15 Million Infrastructure Jobs: An Economic Shot in the Arm to the COVID-19 Recession

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Introduction

More than a year after the initial shutdowns of schools, stores, hotels, and restaurants due to the COVID-19 pandemic, and the subsequent waves of layoffs and business closures, national unemployment rates are back to the single digits while job growth is fluctuating but generally positive.[1] Despite these promising numbers, however, the coronavirus economic crisis is far from over. Notwithstanding economic stimulus, the scarring effects[2] of the COVID-19 recession on institutions and individual careers will linger for years.[3] An infrastructure program would be good economic medicine for the job losses due to the COVID-19 recession as well as the right thing to do in refurbishing and modernizing our crumbling and outdated infrastructure in the interest of longer-term economic growth.

An analysis of the long-term economic impact of infrastructure spending on the economy shows that, on average, every $100 billion spent could potentially boost job growth by 1 million jobs in terms of full-time equivalents (FTEs).[4] However, any type of economic stimulus is not without risks such as inflationary pressure[5] or a stock market bubble.

The economy is still in crisis, the roads are still crumbling and bridges are still rusting. Now that Congress has passed a $1.9 trillion accelerated investment plan to combat the virus and economic downturn,[6] the Biden-Harris administration is suggesting spending an additional $1.5 trillion specifically on building and restoring the nation's infrastructure.[7] The plan would address building new roads and bridges, as well as refurbishing old ones; restoring and expanding mass-transit systems, the electric grid, railroad lines and water and sewer pipes; and building out the nation's broadband network, which could bring high-speed Wi-Fi to much of the nation. While an infrastructure bill has yet to be introduced, we used the $1.5 trillion figure as a reasonable estimate of what the size of the final package would be—it is less than the $2 trillion plan Biden called for during the presidential campaign,[8] but larger than the $1 trillion plan that

[1] This recession has been a long time coming. Long before the COVID-19 pandemic shut down businesses and schools across the nation, economic pundits had already predicted a recession for 2020. Financial models showed a 20–49 percent chance of a recession in 2020. These predictions came with no knowledge of a pending pandemic. See Pickert et al., "U.S. Recession Model at 100% Confirms Downturn Is Already Here," October 14, 2019.
[2] Scarring is defined as reduced lifetime incomes caused by entering the workforce during a downturn. Kahn, "The Long-Term Labor Market Consequences of Graduating from College in a Bad Economy," 2010.
[3] Faced with the quandary of choosing between a sub-par job or prolonged unemployment, new college graduates should expect to earn up to 7 percent less for every 1 percent increase in the unemployment rate. The inertia of pay parity for the scarred class is likely to persist for more than 15 years, with graduates still earning 2.5 percent lower than their peers who entered the workforce during rosier economic times. Kahn, "The Long-Term Labor Market Consequences of Graduating from College in a Bad Economy," 2010.
[4] Bivens, "The Potential Macroeconomic Benefits from Increasing Infrastructure Investment," 2017.
[5] Summers, "The Biden Stimulus Is Admirably Ambitious. But It Brings Some Big Risks, Too," 2021.
[6] Kaplan, "What's In the Stimulus Bill?," 2020.
[7] Biden-Harris campaign, "The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future," 2020
[8] Biden-Harris campaign, "The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future," 2020.

business leaders and Republicans said they would be willing to support.[9] The $1.5 trillion price tag is the same size as an infrastructure package passed by the House in the summer of 2020.[10] For the purposes of this report, we chose this figure to illustrate how transformative a large infrastructure plan would be.

The United States will need more stimulus spending to get out of the deepest recession since the Great Depression.[11] Monthly reports by the US Bureau of Labor Statistics show increases in the number of jobs that have been permanently lost, not due simply to temporary closures or furloughs due to the virus.[12] The Congressional Budget Office estimates it could take up to three years to recover the jobs lost in the first 10 months of 2020.[13] Expired federal supplements to unemployment benefits and business relief supplements (the Paycheck Protection Program) have not resulted in mass movement back into the workplace because many of the jobs that workers would have returned to are permanently gone. This recession is different from past recessions mainly because it is not necessarily pushing people into pursuing more education. Rather, college enrollment during the pandemic continues to falter, even with a large and steady number of long-term unemployed workers.[14]

Many of the jobs that have been lost in this recession are not coming back.[15] The jobs that will be created will be new jobs, sometimes combining aspects of jobs that were lost. An infrastructure stimulus plan would create[16] 15 million jobs over the next decade,[17] and finally spread some economic gains to groups that have been neglected as the economy has increasingly automated. The infrastructure jobs that would be created would be spread among workers with many levels of educational attainment. An infrastructure program of a magnitude suggested by the Biden-Harris proposal would reverse a long-term decline in jobs and earnings for those with high school diplomas or less, creating 8 million jobs for this population.[18] Most of these workers would need as little as a few months of training in new positions and might even be motivated to change from their old professions into these new infrastructure opportunities.[19] This is especially true if a bill modeled on the Biden-Harris proposal includes targeted aid[20] and accompanying

[9] Karni and Tankersley, "After Stimulus, Biden to Tackle Another Politically Tricky Issue: Infrastructure," 2021.
[10] Laris, "House passes $1.5 trillion infrastructure bill," 2020.
[11] Miller, "Yellen, Summers Spar About Overheating Risk in Stimulus Plan," 2021.
[12] The United States lost 22 million jobs in March and April of 2020, then gained 13 million jobs from May 2020 through February 2021. Georgetown University Center on Education and the Workforce analysis of data from the US Bureau of Labor Statistics, Current Employment Statics (CES) survey, 2020.
[13] Congressional Budget Office, "An Overview of the Economic Outlook: 2021 to 2031," 2021.
[14] Rampell, "Tough Economies Usually Push People into More Education," 2021.
[15] This is because the recession accelerated trends in job losses that started many years ago, as the nature of work changed to incorporate technology not only as a complement to workers but also as a substitute for tasks and activities on the job and, ultimately, a substitute for many of the jobs themselves. See Autor and Salomons, "Is Automation Labor Share-Displacing?" 2018.
[16] In reality, this investment could create and/or save 15 million jobs by generating opportunities for new jobs that did not exist before the stimulus as well as providing the necessary investment to save jobs that would otherwise be lost due to state and local government budget shortfalls.
[17] One estimate suggested that in 2007, $1 billion in federal highway expenditures supported about 30,000 jobs—10,300 in construction, 4,675 in supporting industries, and 15,094 in induced employment. A Standards & Poor study in 2015 estimated 29,000 direct jobs per $1.3 billion dollars in infrastructure spending. Finally, alternative estimates by the US Department of Transportation temper those original estimates to about 13,000 jobs for every $1 billion in highway spending.
[18] Autor and Reynolds, 2020, lament the fact that too few low-wage jobs will return after the COVID-19 crisis. This might be a way to supplement those job losses.
[19] Parker et al., "Unemployed Americans Are Feeling the Emotional Strain of Job Loss," 2021.
[20] *New York Times*, "Desperate Times, Creative Measures," 2021.

provisions specifying "prevailing wages" for infrastructure jobs.[21] Such a bill would also create 4.8 million jobs for workers with more than a high school diploma but less than a bachelor's degree, as well as 2.25 million jobs for workers with bachelor's degrees and above.

An infrastructure program also opens up opportunities for various forms of work-based learning, including short-term training, noncredit education at community colleges, paid internships, apprenticeships, and industry-based certifications. Currently, 6.6 million workers with licenses and test-based industry certifications work in infrastructure jobs, including workers with commercial driver's licenses, those who have completed federally authorized training in workplace safety, and those with certifications in construction education.[22] Installation, maintenance and repair occupations have the second-highest concentrations of industry-based certified workers of any industry, second only to information technology.[23] Policy analysts are pushing for the Biden-Harris infrastructure spending plan to include training opportunities for all workers at various levels of educational attainment, including dedicated training funds that specifically target local labor market needs.[24]

Spending on infrastructure would at least temporarily reverse the long-term decline in blue-collar jobs accelerated by the demise of domestic manufacturing.[25] In addition, a strong infrastructure program would temporarily restore the total number of blue-collar jobs that have been lost to trade and technology since China joined the World Trade Organization.[26] Some employers are already worrying that the skill demands of jobs created by a huge infrastructure plan would outstrip the skills of workers. Even without an infrastructure plan in place, construction firms report that finding skilled labor is their largest concern. Upward of 330,000 construction jobs are unfilled.[27]

The plan would help employ many Latino and Black workers. The Latino and Black communities have been hard hit by the recession for two reasons: first, they have had disproportionately high rates of hospitalizations and deaths due to COVID-19;[28] and, second, they have been disproportionately subject to job losses primarily because of their generally lower levels of educational attainment.[29] Sixty-one percent of Latino workers and 45 percent of Black workers have a high school diploma or less, compared with 34 percent of White workers.[30]

The jobs would be spread across the country. In general, the job opportunities favor relatively more populated coastal states, but all stand to benefit from the infrastructure

[21] The Davis-Bacon Act requires that prevailing wages be paid on federally funded public works projects, where prevailing wages are defined as what the local standards are for wages for similar jobs in the area.
[22] Georgetown University Center on Education and the Workforce analysis of US Bureau of Labor Statistics, "Data on Certifications and Licenses," 2019.
[23] Appendix A provides a summary of top in-demand infrastructure certifications.
[24] McCarthy et al., "Building Back Better," 2021.
[25] Carnevale et al., *Upskilling and Downsizing in American Manufacturing*, 2019.
[26] Scott and Mokhiber, "The China Toll Deepens," 2018.
[27] Cohen, "Why Finding Workers Is Getting Harder for U.S. Homebuilders," 2021.
[28] Miller, "COVID-19 Reduced U.S. Life Expectancy, Especially Among Black and Latino Populations," 2021.
[29] US Census Bureau, American Community Survey (ACS), 2015–2019 (pooled).
[30] We use the term Black to refer to people who identify as Black or African American and the term Latino to refer to people who identify as Hispanic or Latino, including people who identify racially as Black and ethnically as Latino. In charts, tables, and related references to data, we use the terms White, Black/African American, and Hispanic/Latino.

investment, including states that have not had as much economic growth as other states. Almost one out of every five jobs created by the infrastructure proposal would be generated in the Midwestern states.[31] More than 22 percent of the jobs would go to states in the Southeast, including such states as Arkansas, Mississippi, and West Virginia, which have some of the lowest median household incomes in the nation[32] (Appendices C and D).

Such a substantial investment in infrastructure is sure to have multiplier effects. Spending on infrastructure boosts downstream industries and spurs consumption spending as more people are employed in a fully functioning economy. Maintaining low transportation costs and reliably delivering clean water, electricity, and broadband services is important for business efficiency. Therefore, it is likely that infrastructure improvements will create additional jobs that are not all directly related to infrastructure in the long term. In other words, efficient, competent, and functional infrastructure is a prerequisite for productivity, competition, and growth.

Moreover, an infrastructure program that includes both traditional brick-and-mortar spending along with new smart infrastructure like broadband would bring long-term economic returns, increasing Gross Domestic Product (GDP) by as much as $320 billion per year for as long as the stimulus plan continues.[33] The Biden-Harris infrastructure proposal would seek to provide broadband access to the 21.3 million Americans (6.5 percent of the population) who do not have high-speed internet connections.[34] Of those 21.3 million people, 4.2 million are Black, 6 million are Latino, and 11.1 million are White.[35]

Political barriers to an infrastructure program can't be discounted in spite of a strong economic case for infrastructure spending. In 2017, President Trump proposed spending up to $1 trillion on infrastructure projects,[36] but his proposal did not gain momentum because of concerns about inflation, interest rate hikes, and the potential for crowding out private investment. His administration also worried about whether the long-term impact of repayment on future generations was worth the immediate payoff of creating millions of new jobs. But that was pre-2020, when the health and economic fortunes of the nation were immensely different. Policy objections today may be more muted because of the COVID-19 recession.

Another argument in favor of increased infrastructure spending is that it could be a political miracle as well an economic one. There is bipartisan appeal in this type of stimulus spending. Almost everyone, regardless of political affiliation, can get behind a spending bill that fixes bridges and improves broadband access, especially if state and local earmarks are allowed to entice individual senators and representatives.

Partisan politics might interfere with an infrastructure plan, but the Biden-Harris proposal seems relatively even-handed in the distribution of potential benefits to both political parties. An infrastructure bill would potentially boost Democratic standing with working

[31] Illinois, Ohio, and Michigan stand to make big gains.
[32] Florida, Georgia, and North Carolina are big winners.
[33] Business Roundtable, "Road to Growth," 2015.
[34] Federal Communications Commission, "Inquiry Concerning Deployment of Advanced Telecommunications Capability," 2019.
[35] Georgetown University Center on Education and the Workforce analysis of data from FCC, "Inquiry Concerning Deployment of Advanced Telecommunications," 2019, and Pew Research data, 2019.
[36] Carnevale and Smith, *Trillion Dollar Infrastructure Proposals Could Create Millions of Jobs*, 2017.

class voters. Democrats are accused of losing touch with working-class Americans in general because of their doctrinaire support for trade and technology despite the de-industrialization and de-unionization it inspired. They traded working class support for the rising tide of college graduates. For Republicans, an infrastructure program would be good for their working-class supporters who feel left behind by economic change. Our estimates show that of the 15 million jobs that could be created with this infrastructure stimulus, 8.6 million would be available in Democratic-leaning blue states, and 6.4 million would be available in Republican-leaning red states. There would be 2.7 million infrastructure jobs just in the seven closely contested states that were key to the outcome of the 2020 presidential election: Arizona, Georgia, Michigan, Nevada, North Carolina, Pennsylvania, and Wisconsin.

Low interest rates may just be the secret sauce that allows a Biden-Harris spending plan on infrastructure to succeed. The Federal Reserve dropped interest rates effectively to zero in March 2020, when the pandemic began to sweep the United States, and is promising to keep interest rates low until the economy has "weathered recent events."[37]

If federal deficit spending increases by nearly $2 trillion to pay for an "accelerated" investment, including money for infrastructure, low interest rates will lessen the blow of the government debt load in the years that follow.

There are legitimate labor market concerns about the distribution of jobs in an infrastructure program. Jobs held by women have accounted for close to 55 percent of the jobs lost since the pandemic began, but infrastructure jobs tend to be male dominated: 90 percent of infrastructure jobs are currently held by men. As a result, efforts need to be made to ensure inclusion of women as infrastructure jobs are expanded.[38]

In addition, it will be important to plan for the short-term versus the long-term education and labor market effects of an infrastructure program. The surge in job creation in infrastructure programs comes in the initial years and eventually wanes because it takes a lot more people to build the infrastructure than to maintain it once it is built. Many good infrastructure jobs will likely be gone by the end of the 10-year infrastructure stimulus. If these jobs are lost, we risk repeating the tragic shift out of blue-collar jobs that began in the 1980s when good blue-collar jobs that only required a high school education were eliminated by the deindustrializing effects of technology and offshoring.

The missing pieces of the Biden-Harris infrastructure plan are education, training, and labor-market services that help people get good jobs and find retraining for a new job when the good job disappears. The Biden-Harris infrastructure proposal is one more instance that highlights the need for appropriately funding and integrating this ecology of social insurance, workforce development, education, and training programs. The task is complex but there are a lot of sensible ideas that point the way forward. We can begin by holding economic and racial justice as a core operational principle in connecting the dots in our education, training and labor market institutions.

[37] Board of Governors of the Federal Reserve System, "Federal Reserve Issues FOMC Statement," 2020.
[38] At the start of the recession, high school-educated women experienced unemployment rates that were 5 percentage points higher than similarly qualified men, while women with bachelor's degrees experienced unemployment rates that were 2 percentage points higher than similarly qualified men. See "Tracking COVID-19 Unemployment and Job Losses," 2021, an interactive data set created by the Georgetown University Center on Education and the Workforce.

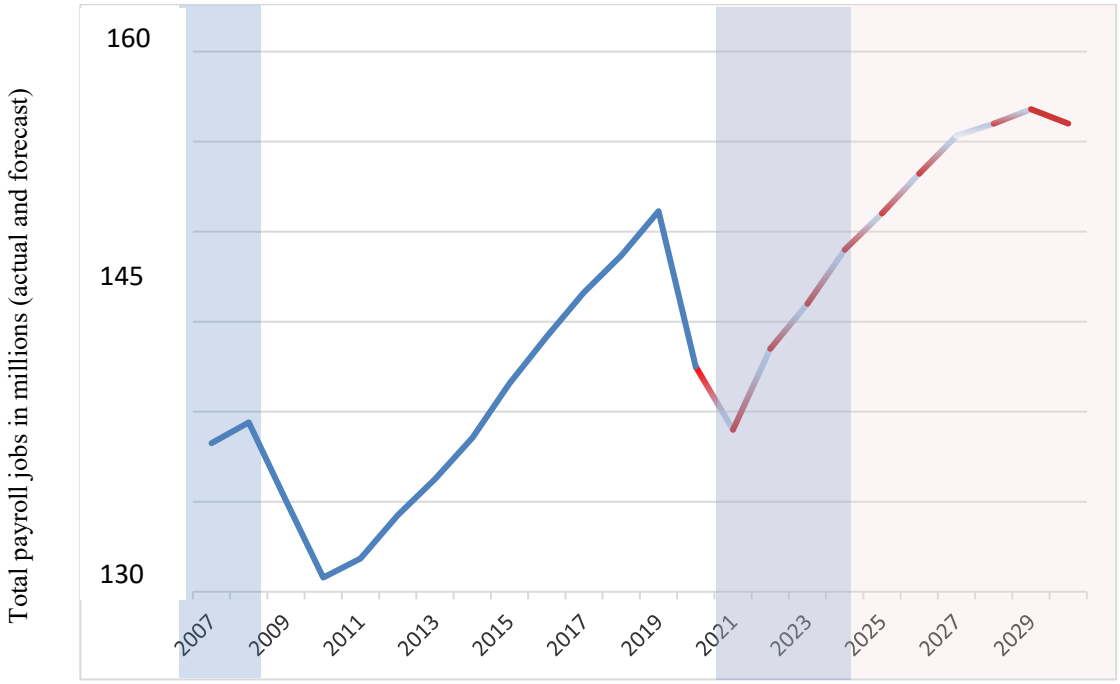
An infrastructure stimulus plan would result in job growth across the nation

Many policy shifts could be enacted to spur the economy to emerge from the recession caused by the COVID-19 pandemic, but a massive investment in infrastructure holds unusual promise because it most helps many of the neediest workers and spurs long-term growth, in addition to having potential to get bipartisan support.

The Biden-Harris infrastrucure investment plan could restore the pace of job creation that was derailed by the COVID-19 recession (Figure 1). If enacted,[39] the infrastructure program could put the United States back on a pre-recession job growth path and create and/or save 15 million jobs.[40] The pandemic recession has touched all industries and, by extension, all jobs. Infrastructure jobs averaged 12 percent of all jobs in the US economy prior to the pandemic. Mid-pandemic, the number of infrastructure jobs in 2020 averaged 11 percent of all jobs, reflective of the general malaise in employment across the labor force. Infrastructure-related jobs,[41] which now comprise 11 percent of jobs in the US economy, would increase temporarily to 14 percent of jobs.[42]

[39] President Obama's stimulus package in 2009, for example, allocated roughly $146 billion out of the $792 billion in total spending to infrastructure investments. Other federal agencies and numerous studies have recognized the job-creating potential of infrastructure projects.
[40] This report analyzes only the impact of the Biden-Harris administration's proposed 10-year public infrastructure spending on jobs and education.
[41] See Appendix B for the list of occupations that fall under infrastructure-related jobs.
[42] In the long run, the share of infrastructure jobs would likely decline to 12 percent, with an increasing share for maintenance operations.

Figure 1. Spending $1.5 trillion on infrastructure could create and/or save 15 million jobs over 10 years and return the economy to its long-run growth path.



Source: Georgetown University Center on Education and the Workforce forecast using data from US Bureau of Labor Statistics and IHS Markit.

Note: Checkered line represents projected job growth through 2029.

Spending on infrastructure would spur job growth across a wide sector of the economy, including:

- traditional blue-collar construction and transportation industries;
- smart infrastructure such as smart-grid electrical technologies, broadband and 5G internet technologies, and green technology;[43] and
- white-collar professional and business services, and other downstream industries.

In addition, job growth would be widespread across the country. Blue states, which are more heavily populated, would gain 8.6 million jobs, and red states would gain 6.4 million jobs. About 8.6 million of the jobs, or 57 percent, would come in three geographic areas: the Midwest, the Mid-Atlantic, and the Southeast.[44]

In spite of their seeming economic and political benefits, infrastructure investment proposals have had rough sledding in recent years. Just over a decade ago, the Obama administration allocated roughly $48.1 billion out of a $792 billion stimulus package to transportation infrastructure.[45] The goal of that plan was to create jobs for Americans. But, as officials quickly found out, throwing money at the problem did not create jobs at the rate initially expected. "Shovel-ready was not as shovel-ready as we expected," President Obama observed in June 2011.[46] The $1 trillion investment in infrastructure

[43] Green technology refers to environmentally friendly production processes, including wind and solar energy production, and other processes that do not use fossil fuels. It also includes work that saves energy through making buildings and processes more efficient.
[44] See Appendix C for projected infrastructure job changes by state.
[45] Congressional Research Service, Transportation Infrastructure Investment as Economic Stimulus, 2020.
[46] Ryan, “McConnell: Jobless Not Amused,” 2011.

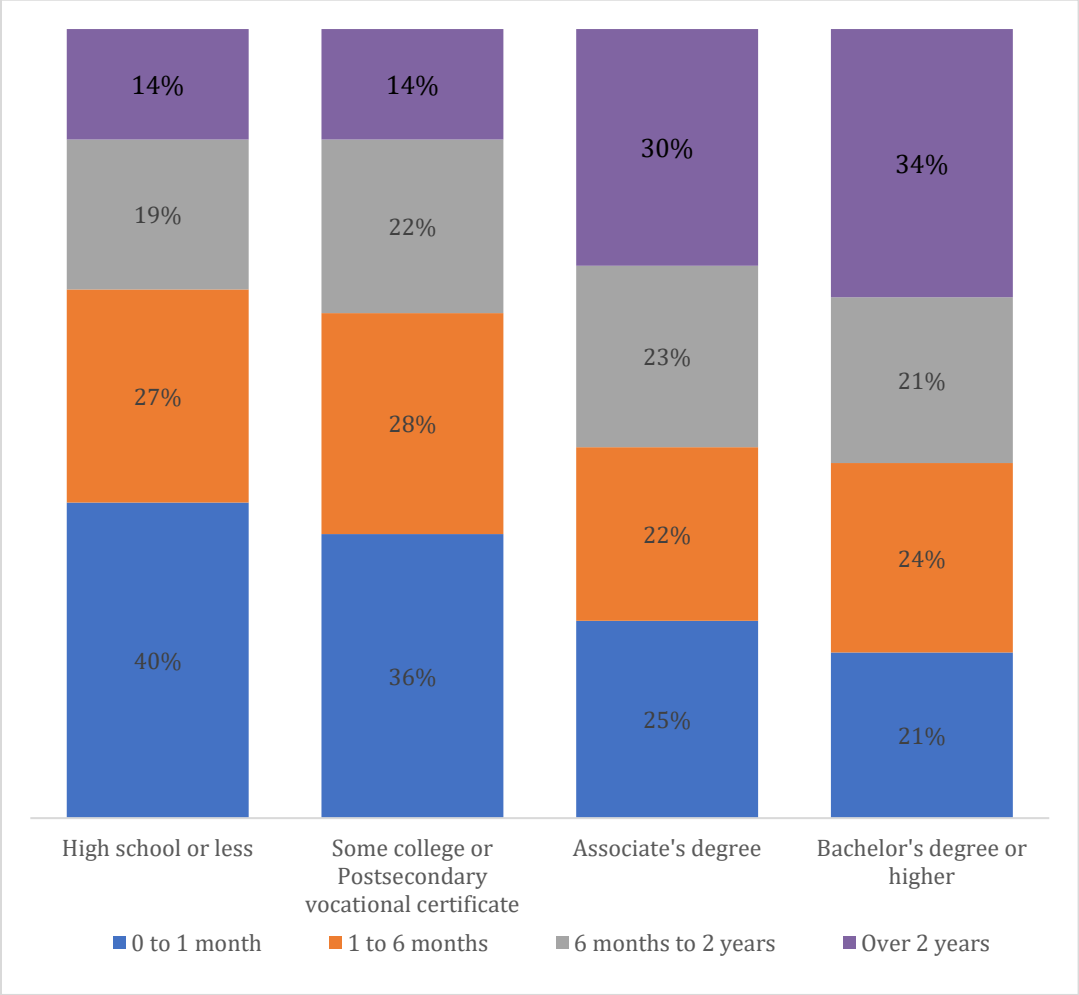
proposed by President Trump in 2017 would have created more than 11 million jobs, but his administration didn't prioritize the plan in the face of political opposition and objections from the private sector.

Part of the reason for the disconnect in how infrastructure investments actually impacted employment was the skills gap: the difference between the credentials and experience of unemployed Americans and new labor market entrants, on the one hand, and the experience and credentials required for infrastructure projects on the other hand. The skills gap therefore makes the length of time between creating a job opening and filling that job of great concern.

The infrastructure jobs that would be created under the Biden-Harris plan would be available to people with a wide range of educational attainment levels, and the jobs would require varying levels of training. Forty percent of the infrastructure jobs that would be created in the Biden-Harris plan would require more than six months of training.[47] In general, the infrastructure jobs that require the highest level of educational attainment will also require the most training (Figure 2). But the other 60 percent of the jobs would require six months of training or less. In all likelihood, high schools, community colleges, and other postsecondary institutions would create short-term programs to train workers for these jobs.

[47] Includes both formal in-classroom training and informal on-the-job training separate and apart from educational attainment.

Figure 2. The longest training in infrastructure jobs is required of workers with a bachelor's degree or higher.



Source: Georgetown University Center on Education and the Workforce analysis of data from the Occupational Information Network (O*NET) 25.0 Database, 2020, and US Census Bureau, American Community Survey (ACS) microdata, 2019.
Note: Values may not sum to 100 percent due to rounding.

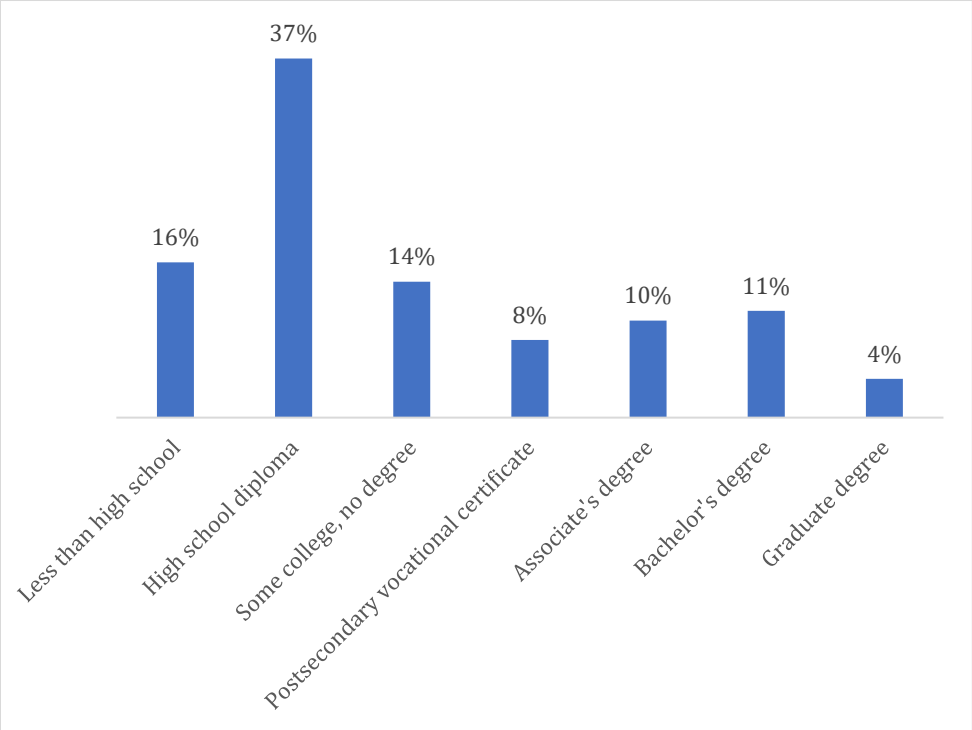
Infrastructure plan would temporarily invigorate the blue-collar economy

Long-term investments in infrastructure have the potential to revitalize, at least temporarily,[48] the blue-collar economy by creating jobs for welders, electricians, technicians, and truck drivers, among other occupations. This revival would be a marked shift in the recent trajectory of the workforce.[49]

[48] Carnevale, et al., *Good Jobs That Pay without a BA*, 2017.
[49] Blue-collar jobs in which high school-educated workers, especially men, could work for good pay have been in decline since the 1970s.

Biden's infrastructure proposal would create jobs at every education level, but the majority of infrastructure jobs (75 percent) will be for people with no more than a high school diploma and some non-degreed short-term training—those who have been harmed most by technology change and trade since the mid-1980s[50] (Figure 3). In addition, the infrastructure proposal would offer good jobs for many college-educated workers. The Biden-Harris proposal would create 1.5 million jobs for those with associate's degrees, 1.6 million jobs for people with bachelor's degrees, and 600,000 jobs for those with graduate degrees.

Figure 3. Most infrastructure jobs will require no more than a high school diploma or some college but no degree, but one-quarter of them will require an associate's degree or higher.



Source: Georgetown University Center on Education and the Workforce analysis of data from US Census Bureau, American Community Survey (ACS), 2019.
Note: Values may not sum to 100 percent due to rounding.

These jobs will consist of both those directly related to infrastructure—including jobs for tradesmen, construction workers, and material moving and transportation workers—as well as downstream jobs only somewhat related to infrastructure, such as in offices and retail services (Table 1).

[50]For a more careful review of these trends, see Carnevale and Rose, *The Undereducated American*, 2011, and Carnevale and Rose, *The Economy Goes to College,* 2015.

Table 1. More than half of 15 million infrastructure jobs will be in transportation and material moving occupations.

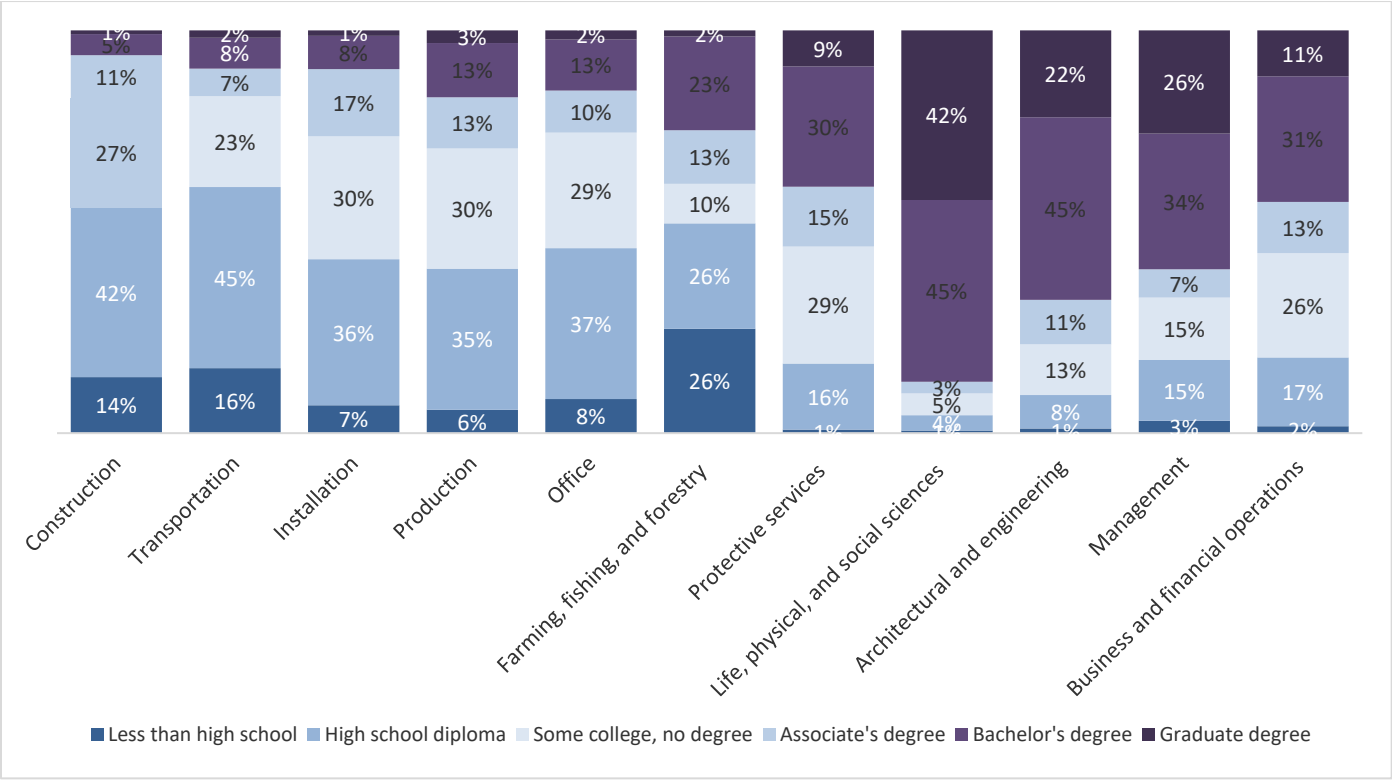
Occupations	Jobs
Transportation and material moving	8,891,000
Construction and extraction	1,624,000
Office and administrative support	1,243,000
Installation, maintenance, and repair	1,019,000
Architectural and engineering	950,000
Management	532,000
Production	300,000
Life, physical, and social science	229,000
Business and financial operations	150,000
Protective service	51,000
Farming, fishing, and forestry	12,000
Total	**~15 million**

Source: Georgetown University Center on Education and the Workforce forecast using data from US Census Bureau and Bureau of Labor Statistics, Current Population Survey (CPS); US Census Bureau, American Community Survey (ACS); US Bureau of Labor Statistics; and IHS Markit.
Note: Values may not sum to total due to rounding.

By occupation, infrastructure jobs are found mostly in transportation and material moving or construction.[51] Jobs in these occupations also largely call for workers with the lowest levels of educational attainment. For example, 73 percent of construction jobs go to workers with a high school diploma or less (Figure 4).

[51] We use a hybrid of occupations identified in Kane and Puentes (2015) and expand these to include occupations that are instrumental to building and maintaining the infrastructure needed to provide high-speed internet more broadly.

Figure 4. About half of managerial and office positions in infrastructure industries are generally available only to those with an associate's degree or higher, but construction jobs usually go to workers with a high school diploma or less.



Source: Georgetown University Center on Education and the Workforce analysis of data from US Census Bureau, American Community Survey (ACS), 2015–2019.
Note: The figure shows education distribution only for infrastructure jobs within each occupation group. Values may not sum to 100 percent due to rounding.

However, many middle-skills opportunities exist in office and administrative support as well as business and financial operations occupations. Infrastructure jobs that require associate's degrees are concentrated in engineering and protective services occupations. Jobs that require bachelor's degrees are concentrated in managerial occupations. Jobs at the graduate level are concentrated in business and financial operations occupations.

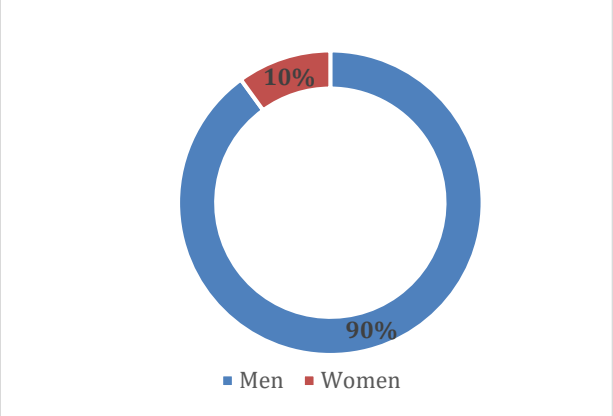
Infrastructure stimulus won't recreate jobs that were lost in the recession

While a large investment in infrastructure projects would invigorate the blue-collar workforce, it would not retrieve the 22 million jobs initially lost in the coronavirus recession or directly impact many of the same people who lost jobs. That is because an infrastructure spending plan would primarily benefit men.

The brunt of the job losses in this pandemic have been disproportionately shouldered by women in service industries. Unlike the "mancession" of 2008, when job losses in construction were precipitated by the housing market and financial collapse, the coronavirus recession first shuttered hotels, restaurants, and retail stores, where more women were employed. The vast majority of jobs created by an infrastructure program

would be in male-dominated career fields, with the construction and transportation industries leading the way. Some researchers suggest that any infrastructure program should prioritize jobs for people and communities most in need.[52] An immediate challenge, therefore, in the interest of gender parity, would be to entice young women into some of the well-paying jobs that will be available. That will take a lot of doing: 90 percent of infrastructure jobs are currently held by men (Figure 5).

Figure 5. The vast majority of infrastructure jobs are filled by men.

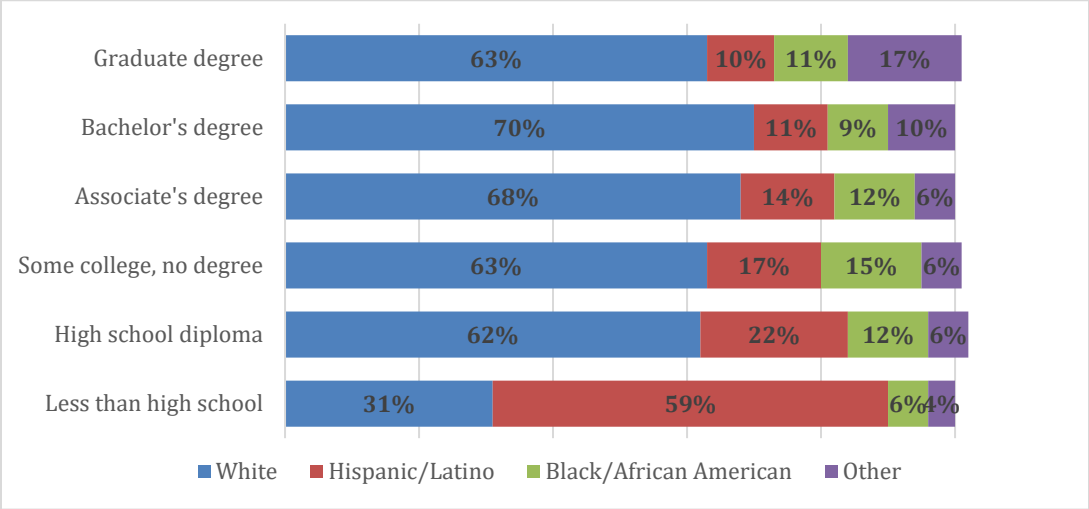


Source: Georgetown University Center on Education and the Workforce analysis of data from US Census Bureau, American Community Survey (ACS), 2019.

The infrastructure plan would also disproportionately benefit Latino and Black workers. They are being left behind in many cases in the modern economy, primarily because of lower levels of educational attainment. Latino workers employed in the infrastructure sector disproportionately have not finished high school (Figure 6). Black workers are more likely than Latino workers to have finished high school, but they are also less likely to have a college degree. The infrastructure plan could employ these workers in the short term, but in the long term, they cannot qualify for a good infrastructure job in a senior/managerial position unless they increase their educational attainment.

[52] McCarthy et al., "Building Back Better," 2021.

Figure 6. Low-education infrastructure jobs have disproportionate shares of Latino workers.

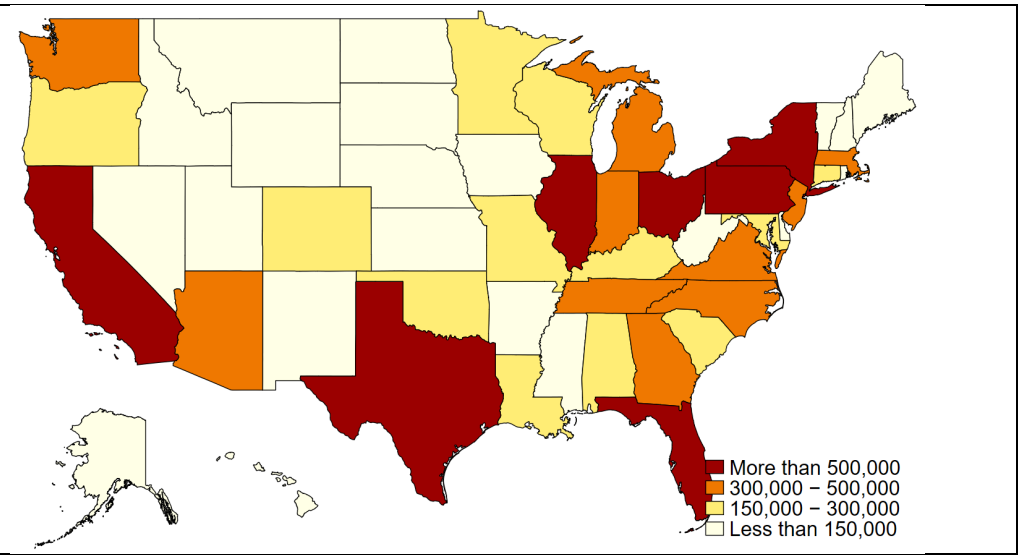


Source: Georgetown University Center on Education and the Workforce analysis of data from US Census Bureau, American Community Survey (ACS), 2015–2019.
Note: Values may not sum to 100 percent due to rounding.

By region, the Southeast stands to benefit the most from an investment in infrastructure jobs, commanding a full 22 percent of new jobs based on a size/unemployment rate weighted average (Figure 7). The Pacific Coastal region is next with 21 percent of infrastructure jobs. New England and the Rocky Mountain states would get the smallest shares of new infrastucture jobs.[53]

Figure 7. The largest shares of 15 million new infrastructure jobs would be in the Southeast and Pacific Coastal states.

Southeast	3,369,000
Pacific Coastal	3,182,000
Midwest	2,845,000
Mid-Atlantic	2,353,000
Southwest	1,896,000
New England	713,000
The Rocky Mountains	642,000
Total	15 million



[53] See Appendices C and D for regional definitions and a breakdown of infrastructure jobs by state.

Source: Georgetown University Center on Education and the Workforce forecast using data from US Census Bureau and Bureau of Labor Statistics, Current Population Survey (CPS); US Census Bureau, American Community Survey (ACS); US Bureau of Labor Statistics; and IHS Markit.

Preparing for the short-term training needed for infrastructure jobs

An infrastructure program could be slowed because of short-term skill shortages. The growth of the US labor force has slowed dramatically with baby boomer retirements and a flattening of women's labor-force participation rates after decades of growth.[54] The Bureau of Labor Statistics projects the civilian labor force to grow by only 0.4 percent point per year through 2029, compared with the average annual growth of 0.5 percent from 2009 to 2019. [55]

Ensuring that workers are indeed prepared to fill the newly created infrastructure jobs to come will be a challenge because many of the workers who will be attracted to the jobs have lower levels of educational attainment.[56] Two-thirds of the infrastructure jobs would require six months of training or less. However, short-term training is largely unfunded by the federal and state governments. To the extent that it exists, short-term training is generally included as noncredit training provided by community colleges and paid for by employers. There will likely be no natural transition to these jobs for currently short- and long-term unemployed workers.[57] This is because many of these jobs require at least a few months of training to operate the machinery or to be able to engage in the specific tasks required on the job.

A larger number of prospective workers have many of the necessary skills for infrastructure work, but no credentials to prove it. Though 16 million non-degreed Americans have the skills for high-wage work, 11 million are employed in low- to middle-wage work.[58] There is strong evidence that many workers are qualified, or nearly so, but there is no public capability to assess and train prospective workers who could fit into these jobs.

Some of the skills gap could be filled by incentives to delay retirement among skilled and experienced workers. The best estimate suggests that 2.7 million infrastructure workers will retire over a new decade.[59] These retirements may result in additional job openings. On the other hand, if the promise of "prevailing wages" in infrastructure jobs raises wages, many infrastructure workers who have left the labor force might be enticed to

[54] Since February 2020, more than 2.3 million women have left the labor force, reducing the labor force participation rate for women to 57 percent, its lowest point since 1988. Ewing-Nelson, "Another 275,000 Women Left the Labor Force in January," 2021.
[55] Dubina et al., Projections overview and highlights, 2019–2029, 2020.
[56] The Great Recession of 2007-09 devastated America's least-educated workers. During the recession, 5.6 million workers with a high school education or less lost their jobs, and collectively they have gained only 80,000 net jobs since the recovery began in 2010. Fifty-two percent of all unemployed workers in this country have a high school education or less.
[57] The number of long-term unemployed (those jobless for 27 weeks or more) was 4.02 million in January 2021 and accounted for 39.5 percent of the unemployed. The number of unemployed workers held steady at 10.1 million.
[58] Blair et al., "Searching for STARs," 2020.
[59] Kane and Puentes, "Expanding Opportunity through Infrastructure Jobs," 2015.

reenter if conditions are favorable.[60] President Biden has signaled his intent to issue an executive order that would raise the minimum wage for federal employees and employees of federal contractors to $15 an hour.[61]

The country will require a ramping up of training programs. Short-term occupational training covers a wide array of programs: from single-day workshops and seminars to multi-year diploma and certificate programs. The postsecondary education system is a major contributor: in the last decade, it has awarded more than 1 million sub-baccalaureate certificates per year and provided millions more Americans with noncredit training.[62] Between 2014 and 2018, the 1,050 members of the American Association of Community Colleges have had about 5 million students enrolled in noncredit courses (around 47 percent of their enrollment in fall 2018).[63]

The training programs may require a greater investment in financial aid. Federal grants and loans are an important pathway for adults to get short term training. Among certificate-seeking students in 2015–16, 45 percent had a Pell Grant and 34 percent had taken out a loan.[64] However, the Higher Education Act limits federal grants and loans to credit programs that provide at least 600 hours (or 15 weeks) of instruction. There does not appear to be compelling evidence for this cutoff, as outcomes do not seem significantly different for students who do not meet this threshold. In fact, a considerable number of adults would stand to benefit if these restrictions were loosened: most certificates held by adults (25–44 years old) are noncredit (56 percent), and nearly half of adults (25–44 years old) hold a certificate that required less than 480 hours of instruction.[65] Expanding Pell Grant eligibility to short-term occupational training could lead to significant increases in enrollment and completion. An Institute of Educational Sciences pilot study found that such an expansion increased enrollment by 15 percentage points, and program completion by 9 percentage points.[66]

In 2019, Sens. Tim Kaine, D-Virginia, and Rob Portman, R-Ohio, cosponsored the Jumpstart Our Businesses by Supporting Students (JOBS) Act, which would have expanded eligibility to use Pell Grants to programs that provide at least 150 hours of instruction over a period of at least eight weeks and would open up funding for noncredit programs that met agreed-upon standards.[67]

Aid for adults seeking noncredit training is sparse both in and outside postsecondary institutions. Neither Title IV of the Higher Education Act nor the Carl D. Perkins Career and Technical Education Act provides funds for noncredit workforce development

[60] Peter Edelman's work at the Georgetown Center on Poverty and Inequality explains why and how we can raise wages for American's low-wage families. See Leadership Conference Education Fund and Georgetown Center on Poverty and Inequality, *Bare Minimum,* 2018.
[61] White House, "Fact Sheet," January 22, 2021.
[62] Carnevale et al., *The Overlooked Value of Certificates and Associate's Degrees*, 2020.
[63] Samuels et al., "Blending Credit & Non-Credit Courses," 2019.
[64] Baum et al., Should the Federal Government Fund Short-term Certificate Programs?, 2020.
[65] Baum et al., Should the Federal Government Fund Short-term Certificate Programs?, 2020.
[66] Thomas, et al., "The Effects of Expanding Pell Grant Eligibility for Short Occupational Training Programs," 2020.
[67] Kaine, "Kaine, Portman Introduce Bipartisan Jobs Act," 2019.

training. Federal funds are available through Title I of the Workforce Innovation and Opportunity Act (WIOA).[68]

While expanding Pell Grant eligibility would help meet short-term training needs for the new infrastructure jobs, 4.9 million of the jobs will require less than one month of training, far less than even the 150-hour threshold of the Kaine-Portman proposal. There is a clear need to reduce all of the financial barriers to accessing short-term training opportunities, particularly for underrepresented populations that depend on aid for postsecondary opportunities.[69] Expanding Pell Grant eligibility to cover this type of training seems politically unlikely because of the perceived difficulty of assessing the quality of the programs. Expanding the WIOA framework would likely be more practical—but it would require a significant expansion of scope.

Infrastructure stimulus could help revive apprenticeship programs

Apprenticeships have the potential to be one of the primary ways to train workers for infrastructure jobs. Apprenticeships are work-based learning programs that combine classroom instruction and on-the-job training. They provide participants with an opportunity to learn the skills they need without paying tuition and while receiving a training wage. Apprentices who complete a registered apprenticeship program earn an industry-recognized credential from the US Department of Labor or a state apprenticeship agency. Apprenticeships offer employers a way to develop the skilled workforce they need, while potentially reducing hiring and turnover costs.[70]

Apprenticeships are particularly relevant for infrastructure jobs because many apprentices receive training in occupations that lead to these jobs. In the first three quarters of 2020, government databases recorded 84,000 active apprentices receiving training in infrastructure-related occupations, accounting for 42 percent of all active apprentices on which the Department of Labor collects data.[71] Some of the top occupations in which apprentices get training are infrastructure-related occupations, including: electricians, truck drivers, plumbers, pipe fitters, and operating engineers. And some of the top industries for apprenticeships are also some of the largest sources of infrastructure jobs, including: construction, transportation and warehousing, and utilities.

[68] For fiscal year 2019, $2.8 billion was authorized under WIOA: $845 million for adult programs, $1.04 billion for displaced workers programs, and $663 million for the American Job Centers. But only a small part of these funds went toward training services (the rest went toward career services). From April 2018 to April 2019, the WIOA adult programs and displaced workers programs provided training for 226,300 adults with $488 million, or a little more than $2,100 per person served.

[69] Baum et al., "Should the Federal Government Fund Short-Term Postsecondary Certificate Programs?" 2020.

[70] Employers can also benefit from apprentices' contributions at a reduced wage during the apprenticeship period, higher post-apprenticeship productivity relative to other employees with similar tenure, the pipeline of skilled employees, employees whose characteristics better match employer needs and company culture, and the reduced need for supervision after the apprenticeship period.

[71] Georgetown University Center on Education and the Workforce analysis of data from the US Department of Labor, Registered Apprenticeship Partners Information Database System (RAPIDS), 2020. This is only a fraction of all active apprentices as the government databases keep information for a total of 39 states and territories.

While active apprentices still represent only a tiny fraction of the workforce (0.4 percent), apprenticeships have been growing rapidly in recent years, with a 128 percent increase in new apprentices who started their programs over the past decade. By one estimate, about the same number of American workers have participated in unregistered apprenticeships as registered ones, giving us a total of approximately 400,000 registered and unregistered apprentices.[72]

Since bottoming out in 2014 at around 19,000, the number of active programs for apprentices has increased to almost 25,000.[73] Registered apprenticeship programs may therefore have the capacity to meet the training needs for new infrastructure jobs under the Biden-Harris plan, especially if they coordinate with the broader sub-baccalaureate training system to meet the needs of infrastructure jobs that will not require a college degree.

However, in order to suitably meet the country's training needs for infrastructure jobs in the post-pandemic recovery, apprenticeships will have to improve their gender inclusiveness. Currently only 9 percent of all active apprentices for which the Department of Labor collects data are women.[74] Since women have been disproportionately hurt in the COVID-19 economic downturn, any jobs and training recovery initiatives will need to ensure that women have commensurate representation among beneficiaries.

[72] Jacoby and Lerman, Industry-Driven Apprenticeship, 2019.
[73] US Employment and Training Administration, "Registered Apprenticeship National Results Fiscal Year 2019," 2019.
[74] Georgetown University Center on Education and the Workforce analysis of data from the Employment and Training Administration, "Registered Apprenticeship National Results Fiscal Year 2019," 2019.

Conclusion

The Biden-Harris administration's proposed $1.5 trillion infrastructure program would create or save 15 million jobs over the next 10 years, helping reinvigorate the US economy as it recovers from the coronavirus pandemic. Indeed, an infrastructure program could put the United States back on its pre-recession job growth path. Infrastructure spending would also improve roads and bridges, ensure reliable access to broadband for millions more Americans, spur consumption, and trigger multiplier effects that would likely create even more jobs down the road.

The stimulus would temporarily revitalize the blue-collar economy, but it would not replace many of the jobs that were permanently lost during the COVID-19 recession. Women in service industries disproportionately lost jobs, while the bulk of the jobs that would be created by an infrastructure program would be in male-dominated fields.

More than half of workers employed in new infrastructure jobs would need some form of short-term training, and the remainder would need six months to two years of training. Expanding the availability of federal funds for training programs would be necessary to prepare workers to fill these newly created jobs.

Politicians have lamented the state of the country's infrastructure for years, but there has not been sufficient political will to move forward with various proposals to revitalize crumbling roads and rusting bridges. The economic devastation caused by the coronavirus pandemic is a strong new impetus for President Biden and lawmakers on Capitol Hill to enact an infrastructure program.

Amid other urgent actions that the Biden-Harris administration is taking in its first few months, it seems clear that infrastructure is becoming a priority. It could be the largest step this administration could take toward restoring widespread job creation and prosperity to the American economy.

References

American Association of Community Colleges. *2016 Fact Sheet.* Washington, DC: American Association of Community Colleges, 2016.

American Association of Community Colleges. *2017 Fact Sheet.* Washington, DC: American Association of Community Colleges, 2017.

American Association of Community Colleges. *2018 Fact Sheet.* Washington, DC: American Association of Community Colleges, 2018.

American Association of Community Colleges. *2019 Fact Sheet.* Washington, DC: American Association of Community Colleges, 2019.

Anderson, Monica, Andrew Perrin, Jingjing Jiang, and Madhumitha Kumar. "10% of Americans Don't Use the Internet. Who Are They?" Pew Research Center, April 22, 2019.

Autor, David, and Anna Salomons. "Is Automation Labor-Displacing? Productivity Growth, Employment, and the Labor Share." *Brookings Papers on Economic Activity* 2018, no. 1 (Spring 2018), 1–87.

Autor, David, and Elisabeth Reynolds. "The Nature of Work after the Covid Crisis: Too Few Low-Wage Jobs." Essay 2020–14, The Hamilton Project, Brookings Institution, Washington, DC, July 2020.

Baum, Sandy, Harry Holzer, and Grace Luetmer. "Should the Federal Government Fund Short-Term Postsecondary Certificate Programs?" Washington, DC: Urban Institute, 2020.

Bivens, Josh. "The Potential Macroeconomic Benefits from Increasing Infrastructure Investment." Washington, DC: Economic Policy Institute. July 18, 2017.

Blair, Peter Q., Tomas G. Castagnino, Erica L. Groshen, Papia Debroy, Byron Auguste, Shad Ahmed, Fernando Garcia Diaz, and Cristian Bonavida. "Searching for STARs: Work Experience as a Job Market Signal for Workers Without Bachelor's Degrees." NBER Working Paper 26844, National Bureau of Economic Research, Cambridge, MA, March 2020.

Board of Governors of the Federal Reserve System. "Federal Reserve Issues FOMC Statement" (press release). Washington, DC: Board of Governors of the Federal Reserve System, March 15, 2020.

Bovino, Beth Ann. "U.S. Infrastructure Investment: A Chance to Reap More Than We Sow." Standard and Poor's Rating Services, McGraw Hill Financial, New York, NY, May 5, 2014.

Business Roundtable. "Road to Growth: The Case for Investing in America's Transportation Infrastructure." September 2015.

Carnevale, Anthony P., Tanya I. Garcia, Neil Ridley and Michael C. Quinn. *The Overlooked Value of Certificates and Associate's Degrees: What Students Need to Know Before They Go to College*. Washington, DC: Georgetown University Center on Education and the Workforce, 2020.

Carnevale, Anthony P. and Artem Gulish. "Women Bear the Brunt of the COVID-19 Recession." Blog post on Medium, June 24, 2020.

Carnevale, Anthony P., Tamara Jayasundera, and Andrew R. Hansen. *Career and Technical Education: Five Ways That Pay Along the Way to the BA*. Washington, DC: Georgetown University Center on Education and the Workforce, 2012.

Carnevale, Anthony P., Neil Ridley, Ban Cheah, Jeff Strohl and Kathryn Peltier-Campbell. *Upskilling and Downsizing in American Manufacturing*. Washington, DC: Georgetown University Center on Education and the Workforce, 2019.
Carnevale, Anthony P., and Stephen J. Rose. *The Economy Goes to College: The Hidden Promise of Higher Education in the Post-Industrial Service Economy*. Washington, DC: Georgetown University Center on Education and the Workforce, 2015.
Carnevale, Anthony P., and Stephen J. Rose. *The Undereducated American*. Washington, DC: Georgetown University Center on Education and the Workforce, 2011.
Carnevale, Anthony P., and Nicole Smith. *Trillion Dollar Infrastructure Proposals Could Create Millions of Jobs: Will the New Jobs Lead to Sustainable Careers?* Washington, DC: Georgetown University Center on Education and the Workforce, 2017.
Carnevale, Anthony P., Jeff Strohl, Ban Cheah, and Neil Ridley. *Good Jobs That Pay without a BA.* Washington, DC: Georgetown University Center on Education and the Workforce, 2017.
CBS News. "Trump Proposes Easing Up Regulations for Major Infrastructure Projects." CBS News, January 9, 2020.
CBS News. "Trump Rolling Back Major Environmental Law to Speed Big Infrastructure Projects." July 15, 2020.
Cohen, Arianne. "Why Finding Workers Is Getting Harder for U.S. Homebuilders." Bloomberg News. January 15, 2021.
Council of Economic Advisers, Executive Office of the President. "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," May 2009.
Congressional Budget Office. "An Overview of the Economic Outlook: 2021 to 2031." February 2021.
Congressional Research Service. "Transportation Infrastructure Investment as Economic Stimulus: Lessons from the American Recovery and Reinvestment Act of 2009. May 5, 2020." Washington, DC: Congressional Research Service.
Dubina, Kevin S., Janie-Lynn Kim, Emily Rolen, and Michael J. Rieley, "Projections overview and highlights, 2019–29," Monthly Labor Review, US Bureau of Labor Statistics, September 2020.
Ewing-Nelson, Claire. "Another 275,000 Women Left the Labor Force in January." National Women's Law Center, February 2021.
Federal Communications Commission. "Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion" (2019 Broadband Deployment Report). GN Docket No. 18–238. Washington, DC: Federal Communications Commission, 2019.
Georgetown University Center on Education and the Workforce. "Tracking COVID-19 Unemployment and Job Losses." [Interactive database]
Helper, Susan, Ryan Noonan, Jessica R. Nicholson, and David Langdon. "The Benefits and Costs of Apprenticeships: A Business Perspective." Washington, DC: US Department of Commerce and Case Western Reserve University, 2016.
IHS Markit. Forecast Tables. 2021.
Jacoby, Tamar, and Robert I. Lerman. "Industry-Driven Apprenticeship: What Works, What's Needed." Opportunity America, February 2019.
Kahn, Lisa B. "The Long-Term Labor Market Consequences of Graduating From College in a Bad Economy." *Labour Economics* 17, no. 2 (April 2010), 303–16.

Kaine, Senator Tim. "Kaine, Portman Introduce Bipartisan Jobs Act to Help Workers Access Training for In-Demand Career Fields," March 14, 2019.
Kane, Joseph W., and Adie Tomer. "Shifting into an Era of Repair: US Infrastructure Spending Trends." Washington, DC: Brookings Institution, May 10, 2019.
Kane, Joseph W., and Robert Puentes. "Expanding Opportunity through Infrastructure Jobs." Washington, DC: Brookings Institution Metropolitan Policy Program. May 2015.
Kaplan, Thomas. "What's in the Stimulus Bill? A Guide to Where the $1.9 Trillion Is Going." *New York Times*, March 7, 2021.
Karni, Annie, and Jim Tankersley. "After Stimulus, Biden to Tackle Another Politically Tricky Issue: Infrastructure." *New York Times*, March 1, 2021.
Laris, Michael. "House passes $1.5 trillion infrastructure bill, but McConnell calls it 'pointless political theater.'" *Washington Post*, July 1, 2020.
Leadership Conference Education Fund and Georgetown Center on Poverty and Inequality. *Bare Minimum: Why We Need to Raise Wages for America's Lowest-Paid Families.* Washington, DC: The Leadership Conference Education Fund and Georgetown Center on Poverty and Inequality, Economic Security and Opportunity Initiative, 2018.
McCarthy, Mary Alice, Carl Van Horn, and Michael Prebil. "Building Back Better: A National Jobs Strategy." Washington, DC: New America. February 18, 2021.
Miller, Jenesse, "COVID-19 Reduced U.S. Life Expectancy, Especially among Black and Latino Populations." Princeton University, January 15, 2021.
Miller, Rich. "Yellen, Summers Spar About Overheating Risk in Stimulus Plan." Bloomberg News, February 8, 2021.
Moody's Analytics. "The Macroeconomic Consequences: Trump vs. Biden." September 23, 2020.
New York Times. "Desperate Times, Creative Measures: Economic Growth Is the Primary Corrective for Unemployment, but Targeted Aid Can Help People Find Jobs More Quickly" (editorial). February 25, 2021.
Parker, Kim, Ruth Igielnik, and Rakesh Kochhar. "Unemployed Americans Are Feeling the Emotional Strain of Job Loss; Most Have Considered Changing Occupations." Pew Research Center. February 10, 2021.
Pickert, Reade, Yue Qiu and Alexander McIntyre. "U.S. Recession Model at 100% Confirms Downturn Is Already Here." Bloomberg News, October 14, 2019.

Rampell, Catherine. "Tough Economies Usually Push People into More Education. It's Not Happening This Time." *Washington Post*. February 11, 2021.
"Road to Growth: The Case for Investing in America's Transportation Infrastructure." Washington, DC: Business Roundtable, September 2015.
Ryan, Josiah. "McConnell: Jobless Not Amused by Obama's 'Shovel-Ready Joke." *The Hill*, June 15, 2011.
Samuels, Keisha, M. Todd Estes, Heather Eckman, Kelly Gillerlain, Shanda Jenkins, Wendy Miller-Edwards, Olivia Reinauer, and Nicole Walker. "Blending Credit & Non-Credit Courses: Best Practices, Opportunities, Barriers." *Inquiry: The Journal of the Virginia Community Colleges* 22, no. 1, (2019).
Scott, Robert E., and Zane Mokhiber. *The China Toll Deepens.* Washington, DC: Economic Policy Institute, October 23, 2018.
Senate Democrats. "A Blueprint to Rebuild America's Infrastructure: Creating Over 15 Million New Jobs," January 24, 2017.

Stein, Jeff, and Seung Min Kim. (March 31, 2020). "Trump Pushes $2 Trillion Infrastructure Package in Next Coronavirus Bill, Saying It Must Be 'VERY BIG & BOLD.'" *Washington Post*, March 31, 2020.

Summers, Lawrence H. "The Biden Stimulus Is Admirably Ambitious. But It Brings Some Big Risks, Too." *Washington Post*, February 4, 2021.

Tankersley, Jim, and Michael Tackett. "Trump Proposes a Record $4.75 Trillion Budget." *New York Times*, March 11, 2019.

Tate, Patricia. "The Employment Outlook for Occupations Tasked With Building America's Infrastructure." *Beyond the Numbers: Employment and Unemployment* 7, no. 17, (October 2018). Washington, DC: US Bureau of Labor Statistics, 2018.

Thomas, Jaime, Naihobe Gonzalez, Nora Paxton, Andrew Wiegand, and Leela Hebbar. "The Effects of Expanding Pell Grant Eligibility for Short Occupational Training Programs: Results from the Experimental Sites Initiative" (NCEE 2021–001). Washington, DC: US Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, 2020.

Tomer, Adie, Joseph Kane, and Lara Fishbane. "An Infrastructure Stimulus Plan for the Covid-19 Recession." Washington, DC: Brookings Institution, Metropolitan Policy Program, July 2020.

US Census Bureau. American Community Survey (ACS: 2015–2019: one-year person level microdata files.

US Census Bureau and Bureau of Labor Statistics. Current Population Survey (CPS) March Supplement (Annual Economic and Social Supplement) microdata files. Washington, DC: US Census Bureau and Bureau of Labor Statistics,

US Department of Education. Institute of Education Sciences, National Center for Education Statistics. Adult Training and Education Survey (ATES) of the National Household Education Surveys Program. Washington, DC: Department of Education, 2016.

US Department of Labor. Bureau of Labor Statistics. "Data on Certifications and Licenses." Washington, DC: Department of Labor, 2019.

US Department of Labor. Bureau of Labor Statistics. "Employment Status of the Civilian Population by Sex and Age," November 2020. Washington, DC: US Department of Labor, 2020.

US Department of Labor. Employment and Training Administration. "Registered Apprenticeship National Results Fiscal Year 2019: 10/01/2018 to 9/30/2019." Washington, DC: US Department of Labor, 2019.

US Department of Labor. Employment and Training Administration. Occupational Information Network (O*NET) 25.0. Washington, DC: Department of Labor, 2020.

US Department of Labor. Employment and Training Administration. "PY 2018 WIOA National Performance Summary." Washington, DC: Department of Labor, 2020.

US Department of Labor. Registered Apprenticeship Partners Information Database System (RAPIDS) data. Washington, DC: US Department of Labor, 2020.

US Department of Transportation. "US Secretary of Transportation Elaine L. Chao Announces $906 Million Investment to Revitalize America's Infrastructure." Washington, DC: US Department of Transportation, June 2020.

White House. "Fact Sheet: President Biden's New Executive Actions Deliver Economic Relief for American Families and Businesses Amid the COVID-19 Crises," January 22, 2021.

Appendix A: In-Demand Certificates and Certifications in Infrastructure Sectors

The following tables[75] present data on the most in-demand certifications and certificates in various fields within the "Infrastructure Sector" using online jobs postings for 2019. We used data from Chmura's JobsEQ tallies of online job postings to determine the demand for credentials in the infrastructure sector. The counts shown are all ads that were active at any point in 2019.

Online job ads are not necessarily reflective of all opportunities in the sector—and have a bias towards baccalaureate degrees. However, they do provide a good indicator of where a vast majority of the larger business enterprises stand with respect to job ads, the credentials that were required, and the salaries that were offered.

Credential information is only recorded when it is explicitly mentioned in the ad. For example, some skills or certifications arguably may be implied by the position itself; but in such cases, to maintain a strict data set, no implied credentials are assumed. Table A gives detailed information on the number of job ads for positions in infrastructure-related fields, broken down by a number of characteristics.

Table A. The Most In-Demand Certificates and Certifications across Infrastructure Sectors

Engineering

Top 10 Certification in the United States

Certification name	Total ads
Security Clearance	1,861
National Council of Architectural Registration Boards (NCARB) Certification	380
LEED (Leadership in Energy and Environmental Design) Accredited Professional (not specified)	319
Commercial Driver's License (CDL)	270
Certified Survey Technician Level I (CST)	258
Professional Traffic Operations Engineer (PTOE)	207
NICET (National Institute for Certification in Engineering Technologies) Level 1	190
Certification in Cardiopulmonary Resuscitation (CPR)	162
First Aid Certification	161
Concrete Strength Testing Technician (CSTT)	160

[75] Note: Data are subject to revision. Do not use the volume of data for historical comparisons until such time that an adjusted historical series of these data are provided. Exported on: Thursday, April 18, 2019.

Top 10 Hard Skills in the United States	
Skill name	**Total ads**
Autodesk AutoCAD	60,104
Computer Aided Design Software (CAD Software)	35,969
Microsoft Office	26,948
Microsoft Excel	23,807
Autodesk Revit	21,454
Mathematics	11,344
Microsoft Word	11,047
Dassault Systèmes SolidWorks Software	8,635
Microsoft Outlook	7,512
Computer Aided Design and Drafting Software (CADD)	6,772

Top 10 Education Programs in the United States	
Program name	**Total ads**
Civil Engineering	19,598
Engineering	14,132
Architecture	8,026
Mechanical Engineering	3,769
Science	2,766
Structural Engineering	2,640
Electronics	2,225
Technical	2,132
Engineering Technology	2,057
Drafting	1,964

Source: Chmura's JobsEQ; online job postings for 2019.

Construction-related

Top 10 Certifications in the United States	
Certification name	**Total ads**
Commercial Driver's License (CDL)	11,292
OSHA 10	6,162
Class A Commercial Driver's License (CDL-A)	5,521
OSHA 30	2,782
Certification in Cardiopulmonary Resuscitation (CPR)	2,726
First Aid Certification	2,713
Project Management Professional (PMP)	2,213
National Center for Construction Education & Research Certification (NCCER)	1,978
Class B Commercial Driver's License (CDL-B)	1,601
Security Clearance	1,342

Top 10 Hard Skills in the United States	
Skill name	**Total ads**
Power tools	62,727
Plumbing	61,224
Ability to lift 51–100 lbs.	45,881
Microsoft Excel	44,657
Ability to lift 41–50 lbs.	41,588
Microsoft Office	38,769
Microsoft Outlook	20,099
Microsoft Word	19,177
Mathematics	19,054
Using ladders	18,948

Top 10 Education Programs in the United States	
Program name	**Total ads**
Construction management	26,734
Engineering	22,052
Architecture	8,202
Civil engineering	7,418
Construction	3,830
Business	3,285
Mechanical engineering	1,856
Technical	1,708
Electrical technology	1,617
Business administration	1,595

Source: Chmura's JobsEQ; online job postings for 2019.

Construction – Apprenticeship only

Top 10 Certifications in the United States, apprentice-related jobs	
Certification name	**Total ads**
Commercial Driver's License (CDL)	421
OSHA 10	394
National Center for Construction Education & Research Certification (NCCER)	107
Class A Commercial Driver's License (CDL-A)	102
First Aid Certification	49
Certification in Cardiopulmonary Resuscitation (CPR)	38
Security Clearance	27
Class B Commercial Driver's License (CDL-B)	25
OSHA 30	25
DOT Medical Card	18

Top 10 Hard Skills in the United States, Apprentice-Related Jobs	
Skill name	**Total ads**
Power tools	8,897
Plumbing	7,869
Ability to lift 51–100 lbs.	3,146
Ability to lift 41–50 lbs.	2,678
Tape measures	1,912
Using ladders	1,721
HVAC systems	1,548
Drill presses	1,428
Mechanical	1,404
Forklifts	982

Source: Chmura's JobsEQ; online job postings for 2019.

Transportation

Top 10 Certifications in the United States	
Certification name	**Total ads**
Class A Commercial Driver's License (CDL-A)	257,905
Commercial Driver's License (CDL)	111,957
HAZMAT	60,755
Class B Commercial Driver's License (CDL-B)	17,003
DOT Medical Card	7,240
Certified Flight Instructor (CFI)	6,150
First Aid Certification	4,916
Certification in Cardiopulmonary Resuscitation (CPR)	4,867
Class C Commercial Driver's License (CDL-C)	944
Certified Driver Trainer (CDT)	687

Top 10 Hard Skills in the United States	
Skill name	**Total ads**
Tractor-trailer trucks	270,800
Ability to lift 51–100 lbs.	128,626
Tankers	71,238
Ability to lift 41–50 lbs.	64,990
Forklifts	49,064
Google	31,303
Ability to lift 31–40 lbs.	30,987
English	26,082
Cash handling (cashier)	24,120
Hand trucks	22,297

Top 10 Education Programs in the United States	
Program name	**Total ads**
Business	3,319
Logistics	1,640
Business management	913
Supply chain management	885
Engineering	868
Business administration	820
Supply chain	442
Management	430
Transportation	342
Operations management	308

Source: Chmura's JobsEQ; online job postings for 2019.

All others

Top 10 Certifications in the United States	
Certification name	**Total ads**
EPA Section 608 Certification (EPA 608)	4,303
Commercial Driver's License (CDL)	3,290
EPA Universal Certification	2,124
OSHA 10	1,632
Security Clearance	1,570
Certification in Cardiopulmonary Resuscitation (CPR)	1,569
First Aid Certification	1,419
Class A Commercial Driver's License (CDL-A)	1,377
Light Commercial Refrigeration Certification (NATE Certified)	1,208
HAZMAT	614

Top 10 Hard Skills in the United States	
Skill name	**Total ads**
HVAC systems	66,733
Ability to lift 51–100 lbs.	63,530
Inventory management	28,586
Ability to lift 41–50 lbs.	22,385
Computer networking	21,828
Power tools	19,684
Microsoft Office	17,297
Microsoft Excel	16,444
Plumbing	15,704
Telecommunications	14,050

Top 10 Education Programs in the United States	
Program name	**Total ads**
Engineering	1,893
Business	1,516
Electronics	1,371
Technical	1,176
Mechanical engineering	782
Electrical engineering	599
Aviation	551
Science	450
HVAC	412
Logistics	395

Source: Chmura's JobsEQ; online job postings for 2019.

Appendix B: Occupational Distribution of 15 Million Infrastructure Jobs That Will Be Created and/or Saved over 10 Years

Management Occupations			
1	11-3050	Industrial Production Managers	168,010
2	11-3070	Transportation, Storage, and Distribution Managers	119,560
3	11-9020	Construction Managers	66,230
4	11-9040	Architectural and Engineering Managers	177,780
Business and Financial Operations Occupations			
5	13-1080	Logisticians	149,740
Architectural and Engineering Occupations			
6	17-1012	Landscape Architects	23,830
7	17-1022	Surveyors	43,080
8	17-2050	Civil Engineers	298,610
9	17-2080	Environmental Engineers	53,530
10	17-2112	Industrial Engineers	252,700
11	17-2120	Marine Engineers and Naval Architects	8,690
12	17-2160	Nuclear Engineers	19,340
13	17-3011	Architectural and Civil Drafters	99,050
14	17-3022	Civil Engineering Technicians	71,600
15	17-3025	Environmental Engineering Technicians	16,900
16	17-3026	Industrial Engineering Technicians	62,710
Life, Physical, and Social Science Occupations			
17	19-1031	Conservation Scientists	21,490
18	19-1032	Foresters	8,790
19	19-2043	Hydrologists	112,140
20	19-3050	Urban and Regional Planners	34,380
21	19-4040	Geological and Petroleum Technicians	15,040
22	19-4050	Nuclear Technicians	6,540
23	19-4093	Forest and Conservation Technicians	30,870
Protective Service Occupations			
24	33-3052	Transit and Railroad Police	5,470
25	33-9093	Transportation Security Screeners	45,320
Office and Administrative Support Occupations			
26	43-4180	Reservation and Transportation Ticket Agents and Travel Clerks	148,280
27	43-5010	Cargo and Freight Agents	89,380
28	43-5020	Couriers and Messengers	98,070
29	43-5032	Dispatchers, Except Police, Fire, and Ambulance	205,810

30	43-5040	Meter Readers, Utilities	31,550
31	43-5070	Shipping, Receiving and Traffic Clerks	669,890

Farming, Fishing, and Forestry Occupations			
32	45-4010	Forest and Conservation Workers	12,310
Construction and Extraction Occupations			
33	47-2071	Paving, Surfacing, and Tamping Equipment Operators	51,180
34	47-2072	Pile-Driver Operators	3,710
35	47-2110	Electricians	675,360
36	47-2151	Pipelayers	44,150
37	47-2152	Plumbers, Pipefitters, and Steamfitters	474,240
38	47-2230	Solar Photovoltaic Installers	11,430
39	47-3013	Helpers—Electricians	75,310
40	47-3015	Helpers—Pipelayers, Plumbers, Pipefitters, and Steamfitters	56,750
41	47-4040	Hazardous Materials Removal Workers	44,640
42	47-4050	Highway Maintenance Workers	141,730
43	47-4060	Rail-Track Laying and Maintenance Equipment Operators	15,820
44	47-4070	Septic Tank Servicers and Sewer Pipe Cleaners	29,210
Installation, Maintenance, and Repair Occupations			
45	49-2021	Radio, Cellular, and Tower Equipment Installers and Repairers	14,950
46	49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	227,990
47	49-2091	Avionics Technicians	17,480
48	49-2093	Electrical and Electronics Installers and Repairers, Transportation Equipment	15,340
49	49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	22,470
50	49-3010	Aircraft Mechanics and Service Technicians	130,500
51	49-3030	Bus and Truck Mechanics and Diesel Engine Specialists	271,750
52	49-3043	Rail Car Repairers	24,710
53	49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	45,320
54	49-9051	Electrical Power-Line Installers and Repairers	122,780
55	49-9052	Telecommunications Line Installers and Repairers	103,440
56	49-9080	Wind Turbine Service Technicians	8,400
57	49-9092	Commercial Divers	4,200

58	49-9097	Signal and Track Switch Repairers	9,770

Production Occupations			
59	51-8011	Nuclear Power Reactor Operators	6,640
60	51-8012	Power Distributors and Dispatchers	11,040
61	51-8013	Power Plant Operators	33,500
62	51-8020	Stationary Engineers and Boiler Operators	34,290
63	51-8030	Water and Wastewater Treatment Plant and System Operators	113,600
64	51-8091	Chemical Plant and System Operators	31,650
65	51-8092	Gas Plant Operators	16,310
66	51-8093	Petroleum Pump System Operators, Refinery Operators, and Gaugers	40,540
67	51-8099	Plant and System Operators, All Other	12,110
Transportation and Material Moving Occupations			
68	53-1010	Aircraft Cargo Handling Supervisors	7,520
69	53-1021	First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand	187,060
70	53-1031	First-Line Supervisors of Transportation and Material-Moving Machine and Vehicle Operators	206,400
71	53-2010	Airline Pilots, Copilots, and Flight Engineers	84,590
72	53-2012	Commercial Pilots	42,000
73	53-2021	Air Traffic Controllers	24,520
74	53-2022	Airfield Operations Specialists	9,080
75	53-2030	Flight Attendants	114,190
76	53-3021	Bus Drivers, Transit and Intercity	176,220
77	53-3022	Bus Drivers, School or Special Client	499,730
78	53-3032	Heavy and Tractor-Trailer Truck Drivers	1,909,460
79	53-3033	Light Truck or Delivery Services Drivers	901,300
80	53-3040	Taxi Drivers and Chauffeurs	308,280
81	53-4011	Locomotive Engineers	44,440
82	53-4012	Locomotive Firers	1,170
83	53-4013	Rail Yard Engineers, Dinkey Operators, and Hostlers	4,690
84	53-4020	Railroad Brake, Signal, and Switch Operators	21,980
85	53-4030	Railroad Conductors and Yardmasters	48,350
86	53-4040	Subway and Streetcar Operators	13,090
87	53-4099	Rail Transportation Workers, All Other	4,980
88	53-5010	Sailors and Marine Oilers	33,500
89	53-5021	Captains, Mates, and Pilots of Water Vessels	41,320
90	53-5022	Motorboat Operators	3,910
91	53-5030	Ship Engineers	10,060
92	53-6010	Bridge and Lock Tenders	3,810

93	53-6040	Traffic Technicians	6,640
94	53-6050	Transportation Inspectors	30,090
95	53-6060	Transportation Attendants, Except Flight Attendants	20,710
96	53-6099	Transportation Workers, All Other	38,190
97	53-7031	Dredge Operators	1,860
98	53-7050	Industrial Truck and Tractor Operators	551,600
99	53-7062	Laborers and Freight, Stock, and Material Movers, Hand	2,639,320
100	53-7064	Packers and Packagers, Hand	716,780
101	53-7071	Gas Compressor and Gas Pumping Station Operators	3,810
102	53-7072	Pump Operators, Except Wellhead Pumpers	12,800
103	53-7080	Refuse and Recyclable Material Collectors	128,940
104	53-7120	Tank Car, Truck, and Ship Loaders	11,820
105	53-7199	Material Moving Workers, All Other	26,760
		TOTAL	15 Million

Source: Georgetown University Center on Education and the Workforce forecast using data from US Census Bureau and Bureau of Labor Statistics, Current Population Survey (CPS); US Census Bureau, American Community Survey (ACS); US Bureau of Labor Statistics; and IHS Markit.

Appendix C: State Distribution of 15 Million Infrastructure Jobs, Weighted by State Population

New England		Mid-Atlantic		Southeast		Midwest		The Rocky Mountains		Southwest		Pacific Coastal	
Connecticut	162,930	Delaware	44,500	Alabama	224,070	Illinois	579,080	Colorado	263,160	Arizona	332,630	Alaska	33,430
Maine	61,430	District of Columbia	32,250	Arkansas	137,910	Indiana	307,650	Idaho	81,670	New Mexico	95,820	California	1,805,640
Massachusetts	314,980	Maryland	276,280	Florida	981,500	Iowa	144,180	Montana	48,840	Oklahoma	180,830	Hawaii	64,700
New Hampshire	62,140	New Jersey	405,900	Georgia	485,200	Kansas	133,130	Nevada	140,760	Texas	1,325,060	Oregon	192,740
Rhode Island	48,410	New York	889,000	Kentucky	204,170	Michigan	456,380	Utah	146,510			Washington	347,990
Vermont	28,520	Pennsylvania	585,030	Louisiana	212,440	Minnesota	257,720	Wyoming	26,450				
				Mississippi	136,010	Missouri	280,470						
				North Carolina	479,290	Nebraska	88,400						
				South Carolina	235,290	North Dakota	34,820						
				Tennessee	312,080	Ohio	534,170						
				Virginia	390,060	South Dakota	40,430						
				West Virginia	81,900	Wisconsin	266,080						

Source: Georgetown University Center on Education and the Workforce forecast using data from US Census Bureau and Bureau of Labor Statistics, Current Population Survey (CPS); US Census Bureau, American Community Survey (ACS); US Bureau of Labor Statistics; and IHS Markit.

Appendix D: State Distribution of 15 Million Infrastructure Jobs, Weighted by State Population and Unemployment Rates

New England		Mid-Atlantic		Southeast		Midwest		The Rocky Mountains		Southwest		Pacific Coastal	
Connecticut	159,750	Delaware	45,870	Alabama	202,800	Illinois	742,480	Colorado	211,710	Arizona	280,150	Alaska	27,740
Maine	47,100	District of Columbia	35,270	Arkansas	126,550	Indiana	239,770	Idaho	62,620	New Mexico	113,220	California	2,496,740
Massachusetts	380,100	Maryland	250,050	Florida	937,680	Iowa	85,180	Montana	32,540	Oklahoma	120,470	Hawaii	122,810
New Hampshire	46,870	New Jersey	341,860	Georgia	390,350	Kansas	98,740	Nevada	222,950	Texas	1,382,490	Oregon	193,830
Rhode Island	63,900	New York	1,083,980	Kentucky	143,720	Michigan	487,630	Utah	92,080			Washington	341,200
Vermont	15,060	Pennsylvania	595,680	Louisiana	216,310	Minnesota	194,380	Wyoming	20,280				
				Mississippi	121,390	Missouri	172,760						
				North Carolina	439,810	Nebraska	38,890						
				South Carolina	150,840	North Dakota	19,260						
				Tennessee	247,150	Ohio	564,040						
				Virginia	304,000	South Dakota	20,840						
				West Virginia	88,540	Wisconsin	180,620						

Source: Georgetown University Center on Education and the Workforce forecast using data from US Census Bureau and Bureau of Labor Statistics, Current Population Survey (CPS); US Census Bureau, American Community Survey (ACS); US Bureau of Labor Statistics; and IHS Markit.