidding processes. LA Metro, Amtrak, and Chicago have already used USEP, and new legislation proposed in New York State would mandate the public bus system's conversion to electric using USEP.[56]

In addition to supplier diversity goals, it is equally important to establish standards protecting workers on public contracts. In the slow economic recovery following the Great Recession, more than 300,000 workers on federal contracts were victims of wage-related labor violations,[57] and repeated analyses of federal contracting data show that this trend is ongoing. Lowest-bid contracting especially harms women and workers of color, who are disproportionately employed in low-pay and high-risk industries.[58] High-road contracting can help end economic segregation that consigns women and workers of color to low pay and multigenerational wealth disparities. Colorado can immediately put to use its annual outsourcing budget to ensure private sector adherence to the state's climate, equity, and workforce goals.

PRIVATE INFRASTRUCTURE REGULATION AND INCENTIVES

While prevailing wage laws only apply to projects where state or federal money is used, the state can leverage its other powers to improve the quality of jobs in the private sector. A tax credit can be offered for projects that meet certain labor standards, along with a tax exemption for projects that pay prevailing wage and for projects developed under a Project Labor Agreement (PLA) or Community Workforce Agreement (CWA).

Beyond tax credits and exemptions, permit review and licensing and skill standards are other ways the state government can influence job quality in the private sector. California just adopted legislation to require EV Infrastructure Training Program (EVITP) certification for crews that install EV charging infrastructure.[59] Illinois requires that distributed solar installers meet certification criteria equivalent to at least an associate degree.[60] Stringent licensing and skill standards can improve job quality while also ensuring public safety.

These measures should not be considered costs to state government because there are significant public benefits of higher worker wages. When jobs do not pay enough, workers turn to public assistance in order to meet their basic needs. Welfare expenditures can be reduced by higher wages and increases in employer-provided health insurance.

56 Jobs to Move America, "U.S. Employment Plan" (April 10, 2020), https://www.ladbs.org/services/green-building-sustainability/existing-buildings-energy-water-efficiency-program/2016-ebewe-annual-report.

57 Office of Senator Elizabeth Warren, "Breach of Contract: How Federal Contractor Fail American Workers on the Taxpayer's Dime" (United States Senate), accessed August 13, 2021, https://www.warren.senate.gov/files/documents/2017-3-6_Warren_Contractor_Report.pdf.

58 In the Public Interest, "How Privatization Increases Inequality" (In the Public Interest, September 28, 2016), accessed August 13, 2021, https://www.inthepublicinterest.org/wp-content/uploads/InthePublicInterest_InequalityReport_Sept2016.pdf.

59 "Energy: Transportation Electrification: Energy Efficiency Programs: School Energy Efficiency Stimulus Program," Pub. L. No. AB-841 (2020), https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB841.

60 "Illinois Solar Energy Association - Distributed Generation Installer Certification," Distribution Generation Installer Certification, accessed August 13, 2021, https://illinoissolar.org/dgcertification.

CUT OFF THE LOW ROAD

Improving job quality will be more difficult and less effective if firms that skirt laws and regulations continue to undercut responsible employers. In the gig economy, misclassifying employees as independent contractors allows companies to avoid supporting the social safety net or reimbursing workers for the costs incurred in doing their job, such as mileage reimbursement. Employee classification protects workers through workers compensation insurance, family and medical leave, unemployment insurance, and workplace health and safety laws. One study on the misclassification of truck drivers in California shows that compliance with the state's environmental regulation was lower for misclassified drivers because they could not afford the costs of compliance.[61] Cutting off the low road through increased enforcement and fines is essential for meeting the state's energy, equity, and workforce goals.

3. Improve Access to Economic Opportunity for People of Color, Women, and Other Marginalized Groups[62]

While we cannot achieve equity without ensuring job quality, improving job quality does not automatically improve equity. In fact, often, as job quality improves, jobs tend to become more exclusionary. This is the result of a broken system, and deliberate investments are required to counter this trend and build a system of equity and inclusion. These investments involve building and strengthening partnerships between employers, training providers, and community-based organizations; securing commitments from employers to hiring participants of training programs; conditioning financial assistance for clean energy or workforce development on targeted hire standards; expanding public sector employment; and improving access to broad occupational training.

BUILD PLACE-BASED TRAINING PARTNERSHIPS

When investing in workforce education and training, respond to employer needs, but also secure employer commitments to interviewing and hiring graduates of the training programs. In addition to employer partnerships, partnering with community-based organizations can support improved recruitment of under-represented populations and provide support services needed for participant success, such as childcare, transportation, mentoring, counseling, or other supports. No single entity in a community can, alone, correct for historic and systemic racism and sexism in tan industry. To ensure diversity, equity, and inclusion, invest in establishing and strengthening formal partnerships.

CONDITION PUBLIC FUNDING ON TARGETED HIRE STANDARDS

By emphasizing both job quality and job access together, Colorado can enable inclusive access not only to jobs, but to good, career-track, family-sustaining jobs. Job training and education may improve outcomes for individual workers, but demand-side levers in the procurement process—like targeted and local hire criteria—are essential "pull" mechanisms that ensure upward mobility. To promote equity, tools to improve job quality and job access must go hand-in-hand; when they do not, better-quality jobs are likely to become more exclusionary, keeping people of color, women, and other marginalized people relegated to more precarious and low-paying employment. The clean energy industry has a lot of work to do to overcome race and gender disparities; the gender pay gap is greater in solar than in the broader U.S. workforce, and senior executives in the solar industry are disproportionately white.[63]

61 Sam Appel and Carol Zabin, "Truck Driver Misclassification: Climate, Labor, and Environmental Justice Impacts" (UC Berkeley Labor Center, August 2019), https://laborcenter.berkeley.edu/pdf/2019/Truck-Driver-Misclassification.pdf.

62 Supplier diversity initiatives and worker-owned cooperatives have been held up as promising tools for supporting economic equity; however, these are business/employer strategies, rather than workforce strategies and are not covered here. In both cases, efforts to support and build the capacity of these firms to meet job quality and inclusion standards will be necessary. The structure and/or ownership of the firm alone do not fully protect workers from exploitation and low-road practices.

63 "U.S. Solar Industry Diversity Study 2019."

EXPAND THE PUBLIC SECTOR

A strong public sector is essential for long-term climate adaptation and resiliency. Communities benefit from a robust public sector. Public employees across all occupations enhance community well-being, help people navigate ordinary hardships, and respond effectively to emergencies. Public health workers, social workers, 911 operators, and librarians join with maintenance workers, stormwater managers, and others to maintain safe and operational systems and step up in times of crisis. There is also an opportunity for expanded public employment in energy efficiency, tree planting, and other climate activities.

Public-sector employment enhances racial equity in the workplace. Even as the private sector has remained segregated, the public sector has been a critical source of well-compensated, stable jobs for Black Americans since the mid-20th century. The median wage earned by Black employees is significantly higher in the public sector than in other industries. Some 44 percent of Black public-sector workers are able to gain economic security through homeownership, as opposed to 28 percent of Black private-sector workers.[64] From 2008-2010, 21.2% of all Black workers were public employees, compared with 16.3 percent of all other workers.[65] Public-sector contraction and outsourcing, therefore, disproportionately affects Black workers.[66] Expanding state and municipal employment can also support equity by providing jobs for individuals facing barriers to employment such as poverty, lack of a high school diploma or GED, a criminal record, or homelessness.

IMPROVE ACCESS TO BROAD OCCUPATIONAL TRAINING

Education and training will be essential to meet the demands of a low-carbon economy, but workforce education and training must be calibrated to labor market demand. Otherwise, the supply of workers can outstrip the demand for workers, increasing competition between workers and driving down wages.

Rather than training people for new "green jobs," an emphasis should be placed on training people for traditional occupations. Broad occupational training remains important. A worker will have more options, a more-stable career, and better pay as a fully licensed electrician than as a solar installer. Many of the jobs we think of as "green" are jobs that fall within traditional occupational jurisdiction. As the demand for workers proficient with new technologies grows, there is an opportunity to train more people with the foundational broad knowledge and skills to be able to grow and adapt with the technology.

Apprenticeship provides a college-alternative pathway to a family-sustaining career, but apprenticeships are competitive and selective. Pre-apprenticeship or apprenticeship-readiness programs are a good way to introduce new workers to trades work, provide them with some on-the-job experience, math skills, and work-readiness skills to successfully gain entry to and succeed in an apprenticeship program. The Multi-Craft Core Curriculum (MC3) is a comprehensive pre-apprenticeship training curriculum that has received support from industry, government, and labor partners.[67] Across the country, community-based organizations, high schools, and community colleges utilize the MC3.[68, 69] Many MC3 pre-apprenticeship programs are targeted to specific populations, such as women, opportunity youth, or formerly incarcerated individuals and provide specific wrap-around support services.

64 Deja Thomas, Lola Smallwood-Cuevas, and Saba Waheed, "Reimagined Recovery: Black Workers, the Public Sector, and COVID-19" (UCLA Labor Center, June 2020), https://www.labor.ucla.edu/publication/reimagined-recovery-black-workers-the-public-sector-and-covid-19/.

65 Steven C. Pitts, "Black Workers and the Public Sector" (UC Berkeley Labor Center, April 3, 2011), https://laborcenter.berkeley.edu/black-workers-and-the-public-sector/.

66 "How Privatization Increases Inequality" (In the Public Interest), accessed August 13, 2021, https://www.inthepublicinterest.org/report-how-privatization-increases-inequality-2/.

67 North American Building Trades Unions, "The Building Trades' Multi-Craft Core Curriculum: A Guide for Students and Parents," 2017, https://nabtu.org/wp-content/uploads/2017/08/MC3-in-Our-Schools-A-Guide-for-Students-and-Parents.pdf.

68 Tommy Burress, Tom Gannon, and Ragini Kapadia, "Community-Based Organizations and Union Apprenticeship Programs: Creating Pathways to Careers in the Unionized Construction Trades for Minorities and Lower-Skilled Workers" (Green Ways: A Jobs for the Future initiative, April 2011), https://jfforg-prod-prime.s3.amazonaws.com/media/documents/CommBasedOrg-UnionApprentProg_040212.pdf.

69 North American Building Trades Unions, "Why Should We Teach MC3 in Our Schools?," 2017, https://nabtu.org/wp-content/uploads/2017/03/Why-We-Should-Adopt-the-MC3-in-Our-School-2-22-17.pdf; North American Building Trades Unions, "What Is a Building Trades Apprenticeship Readiness Program?," (2018), https://nabtu.org/wp-content/uploads/2018/02/ARP-MC3-Program-Overview.pdf.

CONCLUSION

The analysis herein examines the impacts of a reference case and three defined scenarios for decarbonizing Colorado's economy, each of which focuses on energy. The production and consumption of energy are indeed at the core of decarbonization, but the state's transition to a green economy can and must also involve changes in many other economic areas—the development of new sectors and the waning of others—which are not fully captured here. With intention and commitment, deep decarbonization can support the growth of high-quality jobs and improved economic opportunity for workers facing transition as well as those who've been left behind. The recommendations outlined can help forge a resilient, just, and sustainable future for the State of Colorado.

APPENDICES