C40 Cities Climate Leadership Group Inc

Green Jobs Analysis and Workforce Equity Assessment Report for the city of Phoenix, U.S

cambridge econometrics

clarity from complexity

Final Report

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Executive Summary

The Green Jobs Analysis and Workforce Equity Assessment Report for Phoenix explores the potential impacts of selected climate interventions on job creation and distribution in the city of Phoenix. The study compares these potential impacts against the city's current employment landscape, providing quantitative and qualitative insights about the distribution of these jobs within the current labour market of Phoenix.

This report first explores the current labour market in Phoenix to understand the demographics of its workers, existing inequities, and the quality of current jobs. The report also analyses the current skills requirements for various sectors and provides a picture of the requirements from the workforce to support key climate actions. Furthermore, the report provides an equity assessment of the workforce in green jobs supported by climate interventions to understand the distribution, accessibility, and quality of future jobs. The workforce equity assessment uses key demographic metrics such gender, race, education and working conditions.

The report's findings are intended to support the city of Phoenix in understanding its green jobs potential and the distribution of these jobs and provide insights to address equity considerations when investing in and delivering certain climate interventions. The equity analysis in the report considers the employment demographics for jobs supported by five clusters of climate interventions selected for relevance to urban climate action plans. Out of the five broader intervention clusters, three clusters relate to mitigation interventions: energy, transport and waste. The other two clusters relate to adaptation interventions: buildings and parks (adaptation measures related to green urban infrastructure), and water (adaptation measures related to water).

The key findings from the current workforce assessment, and the key results from the workforce equity analysis are summarised below.

* **The city of Phoenix is characterised by a growing workforce and relatively low unemployment.** Among the unemployed, women, Black people, Hispanic and Latino people, and disabled people have the highest rates.
* A person working full-time at minimum wage ($12 per hour) in Phoenix in 2020 would earn about $25,000 annually. Workers in the "utilities" sector enjoy the highest median income, earning about $67,000. **Almost all sectors, including those impacted by climate interventions, are characterised by a persistent gender wage gap.**
* In terms of working conditions, jobs in sectors that are typically thought of as "blue collar" are male dominated, often characterised by long working hours, and have higher rates of harmful workplace exposures. Since climate action implementation will support thousands of "blue collar" jobs, **there is an opportunity to put in place policies to ensure that the working conditions in these sectors, including health and safety aspects**, are improved at the same time and that the city of Phoenix creates good-quality jobs.

* **From the interventions analysed, 75% of the green jobs are estimated to be supported at the city-level** (about 310,000 jobs in total, by 2030), **and most jobs will occur during the construction phase** (80% of total jobs, about 250,000 jobs). During the construction phase, most jobs will be supported in the "construction" "transportation and warehousing" and "agriculture, forestry, fishing, and hunting" sectors. As such, these sectors may see a peak in employment which will later stabilize as projects are completed. In some cases, the jobs needed to complete climate-related projects would represent a large increase in a sector's employment (i.e. the "agriculture, forestry, fishing, and hunting" sector currently supports 2,500 jobs in Phoenix, but adaptation interventions will require considerably more workers in the sector). As such, workers may need to transition from other sectors or travel from outside of the city to fill the new labour demand in these sectors.

* The below tables present summaries of the jobs supported by the mitigation and the adaptation interventions, respectively, at the national- and the city-level.

Total jobs supported by the mitigation interventions out to 2030, national vs. city-level

Intervention	National jobs	Share of total national jobs (%)	City-level jobs	Share of total city-level jobs (%)
Electric Commuter Rail	27,298*	38%	30,308	59%
Solar PV	18,498	26%	8,778	17%
Electric cars	9,296	13%	3,079	6%
Diesel/biofuel buses	5,835	8%	2,489	5%
Biofuel cars	5,796	8%	2,477	5%
BRT	1,536*	2%	2,327	5%
Electric buses	1,341	2%	853	2%
Cycle infrastructure	828	1%	419	1%
Advanced recycling	331	0%	248	0%
Hydro	140	0%	95	0%
Composting plant	87	0%	64	0%
EV infrastructure	94	0%	63	0%
Onshore wind	44	0%	24	0%
Total jobs	**71,122**	**100%**	**51,224**	**100%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure and employment multipliers on selected climate interventions in Phoenix out to 2030, in line with the city CAP

'*' denotes interventions where national job estimates are lower than local, driven by the underlying multipliers, which in these cases are smaller for the national-level than for the city-level. National multipliers will be higher where 1) the labor wage is lower than in Maricopa County (and therefore the same payments to labor employ more people) and/or 2) where manufacturing activity is included in the US but not in the local region. Where local jobs are higher than national jobs, that can be interpreted as a reflection of the region having below national average wages.

Total jobs supported by the adaptation interventions out to 2030, national vs. city-level

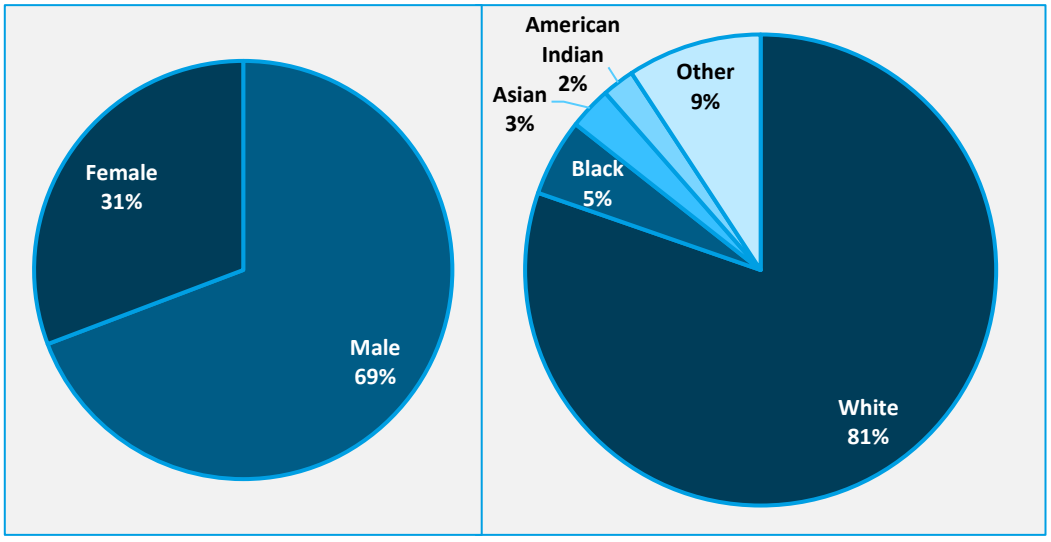
Intervention	National jobs	Share of total national jobs (%)	City-level jobs	Share of total city-level jobs (%)
Urban parks	116,971*	34%	124,048	48%
Living walls	81,024	23%	58,746	23%
Blue SuDs	71,259	21%	33,499	13%
Green SuDS	36,670	11%	18,446	7%
Grey flood barriers	22,634	7%	10,811	4%
Green roofs	11,108	3%	7,693	3%
Wastewater reuse	4,460	1%	5,541	2%
White roofs	1,467	0%	799	0%
Water efficiency	717	0%	347	0%
Street trees	319	0%	189	0%
Total jobs	**346,630**	**100%**	**260,119**	**100%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure and employment multipliers on selected climate interventions in Phoenix out to 2030, in line with the city CAP

'*' denotes interventions where national job estimates are lower than local, driven by the underlying multipliers, which in these cases are smaller for the national-level than for the city-level. National multipliers will be higher where 1) the labor wage is lower than in Maricopa County (and therefore the same payments to labor employ more people) and/or 2) where manufacturing activity is included in the US but not in the local region. Where local jobs are higher than national jobs, that can be interpreted as a reflection of the region having below national average wages.

* This study also assesses the equity and quality of green jobs supported by climate actions. An important component of job equity is understanding who is likely to fill the new jobs. **The sectors that would experience the most job growth tend to be male dominated, whilst the race distribution seems to be in line with the current racial distribution of jobs in the city**. **This finding shows the importance of enhancing accessibility, inclusivity and ensuring gender equity of the jobs supported from climate action implementation**.

Expected distribution of green jobs in Phoenix out to 2030, by gender and race



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure and employment multipliers on selected climate interventions in Phoenix out to 2030, in line with the city CAP

* Most of these jobs do not have high educational attainment requirements. **For all intervention clusters except waste, a high school degree or less is sufficient for about 40% of the workforce.** This has implications for the accessibility of these jobs as lower education requirements enables barriers to enter these jobs to be reduced. Another 30% will be expected to have completed some college or received an associate degree. Workers in the waste intervention cluster are on average more educated, with 63% attending at least some college (which might be linked to the sectoral grouping of "administrative and support and waste management services").

* **Overall, jobs in water-related adaptation and waste have the highest number of quality indicators above the reference level.** Workers in water adaptation jobs are expected to enjoy relatively few workplace exposures, high job stability, and high pay. The workforce in these green jobs is expected to be racially diverse. However, very few female workers will be able to enjoy the benefits of working in these green jobs, as only 29% are expected to be hired in this intervention cluster. For waste jobs, the workforce is anticipated to be relatively diverse, with a relatively high portion of female and non-White workers – however, workplace exposures may be higher in this sector.

* **Not all green jobs are anticipated to provide a living wage without additional measures in place**. Based on current wages, buildings and parks adaptation and waste jobs may not provide a living wage for single workers. Jobs in buildings and parks adaptation interventions also have the fewest number of good-quality indicators in our analysis, with relatively low job stability, wages, and portion of female employment. These quality shortcomings represent an opportunity for the city to improve and ensure that, with the right policies in place, green jobs supported by climate actions can be good quality and decent jobs.

* Importantly, the **implementation of climate action should be coupled with strong social and workforce development policies** to guarantee that the green jobs are also inclusive and accessible to all.

Notes to the Executive Summary of the Workforce Equity Assessment report

- When we refer to ‘green jobs’ in the Workforce Equity Assessment report and the Executive Summary, we are referring to the jobs (direct, indirect and induced) created and or supported through the implementation of specific climate action interventions object of this assessment. With this, C40 Cities is not making a recommendation that this should be the standard definition of green jobs, which is much broader and goes beyond the jobs created from climate mitigation and adaptation projects that are a part of the green economy.

- As indicated through the report, not all jobs driven by the indicated investments in climate projects will be *new*. There will be new employment created, but a part may be existing jobs that will be transformed or sustained through these investments in climate projects.

Introduction

This employment and workforce equity assessment report explores the potential impacts of selected climate interventions on job creation and distribution in the city of Phoenix. It also compares these potential impacts against the city's current employment landscape, thereby adding quantitative and qualitative insights about the labour market of Phoenix.

This report is embedded in a wider piece of research of C40 Cities that is exploring the local jobs impacts of climate interventions. Previous research for Italy, South Africa and the United States was conducted at the national and local level for pilot cities in Houston (USA), Miami (USA), Rome (Italy), Milan (Italy), Cape Town (South Africa), and Johannesburg (South Africa)[1].

Expanding this body of research, this report first explores the current labour market in Phoenix to understand the demographics of its workers, existing inequities, and the quality of jobs and skills needed to support key climate actions. The second part of the report then provides an equity assessment of the workforce in the green jobs supported by climate interventions to understand the distribution, accessibility and quality of future jobs. This workforce equity assessment uses key demographic metrics such gender, education and working conditions.

The report's findings are intended to support the city of Phoenix in understanding its green jobs potential and provide insights to address equity considerations when investing in and delivering certain climate interventions. The equity analysis in the report considers the employment demographics for jobs supported by five clusters of climate interventions selected for relevance to urban areas: Adaptation - Buildings and parks, Adaptation – Water, Energy, Transport, and Waste.

All data in the *Current workforce assessment* sub-chapter reflect residents of Phoenix, Maricopa County, or Arizona, rather than those employed in the respective areas. Data in the *Equity aspects of the climate action implementation* sub-chapter reflects the jobs supported by the interventions in the city of Phoenix, as well as its impact at the national level (USA).

The remainder of the report is structured as follows:

- **Section 1** presents an assessment of the current workforce in Phoenix, including employment demographics and the skills base. Certain aspects, such as working conditions are presented with data at the national or state level (due to lack of local data) - this is always flagged next to the respective indicators. Equity impacts are examined across gender, education, age, skills, wage, stability of employment and full and part-time employment demographics.
- **Section 2** presents an assessment of how the selected climate interventions are expected to support jobs at the city level. This section also evaluated equity aspects of the jobs supported by climate

[1] C40 Cities (2021) Creating local green jobs in the United States, Italy and South Africa. Available at: https://www.c40knowledgehub.org/s/article/Creating-local-green-jobs-the-United-States-Italy-and-South-Africa?language=en_US.

interventions, as well as skill requirements and gaps related to delivering climate interventions.

- **Section 3** concludes with a summary of key findings, highlighting key lessons for delivering equitable jobs through climate interventions in the city of Phoenix.

An **Annex** with additional information on the methodology, detailed data sources and limitations is included.

Notes to the Workforce Equity Assessment report

- When we refer to 'green jobs' in the Workforce Equity Assessment report and the Executive Summary, we are referring to the jobs (direct, indirect and induced) created and or supported through the implementation of specific climate action interventions or projects object of this assessment. With this, C40 Cities is not making a recommendation that this should be the standard definition of green jobs, which is much broader and goes beyond the jobs created from climate mitigation and adaptation projects that are a part of the green economy.

- As indicated through the report, not all jobs driven by the indicated investments in climate projects will be *new*. There will be new employment created, but a part may be existing jobs that will be transformed or sustained through these investments in climate projects.

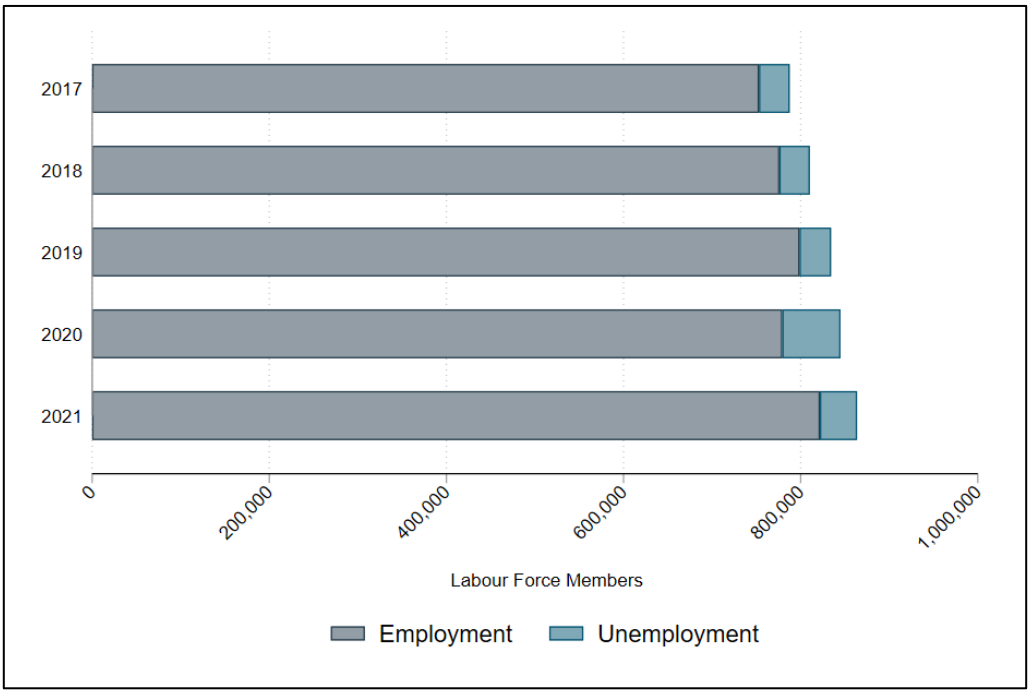
1 Current workforce assessment

This section presents an assessment of the local workforce in Phoenix. Data represent the most recent sources available. Where possible, data is shown at the city level. Where city-level data was not available, state or national level data has been used.

Employed/ Unemployed

Already one of the most populous cities in the US, Phoenix continues to gain new residents each year. Phoenix had the second highest number of new residents of any city in the US between 2020 and 2021, with over 13,000 new residents.[2] As seen in Figure 1, this expansion is reflected in the city's growing workforce. Between 2017 and 2021, Phoenix saw a 10% increase in its total workforce, gaining over 76,000 new workers over the five-year period.

Figure 1: Phoenix labour force, employment, and unemployment, 2017-2021



Note: The figure displays the number of labour force members by year and employment status. Estimates are not seasonally adjusted.
Source(s): Arizona Commerce Authority

Prior to the onset of the COVID-19 pandemic, the annual average unemployment rate in Phoenix remained under 4.5%. In 2020, unemployment rose to 7.8%, with about 66,000 labour force members out of work. By 2021, unemployment recovered by almost 3 percentage points, with only about 4.9% of the workforce unemployed.

Within Phoenix's labour force, unemployment rates vary by demographic characteristics. As seen in Table 1, unemployment is highest for the 16 to 29 age group and lowest for those over 55 years of age. For all age groups except 16 to 29, women experience higher rates of unemployment than men. When considering unemployed by gender and race, **women have higher unemployment rates than their male counterparts across almost all racial**

[2] US Census Bureau "Fastest-Growing Cities Are Still in the West and South."

groups. Black women in particular experience high unemployment rates compared to women in other races and men, with about 9.5% of the labour force unable to find work. Conversely, Asian men experience the lowest rates of unemployment, followed by Asian women. **In terms of ethnicity, Hispanic and Latino people are more likely to be unemployed than those outside of the ethnic group.** This disparity is particularly pronounced for Hispanic and Latino women who have an unemployment rate over 2 percentage points higher than non-Hispanic or Latino women (6.5% versus 4.3%). Unemployment rates are lowest for those with a bachelor's or higher degree and highest for those with only a high school education or less. **Disabled people suffer the highest unemployment rate** of any group (13%) and are almost three times more likely to be unemployed than those without a disability.

Table 1: Phoenix unemployment rate (%) by demographic characteristics, 2016-2020 five-year estimates

Unemployment Rate							
By Age & Sex							
Male All Ages	Male Age 16-29	Male Age 30-54	Male Age 55+	Female All Ages	Female Age 16-29	Female Age 30-54	Female Age 55+
5.2	8.5	4.1	3.4	5.6	8.4	4.7	3.5
By Race & Sex							
White Male	Black Male	Asian Male	Other Races Male	White Female	Black Female	Asian Female	Other Races Female
4.5	8.2	3.2	6.8	5.0	9.4	4.1	6.7
By Ethnicity & Sex							
Male Not Hispanic or Latino		Male Hispanic or Latino		Female Not Hispanic or Latino		Female Hispanic or Latino	
4.6		4.9		4.3		6.5	
By Educational Attainment							
Less than High School		High School		Some College or Associate's Degree		Bachelor's Degree or Higher	
5.9		6.5		4.4		2.5	
By Disability Status							
Disabled				Not Disabled			
13.0				4.7			

Note(s): This table displays unemployment rates for Phoenix residents by demographic characteristics. Unemployment rate estimates come from author's calculations based on the American Community Survey five-year data for Phoenix City Census Designated Place (CDP) from 2016-2020.

Source(s): US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

Table 2 shows employment by sector. The "health care and social assistance" and "retail trade" sectors provide the most jobs in Phoenix, together employing almost a quarter of the city's workforce. The sector with the next highest level of employment, "accommodation and food services" is associated with the lowest earnings, with the median worker earning less than $21,000 annually. For reference, a person working full-time at minimum wage ($12 per hour in 2020) in Phoenix would earn about $25,000 annually. However, only about half

of the workers in the “accommodation and food services” sector work full-time year-round. Workers in the “utilities” and “professional, scientific, and technical services” sectors enjoy the highest median income, earning about $67,000 and $60,000 respectively. Workers in “white collar” or government-supported industries, such as “management of companies and enterprises” “public administration” and “finance and insurance” have relatively high job stability, as shown by a large portion working full-time year-round.

Table 2: Phoenix employment and earnings by sector, 2016-2020 five-year estimates

Sector	Total Employment	Percent of Total Employment	Median Earnings	Percent Full-Time Year-Round
Health care and social assistance	100,018	12.2%	$39,266	74%
Retail trade	95,163	11.6%	$26,557	64%
Accommodation and food services	69,888	8.5%	$20,990	52%
Construction	68,194	8.3%	$38,367	82%
Administrative and support and waste management services	59,308	7.2%	$26,296	71%
Finance and insurance	61,416	7.5%	$52,791	89%
Educational services	60,017	7.3%	$40,149	65%
Manufacturing	57,150	6.9%	$41,525	84%
Professional, scientific, and technical services	59,504	7.2%	$60,213	80%
Other services, except public administration	40,137	4.9%	$25,510	63%
Transportation and warehousing	41,760	5.1%	$34,494	72%
Public administration	29,176	3.5%	$51,849	90%
Wholesale trade	21,101	2.6%	$46,045	84%
Real estate and rental and leasing	19,086	2.3%	$43,440	76%
Information	15,726	1.9%	$45,000	79%
Arts, entertainment, and recreation	15,342	1.9%	$26,807	53%
Utilities	5,175	0.6%	$66,840	89%
Agriculture, forestry, fishing and hunting	2,458	0.3%	$31,158	67%
Management of companies and enterprises	1,432	0.2%	$49,940	92%
Mining, quarrying, and oil and gas extraction	666	0.1%	$54,500	89%

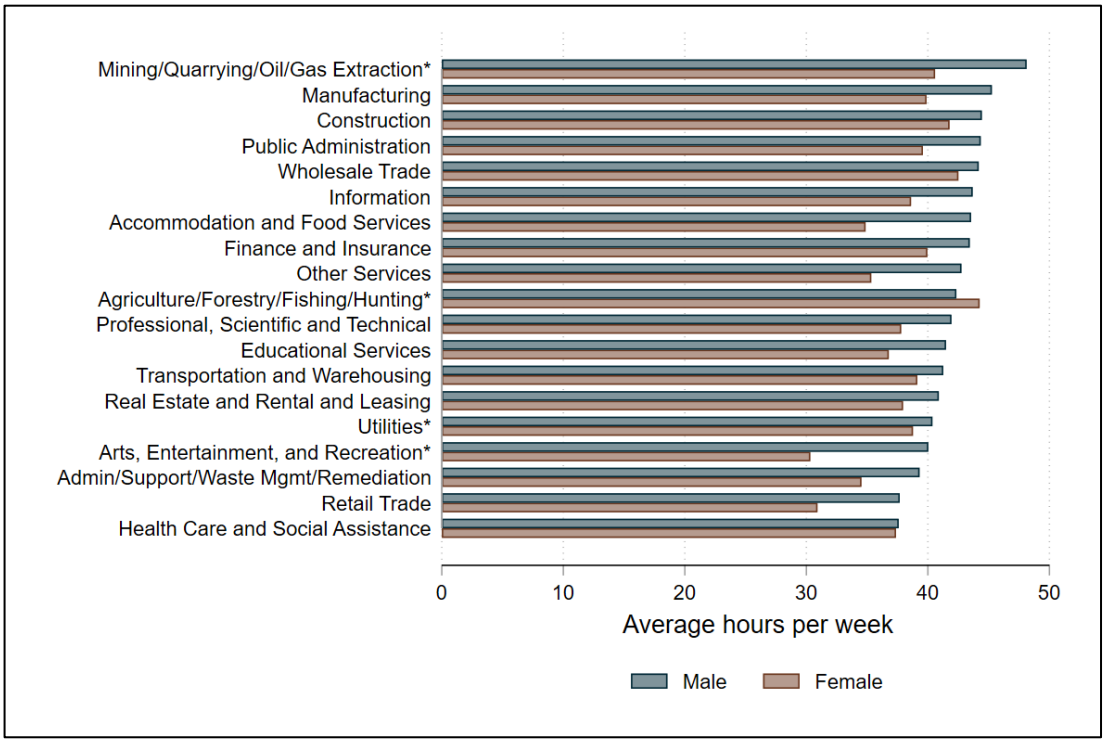
Note(s): This table shows the number of employed Phoenix residents and median annual earnings by sector. Employment estimates come from the American Community Survey five-year data for Phoenix City CDP from 2016-2020. Median earnings are reported in 2020 inflation-adjusted dollars.

Source(s): US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

Working Conditions

Understanding working conditions is central to evaluating the quality of jobs. Working conditions are also an important component of the ILO decent job framework.[3] To inform this analysis, this section provides an overview of working conditions in the U.S.[4] by sector. Data used in this analysis come from the 2015 American Working Conditions Survey, a nationally representative survey.[5,6]

Figure 2: Average hours worked per week in the United States by sector and gender, 2015

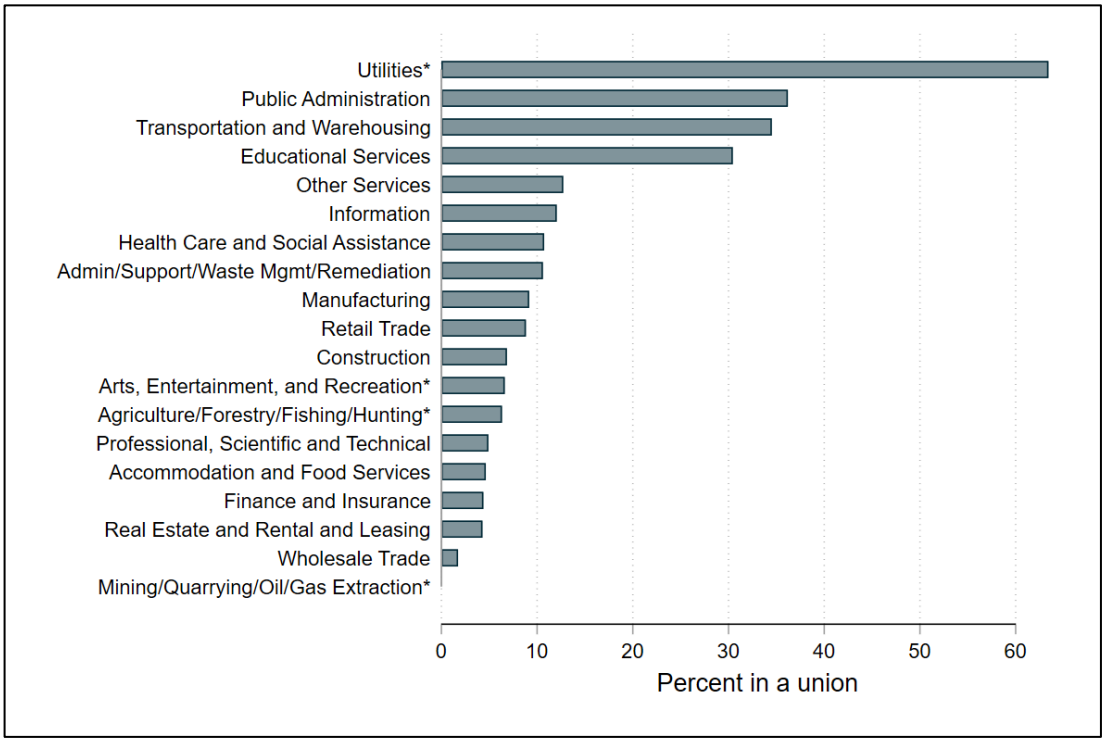


Note(s): Sectors marked with a "*" have between 10 and 30 observations (i.e. less realiable). The "management of companies and enterprises" sector was dropped from the dataset because it only had three observations.
Source(s): Maestas et al., 2017

On average, men work more hours than women at their main jobs.[7] While the typical work week in the US is 40 hours, across all sectors, men work an average of 42 hours per week while women work about 37 hours in a week. Jobs in sectors that are typically thought of as "blue collar" such as "mining, quarrying and oil and gas extraction" "manufacturing" and "construction" are particularly demanding of their male employees in terms of weekly hours (see Figure 2). Male workers in these industries spend about 44-48 hours per week working.

[3] "ILO 2022."
[4] Data was not available at the state- or city-level.
[5] Relevant to working conditions, the survey provides information about weekly hours worked, employee benefits, workplace exposures, and union membership.
[6] Maestas et al. (2017)
[7] In some cases, workers hold more than one job. This data is based on the respondents' main job.

Figure 3: Union membership in the United States by Sector, 2015



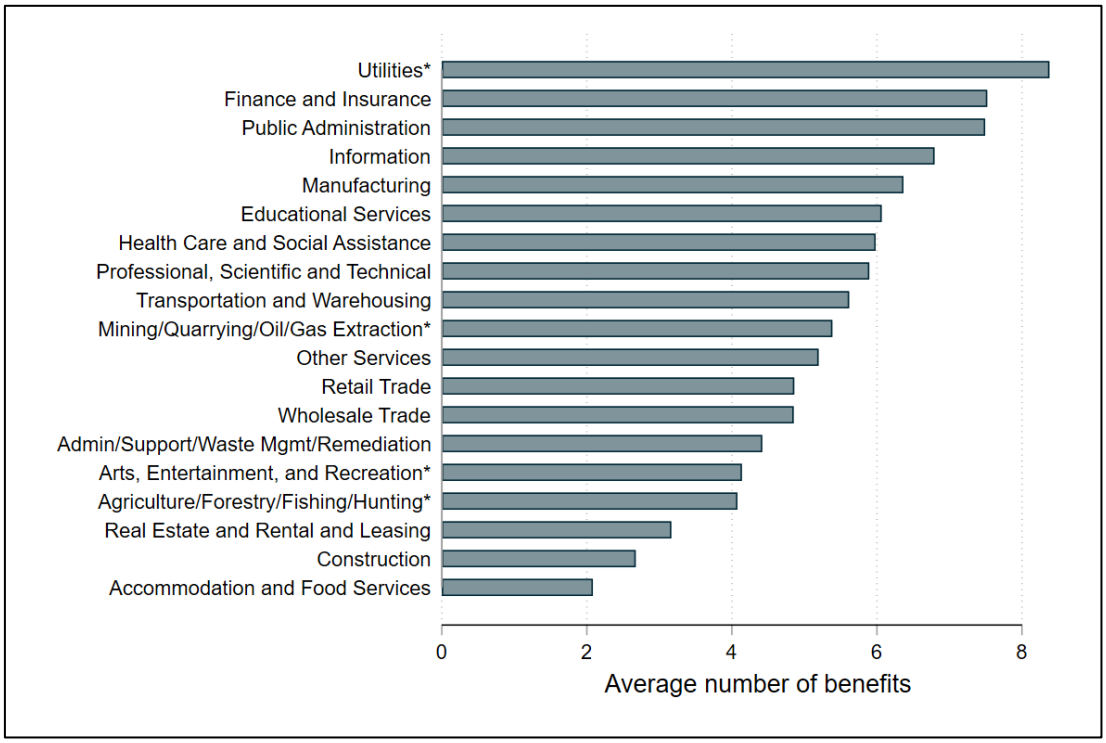
Note(s): Sectors marked with a "*" have between 10 and 30 observations (i.e. less realiable). The "management of companies and enterprises" sector was dropped from the dataset because it only had three observations.
Source(s): Maestas et al., 2017

Unions work on behalf of employees to collectively advocate for higher pay, better working conditions, and more benefits. As seen in Figure 3, union membership in the US varies by sector. More than 60% of workers in the "utilities" sector are union members, as well as about one-third of workers in "public administration" "transportation and warehousing" and "educational services". All other sectors have a rate of union membership of less than 15%.

Sectors with high union membership rates tend to provide workers with more benefits. The working conditions survey asks respondents how many of nine possible benefits they receive through their employer.[8] On average, workers in unions receive about seven of these nine benefits whereas non-union workers receive about five. Figure 4 shows the average number of these nine benefits received by workers in each sector. Workers in the "utilities" sector receive over eight of these benefits on average, while "accommodation and food services" workers only receive about two.

[8] The survey asks respondents which of the following nine benefits they receive through their employer: 1) paid sick time, 2) paid vacation time, 3) paid holidays, 4) health insurance, 5) dental insurance, 6) pension/retirement benefits, 7) life insurance 8) disability insurance 9) flexible spending account.

Figure 4: Number of employer-provided benefits in the United States by sector, 2015



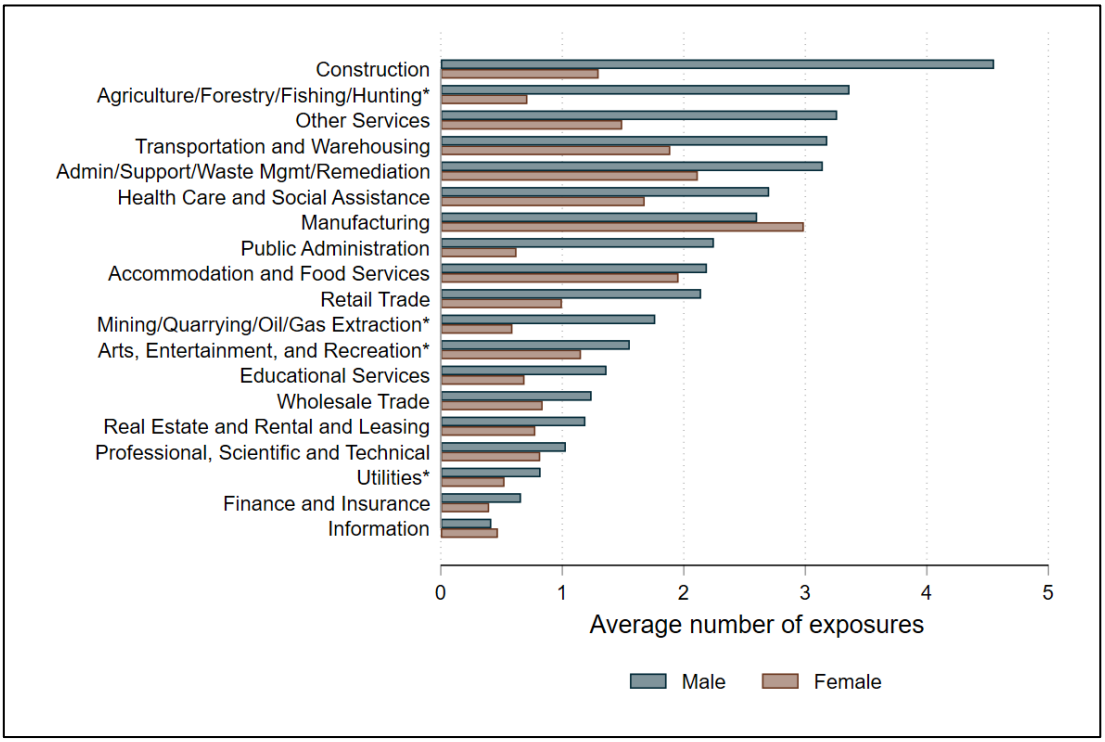
Note(s): Sectors marked with a "*" have between 10 and 30 observations (i.e. less realiable). The "management of companies and enterprises" sector was dropped from the dataset because it only had three observations.
Source(s): Maestas et al., 2017

Another factor contributing to working conditions is harmful workplace exposures.[9] On average workers are exposed to about 1.8 harmful conditions at their place of work. As seen in Figure 5, the average number of exposures varies by sector and gender. For men, workers in the "construction" sector experience the highest number of exposures at work, averaging about 4-5. For women, "manufacturing" is associated with the highest number of exposures (3.0). Overall, men experience more harmful workplace exposures than women (2 compared to around 1).

Some sectors are associated with working conditions that can be improved. In particular, the "construction" sector suffers from long hours, fewer benefits, and a higher number of harmful of exposures for male employees (who make up the majority of the workforce in the sector), compared to other sectors. Conversely, "utilities" sector averages under 40 working hours per week, has the highest rate of union members, offers the most employee benefits, and has relatively few workplace exposures.

[9] In the survey data, these exposures include: 1) vibrations – hand tools/machinery, 2) loud noise, 3) high temperatures, 4) low temperatures, 5) breathe smoke/fumes/powder/dust, 6) breathe vapours, 7) handling chemical products, 8) breathe tobacco smoke, 9) handling infectious materials.

Figure 5: Harmful workplace exposures in the United States by sector, 2015



Note(s): Sectors marked with a "*" have between 10 and 30 observations (i.e. less realiable). The "management of companies and enterprises" sector was dropped from the dataset because it only had three observations.
Source(s): Maestas et al., 2017

Occupation

Within each sector, workers are categorized into five broad occupations: 1) management, business, science, and arts, 2) services, 3) sales and office, 4) natural resources, construction, and maintenance, and 5) production, transportation, and material moving. As seen in Table 3, the "educational services, and health care and social assistance" sector, which employs the most workers in Phoenix, mostly consists of jobs in "management, business, science, and arts" occupations (64%).

Table 3: Phoenix employment by sector and occupation, 2016-2020 five-year estimates

Sector	Occupation					Total
	Management, business, science, and arts	Service	Sales and office	Natural resources, construction, and maintenance	Production, transportation, and material moving	
Retail trade	13,264	3,640	54,576	3,854	19,829	**95,163**
Construction	10,646	152	3,496	51,526	2,374	**68,194**
Finance and insurance, and real estate, and rental and leasing	38,438	2,689	36,847	1,034	1,494	**80,502**
Educational services, and health care and social assistance	102,194	36,035	18,363	862	2,581	**160,035**

Manufacturing	17,597	1,048	6,619	3,348	28,538	**57,150**
Professional, scientific, and management, and administrative, and waste management services	54,774	32,031	24,001	4,064	5,374	**120,244**
Other services, except public administration	7,429	15,648	4,648	6,413	5,999	**40,137**
Transportation and warehousing, and utilities	6,324	915	12,471	2,422	24,803	**46,935**
Public administration	12,997	7,580	6,936	1,005	658	**29,176**
Wholesale trade	4,511	499	9,850	1,218	5,023	**21,101**
Information	8,406	389	5,157	1,258	516	**15,726**
Arts, entertainment, and recreation, and accommodation and food services	16,057	52,890	12,079	718	3,486	**85,230**
Agriculture, forestry, fishing and hunting, and mining	762	315	158	1,587	302	**3,124**
Total	**293,399**	**153,831**	**195,201**	**79,309**	**100,977**	**822,717**

Note(s): This table displays the number of employed Phoenix residents by occupation and sector. The ACS public-use microdata sample data on occupation aggregates sectors in compliance with the Census disclosure avoidance rules. As a result, the sectors in this table are more aggregated than the sectors in Table 2 and the rest of this report. Employment estimates come from the American Community Survey five-year data for Phoenix City CDP from 2016-2020.

Source(s): US Census Bureau, 2020 5-year American Community Survey. Accessed through Manson, Steven et al.

Demographic breakdown

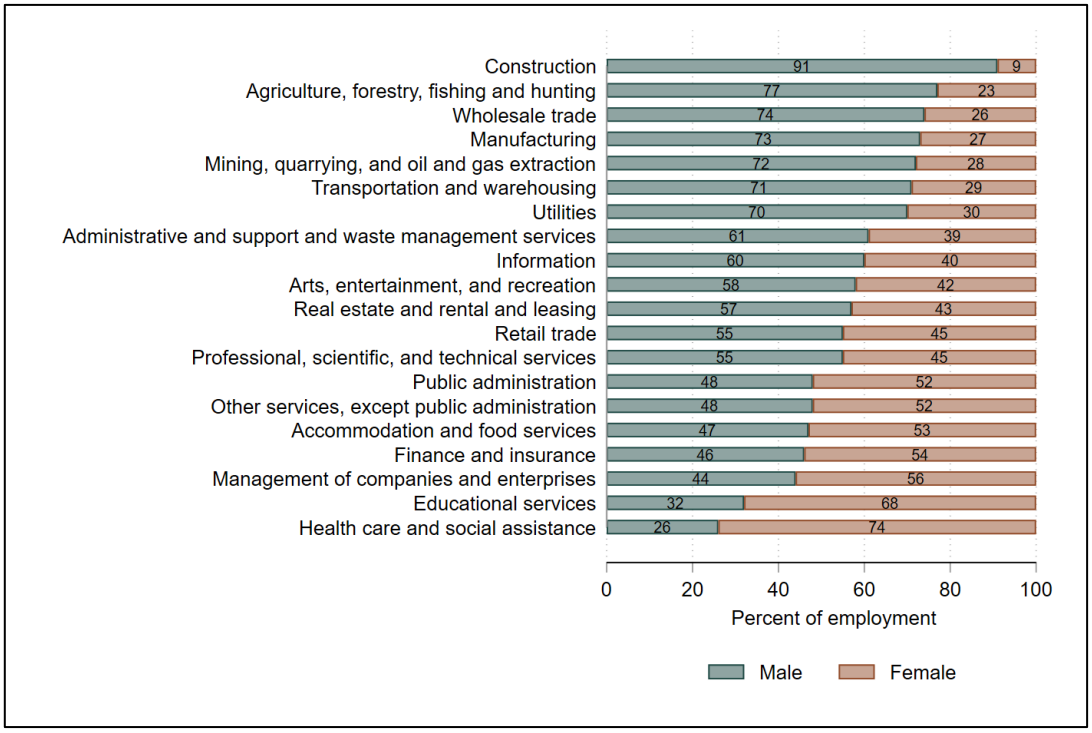
Further breaking down employment by demographic characteristics allows for comparisons across gender, race, ethnicity, and education level within each sector. Employment by sector varies by these demographic characteristics, revealing some inequalities in Phoenix's workforce. In most sectors, workers are majority male and predominantly White. For gender data, median earnings breakdowns expose a **persistent earnings gap between men and women (in the favour of men) for almost all sectors.** Educational attainment also varies substantially by sector, with only about half of workers in "blue collar" sectors attending at least some college, compared to 80% of those working in professional careers.

Gender

Overall, employment of Phoenix residents is evenly split between genders, with **about 54% of the labour force in Phoenix being male and 46% female.** However, the division of employment by gender varies by sector. Male workers dominate 13 of the 20 sectors shown in Figure 6. At the same time, the sector with the most workers, "health care and social assistance" is almost three-quarters female. The "educational services" sector is also made up of mostly women (68%). Alternatively, only 9% of workers in the "construction" sector are female. Women also account for less than one-third of total employment in the

"manufacturing" "transportation and warehousing" "wholesale trade" "utilities" "agriculture, forestry, fishing and hunting" and "mining, quarrying, and oil and gas extraction" sectors.

Figure 6: Phoenix employment by sector and gender, 2016-2020 five-year estimates



Note(s): This figure displays the portion of employed Phoenix residents by sector and gender. For total employment estimates by sector for the city of Phoenix, see Table 2. Employment estimates come from the American Community Survey five-year data for Phoenix City CDP from 2016-2020.

Source(s): US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

On average, men earn more than their female counterparts in all sectors except construction. (Note only about 6,000 women work in the construction sector, out of a total of around 68,000. The higher income for women in the sector may be a result of women occupying more office and administrative roles than men.) This gender disparity is most notable in the "professional, scientific, and technical services" and "management of companies and enterprises" sectors, where men earn 33 and 37% more than women, respectively (see Table 4). Across all sectors, the average difference in median earnings between men and women is about $9,400.[10] For men, the highest earning sector is "professional, scientific, and technical services" with median annual earnings of almost $73,000. For women, working in the "utilities" sector yields the highest earnings, with an annual average of just under $60,000. For both genders, the "accommodation and food services" sector provides the lowest earnings.

[10] This value represents the mean of the difference column in Table 5 and is not weighted based on sectoral employment.

Table 4: Phoenix median earnings by sector and gender, 2016-2020 five-year estimates

Sector	Male Median Annual Earnings	Female Median Annual Earnings	Difference (Male - Female)	Percent Difference
Health care and social assistance	$48,450	$34,631	$13,819	29%
Retail trade	$29,355	$22,365	$6,990	24%
Accommodation and food services	$21,777	$17,388	$4,389	20%
Construction	$35,042	$35,789	($747)	-2%
Administrative and support and waste management services	$25,653	$22,060	$3,593	14%
Finance and insurance	$63,302	$45,948	$17,354	27%
Educational services	$42,496	$38,046	$4,450	10%
Manufacturing	$43,990	$33,047	$10,943	25%
Professional, scientific, and technical services	$72,602	$48,838	$23,764	33%
Other services, except public administration	$30,347	$21,563	$8,784	29%
Transportation and warehousing	$36,988	$32,300	$4,688	13%
Public administration	$60,718	$44,479	$16,239	27%
Wholesale trade	$45,956	$37,175	$8,781	19%
Real estate and rental and leasing	$45,170	$40,452	$4,718	10%
Information	$46,176	$35,113	$11,063	24%
Arts, entertainment, and recreation	$27,509	$21,840	$5,669	21%
Utilities	$67,774	$59,979	$7,795	12%
Agriculture, forestry, fishing and hunting	$30,305	$22,554	$7,751	26%
Management of companies and enterprises	$62,741	$39,651	$23,090	37%
Mining, quarrying, and oil and gas extraction	$56,618	$51,667	$4,951	9%

Note(s): This table displays median earnings of Phoenix residents by sector and gender. Table rows are ordered based on the number of employees in each sector from highest to lowest (see Table 2). Earnings estimates come from the American Community Survey five-year data for Phoenix City CDP from 2016-2020. Median earnings are reported in 2020 inflation-adjusted dollars. The last column is shaded based on the percentage difference between male and female earnings at 10% intervals (less than 0; 0 to 10; 10 to 20; 20 to 30; and 30-40).

Source(s): US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

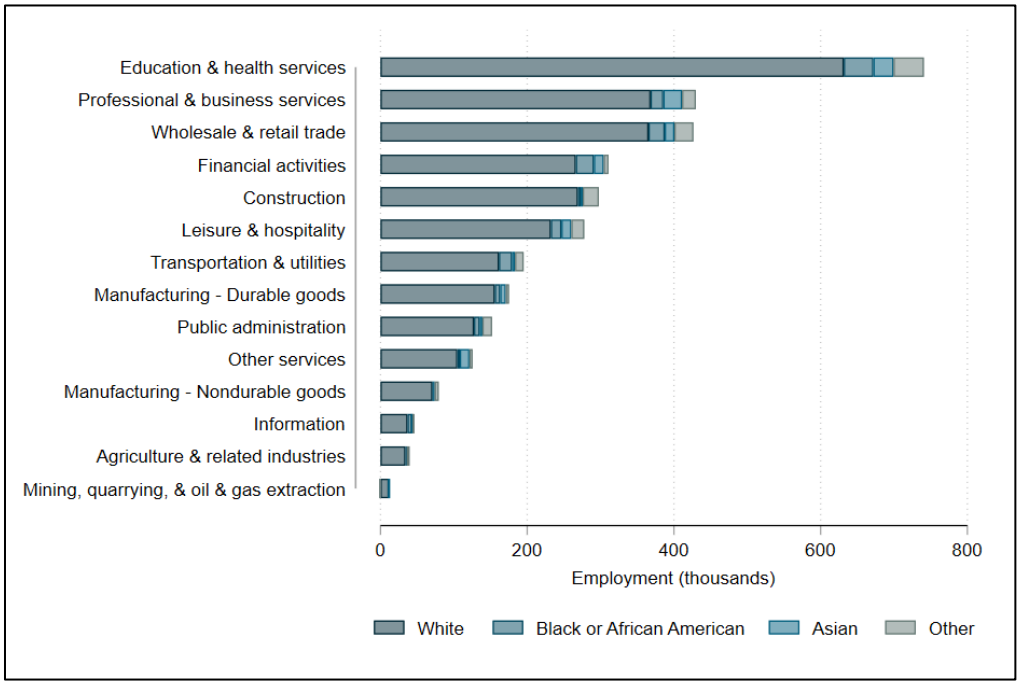
Race

Employment data for sector and race were not available for Phoenix City or Maricopa County. For this reason, data in this section are reported at the state level (Arizona). As seen in Figure 7, White employees make up the majority of the labour force in all sectors in Arizona (82%). Black and African American people represent about 5.4% of Arizona's total population and 5.1% of the total workforce in Arizona.[11] Based on this estimate, Black and African American

[11] "U.S. Census Bureau QuickFacts."

workers are overrepresented by one percentage point or more in the “financial activities” “information” and “transport and utilities” sectors. The sector with the highest portion of Black or African American employees is “information” (13%). About 3.8% of Arizonans are Asian[12] and Asian workers represent 3.8% of the total workforce. The “other services” sector employs the highest portion of Asian Arizonans (10%).

Figure 7: Arizona employment by sector and race, 2020



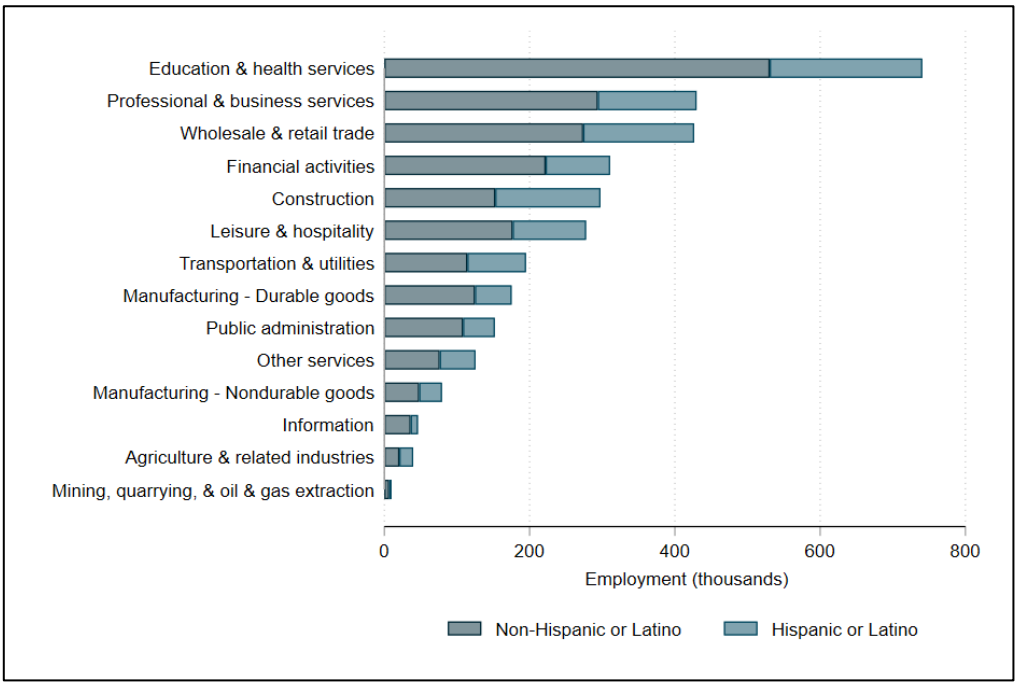
Note(s): This figure displays the number of employed Arizona residents by sector and race. Employment estimates come from the Bureau of Labor Statistics Geographic Profile of Employment and Unemployment.
Source(s): U.S. Bureau of Labor Statistics

Ethnicity

Employment data for sector and ethnicity were not available at the city or county level at the time of this analysis, and are summarized here for the state of Arizona. Given the state’s proximity to the US border with Mexico, a relatively high portion of Arizonans are Hispanic or Latino. In total, about one-third of Arizonans have Hispanic or Latino ethnicity. Based on this estimate, employment in the “construction” “agriculture and related industries” “transportation and utilities” “manufacturing – nondurable goods” and “other services” sectors is relatively high among Hispanics and Latinos, as they occupy about 40% or more of jobs in those sectors (see Figure 8).

[12] “U.S. Census Bureau QuickFacts.”

Figure 8: Arizona employment by sector and ethnicity, 2020

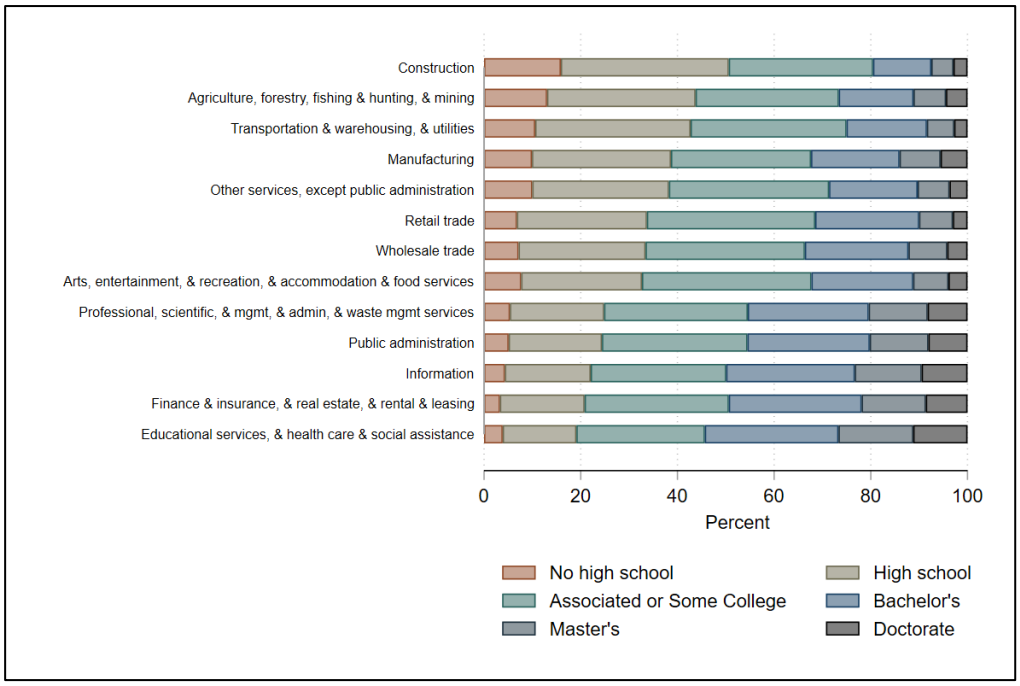


Note(s): This figure displays the number of employed Arizona residents by sector and ethnicity. Employment estimates come from the Bureau of Labor Statistics Geographic Profile of Employment and Unemployment.
Source(s): U.S. Bureau of Labor Statistics

Education Level

Educational attainment is a key factor in skills development and career opportunity. As seen in Figure 9, educational attainment varies substantially between sectors in Phoenix. In the “construction” sector, about half of workers have a high school degree or less. Alternatively, in professional sectors such as “information” “finance and insurance, real estate, and renting and leasing” and “educational services and health care and social assistance” about half of workers have a bachelor’s degree or higher. As seen on Table 2, professional degrees tend to be associated with higher pay, while “blue collar” jobs are associated with lower levels of educational attainment and lower pay.

Figure 9: Portion of sectoral employment in Phoenix by education level, 2016-2020 five-year estimates



Note(s): Educational attainment data are not available for Phoenix by sector. However, the distribution of educational attainment by occupation are provided at the national level by the U.S. Bureau of Labor Statistics. These data are aggregated to match the broad occupation sections shown in Table 3 using Industry and Occupation Classifications provided by the U.S. Census Bureau. These aggregated data are crosswalked with occupation by sector data shown in Table 3 to estimate educational attainment by sector. For total employment estimates by sector for the city of Phoenix, see Table 2.

Source(s): U.S. Bureau of Labor Statistics, 2021; US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

2 Job creation potential and equity aspects of climate action implementation

This part of the report looks into the job creation potential of 23 climate interventions in line with the city of Phoenix's Climate Action Plan (CAP).[13]

For the purpose of this analysis, we have grouped these interventions into five broad clusters, as seen in Table 5. Investment in climate interventions generates economic activity and jobs, as well as bringing additional benefits for people's lives, such as cleaner air, clean energy, and a stronger public transport network. These interventions will also help Phoenix to meet its climate targets (the associated emissions reduction potential of some of these mitigation interventions can be found in *Annex 3 Potential of emissions reduction of specific interventions*). Importantly, investment into these climate interventions support local and national jobs. Out of the five broader intervention clusters, three clusters relate to mitigation interventions: *Energy*, *Transport* and *Waste*. The other two clusters relate to adaptation interventions: *Adaptation – Buildings and parks* (adaptation measures related to green urban infrastructure), and *Adaptation – Water* (adaptation measures related to water).

The jobs estimates in this section are calculated combining two components:

1) Specific local job multipliers for Phoenix (job-years supported by 1 million USD invested – see Table 5 below).[14]

2) Costs estimates: estimation of the expenditure or investment needed (in million USD) for both CAPEX and Operations and Maintenance costs, needed to deliver each intervention, in line with the level of ambition of the city's Climate Action Plan.

Table 5: Total number of job-years supported by 1 million USD invested (CAPEX + OPEX), by intervention

Intervention	Intervention cluster	Number of jobs-years[1] per 1 million USD invested (CAPEX + OPEX)
Blue SuDs	Adaptation - Water	26.07
BRT	Transport	58.97
Efficient lighting (buildings)	Buildings	6.13
Commercial heat pumps	Buildings	26.20
Cycle infrastructure	Transport	22.44
Diesel/biofuel buses[15]	Transport	18.44
Energy efficient new builds	Buildings	22.72
Efficient street lighting	Buildings	5.48

[13] City of Phoenix (2021). Phoenix Climate Action Plan. Available at: https://www.phoenix.gov/oepsite/Documents/2021ClimateActionPlanEnglish.pdf

[14] Job multipliers are specific for Phoenix (Maricopa County) and have been modelled by Vivid Economics (see methodology notes). The methodology used builds from preceding research: C40 Cities (2021) Methodology – Urban Climate Action in U.S., South Africa and Italy. The published methodology is available here.

[15] "Diesel/Ethanol buses" are analysed as a climate action because the city is planning to expand its bus fleet and a part of those buses will continue to be diesel. However, the city of Phoenix is also planning to add new biofuel buses.

Electric buses	Transport	49.30
Electric cars	Transport	40.89
Electric Commuter Rail	Transport	25.67
EV infrastructure	Transport	21.05
Biofuel cars[16]	Transport	18.40
Green roofs	Adaptation - Buildings and parks	26.59
Green SuDS	Adaptation - Water	26.78
Grey flood barriers	Adaptation - Water	23.66
Living walls	Adaptation - Buildings and parks	38.83
Residential heat pumps	Buildings	25.77
Solar PV	Energy	10.87
Street trees	Adaptation - Buildings and parks	34.42
Urban parks	Adaptation - Buildings and parks	28.41
Wastewater reuse[17]	Adaptation - Water	18.45
Water efficiency	Adaptation - Water	23.69
White roofs	Adaptation - Buildings and parks	5.92
Advanced recycling	Waste	22.97
Composting plant	Waste	26.58
Hydro	Energy	12.77
Onshore wind	Energy	9.81
Wholehouse retrofits	Buildings	27.82

Notes: 1. Total job years, including jobs from direct, indirect, and induced impacts.
Source(s): C40 and Cambridge Econometrics calculations based on employment multipliers from Vivid Economics (2022); and estimated expenditure on selected climate interventions in Phoenix, in line with the city CAP

It is to be noted that under the city's current climate mitigation modelling within Pathways,[18] limited interventions[19] were planned within the building's retrofits intervention cluster (a category that normally drives a very high job creation potential). This is an area that could be analysed at a later stage as the city progresses with its climate action plan given that energy efficiency improvements in buildings can have a significant impact on reducing emissions and creating job opportunities.

Investment in climate interventions would stimulate economic activity and job creation in Phoenix. These impacts can be divided into three distinct categories: direct, indirect, and induced.

- **Directly** impacted sectors include industries that would experience an increase in labour demand as a direct result of investment in climate actions. For example, climate interventions may require substantial changes to buildings or infrastructure. As a result, there may be an increase in labour demand in the "construction" sector.

[16] This intervention refers to the expansion of biofuel vehicles.
[17] Wastewater reuse was not an action included in the city's Climate Action Plan, but has been modelled for information, assuming slight improvement in the target (target percentage of all water reused: 89% to 90%).
[18] Pathways is a climate action planning tool for developing city decarbonisation roadmaps covering transport, waste, buildings and energy, developed and maintained by C40 Cities.
[19] The city of Phoenix is looking into residential energy efficiency improvements, as well as in city-owned buildings. However, these interventions had not been included in the Pathways model and therefore were not included in this analysis.

- **Indirectly** impacted sectors benefit from increased demand for supply chain components as a result of climate intervention investment. Indirectly affected sectors might include “manufacturing” and “transportation and warehousing”.

Induced effects occur as the stimulation of labor market activities catalyzes spending in other sectors, such as “accommodation and food services” and “arts, entertainment, and recreation”.

As the methodologies for estimating the costs of mitigation and adaptation are different, we have divided the rest of this section in two parts.

2.1. Mitigation

Total jobs

This section presents the estimated number of jobs supported by the assessed climate mitigation interventions, at the national level and at the city level. ‘National jobs’ refer to the jobs that will be created in other parts of the country, across the supply chains outside of the city, through investments in Phoenix’s climate actions.

Table 6: Total jobs supported by the mitigation interventions, national vs. city-level

Intervention	National jobs	Share of total national jobs (%)	City-level jobs	Share of total city-level jobs (%)
Electric Commuter Rail	27,298*	38%	30,308	59%
Solar PV	18,498	26%	8,778	17%
Electric cars	9,296	13%	3,079	6%
Diesel/biofuel buses	5,835	8%	2,489	5%
Biofuel cars	5,796	8%	2,477	5%
BRT	1,536*	2%	2,327	5%
Electric buses	1,341	2%	853	2%
Cycle infrastructure	828	1%	419	1%
Advanced recycling	331	0%	248	0%
Hydro	140	0%	95	0%
Composting plant	87	0%	64	0%
EV infrastructure	94	0%	63	0%
Onshore wind	44	0%	24	0%
Total jobs	**71,122**	**100%**	**51,224**	**100%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure and employment multipliers on selected climate interventions in Phoenix out to 2030, in line with the city CAP

‘*’ denotes interventions where national job estimates are lower than local, driven by the underlying multipliers, which in these cases are smaller for the national-level than for the city-level. National multipliers will be higher where 1) the labor wage is lower than in Maricopa County (and therefore the same payments to labor employ more people) and/or 2) where manufacturing activity is included in the US but not in the local region. Where local jobs are higher than national jobs, that can be interpreted as a reflection of the region having below national average wages.

In total, it is estimated that 71,000 green jobs could be created and supported by these mitigation actions at the national level (in- and outside of Phoenix). Out

of the interventions analysed, the mitigation interventions with the highest job creation potential are electric commuter rail, followed by solar PV.

Out of these, 72% (51,000 jobs) will be created and supported in the city of Phoenix by the climate interventions analysed (see Table 7**).** The next section will discuss this subset of jobs that is expected to be supported locally. Compared with other US cities, the city of Phoenix is less reliant on imports, which impacts the employment potential of climate interventions (i.e. more jobs are expected to be created locally in Phoenix as a result of a similar investment).[20]

Table 7: Total jobs supported by the mitigation intervention clusters, national vs. city-level

Intervention cluster	National jobs	City-level jobs	City-level jobs in % of total national jobs
Energy	18,682	8,897	48%
Transport	52,023	42,015	81%
Waste	417	312	75%
Total jobs	**71,122**	**51,224**	**72%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030, in line with the city CAP

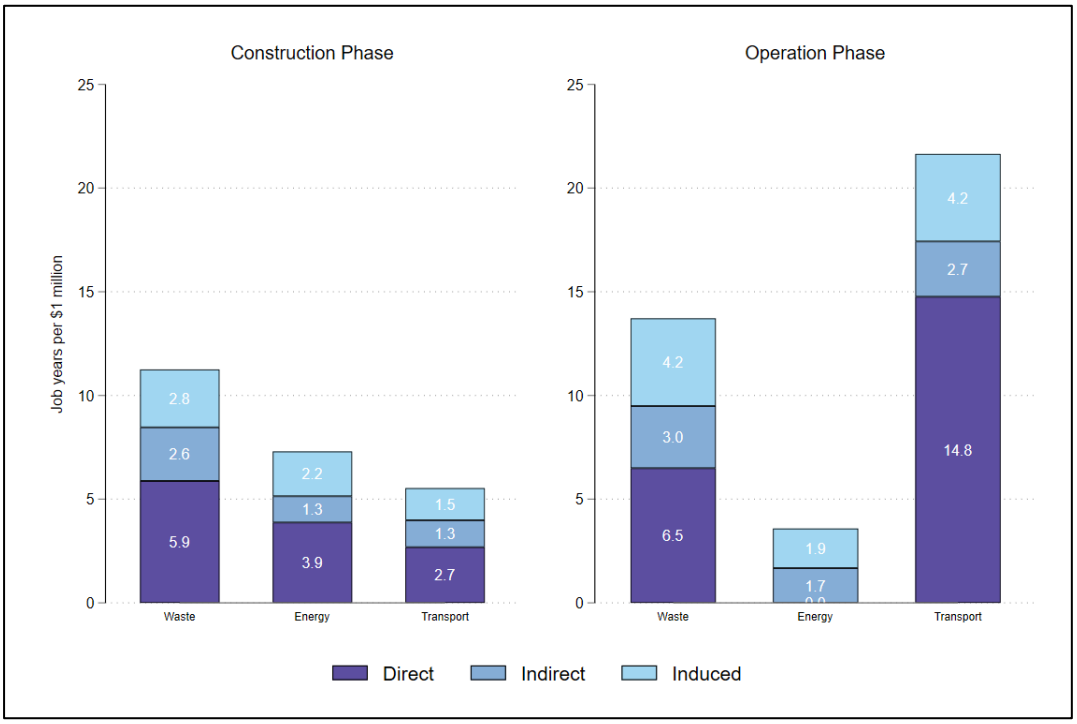
Estimates of jobs in the city[21]

Figure 10 shows the relative cost-effectiveness of mitigation intervention clusters in terms of job creation by impact type. In general, direct impacts account for the largest portion of job-years growth as a result of climate action, followed by induced impacts. Waste interventions support the most job-years (1 job year representing a unit of employment equivalent to one year of work for one person at an average annual wage for a given sector) per 1 million US dollars invested during the construction phase, followed by energy and transport. During the operation phase, transport interventions represent the most cost-effective way to support green job-years in the city, with about 22 job-years per million US dollars invested.

[20] Based on C40 Cities analysis. In 2021, Houston's imports were in the order of USD 75.9 billion vs USD 536 million by Phoenix. Sources: https://oec.world/en/profile/subnational_usa_port/houston-tx

[21] For a more detailed analysis of jobs by sector and phase, see *Annex 1 Sectoral breakdown of jobs supported by climate interventions.*

Figure 10: Job-years per million USD invested in Phoenix by intervention cluster, phase, and impact type for mitigation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

On average, the employment multipliers for the mitigation interventions analysed (Table 5) (expressed in job-years per million US dollars invested) are 21.7 job-years per million invested. Multipliers vary considerably across intervention clusters, with highest multipliers for Transport-related interventions (~32 job-years, on average) and lowest for the Energy-related interventions (~11 job-years, on average). Nevertheless, climate actions even in areas with relatively lower multipliers present an added potential to reduce the risks from climate change, bring additional health and other benefits to people's lives, and to support jobs at the same time.

As a comparison, employment multipliers for other, non-climate actions fall broadly somewhere between 10 and 25, as evidenced by a recent data collection[22] on industry-specific employment multipliers in the US economy.

Table 8: Total jobs supported in Phoenix by intervention clusters and phase, in *mitigation*

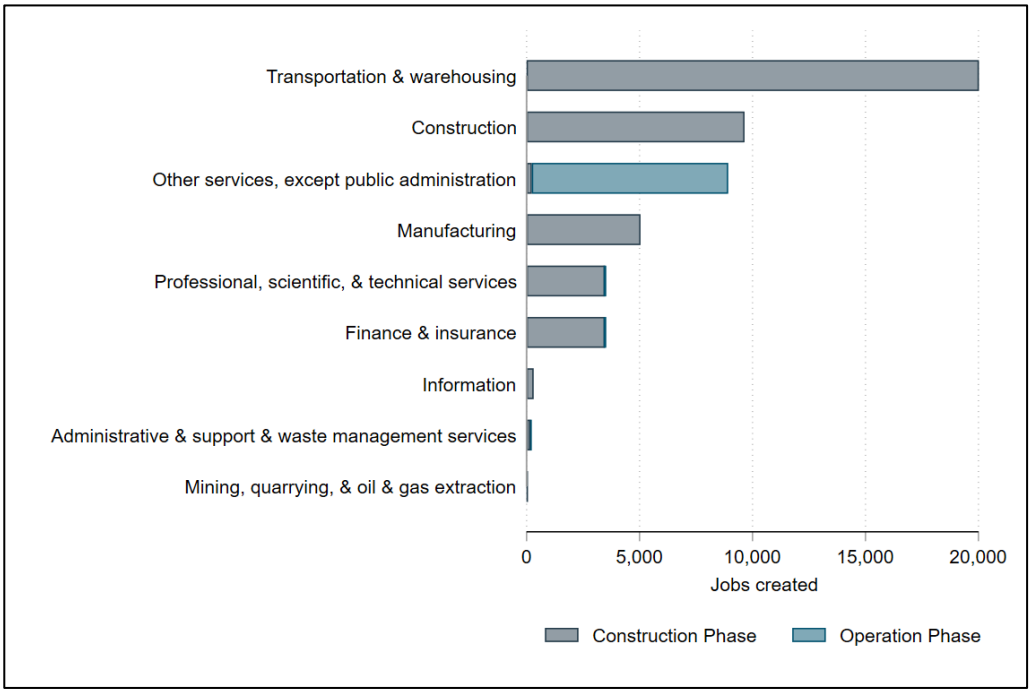
Intervention cluster	City-level jobs	CAPEX jobs	% in total CAPEX	OPEX jobs	% in total OPEX
Transport	42,015	33,528	79%	8,486	97%
Energy	8,897	8,686	20%	211	2%
Waste	312	216	1%	95	1%
Total jobs	**51,224**	**42,431**	**100%**	**8,793**	**100%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030, in line with the city CAP

[22] Economic Policy Institute (2019) Updated employment multipliers for the U.S. economy. Available at: https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/

Table 8 and Figure 11 summarize the **total job creation** aggregated across all mitigation interventions by phase in the first five years. About 83% (over 42,000 jobs) of the total jobs created and supported by mitigation interventions will occur during the construction phase. This can contribute to support the economic recovery from Covid-19 through the creation of jobs in the short-term (for a period of 5 years in this analysis) The rest of the jobs (8,800) will occur in the operation phase (up to 2030 in the period estimated). During the operation phase, almost all jobs will be created in the "other service, except public administration" sector. For a detailed breakdown of green jobs by sector and intervention, see *Annex 1 Sectoral breakdown of jobs supported by climate interventions*.

Figure 11: Total job creation in Phoenix by sector and phase for mitigation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

In the **construction phase,** most jobs would be created and supported in the "transportation and warehousing" sector (about 20,000 jobs). As discussed in the *Current workforce assessment*, there are currently about 42,000 workers in this sector in Phoenix. As such, these interventions could ensure that existing green jobs in the transport sector are maintained and new ones are created About 10,000 jobs would be supported in the "construction" sector, which currently employs about 68,000 people.

As discussed in the *Current workforce assessment* section, the "transport and warehousing" sector tends to be male dominated and relatively low-paid. Without additional measures to improve inclusivity and job quality, these new jobs in the "transport and warehousing" sector will likely follow current trends, so there is an opportunity to ensure that the green jobs in this sector drive job quality improvements as projects are implemented.

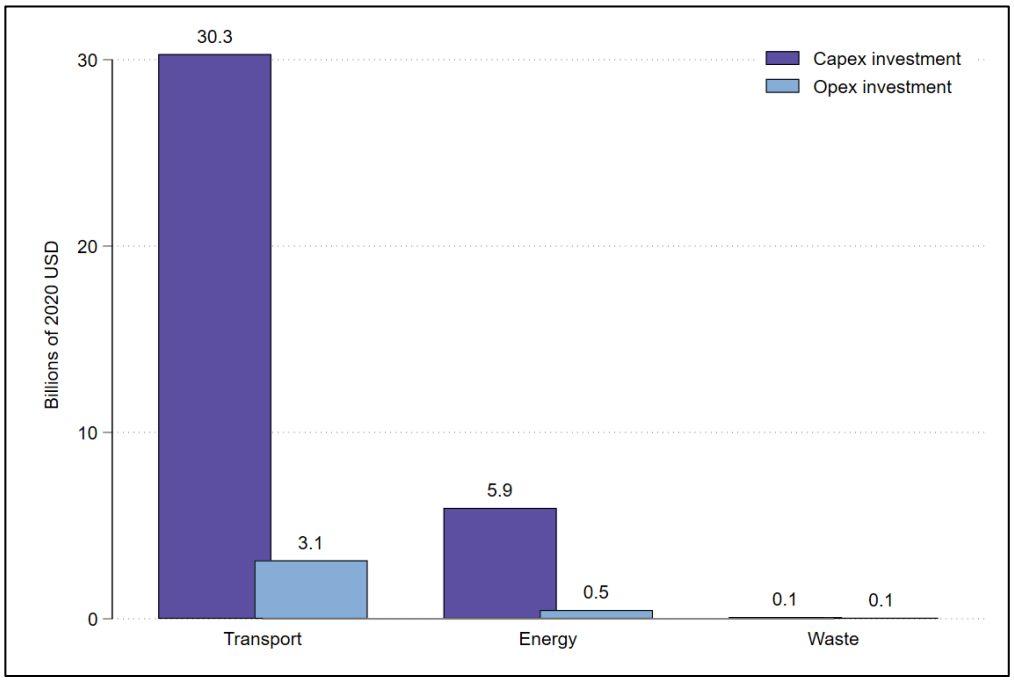
In the "construction" sector, currently, construction jobs in Phoenix are male dominated (91%). However, this sector tends to be relatively well-paid and provide stable work throughout the year. In term of working conditions, the

"construction" sector suffers from long hours, fewer benefits, and a higher number of harmful of exposures for male employees (who make up the majority of the workforce in the sector), compared to other sectors.

In the **operation phase,** after the construction period, almost all the jobs (99%) are in the "other services, except public administration" sector (around 9,000 jobs will be created and supported in total). This sector currently employs about 40,000 workers and jobs tend to be part-time or seasonal (37%) and on average pay lower than the minimum wage (median annual earnings of $25,500), which shows scope for improvement.

Investment needed

Figure 12: Investment need by intervention cluster in Phoenix for mitigation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030, in line with the city CAP

The total capital investment needed across the public and private sector for the mitigation interventions is estimated to be over $36.3 billion (or over $7 billion per year for the next 5 years). To provide some context, this total investment need (Capex and Opex, $40 billion) for mitigation actions out to 2030 amounts to about 15% of total 2020 yearly GDP of Phoenix-Mesa-Scottsdale, AZ metropolitan area[23]. Figure 12 shows the estimated expenditure needed by intervention cluster to implement these climate actions in line with the ambition of the city's CAP by 2030.[24] For mitigation interventions, transport requires the largest overall investment ($33 billion between Capex and Opex). Capex investments make up the vast majority of overall investment needs.

It is to be noted that the presented costs are not 100% additional costs, as a Business-as-Usual (BAU) case would also need considerable investment in

[23] Source: https://fred.stlouisfed.org/series/NGMP38060#0

[24] CAPEX stands for Capital expenditure, and includes the up-front spending used to purchase and construct assets that will be used and maintained over the long term. OPEX stands for Operation and maintenance expenditure, and includes the costs of 'day-to-day' expenses of keeping an asset working and accessible for users. OPEX does not include fuel costs.

both mitigation and adaptation type of interventions. While the BAU case is not analysed in this study, it is assumed that the BAU case would include proportionately more OPEX-type of investment, compared to CAPEX investment, than the here-assessed scenario (due to less direct capital investment taking place), and would not bring the additional benefits of a green economy.

2.2. Adaptation

While the costing of mitigation type of interventions stem from analysis undertaken with city representatives in a comprehensive and detailed climate modelling tool (*C40 Pathways model*), the costing of adaptation interventions was done using more high-level targets, which are less city-specific. As such, the employment impact resulting from mitigation and adaptation interventions should not be directly compared due to differences in the methodological approach (see *Annex 3 Methodology*). As a result, the estimated job impact of some of the adaptation interventions (such as investment in living walls, green roofs and urban parks) may be higher in our estimates than in reality – this will depend on the targets that the city of Phoenix sets.

National- vs city-level jobs

This section presents the jobs supported by the assessed adaptation climate interventions, at the national level and at the city level.

Table 9: Total jobs supported by the adaptation interventions, national vs. city-level

Intervention	National jobs	Share of total national jobs (%)	City-level jobs	Share of total city-level jobs (%)
Urban parks	116,971*	34%	124,048	48%
Living walls	81,024	23%	58,746	23%
Blue SuDs	71,259	21%	33,499	13%
Green SuDS	36,670	11%	18,446	7%
Grey flood barriers	22,634	7%	10,811	4%
Green roofs	11,108	3%	7,693	3%
Wastewater reuse	4,460	1%	5,541	2%
White roofs	1,467	0%	799	0%
Water efficiency	717	0%	347	0%
Street trees	319	0%	189	0%
Total jobs	**346,630**	**100%**	**260,119**	**100%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure and employment multipliers on selected climate interventions in Phoenix out to 2030, in line with the city CAP

'*' denotes interventions where national job estimates are lower than local, driven by the underlying multipliers, which in these cases are smaller for the national-level than for the city-level. National multipliers will be higher where 1) the labor wage is lower than in Maricopa County (and therefore the same payments to labor employ more people) and/or 2) where manufacturing activity is included in the US but not in the local region. Where local jobs are higher than national jobs, that can be interpreted as a reflection of the region having below national average wages.

In total, it is estimated that nearly 347,000 jobs will be supported at the national level (in- and outside of Phoenix) through the investment in adaptation actions in Phoenix. Out of these jobs, 75% (260,000 jobs) will be supported in the city

of Phoenix. Out of the interventions analysed, the adaptation interventions with the highest job creation potential are urban parks, living walls and Sustainable Drainage Systems (SuDS).

The next section provides more information on this subset of jobs that is expected to be supported locally. Compared with other US cities, the city of Phoenix is less reliant on imports, which impacts the employment potential of climate interventions (i.e. more jobs are expected to be created locally in Phoenix as a result of a similar investment).[25]

Table 10: Total jobs supported by the adaptation intervention clusters, national vs. city-level

Intervention cluster	National jobs	City-level jobs	City-level jobs in % of total national jobs
Adaptation - Buildings and parks	210,890	191,475	91%
Adaptation - Water	135,740	68,644	51%
Total jobs	**346,630**	**260,119**	**75%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030, in line with the city CAP

Estimates of jobs in the city[26]

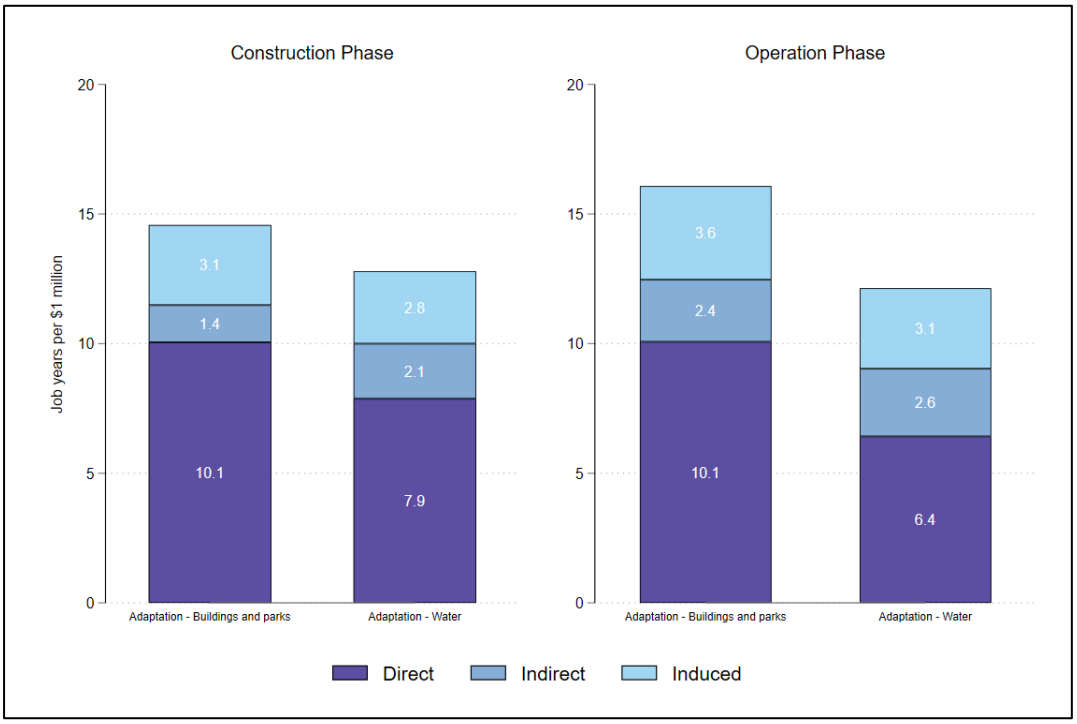
Investment into adaptation interventions, in turn, generates economic activity and jobs, all while making the city of Phoenix more resilient against future climate impacts.

Figure 13 shows the relative cost-effectiveness of intervention clusters in terms of jobs supported. Buildings and parks adaptation interventions support the most job-years per 1 million US dollars invested during both the construction and operation phases. In both adaptation clusters, most of the jobs are supported through direct impacts from climate investments.

[25] Based on C40 Cities analysis. In 2021, Houston's imports were in the order of USD 75.9 billion vs USD 536 million by Phoenix. Sources: https://oec.world/en/profile/subnational_usa_port/houston-tx

[26] For a more detailed analysis of jobs by sector and phase, see *Annex 1 Sectoral breakdown of jobs supported by climate interventions.*

Figure 13: Job-years per million USD invested in Phoenix by intervention cluster, phase, and impact type for adaptation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

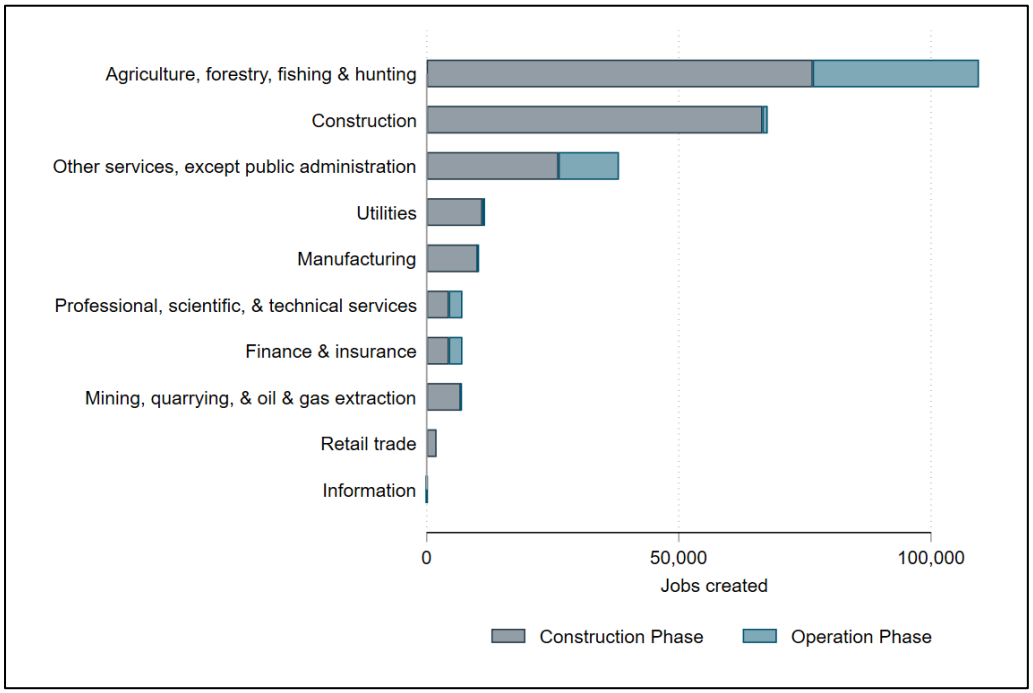
Table 11: Total jobs supported in Phoenix by intervention clusters and phase, in adaptation

Intervention cluster	City-level jobs	CAPEX jobs	% in total CAPEX	OPEX jobs	% in total OPEX
Adaptation - Buildings and parks	191,475	147,518	71%	43,957	85%
Adaptation - Water	68,644	60,603	29%	8,041	15%
Total jobs	**260,119**	**208,121**	**100%**	**51,998**	**100%**

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030, in line with the city CAP

Table 11 and Figure 14 summarize the **total job creation** aggregated across adaptation interventions by phase. Out of the total 260,000 jobs supported, most jobs (208,000, 80% of total jobs) will occur during the construction phase in the first five years. The rest of the jobs (52,000) will be supported in the operation and maintenance phase.

Figure 14: Total job creation in Phoenix by sector and phase for adaptation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

In the **construction phase,** climate interventions related to buildings and parks adaptation would support the most overall jobs (about 148,000 jobs). Most of the jobs for adaptation interventions are in the “agriculture, forestry, fishing, and hunting” (77,000 jobs) and “construction” (67,000). As discussed in the *Current workforce assessment*, the “agriculture, forestry, fishing, and hunting” sector currently employs less than 2,500 workers in Phoenix. As such, this influx of jobs could likely be filled by workers from the more rural surrounding communities or create new training/skill opportunities in the city for these jobs. Similarly, to satisfy this level of potential employment, the “construction” sector would likely need to recruit workers from outside of the city or retrain existing workers. As discussed in the *Current workforce assessment*, the “agriculture, forestry, fishing, and hunting” sector tends to be male dominated, majority White, low paid, and part-time or seasonal rather than full-time year-round. As mentioned above, this shows the need for measures to improve inclusiveness and job quality, so that the jobs created and supported from adaptation actions could improve these trends. Construction jobs are also male dominated (91%) but are better paid and more stable.

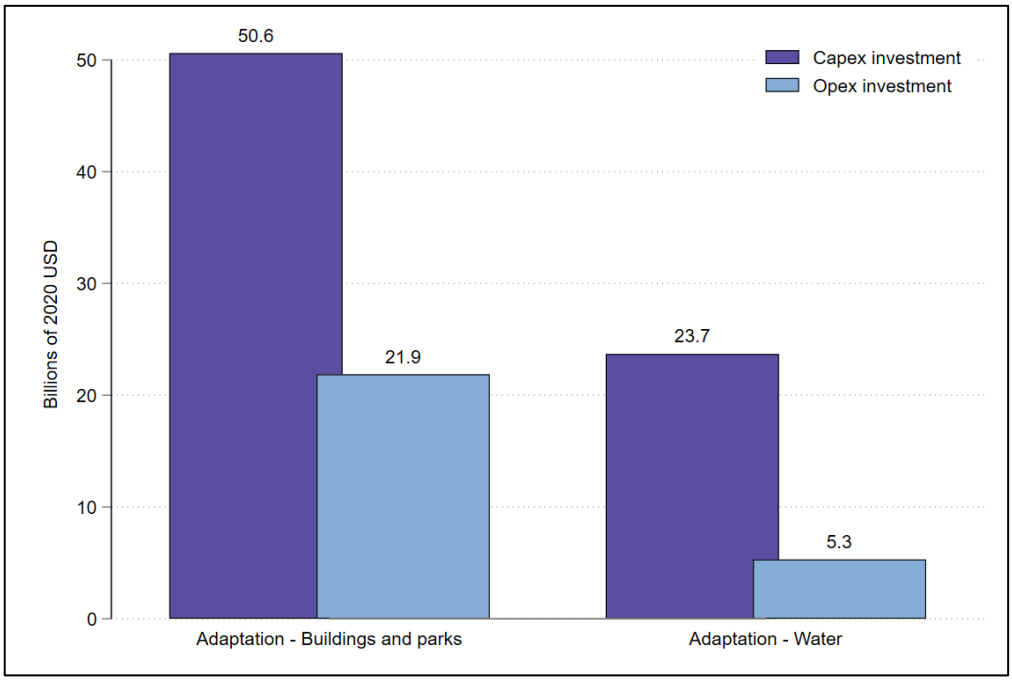
In the **operation phase,** after the construction period, adaptation interventions will support about 52,000 jobs. Most of these jobs (71%) are supported from building and parks adaptation actions. As in the construction phase, most jobs are supported in the “agriculture, forestry, fishing, and hunting” sector, with most of the jobs likely falling under agriculture or forestry. As discussed above jobs

in this sector currently tend to exclude females and fall short of decent jobs standards compared to other sectors. The jobs in this sector supported by climate initiatives represent an opportunity for the city to ensure that the working conditions of workers in these sectors, also including health and safety aspects, are improved at the same time. Coupled with the right social and workforce development policies, climate interventions can support jobs that are also inclusive and accessible to all. For a detailed breakdown of green jobs by sector and intervention, see *Annex 1 Sectoral breakdown of jobs supported by climate interventions*.

Investment needed

The total capital investment needed across the public and private sector for the adaptation type of interventions is estimated to be around $74 billion (or around $15 billion per year for the next 5 years). To provide some context, this total investment need (Capex and Opex, $101 billion) for adaptation actions out to 2030 amounts to about 35% of total 2020 yearly GDP of Phoenix-Mesa-Scottsdale, AZ metropolitan area[27]. As with mitigation interventions, this investment in climate actions will benefit current and future generations, and lead to a more resilient city prepared for future extreme weather events.

Figure 15: Investment need by intervention cluster in Phoenix for adaptation interventions



Source: C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030, in line with the city CAP

Figure 15 shows the estimated expenditure by intervention cluster for the adaptation interventions for Phoenix, based on the actions analysed from Phoenix's Climate Action Plan (CAP). The figure shows the level of investment needed to implement these adaptation climate actions in line with the ambition of the city's CAP by 2030.[28]

[27] Source: https://fred.stlouisfed.org/series/NGMP38060#0

[28] CAPEX stands for Capital expenditure, and includes the up-front spending used to purchase and construct assets that will be used and maintained over the long term. OPEX stands for Operation and maintenance expenditure, and includes the costs of 'day-to-day' expenses of keeping an asset working and accessible for users. OPEX does not include fuel costs.

It is to be noted that the presented costs are not 100% additional costs, as a Business-as-Usual (BAU) case would also need considerable investment in both mitigation and adaptation type of interventions. While the BAU case is not analysed in this study, it is assumed that the BAU case would include proportionately more OPEX-type of investment, compared to CAPEX investment, than the here-assessed scenario (due to less direct capital investment taking place).

2.3. Quality of the jobs and educational requirements

Who is likely to hold these green jobs?

An important component of assessing the job creation potential of climate actions is understanding who is likely to fill these green jobs. Table 12 displays various demographic characteristics of expected workers by intervention cluster.

On average, 65% of these jobs are expected to go to male workers, with equal employment by gender only anticipated in waste interventions where 49% of workers are expected to be women. As shown in Table 12, in the other interventions clusters, women are underrepresented, with Adaptation -water intervention cluster having the lowest share of female workers (29%). Without specific strategies (e.g., worker protections, reskilling programs, workplace policies) from the cities to boost equal representation of female workers in the specific project, the climate actions are at risk of disproportionately benefitting male workers.

In line with current demographics, most workers will be White (about four of every five workers). Black and Asian workers are more likely to benefit from jobs created in the waste interventions (7% and 5%, respectively, of jobs) the most among the clusters presented Table 12. American Indian workers are likely to represent around 2% of the workers in all intervention clusters. In all climate action interventions, White workers are represented in line with their presence in the overall Phoenix workforce (shown in Figure 7). Unless polices promoting workforce equity in Phoenix's overall economy are introduced to change the workforce distribution across race, White workers will occupy a majority of the new jobs.

From an ethnicity distribution, Hispanic workers will benefit from between a quarter (in Waste) to almost half (in Adaptation - Buildings and parks) of jobs. In total, about one-third of Arizonans have Hispanic or Latino ethnicity, making the group underrepresented in transport and waste interventions but overrepresented in adaptation and energy interventions.

Table 12: Equity data for green jobs by climate intervention cluster in Phoenix

Intervention cluster	Jobs Per $1 Million Invested	% Female Employ-ment	Educational Attainment	Race					Ethnicity
			% with Bachelor degree or higher	White	Black	Asian	American Indian	Other	% Hispanic
Adaptation - Buildings and parks	2.6	30%	27%	80%	5%	3%	2%	10%	45%
Adaptation - Water	2.4	29%	25%	81%	5%	3%	2%	9%	43%
Energy	1.4	30%	29%	82%	4%	4%	2%	9%	37%
Transport	1.3	36%	28%	80%	6%	4%	2%	8%	31%
Waste	2.1	49%	43%	79%	7%	5%	2%	8%	26%
Current distribution	**N/A**	**46%**	**39%**	**82%**	**5%**	**4%**	**N/A**	**9%**	**33%**

Note(s): Gender, race, and ethnicity shares are calculated based on jobs multipliers (Vivid Economics) to estimate the distribution of jobs across these categories. Educational attainment values are estimated by applying existing sectoral distributions to the total job creation in each intervention cluster. Educational attainment data are not available for Phoenix by sector. However, the distribution of educational attainment by occupation are provided at the national level by the U.S. Bureau of Labor Statistics. These data are aggregated to match the broad occupation sections shown in Table 3 using Industry and Occupation Classifications provided by the U.S. Census Bureau. These aggregated data are crosswalked with occupation by sector data shown in Table 3 to estimate educational attainment by sector.

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers; U.S. Bureau of Labor Statistics, 2021; US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

Green jobs[29] in buildings and parks adaptation, water adaptation, energy, and transport clusters have relatively low and medium skill requirements. In these clusters, over 70% of employees will not need an educational attainment as high as a bachelor's degree. Skills requirement for waste interventions are more in line with the current city workforce, where about 39% hold bachelor's degree or higher. Similarly, about 43% of jobs in the waste cluster will require a college degree. Figure 16 provides a more detailed breakdown of education level requirement by intervention cluster. For all intervention clusters except waste, a high school degree or less is sufficient for about 40% of the workforce. Another 30% have completed some college or received an associate degree. Workers in the waste interventions are more educated, with 63% attending at least some college.[30] The educational requirements of the green jobs in waste are similar to the existing educational attainment by sector in the current workforce. Other interventions require less education than the current workforce average. As

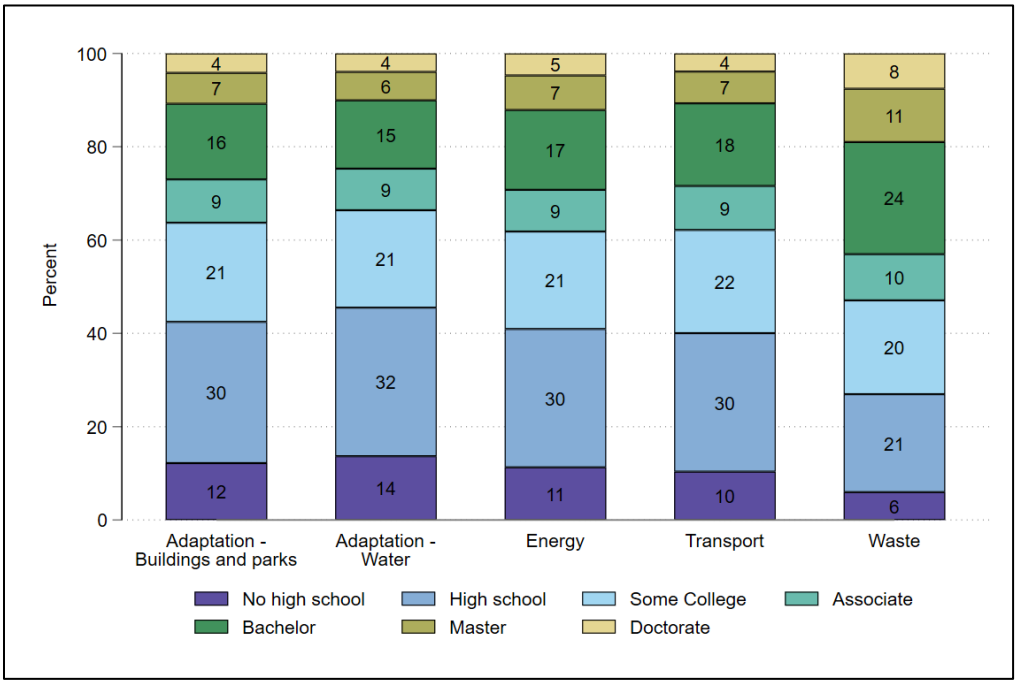
[29] Mapping the estimated job creation by sector with the current demographic characteristics of employees in those sectors enables evaluation across education attainment, where job multipliers are not available.

[30] While the educational distribution of waste workers is in line with the city average, the contrast to other intervention clusters combined with the relatively low wages (see Table 13) in the intervention cluster is unexpected. Because we use the current sectoral distribution of education to estimate the educational attainment level for the green jobs, this result may be due to the sectoral grouping of waste workers with "administrative and support and waste management services."

such, the current workforce can be re-tooled and reskilled to transition to these green jobs, without being required to attain further education. The successful transition of these workers depends on the development of policies to protect workers in this transition and ensure job security.

From Table 12, waste interventions are also those that have the highest share of women and the lowest share of White workers. From these three aspects, waste interventions are likely to provide the most equal opportunities while also offering good quality of jobs (based on the education requirement).

Figure 16: Education requirement for new jobs in Phoenix by intervention cluster

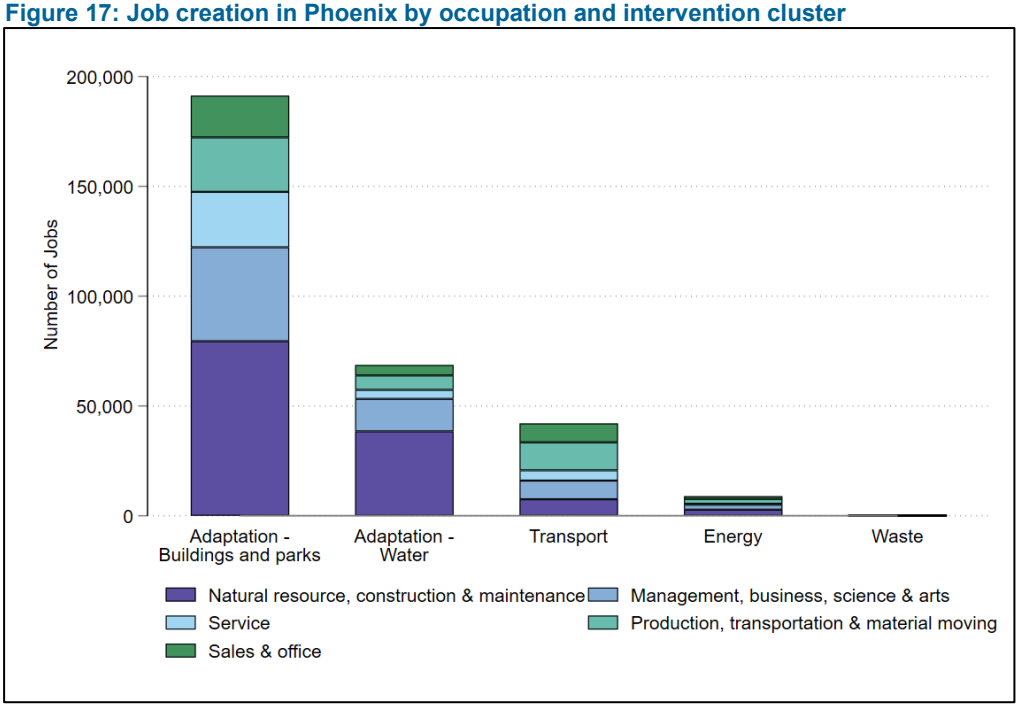


Note(s): Educational attainment data are not available for Phoenix by sector. However, the distribution of educational attaionment by occupation are provided at the national level by the U.S. Bureau of Labor Statistics. These data are aggregated to match the broad occupation sections shown in Table 3 using Industry and Occupation Classifications provided by the U.S. Census Bureau. These aggregated data are crosswalked with occupation by sector data shown in Table 3 to estimate educational attainment by sector with green jobs.

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers; U.S. Bureau of Labor Statistics, 2021; US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

Figure 17 shows which occupations (type of work) these green jobs are likely to fall under for each intervention cluster. Many of the jobs in the adaptation clusters would be in the “natural resources, construction, and maintenance” occupation. Jobs supported by mitigation interventions are spread across a wide variety of occupations. Currently, about 79,000 workers in Phoenix fall under this occupation.

Figure 17: Job creation in Phoenix by occupation and intervention cluster



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers; U.S. Bureau of Labor Statistics, 2021; US Census Bureau, 2020 5-year American Community Survey (ACS). Accessed through Manson, Steven et al.

Job quality

This section assesses the quality of the jobs that will be created by climate interventions. The International Labour Organization (ILO) outlines indicators of decent jobs, including adequate earnings, decent working time, stability and security of work, safe work environment, equal opportunity, and social security.[31]

Table 13: Quality assessment of green jobs in Phoenix

Intervention cluster	Working Conditions			Job Stability	Wages	Equity		Skills	Number of indicators better than reference
	Average Hours per Week	Average Number of Benefits	Average Number of Workplace Exposures	% Full-Time Year-Round	Average Annual Wage	% Female Employ-ment	% Non-White	% with College Degree or Higher	
Adaptation - Buildings and parks	41.0	5.4	1.7	72%	$35,353	30%	20%	27%	**2**
Adaptation - Water	41.5	5.6	1.6	78%	$38,390	29%	19%	25%	**4**
Energy	40.6	5.4	1.9	82%	$41,680	30%	18%	29%	**3**
Transport	41.2	5.6	1.7	73%	$36,040	36%	20%	28%	**3**
Waste	39.5	4.9	2.3	71%	$27,269	49%	21%	43%	**4**
Reference/ comparison	**40.0**	**6.0**	**1.8**	**73%**	**$36,500**	**46%**	**14%**	**39%**	

[31] "ILO 2022."

Note(s): Working condition, job stability, wage, and educational attaiment are estimated by applying existing sectoral distributions to the total job creation in each intervention cluster.
Source(s): C40 and Cambridge Econometrics calculations based on 1) estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers; 2) Maestas et al., 2017 and 3) US Census Bureau, 2020 5-year American Community Survey (ACS), accessed through Manson, Steven et al.

Table 13 summarizes the quality of green jobs based on criteria on decent jobs (working conditions, job stability, wages, equity, and skills), where information is available. The table also provides a reference value against which each estimate is compared (for example, the standard work week in the US is 40 hours and the average hours worked for green jobs is generally expected to be slightly higher). The working conditions assessment is based on the number of hours worked per week, number of benefits received from employers, and the number of harmful workplace exposures (described in detail in the "Working conditions" section of the *Current workforce assessment*).

The majority of workers in the US receive the following six benefits through their employer: paid sick leave, paid vacation time, paid holidays, health care, retirement benefits, and life insurance.[32] Other benefits considered in the working condition assessment, such as dental insurance, disability insurance, and flexible spending accounts are less common. In general, the average number of benefits provided to employees of green jobs in Phoenix falls just short of the six standard benefits. Waste interventions are expected to provide the fewest benefits to workers, averaging less than five.

High-quality jobs also provide a safe work environment for employees. A safe workplace will have limited exposures to harmful conditions, such as loud noises, high or low temperatures, or exposure to hazardous materials. While the severity of the exposures may vary, a relatively low number of harmful exposures are expected for these green jobs. The average number of harmful workplace exposures in the US is 1.8.[33] For jobs supported by climate actions, the expected number of exposures is lower than this national average for all intervention clusters except energy and waste. **Climate interventions, on average, will create safer, healthier working environments for workers, and support better quality jobs.**

The portion of full-time year-round employees serves as a proxy for job stability. While some part-time work is expected, a higher percent of full-time year-round employees generally indicates more job stability. As a reference, on average, about 73% of workers in Phoenix work full-time year-round. Climate interventions, on average, are expected to create and support jobs with similar or higher % of full-time employment.

Average annual wages are also considered in the job quality assessment. For reference, a person working full-time at minimum wage ($12.80 per hour) in Phoenix in 2022 earns about $26,600 annually. However, the minimum wage is not considered a living wage in the area. The MIT living wage calculator suggests that the living wage for a single adult with no children living in the Phoenix-Mesa-Scottsdale area is $17.55 per hour, which translates to an

[32] "BLS | Employee Benefits in the United States."
[33] Maestas et al., "Working Conditions in the United States."

annual income of $36,500 if the person works full-time.[34] Based on this standard, workers in transport would earn just below a living wage, while those in water adaptation and energy jobs would have higher average salaries. Based on current wages, buildings and parks adaptation and waste jobs would not provide a living wage for single workers.

Good quality jobs should also provide equal employment opportunities regardless of gender and race. In Phoenix, about 46% of workers are female. However, only about one-third or less of green jobs are expected to be filled by women in all intervention clusters except waste, where employment is more evenly split between genders. Across all intervention clusters, the portion of jobs filled by non-White workers is expected to be higher than the current city average, about one in five workers are expected to be non-White.

[34] "MIT Living Wage Calculator."

2.4 Strategies for Advancing Workforce Equity

To ensure the post COVID-19 economic recovery is just and equitable, investments into economic recovery and climate action should be used to advance equity and economic participation for vulnerable groups. The current economy is characterised by higher harmful workplace exposures in some sectors and a significant gender pay gap. Investment into climate action provides the opportunity to address pre-existing socio-economic inequities, to ensure the transition to a green economy is just.

To address these inequities, the city of Phoenix could introduce the following measures;

- Ensure the protection of workers in extractive industries to transition to green jobs by implementing social protection measures to guarantee job security
- Implement retooling and reskilling programmes with pathways for workers transitioning into green jobs. Workers will need new skills to work in green jobs, but the gap between current and future skills required is not wide. This provides an opportunity for reskilling of workers and can minimise job losses due to skills requirements.
- Develop workplace policies that promote gender equity in pay. The current gender wage gap will continue and sustain economic inequalities between men and women if policies are not developed to ensure equal pay for equal work.
- The research shows that green jobs will on average support a healthier, safer working environment with less harmful workplace exposures. However, policies to ensure that these jobs also support living wages are also needed.
- The city can also partner with local organisations to attract more women across the sectors through targeted training and skills development programmes to ensure an equitable gender representation in the new economy.

3 Conclusion and key findings

The city of Phoenix is characterised by a growing employment and a decline in the unemployment in the last five years. Among the unemployed, women, Black people, Hispanic and Latino people, and disabled people have the highest rates.

A person working full-time at minimum wage ($12 per hour) in Phoenix in 2020 would earn about $25,000 annually. Workers in the “utilities” sector enjoy the highest median income, earning about $67,000. In terms of gender wage gap, almost all sectors, including those impacted by climate interventions, are characterised by a persistent gap.

In terms of working conditions, jobs in sectors that are typically thought of as “blue collar” are male dominated, demanding of their employees (as demonstrated by long working hours), and have high rates of harmful workplace exposures. Since climate action implementation will support thousands of “blue collar” jobs, there is an opportunity to put in place policies to ensure that the working conditions in these sectors, including health and safety aspects, are improved at the same time. Furthermore, the implementation of climate action should be coupled with strong social and workforce development policies to guarantee that the green jobs are also inclusive and accessible to all.

From the interventions analysed, 75% of the green jobs are estimated to be supported at the city-level (about 310,000 jobs in total, by 2030), and most jobs will occur during the construction phase (80% of total jobs, about 250,000 jobs). During the construction phase, most jobs will be supported in the “construction” “transportation and warehousing” and “agriculture, forestry, fishing, and hunting” sectors. As such, these sectors may see a peak in employment which will later stabilize as projects are completed. In some cases, the jobs needed to complete climate-related projects would represent a large increase in a sector’s employment (i.e. the “agriculture, forestry, fishing, and hunting” sector currently supports 2,500 jobs in Phoenix, but adaptation interventions will require 77,000 workers in the sector). As such, workers may need to transition from other sectors or travel from outside of the city to fill the new labour demand in these sectors.

This study also assessed the equity and quality of the green jobs supported by climate actions. An important component of job equity is understanding who is likely to fill the new jobs. The sectors that would experience the most job growth tend to be male-dominated and majority White. This finding shows the importance of enhancing inclusivity and accessibility of the jobs supported from climate action implementation. Most jobs do not have high educational attainment requirements and would likely not require retraining.

For all intervention clusters except waste, a high school degree or less is sufficient for about 40% of the workforce. Another 30% will be expected to have completed some college or received an associate degree. Workers in the waste intervention cluster are on average more educated, with 63% attending at least some college (which might be linked to the sectoral grouping of “administrative and support and waste management services”).

Overall, jobs in the water-related adaptation and waste have the highest number of quality indicators better than the reference. Workers in water adaptation jobs, are expected to enjoy relatively few workplace exposures, high job stability, and high pay. The workforce in these green jobs is expected to be racially diverse. However, very few female workers will be able to enjoy the benefits of working in these green jobs, as only 29% are expected to be hired in this intervention cluster. For waste jobs, the workforce is anticipated to be relatively diverse, with a relatively high portion of female and non-White workers. Workers in these jobs will also enjoy work-life balance with relatively short work weeks. However, these green jobs are not anticipated to provide a living wage without additional measures in place. Buildings and parks adaptations have the fewest number of positive indicators, with relatively low job stability, wages, and portion of female employment. Again, these quality shortcomings represent an opportunity for the city to improve job quality by ensuring high-quality green jobs are provided to workers supported by climate actions.

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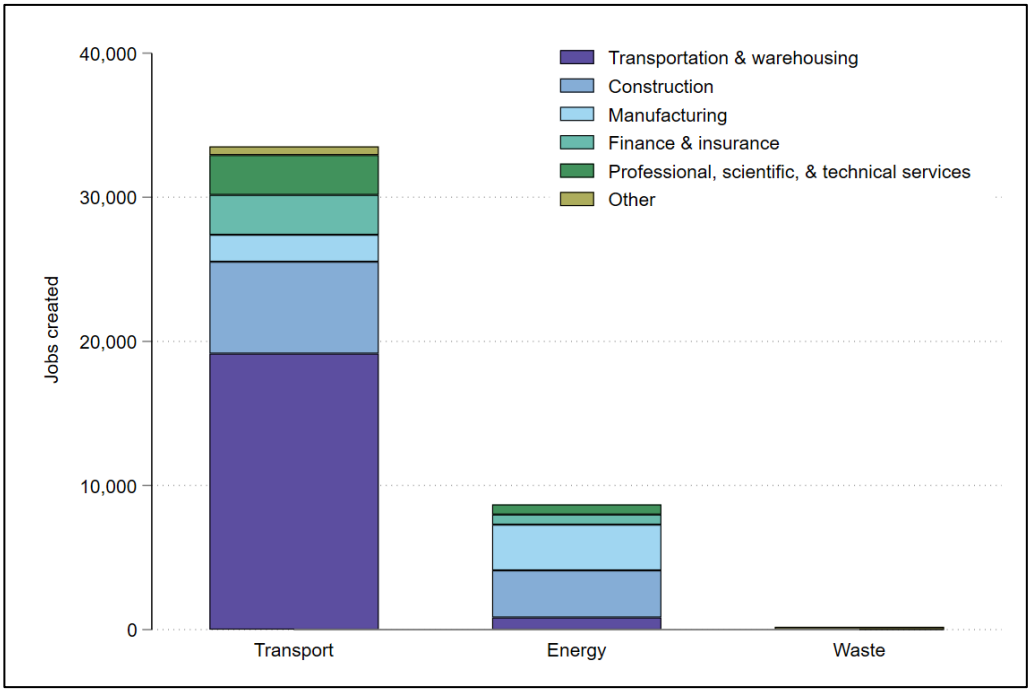
Annex 1 Sectoral breakdown of jobs supported by climate interventions

Mitigation

Figure 18: Green jobs in Phoenix in the construction phase by intervention cluster and sector for mitigation interventions

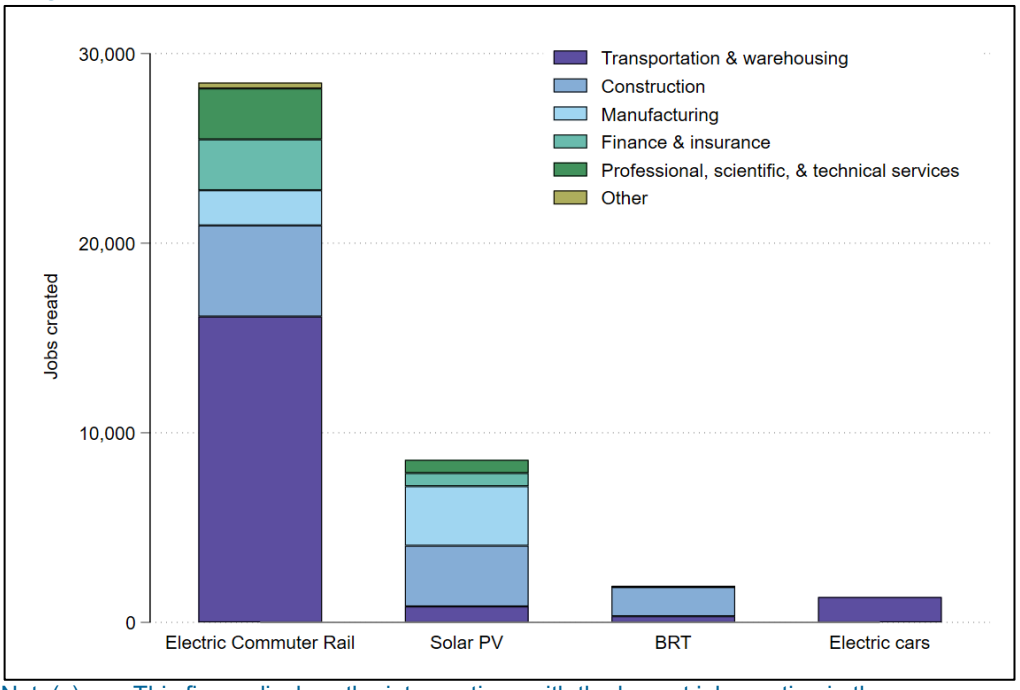


Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

In the **construction phase,** as seen in Figure 18 most jobs would be created in transport interventions. The majority of the jobs generated through transport interventions would be in the “transportation and warehousing” sector (about 20,000). As discussed in the Current workforce assessment, there are currently about 42,000 workers in this sector in Phoenix. About 10,000 jobs would be generated in the “construction” sector, which currently employs about 68,000 people.

Figure 19 displays the four individual interventions with the most job creation during the construction phase. The electric commuter rail intervention generates the most jobs (over 28,000 jobs), followed by solar PV (about 9,000 jobs). In these interventions, most jobs are generated in the “transportation and warehousing” and “construction” sectors.

Figure 19: Green jobs in Phoenix in the construction phase by sector for select mitigation interventions

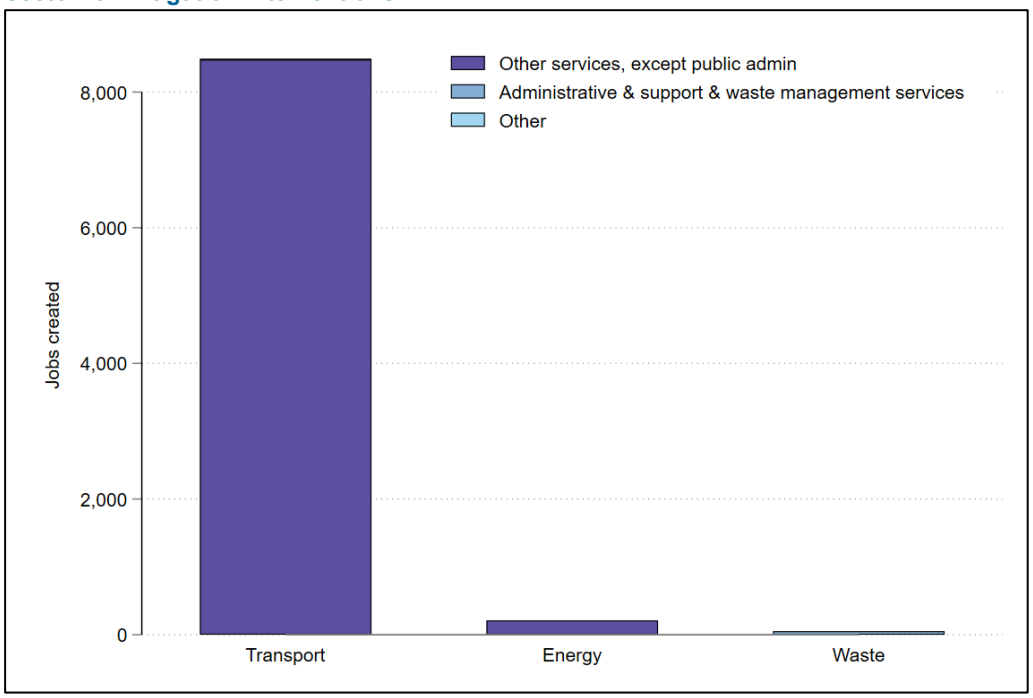


Note(s): This figure displays the interventions with the largest job creation in the construction phase.

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

As shown in Figure 20, in the **operation phase,** after the construction period, almost all of the new jobs (99%) are in the “other services, except public administration” sector.

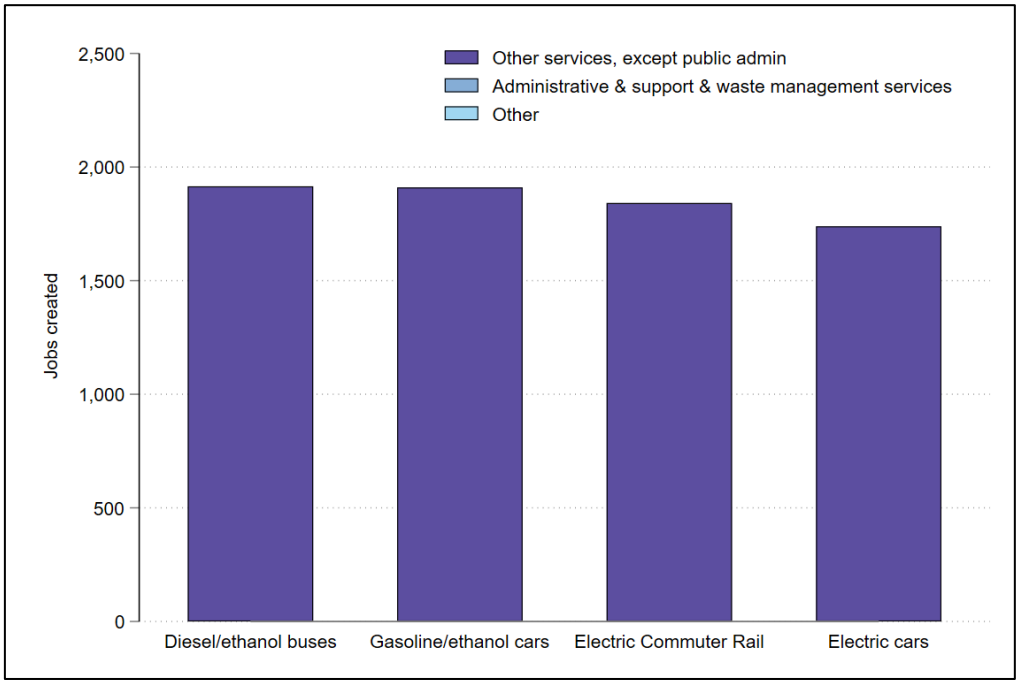
Figure 20:Green jobs in Phoenix in the operation phase by intervention cluster and sector for mitigation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

Figure 21 shows the mitigation interventions with the most new jobs during the operation phase. All of these interventions fall under the transport intervention cluster and would generate jobs in the "other services, except public administration" sector.

Figure 21: Green jobs in Phoenix in the operation phase by sector for select mitigation interventions



Note(s): This figure displays the interventions with the largest job creation in the operation phase.

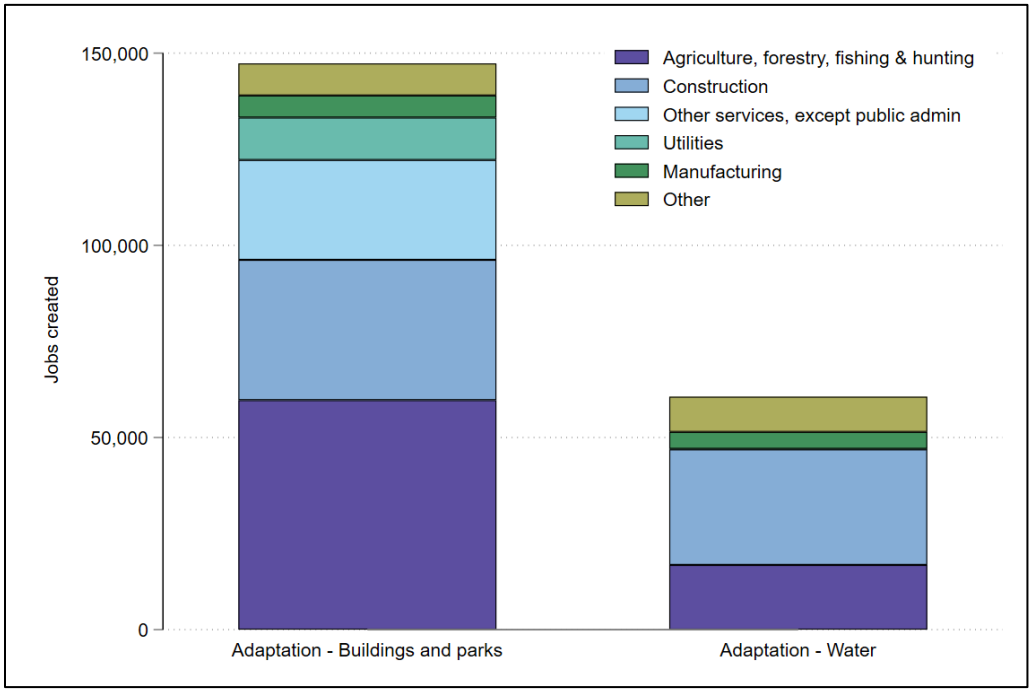
Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

Adaptation

In the **construction phase,** as seen in Figure 22, adaptation interventions related to buildings and parks would generate the most overall jobs (about 148,000 jobs). Most of the jobs for adaptation interventions are in the "agriculture, forestry, fishing, and hunting" (77,000 jobs) and "construction" (67,000).

Adaptation

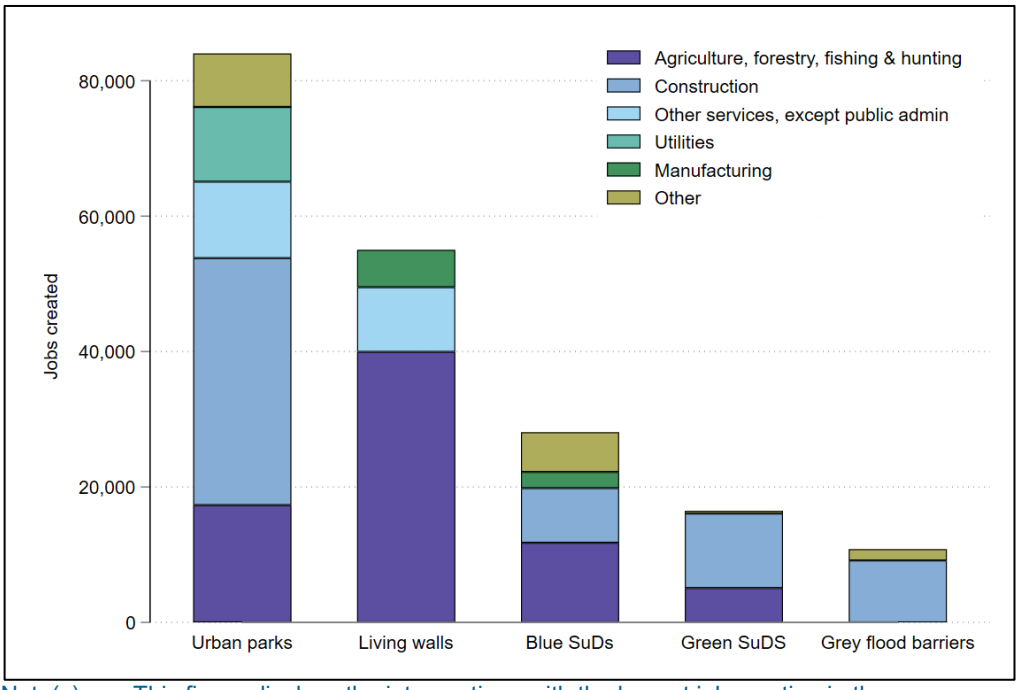
Figure 22: Green jobs in Phoenix in the construction phase by intervention cluster and sector for adaptation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

Figure 23 displays the individual interventions with the most job creation during the construction phase. The urban parks intervention generates the most jobs (over 80,000 jobs), followed by living walls (over 55,000 jobs). Both of these interventions fall under the buildings and parks adaptations cluster.

Figure 23: Green jobs in Phoenix in the construction phase by sector for select adaptation interventions

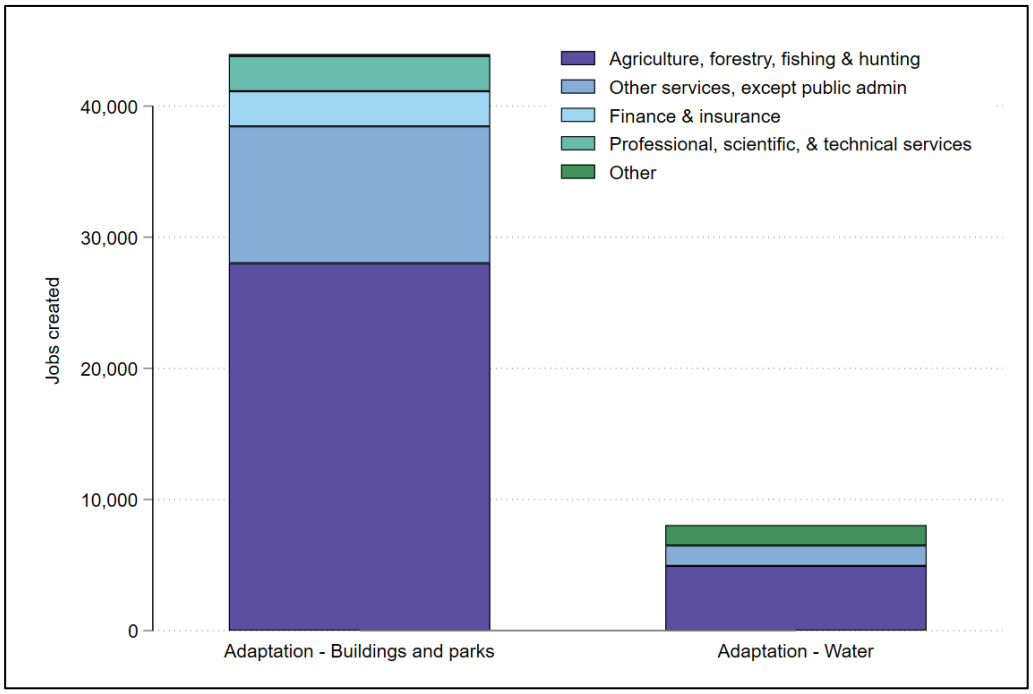


Note(s): This figure displays the interventions with the largest job creation in the construction phase.

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

Overall, adaptation interventions generate the most jobs in the “agriculture, forestry, fishing, and hunting” sector (see Figure 24).

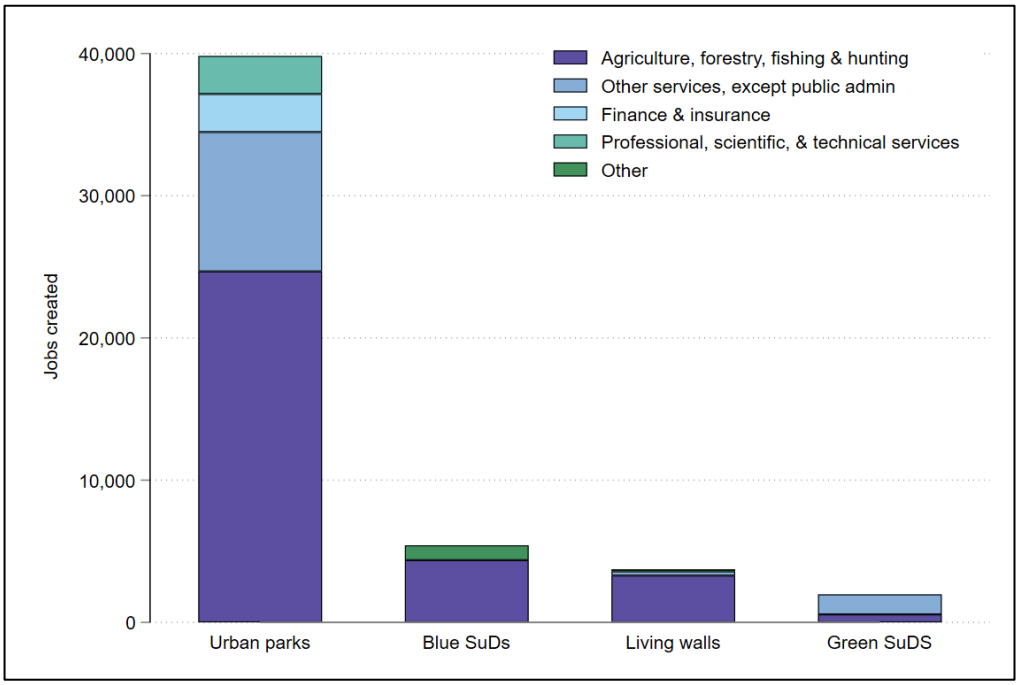
Figure 24: Green jobs in Phoenix in the operation phase by intervention cluster and sector for adaptation interventions



Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

Like the construction phase, the urban parks intervention generates the most employment in the operations phase. This intervention accounts for about 90% of the total job creation in the buildings and parks adaptation cluster in the operation phase. As seen in Figure 25, over 60% of the operation phase jobs in this intervention are in the “agriculture, forestry, fishing, and hunting” sector. Blue SuDs interventions, which constitute the majority of operation phase jobs in the water adaptation cluster, also generate jobs in “agriculture, **forestry**, fishing, and hunting,” with most jobs likely falling under agriculture and forestry.

Figure 25: Green jobs in Phoenix in the operation phase by sector for select adaptation interventions



Note(s): This figure displays the interventions with the largest job creation in the operation phase.

Source(s): C40 and Cambridge Econometrics calculations based on estimated expenditure on selected climate interventions in Phoenix out to 2030 in line with the city CAP, and Intervention-specific employment multipliers

Annex 2 Summary of city-level job estimates

The jobs results presented in the table below correspond to the level of investment indicated earlier in the report and that has been calculated specifically for the city of Phoenix based on the city's climate action plan.

Table 14 Total jobs supported by the climate interventions at the city level (construction phase + operational phase) and demographic disaggregation

			City-level outputs gender		City-level outputs for race										City-level outputs for ethnicity	
Intervention	Sector	City-level jobs	City level jobs for female	City level jobs for female %	City level jobs for Asian	City level jobs for Asian %	City level jobs for American Indian	City level jobs for American Indian %	City level jobs for Black	City level jobs for Black %	City level jobs for White	City level jobs for White %	City level jobs for Other	City level jobs for Other %	City-level jobs for ethnicity (Hispanics)	City-level jobs for ethnicity (Hispanics) %
Blue SuDs	Adaptation - Water	33,499	9,566	29%	815	2.4%	816	2.4%	1,694	5.1%	26,909	80.3%	3,265	9.7%	15,490	46%
BRT	Transport	2,327	656	28%	64	2.7%	47	2.0%	115	4.9%	1,900	81.7%	201	8.6%	903	39%
Cycle infrastructure	Transport	419	166	40%	21	4.9%	6	1.4%	27	6.4%	335	80.1%	30	7.1%	112	27%
Diesel/ethanol buses	Transport	2,489	910	37%	114	4.6%	45	1.8%	135	5.4%	2,006	80.6%	189	7.6%	720	29%
Electric buses	Transport	853	295	35%	30	3.5%	18	2.1%	75	8.8%	653	76.5%	78	9.1%	263	31%
Electric cars	Transport	3,079	1,138	37%	126	4.1%	59	1.9%	241	7.8%	2,381	77.3%	272	8.8%	924	30%
Electric Commuter Rail	Transport	30,308	11,108	37%	1,371	4.5%	459	1.5%	1,761	5.8%	24,325	80.3%	2,392	7.9%	9,411	31%
EV infrastructure	Transport	63	18	29%	2	3.2%	1	1.9%	3	4.2%	52	82.5%	5	8.2%	24	37%
Gasoline/ethanol cars	Transport	2,477	929	38%	113	4.6%	45	1.8%	136	5.5%	1,994	80.5%	190	7.6%	717	29%
Green roofs	Adaptation - Buildings and parks	7,693	2,208	29%	230	3.0%	178	2.3%	391	5.1%	6,192	80.5%	701	9.1%	3,232	42%
Green SuDS	Adaptation - Water	18,446	5,182	28%	460	2.5%	418	2.3%	854	4.6%	15,003	81.3%	1,711	9.3%	8,134	44%
Grey flood barriers	Adaptation - Water	10,811	3,386	31%	339	3.1%	195	1.8%	502	4.6%	8,886	82.2%	887	8.2%	4,036	37%

Living walls	Adaptation - Buildings and parks	58,746	16,037	27%	1,169	2.0%	1,605	2.7%	3,074	5.2%	46,698	79.5%	6,199	10.6%	30,043	51%
Solar PV	Energy	8,778	2,665	30%	317	3.6%	163	1.9%	389	4.4%	7,162	81.6%	746	8.5%	3,259	37%
Street trees	Adaptation - Buildings and parks	189	57	30%	4	2.3%	5	2.6%	10	5.3%	151	79.7%	19	10.1%	92	48%
Urban parks	Adaptation - Buildings and parks	124,048	38,300	31%	3,513	2.8%	2,759	2.2%	6,553	5.3%	99,821	80.5%	11,403	9.2%	52,441	42%
Wastewater reuse	Adaptation - Water	5,541	1,978	36%	233	4.2%	89	1.6%	308	5.6%	4,473	80.7%	440	7.9%	1,804	33%
Water efficiency	Adaptation - Water	347	111	32%	17	4.9%	6	1.6%	18	5.2%	281	80.8%	26	7.4%	99	29%
White roofs	Adaptation - Buildings and parks	799	279	35%	39	4.9%	13	1.6%	43	5.4%	643	80.5%	61	7.6%	231	29%
Advanced recycling	Waste	248	124	50%	13	5.4%	4	1.6%	17	6.8%	195	78.7%	19	7.6%	64	26%
Composting plant	Waste	64	29	46%	3	4.7%	1	1.7%	4	6.0%	51	80.1%	5	7.5%	18	28%
Hydro	Energy	95	26	28%	3	2.9%	2	1.9%	4	4.0%	78	82.6%	8	8.5%	37	40%
Onshore wind	Energy	24	8	33%	1	4.5%	0	1.7%	1	5.1%	19	80.3%	2	8.5%	8	34%

Annex 3 Potential of emissions reduction of specific interventions

The table below provides a summary of the potential of emissions reduction in 2030 for some of the mitigation interventions analysed in this report against their Business-as-usual scenario (they are not cumulative emissions savings by 2030). They have been extracted from C40 Pathways tool.

Table 15 Summary of the potential of emissions reduction of selected mitigation interventions in 2030 (compared to the Business-as-Usual scenario) in line with the C40 Pathways tool

Intervention	Emission reduction tCO2e in 2030	Matching jobs interventions
Grid decarbonization	7,737,570	Solar PV, onshore wind, hydro
Mode shift - walking & cycling	1,023,112	Cycle infrastructure
Mode shift - transit	1,154,316	BRT, electric commuter rail, diesel buses
Fuel switch - private vehicles	1,090,685	Electric vehicles, biofuel vehicles
Solid waste management	69,190	Advanced recycling, composting

Annex 4 Methodology

The objective of this Annex is to outline the methodological approach followed in performing the analysis for this report, as well as detailed data sources, assumptions and limitations taken in the analysis.

Approach

The work included three key steps:

Step 1: Current workforce assessment at the city level

This step involved developing a robust profile of the current city-level labour market by constructing a database with labour market demographics and skills. This included compiling data from various international, national-, country- and city-level sources into an accessible Excel workbook.

Step 2: Job creation from selected climate interventions

This step involved estimating the jobs supported by investment into the selected set of climate intervention in the city. Employment impacts were derived using employment multipliers (expressed in job-years resulting from a USD 1 million investment into a certain climate intervention), and assumptions on the expected investment levels (captured at the intervention or intervention cluster level, based on the city's Climate Action Plan and other sources).

Note: In addition to this report, a comprehensive job tool has been shared with the city with all the details of estimated investments, raw employment multipliers and expected job-years and jobs.

Step 3: Assessment of the green jobs from an equity- and job quality perspective

This step involved assessing the green jobs-related workforce in terms of key demographics, assessing the quantitative outputs from steps 1 and 2 against a 'good quality jobs' concept. This step involved matching the climate interventions to economic sectors to be able to see employment impacts by sector.

The methodology for the equity assessment approach is summarised below.

Current workforce assessment at city level

- review of the key labour statistics in terms employment, unemployment
- sectoral employment distribution by age, gender, education level, wages and working conditions

Job creation from climate action interventions

- mapping the job creation from the investment in climate action interventions to different sectors

Assessment of the new jobs

- potential workforce structure in terms of age, gender, education level
- assessment of the level of job quality measured through current working conditions, wages and working hours in the sectors with job creation

The methodological approach does not consider changes or improvements in the average job quality in a sector. Therefore, it is possible that not all future green jobs are of similar quality.

Data sources – Multipliers

The employment multipliers used for the analysis have been developed by Vivid Economics using their I3M model[35], building on an approach developed as part of a preceding research commissioned by C40 Cities estimating job creation potential in Italy, South Africa and the United States (for both the mitigation and the adaptation type of interventions). The methodology is presented in the detailed methodology report[36] published by C40 Cities in 2021.

Vivid's I3M model generates national multipliers which are then scaled for local multipliers using city-specific economic data. For Phoenix, no downscaling was needed as Vivid Economics I3M outputs are already at the county level (Maricopa County). This is because IMPLAN data was used for the input-output tables, which enables analysis at both the national and state level (for more details, see section 2.3.2 at the methodology report[37]).

As part of this study's analysis for Phoenix, additional multipliers were developed using Vivid Economics' methodology for the interventions specified in the table below (the remaining ones can be found in Table 1 of the preceding methodology[38]).

Table 16 Additional multipliers used for selected interventions

Intervention	Description
Advanced recycling	Setting up advanced recycling facilities
Composting plant	Setting up organic waste treatment (or composting) facilities
Efficient lighting (buildings)	Replacing lighting in commercial and residential buildings with more energy efficient lighting (installing LEDs)
Efficient street lighting	Replacement of existing street lighting fixtures with energy efficiency LED fixtures
Biofuel vehicles	Investment into biofuel vehicles for household use[39]
Biofuel / diesel buses	Investment into diesel buses for fleet expansion and into biofuel buses (which can run on 100% biofuels)

[35] I3M: Investment and Intervention Impacts Model, Vivid Economics' economic development model based on national and subnational social accounting matrices.
[36] C40 Cities (2021) Methodology – Urban Climate Action in U.S., South Africa and Italy. Available at: https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q0000001nQa/078oSTl2lqaDZXwf5iJzLeuJQN7iOKuDP690m0F586k
[37] https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q0000001nQa/078oSTl2lqaDZXwf5iJzLeuJQN7iOKuDP690m0F586k
[38] https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q0000001nQa/078oSTl2lqaDZXwf5iJzLeuJQN7iOKuDP690m0F586k
[39] The model did not cover the intervention 'Biofuel vehicles'. For this reason, the intervention for 'Gasoline cars' have been used as a proxy. The cost profiles between gasoline and biofuels vehicles are likely to be very similar in terms of EORA sectors that get stimulated: CAPEX largely into 'Automobile manufacturing', and OPEX into 'Retail trade' (e.g. gas stations or equivalent) and 'Maintenance & repair'. It is to be noted that this approach could be missing some impacts on the agricultural sector.

Data sources – Costing of interventions

The approach to estimating expenditures from climate mitigation interventions is detailed in the methodology report[40] (Appendix C) associated with C40's publication 'Making a case for a Green and Just Recovery' published in 2020. An update to this approach is that for this analysis, the expenditure associated with flexible fuel vehicles (private and transit) was incorporated given this was found to be an additional climate mitigation intervention undertaken by Phoenix.

As an overview, using Phoenix's Pathways[27] CAP scenario and city sectoral profiling data providing by the city, C40 Cities estimated CAPEX (capital expenditure-related) and OPEX (operation and maintenance-related) costs associated with climate mitigation interventions to 2030 in transport, energy and waste. Building related-mitigation interventions did not feature within the city's pathway CAP scenario.

CAPEX and OPEX costs associated with the adaptation type of interventions were developed by Cambridge Econometrics, also building on an approach developed as part of preceding research commissioned by C40 Cities (this is the same report as referred to for the Vivid Economics employment multipliers – see here methodology report[28]).

By way of an overview of the approach, the pilot cities' climate actions plans were consulted to identify planned adaptation interventions as well as baseline data on the extent of their deployment to date and targets to 2030. In the case of Phoenix, we consulted the city's Climate Action Plan[41] published in 2021. Mostly, data was available on planned interventions but not their scale (baseline or target). As a result, for baseline and target deployment, further desktop-research was carried out. In most cases, the targets were based on those first identified as part of research in 2021[42]. Targets are indicative – they may be highly ambitious for some cities and conservative for others. C40 Cities is not making a recommendation by using these targets, the objective is to provide an illustration of potential job creation and spur further research in this area.

For a selected subset of adaptation interventions (namely, for Street trees, Urban parks and White roofs), the city of Phoenix provided costing data (capital investments). In the estimates presented in this report, these costing data are not used - instead, for the sake of consistency, data developed by Cambridge Econometrics was used for the analysis for all the adaptation interventions. However, these cost data, along with the employment estimates resulting from these interventions are presented as add-on calculations, in a separate tab in the comprehensive job tool shared with the city.

Assumptions

Initially, the job estimates, calculated based on the assumed future investment amount corresponding to each intervention (up to 2030) and based on the employment multipliers, are expressed in the number of total job-years supported by the interventions (broken down by gender and race). To derive actual job estimates based on the total job-years estimates, assumptions had to be made on the duration of the FTE job places supported which varies between CAPEX and OPEX types of jobs. Throughout the analysis, one FTE job is assumed to last for 5 years if it is CAPEX-related, and assumed to last for 8 years (until 2030) if it corresponds to OPEX-related investment. At the investment stage, typically short-term jobs are created in the planning and

[40] C40 Cities (2021) Methodology – Urban Climate Action in U.S., South Africa and Italy. Available at: https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q0000001nQa/078oSTl2lqaDZXwf5iJzLeuJQN7iOKuDP690m0F586k

[41] City of Phoenix (2021). Phoenix Climate Action Plan. Available at: https://www.phoenix.gov/oepsite/Documents/2021ClimateActionPlanEnglish.pdf

[42] C40 Cities (2021) Creating local green jobs in the United States, Italy and South Africa. Available at: https://www.c40knowledgehub.org/s/article/Creating-local-green-jobs-the-United-States-Italy-and-South-Africa?language=en_US.

development and installation stages of projects (CAPEX-related jobs), whilst in the operation and maintenance phase of a project (OPEX-related jobs), jobs tend to be more long-term.

Assumptions made related to the mitigation type of interventions are the following. For the mitigation intervention 'Electric Commuter Rail', the CAPEX and OPEX cost of rail infrastructure and rail vehicles are both considered. For the mitigation intervention 'Cycle infrastructure', the corresponding cost is assumed to be wholly capital investment (accounted for as CAPEX costs). For biofuel vehicles and buses, the multiplier for fossil fuel vehicles (gasoline / diesel) was used, however this could underrepresent job potential associated with biofuel supply chains. These are unlikely to be generated in the city however.

Assumptions had to be made related to some of the adaptation type of interventions, too: For the adaptation intervention 'Grey flood barriers', county level data is used for the calculation of jobs due to no data available at the local city-level (therefore, jobs are related to the full investment across the county). For the adaptation intervention 'Street trees', the baseline level was calculated using data on the number of trees to be planted based on the city's Climate Action Plan. For the adaptation intervention 'Wastewater reuse', target was not included in the city's Climate Action Plan, therefore it has been assumed that Phoenix wants to keep its current high share of water reuse (89%) and even wants to improve it slightly as urban green areas and the number of trees will also be expanded, therefore target level is assumed to be 90%. For the adaptation interventions 'Green Sustainable drainage systems', 'Blue Sustainable drainage systems', 'Living walls' and 'White roofs', in lack of robust baseline data the baseline was assumed to be zero – therefore, the investment costs are budgeted assuming the need to reach the 2030 target from zero base.

Limitations and areas for further development

With regards to the longevity of job multipliers, the job multipliers used in this report come from Input-Output tables from 2019 (latest available). Therefore, the validity of the output multipliers is likely to be relatively short termed given the shocks to the economy in the past couple of years (including Covid-19, supply chain issues, commodity prices, etc.). It is advisable to do a sense check to these figures in 3-5 years after this work, as better estimates for multipliers will not be available until the current situation stabilises.

The assessment of jobs impact of mitigation interventions could be improved through inclusion of interventions within the building sector. This is an area that would benefit from review as the city progresses with its climate action plan given that energy efficiency improvements in buildings can have a significant impact on reducing emissions and create opportunities for job creation. Additionally, Phoenix did include targets for increasing landfill gas capture which were not included in the jobs impact as it is not currently an intervention which is costed.

Assessment of the jobs impact of adaptation interventions can be strengthened with more location-specific research and with a more robust dataset including baseline data for each of these interventions, as well as city specific target figures in line with the city's planned actions.

To assess jobs that are supported locally, within the city to jobs that are supported at the national level, two separate sets of multipliers - city multipliers and national multipliers - have been used for the analysis. National multipliers are provided as an indication of the total jobs that could be created (in- and outside the city) based on these investments and should be used with care, as they refer to national averages. In some cases, national multipliers are lower than the city-level ones. National multipliers can be lower where 1) the average labor wage is higher than in Maricopa County (and therefore the same payments to labor employ fewer people) and/or 2) where manufacturing activity is included in the US but not in the local region.

To estimate the extent to which the interventions create local employment opportunities within the city, we scale the multipliers to a city-specific level based on current economic dynamics (see explanation above and more details on preceding methodology – section 2.3)