CAREER AND TECHNICAL EDUCATION (CTE) FOR CLIMATE JOBS

A Framework for Secondary and Postsecondary CTE

Rachel Rosen, MDRC

JULY 2023

mdrc
BUILDING KNOWLEDGE TO IMPROVE SOCIAL POLICY

FUNDERS

This paper was generously supported by funds from The Carnegie Corporation and Bloomberg Philanthropies.

Dissemination of MDRC publications is supported by the following organizations and individuals that help finance MDRC's public policy outreach and expanding efforts to communicate the results and implications of our work to policymakers, practitioners, and others: The Annie E. Casey Foundation, Arnold Ventures, Charles and Lynn Schusterman Family Foundation, The Edna McConnell Clark Foundation, Ford Foundation, The George Gund Foundation, Daniel and Corinne Goldman, The Harry and Jeanette Weinberg Foundation, Inc., The JPB Foundation, The Joyce Foundation, The Kresge Foundation, and Sandler Foundation.

In addition, earnings from the MDRC Endowment help sustain our dissemination efforts. Contributors to the MDRC Endowment include Alcoa Foundation, The Ambrose Monell Foundation, Anheuser-Busch Foundation, Bristol-Myers Squibb Foundation, Charles Stewart Mott Foundation, Ford Foundation, The George Gund Foundation, The Grable Foundation, The Lizabeth and Frank Newman Charitable Foundation, The New York Times Company Foundation, Jan Nicholson, Paul H. O'Neill Charitable Foundation, John S. Reed, Sandler Foundation, and The Stupski Family Fund, as well as other individual contributors.

The findings and conclusions in this report do not necessarily represent the official positions or policies of the funders.

For information about MDRC and copies of our publications, see our website: www.mdrc.org.

ACKNOWLEDGMENTS

The author would like to thank William Corrin, John Hutchins, Rob Ivry, Sabrina Klein, Erika Lewy, Saskia Levy-Thompson, Frank Neipold, and Sarah Salimi for helpful comments and feedback.

CONTENTS

> The limiting factors are going to be…whether we can build out, above all, the human capital that we need. I mean, the best estimate is it's going to take at least a million more electricians in the U.S. If you know a young person who wants to do something that's going to help the world and wants to make a good living at the same time, tell them to go become an electrician. -Bill McKibben, November 15, 2022, New York Times.[1]

INTRODUCTION

The April 2022 report from the Intergovernmental Panel on Climate Change makes some dire predictions about the impacts of climate change, should the planet continue to warm due to human activity that emits greenhouse gases (GHGs) into the atmosphere.[2] Importantly, however, the report also emphasizes that many of the technologies needed to avert the worst impacts of climate change already exist, if the world scales their usage at a rapid pace.

While the scope of a transition toward renewable energy, and away from fossil fuels, as well as other sustainable economic practices is daunting, the United States has recently begun to obtain policy momentum in the push to decouple economic activity from GHG emissions. A suite of recent federal laws, as well as state and local laws and private investments, are set to address the interlocking needs of developing, building, and deploying clean energy infrastructure and transportation.[3]

Demand for everything from solar panels,[4] electric vehicles,[5] and heat pumps,[6] to many other clean energy systems and products has skyrocketed in recent years. This demand will likely continue as prices for many of these goods continue to fall, in many cases below the cost of fossil fuel-powered technologies. This shift will make the transition to clean technologies an economically viable pathway.[7]

However, accompanying this rise in demand is a growing shortage of workers trained in the building, installation, operation, and maintenance of the new technologies. Currently, more than half of the United States' energy employers report difficulties in hiring qualified workers who are trained in building, deploying, and maintaining new energy-efficient and clean technologies. This worker shortage puts at risk the United States' ambitions of cutting GHG emissions substantially this decade.[8]

At the same time, the sheer scope of the need to rapidly expand the number of good climate jobs with family-sustaining wages and advancement opportunities, renders an unprecedented opportunity to provide redress for communities that have historically lacked adequate access to the levers of economic opportunity. In many cases, these same communities have been hardest hit by environmental degradation and the impacts of climate change.[9] Moreover, members of marginalized communities, such as Indigenous and tribal communities that have both struggled economically and have long histories of relating to and managing natural resources in sustainable ways, may already have the necessary knowledge, skills, and habits of mind in relation to issues like conservation and sustainable resource management.

These skills and habits are necessary for leadership in roles facilitating climate stability.[10] In addition, many of these jobs will come from the federal expansion of apprenticeship programs as well as jobs in the skilled trades that do not always require a four-year degree. The urgency of the energy transition, combined with the disruptions to the educational and career trajectories of young people created by the pandemic, have made it more important than ever to both develop new, and scale existing, evidence-based pathways and models of career and technical education (CTE) that can meet the needs of a changing labor market. Doing so could be a way to equitably support young people to achieve success in the climate workforce, where myriad jobs address the needs of society's response to a changing climate.

The Carl D. Perkins Act is the existing federal legislation that provides funding to states for CTE. It requires states to use funds to support equity in CTE for students from a variety of underserved communities, and to create programs that are linked to local labor markets. While Perkins Act funding only represents a portion of funding for CTE, with the bulk coming from individual states, it does provide a framework upon which to equitably build programs in fields where there is current and growing demand. In addition, there is also a significant body of evidence about the effectiveness of CTE for supporting positive educational and economic outcomes for students. Using existing programming, funding, and evidence to adapt educational systems to create a pipeline of talent to fill climate jobs could be a win-win for students, the economy, and the planet.

This paper presents (1) an overview of the scope of jobs that are affected by the transition to a clean energy and climate-resilient economy; (2) a review of the current state of policies aimed at expanding the climate workforce; (3) a review of the evidence about CTE; and (4) a discussion of barriers and potential solutions to improving the education and training pipeline to support an economic transition that is also just and equitable.

WHAT ARE CLIMATE JOBS?

Referred to by a variety of monikers including green and blue jobs, or climate jobs, there are multiple definitions to describe the kinds of jobs that support the development of a more ecologically sustainable economy.[11] For example, the Bureau of Labor Statistics defines green jobs as those that address either adaptation to or mitigation of climate change.[12] Specifically, these jobs do at least one of the following: produce goods and services that benefit the environment; preserve natural resources; serve to make business processes more environmentally friendly; or reduce natural resource use. Other categories of jobs also include those defined as being dedicated to improving resilience to the effects of climate change.[13] Broadly, adaptation and mitigation jobs are those that are focused on reducing or stopping the contributors to climate change, while those that are related to resilience are focused on addressing and managing climate shocks. All of these jobs include both those that are in completely new areas and sectors that are emerging in response to climate change, as well as a broader array of existing jobs that are "greening" in response to a clean energy transition—that is, existing jobs adapting to be more environmentally friendly.[14] The first category of these might include jobs in new industries like wind and solar energy, while

the latter might include the reskilling of heating, ventilation, and air conditioning (HVAC) workers to understand heat pump technology; mechanics who can service electric cars; or electricians who can work on all ends of a clean energy grid. But they also include jobs in areas as diverse as urban planning, landscape architecture, climate risk assessment, disaster management, public health, and justice. The myriad skills demanded by a labor market that is rapidly transitioning to using renewable sources of energy, developing more environmentally friendly products, and conducting business in ways that are less resource intensive while also responding to a more unpredictable and intense climate is changing the way work is done for both workers and employers.

WHICH ECONOMIC SECTORS HAVE CLIMATE JOB GROWTH?

To understand where most climate jobs are emerging or are likely to emerge, it is useful to understand the areas of economic activity that have the greatest impact on GHG emissions, as well as the sectors that have the greatest promise for reducing emissions either through changes in existing technology, or through practices that preserve or restore natural resources. According to a 2019 report put out by an international group of climate, industry, and economic experts, there are six main economic pillars that need to be addressed to facilitate broad decarbonization of the economy.[15] The category of resilience jobs was not included in this report, but has been addressed elsewhere, by organizations such as The Environmental and Energy Study Institute.[16] Together these sectors include:

1. **Zero carbon electricity**—shifting energy creation to renewables (wind, solar, and hydroelectric) and other non-emitting sources of energy (biofuels and nuclear).

2. **Electrification of end use**—eliminating the burning of fossil fuels from activities that rely on energy (such as transportation, heating and cooling, and cooking).

3. **Green fuels**—developing new sources of energy that do not burn fossil fuels (particularly for hard-to-electrify sectors, like aviation).

4. **Smart power grids**—automating the electric grid to be responsive to shifts in the availability of renewably produced electricity to ensure reliable delivery (for example, variability of wind and solar, especially while large-scale battery storage is still ramping up).[17]

5. **Materials efficiency**—reducing the use of products that emit GHGs in their production, including plastics, cement, and metals.[18]

6. **Sustainable land use**—reducing fertilizer use, demand for meat from cattle, and food waste, while also increasing afforestation, sustainable and regenerative farming practices, conservation, water and wetlands protection, and land stewardship.

7. **Resilience—**addressing the impacts of climate disasters and events.

The climate adaptation and resiliency industry was valued at $2.4 billion in 2019[19] and employed over 4 million people in 2020.[20] Many of the sectors that incorporate these jobs are already experiencing high levels of job growth, especially those that are related to changing the kind of energy used to create electricity, changing the products that use electricity, and reducing the overall amount of electricity used. For example, according to the U.S. Department of Energy, in 2021, jobs in electric and hybrid electric cars grew by 25 percent. Those in energy efficiency, solar, wind, and smart grids all grew by between 2 percent and 5 percent. Importantly, jobs in fossil fuels—like coal and petroleum—decreased (by 11.8 percent and 6.4 percent, respectively), while jobs in biofuels grew by 6.7 percent.[21] These rates are compared to overall job growth, which was 2.8 percent for the same period.[22]

The scale of growth, however, varied depending on the maturity of the technologies and processes. For example, growth in sustainable vehicles resulted in the creation of approximately 45,000 new jobs, while growth in biofuels resulted in approximately 1,200 new jobs. Although data on growth in other climate job sectors, such as those in materials efficiency and sustainable agriculture, are harder to find, there is evidence that investments in these fields are also increasing. For example, while the production of steel and cement have been large sources of industrial emissions due to the amount of energy needed to produce these products, several new start-ups[23] have emerged that are working on producing these same materials with greater energy efficiency.[24] Given that early innovation can signal the beginning of growth, the emergence of these efforts indicate which way the sector is moving. Moreover, within each of these sectors, there are multiple levels of jobs and expertise that can be developed in order to facilitate transitions, from research and development to installation and maintenance. In addition, it is also possible that as these new pillars of the economy change, they will lead to new industries and job types which do not yet exist, such as how the internet led to whole new communications sectors. Overall, the figures discussed here suggest that demand for workers in myriad climate fields already exists, and is likely to grow.

IDENTIFYING THE OPPORTUNITY: A SHORTAGE OF SKILLED CLIMATE WORKERS

While it is unclear exactly how many new climate jobs will be created, projections range from between 2 million and 9 million this decade, many of which will be in contracting and construction.[25] For example, it is predicted that the Inflation Reduction Act (IRA) alone will create 900,000 jobs just for HVAC contractors.[26] It is also estimated that the United States will need as many as 80,000 new electricians every year to meet demand.[27] Other immediate areas of strong job growth include other building trades, such as plumbers, pipefitters, and welders. Jobs in clean energy creation and transmission, clean transportation, and sustainable agriculture and land management are also growing. It is predicted that up to 5 million indirect jobs will also be created in fields as diverse as finance, marketing, and other areas necessary to carry out the work of contractors.[28] In addition, shortages of workers with green skills have already been reported. While job listings requiring some kind of green skills grew at 8 percent annually for the five years between 2017–2022, the share of workers with those skills grew at just 6 percent over the same time period.[29] Moreover, the Climate Solutions Lab at Brown University created

a tool for understanding both the sources and extent of job growth that would occur in different sectors and states, if the United States is to reach zero carbon emissions by 2050.[30] The project tracks expected job growth in renewable construction, renewable energy technologies, and energy efficiency, clearly illustrating extensive job growth across many industry sectors and geographic regions from the economic shift to a sustainable economy.

The rapid acceleration of job growth in so many sectors at one time is creating huge demand for skilled workers. Without a corresponding system of education and training for these jobs, the clean energy and sustainability transition could be hampered. For example, according to the U.S. Department of Energy, in 2022, more than half of energy employers in many states reported difficulty finding qualified workers.[31] Likewise, in 2021, solar installations grew by 78 percent over 2019, and jobs increased in 47 states, but 89 percent of solar employers still reported difficulty hiring.[32] Additionally, the vast majority of architects, engineers, and contractors who work in green buildings and construction report that they are unable to find enough workers skilled in green construction.[33] Trade unions that represent workers with skills critical for the energy transition, such as the International Brotherhood of Electrical Workers, have been sounding the alarm for years about a shortage due to an aging workforce and lack of new workers, and this shortage is likely to grow.[34] Finally, anecdotally, some consumers have also begun to report difficulty finding contractors knowledgeable enough about new technologies, like heat pumps, to be able to switch their homes to cleaner and more efficient sources of energy.[35]

For many years, there has been an ongoing debate about a "skills gap," which is when the existing supply of worker skills is misaligned with those demanded of the labor market, both in terms of whether it exists and what its causes are.[36] What makes the shortage of workers to fill climate jobs unique is the ability to identify the areas of labor need, as well as the technological skills needed to address them, before the shortages become acute.[37] This scenario creates a unique opportunity to both meet the growing needs of employers, while also supporting students to enter pipelines for good jobs with middle class wages, and advancement opportunities at the same time.[38] It also provides a unique opportunity to address longstanding equity issues through program development and scaling to communities and populations that are often underserved by existing pathways for economic opportunity and mobility.[39]

Current Federal, State, and Local Policy

In 2021 and 2022, the federal government passed three key pieces of legislation that will provide substantial funding for investing in large-scale infrastructure, manufacturing, and clean energy technology transitions. The Infrastructure, Investment, and Jobs Act (IIJA) invests billions of dollars into transportation, public safety, climate resilience, and job creation. While not explicitly a jobs bill, several provisions in the bill allow funds to be used to support workforce development tied to projects that upgrade multiple transportation systems that are key for reducing emissions. For example, funds for clean municipal bus systems can be combined with funds to train workers to maintain those buses. Likewise, funds to build a

national network of electric vehicle (EV) chargers along the nation's highway system are also available. Although not required to receive federal funds, the bill also allows states to develop human capital plans designed to outline how transportation and infrastructure improvements can be combined with workforce development.[40]

The Inflation Reduction Act (IRA) passed in the summer of 2022 provides almost $400 billion in funding just for clean energy and sustainability, which will also increase demand for workers with skills in climate jobs, by increasing demand for low- and no-emissions products.[41] For example, the bill provides tax credits to consumers and businesses for purchasing or investing in solar and wind technology, energy efficiency and weatherization, EVs and heat pumps. It also provides incentives to increase the development and manufacturing of clean technologies in the United States. Funds are provided to help improve energy efficiency in industrial sites, and for restoration projects in forests and coastal lands. As consumers take advantage of those credits, more industries bring clean energy manufacturing to the U.S., and federal restoration projects increase, skilled workers will be needed to carry out jobs across the country, in myriad industries and work sites. These investments are set to ramp up the implementation and deployment of clean technologies that already exist, at scale.

There are also many technologies and processes that are still in the development stage that have the potential to continue to lower emissions and to create new jobs in new industries over the coming decades. The CHIPS and Science Act that was signed into law in the spring of 2022 authorizes almost $70 billion for the development of zero-carbon industries and climate research.[42] The investments from this bill are set to speed up the time between development and scaling, which means these new industries may emerge on a faster than average timeline. This bill is designed to help keep the bulk of jobs associated with scaling of new technologies in the United States. Earlier green technologies, like solar, were developed domestically, but manufacturing—and jobs—shifted over time to other countries.[43]

It has been widely noted that these three federal bills together represent a new era of federal industrial policy, in which the government uses the law to develop and expand specific industries. In this case, there is a clear federal commitment to shifting the economy to one that both develops and deploys technologies that run without burning fossil fuels, and the scale of these commitments has implications for job growth across the economy.

Even in the few months since the latest of these bills, the IRA, passed in the summer of 2022, clean energy investments in response to the legislation have surged. For example, Toyota, Honda, and LG have all already announced additional investments in expanding U.S.-based battery factories for EVs.[44]

Even as those three pieces of federal legislation mark massive investments in green sectors, states have also passed legislation designed to grow the green workforce. Between 2019 and 2022, Illinois,[45] New Mexico,[46] Washington state,[47] Maine,[48] Virginia,[49] and Maryland[50] passed laws focused specifically on different aspects of climate workforce development, including direct investments to develop climate jobs, grow apprenticeship programs, retrain fossil fuel workers, and expand conservation efforts through youth employment. California and New York have passed multiple bills in an effort to grow their green labor markets over the last

several years.[51] In addition to these bills, California also passed the Golden State Pathways Program law which provides $500 million for the development of educational pathways in four key areas, including STEM-based climate resilience.[52] In New York,[53] $120 million has been spent[54] on workforce development for green industries, and in 2022, three additional laws designed to support the implementation of the original legislation were also passed at the state level.[55] These are combined with the local New York City Climate Mobilization Act, which is designed to create jobs in construction and building retrofitting in the city.[56]

While the federal legislation is expected to create climate jobs in communities across the country, it is likely that even more jobs will be created in states and localities where investment efforts are made from multiple policy and funding streams.

With so many new, emerging, and shifting economic sectors, and demand for skills needed at all levels, there is opportunity for the education and training sectors to meet the moment by both developing and scaling training and pathways models for students at all levels. To that end, the federal legislation that provides funding for CTE is designed to support the development of an equitable pipeline of workers for high demand jobs in local economies. In particular, the reauthorization of the Carl D. Perkins Act in 2018, which provides state funding for CTE at the secondary and postsecondary levels, has already helped fuel an expansion of CTE programming nationally. Particularly relevant for the future climate workforce are the provisions within the Perkins Act that require states to align programming[57] with local labor markets, as well as to address systemic divisions in career access and training for special populations,[58] which include students from economically marginalized communities, students with disabilities, people from populations with chronically low levels of employment, homeless and foster youth, children of service members, and students pursuing non-traditional careers. This last category includes females pursuing traditionally male-dominated fields, and vice versa.

The Current State of Career Technical Education, Evidence, and Training for the Climate Workforce

High-quality CTE and training usually includes a combination of course work related to learning career knowledge and skills; opportunities for work-based learning, such as internships or mentoring experiences, and career advising; and opportunities to earn industry-recognized credentials that provide at least entry-level access to jobs after program completion. While not every CTE program includes all these elements, most include some combinations of them.[59] Many of these program elements are common whether programs are aimed at secondary, postsecondary, or adult students. Nationally, 77 percent of public high school students take at least one CTE course, and CTE has also grown in popularity in recent years as more students have sought alternative pathways to middle class jobs that may or may not require a four-year college degree. Many secondary CTE programs provide elements that allow for an easier transition to aligned programs in community colleges, such as dual enrollment and the earning of entry-level industry-recognized credentials, that can help students eventually earn two- or four-year degrees.

Overview of CTE Evidence

Importantly, there is a lot of strong research evidence to support the efficacy of CTE as a strategy for improving student outcomes.[60] In particular, self-contained models in which students move through programs with other CTE students and which offer multiple learning CTE opportunities, such as Career Academies,[61] Regional Vocational Technical High Schools,[62] and Pathways in Technology Early College High Schools (P-TECH schools)[63] have all shown promise for improving outcomes for students at various stages along their career trajectories. These include higher rates of high school completion and postsecondary enrollment, and increases in longer-term earnings after high school. Some components commonly found in multifaceted CTE programs, like dual enrollment[64] (where high school students earn college credit) and internships,[65] have also shown promise for improving students' postsecondary enrollment outcomes. In addition, the evidence of effectiveness holds across multiple career fields of study, suggesting both that the structures of CTE help support student outcomes, as well as that the impacts may not waiver much for new or changing CTE content. Perhaps most relevant are the multiple emerging studies[66] that have shown increases in wages[67] for students who engaged in high school CTE. In particular, fields like construction, transportation, manufacturing and technology, all of which are fields related to jobs needed for the climate workforce, yield some of the highest post-high school earnings, even though those pathways are not associated with higher postsecondary educational outcomes.[68]

Overview of CTE Content

While specific CTE content, as well as what pathways and programs are offered at different schools, is usually locally determined, many states and programs are guided by the Career Clusters Framework (CCF). The CCF was first developed in 2002 through a collaboration between states and the federal government, and is currently in use in some form by all 50 states.[69] Used as an organizing tool for the development of curriculum and instruction, it has provided the backbone for the content of what states offer in CTE, reinforcing the quality of programs by determining content that is linked to a variety of viable career options. Developed by Advance CTE, an organization that represents state CTE directors, the framework outlines 16 career clusters, linked to 79 career pathways, that provide guidance for states in designing career pathway programs, and helps outline bridges for career pathways between secondary and postsecondary schooling.[70]

The current clusters are broadly defined, dividing fields of work into many areas that could encompass climate jobs, such as agriculture, food, and natural resources; science, technology, engineering, and mathematics; transportation, distribution, and logistics; and architecture and construction. However, to date, the specific career pathways that could be linked to careers in the green economy have not been laid out. Nor have there been guidelines published for educators that outline the ways that many careers—for which there are already existing pathways—should be adapted to meet the changing needs of the labor market. For example, the Architecture and Construction career cluster[71] does not currently include many of the green building careers, in which architecture and construction fields work to make buildings more energy efficient and climate resilient, outlined in the U.S. Department of Energy's Green Buildings Career map.[72] Clear alignment across these kinds of resources

could support educators to better adapt existing pathways to the changing climate careers landscape. Although Advance CTE began to modernize the framework in 2020, the organization does not expect to have a revised version until 2024.[73]

Despite the current and growing shortage of workers for a clean energy transition, the secondary and postsecondary CTE education communities have been relatively slow to respond in terms of developing or adapting career pathways and programs aligned with the climate labor market. Without the rapid scale-up of such programs, there is a risk that there will be a failure to produce either an adequate, long-term pipeline of workers with the skills to do these jobs. Just over half of states, a total of 29, have at least one CTE program that provides either a focus on sustainability or clean energy, a certificate in a related green area, or provides at least one course offering.[74] While this amount signifies that many states are moving in this direction, these programs do not yet exist at close to the scale needed to meet emerging clean energy and sustainability needs. For example, in order to reach the goal of having 20 percent of U.S. energy produced by wind by 2030, which is a U.S. Department of Energy proposal, it is estimated that there need to be anywhere from several hundred to 1,000 new wind training programs alone.[75] The wind industry provides jobs for people at all education levels, from apprenticeship level training all the way up to workers with PhDs. Currently, according to the U.S. Department of Energy, there are 196 wind energy education and training programs across the country, the vast majority of which are housed in institutes of higher education.[76] In addition, through the Department's Wind for Schools program, 143 small wind turbines used for educational purposes have been installed at schools across 12 states. The program, which teaches about wind energy, is not aimed at career training. In addition to these kinds of programs in clean energy, there are also many jobs emerging in what is sometimes referred to as the blue, or ocean, economy. Jobs in sustainable ocean and marine work represent a big piece of the puzzle in addressing climate change, and currently schools in the United States are only producing about 50 percent of the workers needed for the marine economy.[77]

BARRIERS TO CLIMATE WORKFORCE CTE EXPANSION

Currently, the Perkins Act encourages states to align CTE with local labor market demand. However, there are several barriers to this alignment that will likely exacerbate a rapid scale-up of CTE for climate careers. In particular, the field is hampered by (1) bureaucratic and coordination challenges that make developing and adding new pathways a lengthy process, (2) difficulty forming effective and long-lasting relationships with employers, (3) long-standing shortages of teachers for technical courses, and (4) inequitable enrollment in CTE programs. Each of these is described below.

Lengthy Development of New Programs of Study

The Perkins Act aims to drive quality and improvement in CTE through the provision of high-quality programs of study, which are defined as those that offer consecutive sequences of

academic and technical courses that build knowledge, skills, and employability, and that meet the needs of local industry.[78] While the legislation provides funds for states to develop new clusters, this process is often complicated and lengthy. To begin with, states need to approve new pathways and programs of study before they can be adopted by schools. High-quality CTE pathways generally include alignment with state labor market needs, as well as linkages to postsecondary and workforce opportunities. Creating these programs requires coordination and collaboration across multiple stakeholders, including those from secondary, postsecondary, industry, and economic development.[79] And while states can incentivize the creation and adoption of new pathways and programs of study through a combination of fiscal support and accountability, it is nonetheless a lengthy process. For example, a case study of five states that received funds to create new green CTE programs of study in 2010 found that all states took several years to move from development to adoption of a single new program of study. While the reasons for the extended timeline varied somewhat across states, complications included time building effective relationships and gaining buy-in across partners from different sectors. A particular challenge was noted with gaining buy-in from upper-level decision makers in order to facilitate agreements around credit transfer, either between postsecondary partners, or for dual-enrollment programs between secondary and postsecondary partners.[80]

Employer Engagement

While policy makers have an interest in creating pathways and programs of study that align with local labor market needs, schools and colleges also need to collaborate with industry partners in order to successfully adopt and implement programs. Creating successful labor market-aligned programs requires the active collaboration of employers with educational institutions in order to (1) provide educators with knowledge of the skills needed to fill gaps, and (2) provide students with opportunities to learn skills and form relationships through robust work-based learning experiences. Effective partnerships involve contributions to curriculum development, training for teachers, and support and opportunities for students.[81] However, these collaborations also need to provide clear purpose and return on investment for employers, as well as appropriate levels of engagement for employers of different sizes.[82] Successful employer engagement can be undermined by the perception of lopsided relationships, in which more emphasis is placed on the benefit to schools and students, while the benefit to employers is less well articulated, or positioned as altruism, rather than as an investment in talent development.[83] For example, in one report on community college and employer partnerships from the Harvard Business Review, community colleges reported a desire to work more closely with employers, but employers reported mistrust in the capacity of community colleges to meet their needs, as well as a belief that it is easier to find talent on the open market than to invest in relationships with colleges even though these relationships can both grow talent, and create more direct employment matches. Overall, the imbalance in perception and investment in mutual benefit has created a scenario in which the current state of collaboration across these sectors is inadequate to meet America's workforce needs.[84]

CTE Teacher Shortages

Even if CTE programs of study for climate careers and effective employer engagement can be achieved, there have been long standing shortages of CTE teachers nationally for many years. According to the U.S. Department of Education Teacher Shortage Area database,[85] in 2019–2020, 30 states reported teacher shortages in at least one area of CTE, and CTE has been considered a critical shortage area by the U.S. Department of Education since 2004.[86] Part of the reason for the shortage has been an increase in the number of students enrolled in CTE courses, with more than 8 million secondary and 3 million postsecondary students enrolled in at least one CTE course in the 2020–2021 school year.[87] Other reasons for the shortage include CTE teachers leaving the profession for higher-paying industry jobs, as well as certification laws that make it challenging for mid-career or retired industry professionals to become CTE teachers.[88] Given the acute demand for workers across the climate workforce, it may be even more difficult for schools to be competitive in trying to hire CTE teachers with industry experience in these fields into the classroom.

Climate Jobs Equity

One of the greatest challenges to equity in CTE programming has long been that students often sort into CTE fields along traditional gender lines. Programs in education and healthcare are disproportionately female-dominated, while programs in engineering, construction, and agriculture are often male-dominated. As is often seen in the labor market as a whole, many of the female-dominated professions are also lower paid. Moreover, one study from the Minnesota Department of Employment and Economic Development found that even when females did concentrate in male-dominated CTE fields in high school, such as construction, seven years after high school they earned an average of $11,000 less annually than their male counterparts.[89] Other fields where workers are needed to rapidly address climate issues are also still persistently gender segregated. For example, the solar workforce[90] is currently just 30 percent female, and the sea faring profession is less than 2 percent female.[91] These numbers are in contrast to the overall workforce, which is 47 percent female. CTE also continues to struggle with racial disparities in which Black and Latino students are less likely to enroll in STEM CTE courses than their White counterparts.[92] Additionally, some research suggests that Black and Native American workers live in communities with fewer climate jobs, which could hinder the ability of these communities to benefit from expected growth in the sector.[93] Given the specific focus of education on addressing issues of equity, as well as specific provisions in the Perkins Act that incentivize programs that address issues of under-represented workforce populations, CTE programs that receive Perkins funding may be uniquely positioned to address these disparities. Moreover, at least one study found a positive association for females who took engineering CTE in high school being more likely to complete an engineering degree at the Associate's or Bachelor's levels.[94] The need for skilled workers represents a unique opportunity to broaden the workforce of many historically segregated professions, many of which are well-paid, while also raising the earnings

potential for populations that have traditionally been left out of more lucrative careers with long-term growth potential. Broadening the reach of the kinds of students who engage in CTE in high school may be an effective way to increase the overall pipeline of skilled workers into these fields.

RECOMMENDATIONS FOR POLICY AND PRACTICE

The suite of federal laws including the IIJA, CHIPS and Science Act, and the IRA together present a once in a lifetime opportunity for the United States to reduce its greenhouse gas emissions on a timeline that can still avoid some of the worst impacts of climate change. But those ambitions could be endangered if the nation does not simultaneously rapidly scale its education and training infrastructure to meet the increasing demand for climate workers facilitated by those bills. Policy makers, educators, and employers have a historic opportunity to meet the moment and help ensure both a more hopeful climate and economically just future. Here are several ways that states and localities can consider investing in expansion and scale-up of CTE programs designed to prepare young people for climate jobs.

1. Invest in programs with an existing evidence base. There is a robust body of evidence about the kinds of programs that support successful outcomes for students in CTE. Rather than seeking to develop new models, states and districts should invest in scaling these models specifically to train students for jobs in the climate workforce. For example, New York State released a Climate Action Plan[95] in late 2022 that encourages investments in clean energy trainings through models like the P-TECH 9-14 schools,[96] which an MDRC evaluation has found to produce promising impacts for students.

2. Create pathways into community colleges and apprenticeships. Many of the most successful secondary programs create links to postsecondary schooling through dual-enrollment programs. Since the training needs of the climate-related labor market are so large, opportunities for CTE should be provided at both the high school and community college levels. These programs should be aligned with specific local labor market needs and linked to one another through dual enrollment and aligned pathways opportunities, which have been found to be successful for increasing postsecondary enrollment.

3. Create incentives for educators and employers to work together. While many educators recognize the need to train students for the jobs of the future, they don't always know the skills that are most in demand from employers. And many employers want to work with schools and community colleges, but don't know how. Incentivizing formal partnerships between educators and employers that both help educators evolve their knowledge to be responsive to changes in technology and in-demand skills could help support teachers in providing cutting-edge knowledge to their students. In addition, employer engagement in providing real-world learning experiences to students through internships, apprenticeships, and other work-based learning opportunities may also help ensure that students enter the labor market with both the skills and experience needed to be ready to begin

work after graduation. Creating more tightly coupled alignment across the education and employment spaces to help students more seamlessly enter climate jobs could be a promising way to help close the current skills gap for these jobs.

4. Improve broad climate change and sustainability education. Because of the broad social implications of climate change, training students in the basics of sustainability along with specific climate job skills may be an effective way to change how future workers think about the impact of their careers on the environment. To that end, between 2007 and 2014, the Workforce Innovation and Opportunity Act (WIOA) was amended to provide adult training in climate jobs and skills. One study of those programs found that a foundation course called The Green Generalist adapted existing workforce training skills to focus on issues like conservation of resources and recycling, that employers found valuable and that empowered workers to take initiative in taking green actions both as employees and citizens.[97] Reviving or building out similar basic sustainability education could be a promising way to shift how people make decisions with environmental impact within their careers.[98]

5. Leverage school infrastructure investments for CTE. The U.S. Department of Energy is currently providing millions of dollars in funding to help schools and districts upgrade the energy efficiency of their buildings and transportation fleets, as well as provide funding for staff members to serve as energy managers.[99] These infrastructure investments could be paired with training programs for students to learn skills in areas such as solar installation or clean HVAC installation and maintenance.

6. Ensure equity in climate CTE programs. The largest equity divide in CTE has traditionally been the sorting of students into career pathways along traditional gender lines, while many of the most in-demand skills required to transition to a clean energy economy are in high-paying fields that have historically been dominated by males. Communities of color and Indigenous communities are also often the same communities that bear the greatest impacts of climate change.[100] Ensuring that female students and students of color are prepared to take advantage of the economic benefits of the climate workforce could be a win-win for ensuring enough skilled workers are ready to take jobs, while also addressing historic inequities in access to economic opportunity.

7. Create more teacher apprenticeship programs for climate CTE educators. In order for CTE programs to be successful, they need teachers knowledgeable about both industry and teaching. Beginning in 2022, the U.S. Department of Labor endorsed expanding registered apprenticeship programs to the teaching profession as a solution to nationwide teacher shortages. The "earn and learn" models allow people to be paid from day one of the beginning of their teacher training, which makes the teaching profession more accessible to more people. Since then, 10 states have begun utilizing these models to try to increase the teacher pipeline for areas with shortages, including CTE.[101] Expanding these programs could be a promising way to address CTE classroom shortages, particularly for teachers in climate-related CTE fields.

The opportunities to address climate change while creating millions of good jobs with middle class wages created by recent federal and state laws represents an extraordinary opportunity for the country. Increasing partnerships between school districts, community colleges, and employers, and the growing evidence base on the effectiveness of many different CTE programs to support student success, provides an opportunity to meet employer hiring needs with a generation of diverse, skilled workers while also helping to ensure a more hopeful climate future.

ENDNOTES

1 Klein, E. (2022, November 15). Transcript: Ezra Klein interviews Bill McKibben. *The New York Times.* https://www.nytimes.com/2022/11/15/podcasts/transcript-ezra-klein-interviews-bill-mckibben.html

2 Harvey, F. (2022, April 4). IPCC report: "Now or never" if world is to stave off climate disaster. *The Guardian.* https://www.theguardian.com/environment/2022/apr/04/ipcc-report-now-or-never-if-world-stave-off-climate-disaster

3 White House Briefing Room. (2022, February 15). *Fact sheet: Biden-Harris administration advances cleaner industrial sector to reduce emissions and reinvigorate American manufacturing.* https://www.whitehouse.gov/briefing-room/statements-releases/2022/02/15/fact-sheet-biden-harris-administration-advances-cleaner-industrial-sector-to-reduce-emissions-and-reinvigorate-american-manufacturing/

4 Solar Energy Industries Association. (2023). *Solar industry research data: Solar industry growing at a record pace.* https://www.seia.org/solar-industry-research-data

5 Minos, S. (2022, March 1). *New plug-in electric vehicle sales in the United States nearly doubled from 2020 to 2021.* U.S. Department of Energy: Office of the Energy Saver. https://www.energy.gov/energysaver/articles/new-plug-electric-vehicle-sales-united-states-nearly-doubled-2020-2021#:~:text=Sales%20of%20new%20light-duty,electric%20vehicle%20sales%20in%202021

6 Grand View Research, Inc. (2023). *Heat pump market size, share & trends analysis report by technology (air source, water source), by capacity, by operation type, by application (residential, industrial), by region, and segment forecasts, 2023–2030.* https://www.grandviewresearch.com/industry-analysis/heat-pump-market

7 Way, R., Ives, M. C., Mealy, P., & Farmer, J. D. (2022). Empirically grounded technology forecasts and the energy transition. *Joule*, 6(9), 2057–2082. https://doi.org/10.1016/j.joule.2022.08.009

8 Coplon-Newfield, G., Keyser, D., & Schanzer, H. (2022, June). *Energy employment by state 2022: United States energy and employment report.* U.S. Department of Energy. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20State%20Report_0.pdf

9 Environmental Protection Agency. (2021, September). *Climate change and social vulnerability in the United States: A focus on six impacts.* www.epa.gov/cira/social-vulnerability-report

10 American Society of Adaptation Professionals (2020, April 20). *ASAP justice, equity, diversity, and inclusion statement.* https://adaptationprofessionals.org/wp-content/uploads/2020/05/ASAP-Justice-Equity-Diversity-and-Inclusion-Statement.pdf

11 This paper will use the term "climate jobs" to refer to this broad swath of jobs.

12 U.S. Bureau of Labor Statistics. (n.d.). *Measuring green jobs.* https://www.bls.gov/green/home.htm#:~:text=Green%20jobs%20are%20either%3A

13 McGinn, A. (2021, September 23). *Adaptation jobs explainer: Understanding this critical and growing workforce.* Environmental and Energy Study Institute. https://www.eesi.org/articles/view/adaptation-jobs-explainer-understanding-this-critical-and-growing-workforce

14 Boudreau, C. (2022, August 10). Execs at Citi, Schneider Electric, and IBM want bankers, electricians, and data whizzes with green skills. *Business Insider.* https://www.businessinsider.com/citi-schneider-electric-ibm-green-skills-2022-8

15 Sustainable Development Solutions Network (SDSN) & Fondazione Eni Enrico Mattei (FEEM). (2019, September). *Roadmap to 2050: A manual for nations to decarbonize by mid-century.* https://roadmap2050.report/

16 McGinn, A. (2021, September 23). *Adaptation jobs explainer: Understanding this critical and growing workforce.* Environmental and Energy Study Institute. https://www.eesi.org/articles/view/adaptation-jobs-explainer-understanding-this-critical-and-growing-workforce

17 Hering, G. (2020, March 4). *In a 'groundbreaking year," massive U.S. battery storage projects underway in 2020.* S&P Global Market Intelligence. https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/in-a-groundbreaking-year-massive-us-battery-storage-projects-underway-in-2020-57373153

18 Worrell, E., Allwood, J., & Gutowski, T. (2016). The role of material efficiency in environmental stewardship. *Annual Review of Environment and Resources,* 41(1), 575–598. https://doi.org/10.1146/annurev-environ-110615-085737

19 McGinn, A. (2021, September 23). *Adaptation jobs explainer: Understanding this critical and growing workforce.* Environmental and Energy Study Institute. https://www.eesi.org/articles/view/adaptation-jobs-explainer-understanding-this-critical-and-growing-workforce

20 Bertrand, S. (2021, September 23). *Fact sheet: Climate jobs (2021). Environmental and Energy Study Institute.* https://www.eesi.org/papers/view/fact-sheet-climate-jobs

21 Coplon-Newfield, G., Keyser, D., & Schanzer, H. (2022, June). *Energy employment by state 2022: United States energy and employment report.* U.S. Department of Energy. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20State%20Report_0.pdf

22 U.S. Department of Energy. (2022, June 30). *Report: Energy jobs grew faster than overall U.S. employment in 2021.* CleanTechnica. https://cleantechnica.com/2022/06/30/report-energy-jobs-grew-faster-than-overall-u-s-employment-in-2021/?fbclid=IwAR3sEXHkRJTkO-wqyjcayzsodZuHc7mvXd3oV1uXgelJa2feclI1ZEN5wYs

23 Fennell, P., Driver, J., Bataille, C., & Davis, S. J. (2022, March 23). *Cement and steel—nine steps to net zero.* Nature. https://www.nature.com/articles/d41586-022-00758-4

24 Rathi, A. (2022, October 11). Breakthroughs are helping even cement and steel go electric. *Bloomberg.* https://www.bloomberg.com/news/articles/2022-10-11/breakthroughs-are-helping-even-cement-and-steel-go-electric?leadSource=uverify%20wall

25 BlueGreen Alliance. (n.d.). *Nine million jobs from climate action: The Inflation Reduction Act.* https://www.bluegreenalliance.org/site/9-million-good-jobs-from-climate-action-the-inflation-reduction-act/#:~:text=A%20new%20analysis%20commissioned%20by,jobs%20over%20the%20next%20decade%E2%80%94

26 Rewiring America. (n.d.). *What the IRA means for contractors and electricians.* https://assets.ctfassets.net/v4qx5q5o44nj/3ehL1rl7UVhxxBemwYE6lE/292037a110809204ce3fd22b3c94c140/factsheet_Contractors.pdf

27 Pontecorvo, E. (2023, January 11). To get off fossil fuels, America is going to need a lot more electricians. *Grist.* https://grist.org/energy/electrician-shortage-electrify-everything-climate-infrastructure-labor/

28 Rewiring America. (n.d.). *What the IRA means for contractors and electricians.* https://assets.ctfassets.net/v4qx5q5o44nj/3ehL1rl7UVhxxBemwYE6lE/292037a110809204ce3fd22b3c94c140/factsheet_Contractors.pdf

29 LinkedIn Economic Graph. (n.d.). *Global green skills report 2022.* https://economicgraph.linkedin.com/content/dam/me/economicgraph/en-us/global-green-skills-report/global-green-skills-report-pdf/li-green-economy-report-2022-annex.pdf?trk=eg_fow_grn_nav

30 Murray-Gard, A. (2022). *Climate opportunity map: All of America will benefit from investment in clean energy and climate solutions*. Watson Institute of International and Public Affairs: Brown University. https://watson.brown.edu/climateopportunitymap/index.php

31 Coplon-Newfield, G., Keyser, D., & Schanzer, H. (2022, June). *Energy employment by state 2022: United States energy and employment report.* U.S. Department of Energy. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20State%20Report_0.pdf

32 Feldman, D., Dummit, K., Zuboy, J., & Margolis, R. (2022, July 12). *Summer 2022 solar industry update. National Renewable Energy Laboratory.* https://www.nrel.gov/docs/fy22osti/83718.pdf

33 International Labour Organization (ILO) Regional Office for Asia and the Pacific. (n.d.). *Shortage of skilled employees in green building industry.* https://apskills.ilo.org/greenjobs-ap-harmonized/news/shortage-of-skilled-employees-in-green-building-industry

34 Border States. (n.d.). *The state of the electrician shortage in 2022: New data on the impact of COVID-19.* https://solutions.borderstates.com/the-electrician-shortage/

35 Leber, R. (2022, October 8). The most annoying barrier to getting your home off fossil fuels. *Vox.* https://www.vox.com/energy-and-environment/2022/10/8/23387530/home-electrification-heat-pumps-gas-furnace-contractors

36 Rosen, R., Visher, M., & Beal, K. (2018, September). *Career and Technical Education: Current policy, prominent programs, and evidence.* MDRC. https://www.mdrc.org/sites/default/files/CTE%20Paper-Final.pdf

37 Rosen, R., Visher, M., & Beal, K. (2018, September). *Career and Technical Education: Current policy, prominent programs, and evidence.* MDRC. https://www.mdrc.org/sites/default/files/CTE%20Paper-Final.pdf

38 U.S. Departments of Commerce & Labor. (2022, June). *Good jobs principles.* https://www.dol.gov/sites/dolgov/files/goodjobs/Good-Jobs-Summit-Principles-Factsheet.pdf

39 The U.S. Departments of Labor and Commerce have defined good jobs as those that adhere to eight key principles: (1) Fair and equitable recruitment; (2)Provide family sustaining benefits; (3) Where all workers have equal opportunity; (4) Where workers can form and join unions; (5) Have healthy, safe, and accessible workplaces; (6) Where all workers belong, are valued and can contribute meaningfully; (7) Provide stable and predictable living wages; and (8) Provide equitable opportunities to progress.

40 National Governors Association. (2023, February 8). *Workforce development in the IIJA, CHIPS and IRA.* https://www.nga.org/publications/workforce-development-in-the-iija-chips-and-ira/

41 McKinsey & Company Public Sector. (2022, October 24). *The Inflation Reduction Act: Here's what's in it.* https://www.mckinsey.com/industries/public-sector/our-insights/the-inflation-reduction-act-heres-whats-in-it

42 Meyer, R. (2022, August 10). Congress just passed a big climate bill. No, not that one. *The Atlantic.* https://www.theatlantic.com/science/archive/2022/08/chips-act-climate-bill-biden/671095/

43 Meyer, R. (2022, August 10). Congress just passed a big climate bill. No, not that one. *The Atlantic.* https://www.theatlantic.com/science/archive/2022/08/chips-act-climate-bill-biden/671095/

44 Ewing, J., & Penn, I. (2022, September 7). Clean energy projects surge after climate bill passage. *The New York Times.* https://www.nytimes.com/2022/09/07/business/energy-environment/clean-energy-climate-bill.html

45 Illinois.gov. (2021, September 15). *Gov. Pritzker signs transformative legislation establishing Illinois as a national leader on climate action.* https://www.illinois.gov/news/press-release.23893.html

46 Office of the Governor Michelle Lujan Grisham. (2019, March 22). *Governor signs landmark energy legislation, establishing New Mexico as a national leader in renewable transition efforts.* https://www.governor.state.nm.us/2019/03/22/governor-signs-landmark-energy-legislation-establishing-new-mexico-as-a-national-leader-in-renewable-transition-efforts/

47 Washington State Department of Commerce. (n.d.). *Clean Energy Transformation Act.* https://www.commerce.wa.gov/growing-the-economy/energy/ceta/#:~:text=On%20May%207%2C%202019%2C%20Governor,greenhouse%20gas%20emissions%20by%202045

48 An Act to Promote Clean Energy Jobs and To Establish the Maine Climate Council, SP0550 LD 1679. (2019). https://legislature.maine.gov/legis/bills/bills_129th/chapters/PUBLIC476.asp

49 Former Office of the Virginia Governor Ralph S. Northam. (2020, April 12). *Governor Northam signs clean energy legislation.* https://www.governor.virginia.gov/newsroom/all-releases/2020/april/headline-856056-en.html

50 Powell, M. C. (2022, April 4). The Climate Solutions Now Act of 2022. Gordon Feinblatt LLC. https://www.gfrlaw.com/what-we-do/insights/climate-solutions-now-act-2022

51 UC Berkeley School of Law. (2023). *California climate policy dashboard.* https://www.law.berkeley.edu/research/clee/research/climate/climate-policy-dashboard/

52 Gallegos, E. (2022, July 7). College or career? California invests $500 million in program that tackles both. *EdSource*. https://edsource.org/2022/college-or-career-california-invests-500-million-in-program-that-tackles-both/675090

53 New York State Energy Research and Development Authority. (n.d.). *Climate Leadership and Community Protection Act (Climate Act).* https://www.nyserda.ny.gov/All-Programs/CLCPA

54 New York State Energy Research and Development Authority. (n.d.). *Workforce development and training. Opportunities for people who are powering New York's clean energy future.* https://www.nyserda.ny.gov/All-Programs/Clean-Energy-Workforce-Development-and-Training

55 The Governor's Press Office. (2022, July 5). *Governor Hochul signs legislative package to spur energy efficiency, consumer savings, and greenhouse gas emission reductions while supporting prevailing wage measures.* https://www.governor.ny.gov/news/governor-hochul-signs-legislative-package-spur-energy-efficiency-consumer-savings-and

56 NYC Mayor's Office of Climate and Sustainability. (2019). *Climate Mobilization Act.* https://www.nyc.gov/assets/nycaccelerator/downloads/pdf/ClimateMobilizationAct_Brief.pdf

57 Northern, A. M., & Petrilli, M. J. (2019). Aligning CTE courses to local labor markets. *State Education Standard, 19*(3), 25–29. https://files.eric.ed.gov/fulltext/EJ1229644.pdf

58 All4Ed. (2019, September 16). *Perkins Career and Technical Education primer: Special populations.* https://all4ed.org/wp-content/uploads/2019/09/Perkins-CTE-Special-Populations_FINAL.pdf

59 Rosen, R., Visher, M., & Beal, K. (2018, September). *Career and Technical Education: Current policy, prominent programs, and evidence.* MDRC. https://www.mdrc.org/sites/default/files/CTE%20Paper-Final.pdf

60 Rosen, R., Visher, M., & Beal, K. (2018, September). *Career and Technical Education: Current policy, prominent programs, and evidence.* MDRC. https://www.mdrc.org/sites/default/files/CTE%20Paper-Final.pdf

61 Kemple, J. J., & Willner, C. J. (2008). *Career academies: Long-term impacts on labor market outcomes, educational attainment, and transitions to adulthood.* MDRC. https://clear.dol.gov/sites/default/files/CAKemple2008.pdf

62 Brunner, E. J., Dougherty, S. M., & Ross, S. L. (2023). The effects of Career and Technical Education: Evidence from the Connecticut technical high school system. *The Review of Economics and Statistics.* https://doi.org/10.1162/rest_a_01098

63 Rosen, R., Byndloss, D., Parise, L., Alterman, E., & Dixon, M. (2020). *Bridging the school-to-work divide: Interim implementation and impact findings from New York City's P-TECH 9-14 schools.* MDRC. https://www.mdrc.org/sites/default/files/P-TECH_Report_2020.pdf

64 Edmunds, J. A., Unlu, F., Furey, J., Glennie, E., & Arshavsky, N. (2020). What happens when you combine high school and college? The impact of the early college model on postsecondary performance and completion. *Educational Evaluation and Policy Analysis, 42*(2), 257–278. https://journals.sagepub.com/doi/abs/10.3102/0162373720912249

65 Theodos, B., Pergamit, M. R., Hanson, D., Edelstein, S., Daniels, R., & Srini, T. (2017). *Pathways after high school: Evaluation of the Urban Alliance high school internship program.* Urban Institute. https://www.urban.org/research/publication/pathways-after-high-school-evaluation-urban-alliance-high-school-internship-program

66 Kemple, J. J., & Willner, C. J. (2008). *Career academies: Long-term impacts on labor market outcomes, educational attainment, and transitions to adulthood.* MDRC. https://clear.dol.gov/sites/default/files/CAKemple2008.pdf

67 Ecton, W. G., & Dougherty, S. M. (2022). Heterogeneity in high school Career and Technical Education outcomes. *Educational Evaluation and Policy Analysis, 45*(1), 157–181. https://doi.org/10.3102/01623737221103842

68 Ecton, W. G., & Dougherty, S. M. (2022). Heterogeneity in high school Career and Technical Education outcomes. *Educational Evaluation and Policy Analysis, 45*(1), 157–181. https://doi.org/10.3102/01623737221103842

69 Advance CTE. (2021, April 1). *Advance CTE launches online portal to crowdsource innovative ideas to modernize The National Career Clusters Framework.* https://careertech.org/advance-cte-launches-online-portal-crowdsource-innovative-ideas-modernize-national-career-clusters

70 Career pathways include sequenced courses and related opportunities, such as internships and other work-based learning experiences in a specific career field. Programs that bridge from secondary to postsecondary schooling create continuity in career learning across these educational sectors.

71 Advance CTE. (n.d.). *CareerClusters pathways to college and career readiness: Architecture and construction.* https://cte.careertech.org/sites/default/files/CCFrame-ArchitectureandConstruction.pdf

72 Interstate Renewable Energy Council (IREC). (n.d.). *Green buildings career map.* U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. https://greenbuildingscareermap.org/

73 Advance CTE. (2023, May 10). *Pathways to college and career readiness career clusters: Latest update.* https://careertech.org/the-framework

74 Katz, E., Schifter, L., & La Pinta, A. (2020). *A state policy landscape 2020: Career and Technical Education.* The Aspen Institute. https://www.thisisplaneted.org/img/K12-StatePolicyLandscape2020-Screen.pdf

75 Keyser, D. & Tegen, S. (2019, July). *The wind energy workforce in the United States: Training, hiring, and future needs.* National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy19osti/73908.pdf

76 U.S. Department of Energy WindExchange. (n.d.). *Wind energy education and training programs.* https://windexchange.energy.gov/training-programs

77 Economist Impact World Ocean Initiative. (2022, December 11). *How to build 'blue" skills for the ocean economy.* https://impact.economist.com/ocean/sustainable-ocean-economy/how-to-build-blue-skills-for-the-ocean-economy

78 Advance CTE. (2018, October 16). *Perkins side-by-side.* https://cte.careertech.org/sites/default/files/PerkinsV_Side-by-Side_Draft_Updated101618.pdf

79 Advance CTE. (2017, April). *Raising the bar: State strategies for developing and approving high-quality career pathways.* https://careertech.org/resource/raising-the-bar

80 Advance CTE. (n.d.). *Developing a statewide model program of study: Five states share insights.* https://cte.careertech.org/sites/default/files/Statewide_POS_Report.pdf

81 Alterman, E., Medina, F., & Parise, L. (2022, July). *Establishing effective employer-school partnerships: Lessons from employers and schools in NYC's original P-TECH grades 9-14 schools.* MDRC. https://www.mdrc.org/publication/establishing-effective-employer-school-partnerships

82 Washington STEM. (n.d.). *Lessons in career connected learning for youth and young adults.* Washington State National Governor's Association Policy Academy for Work Based Learning. https://wsac.wa.gov/sites/default/files/Lessons%20in%20Career%20Connected%20Learning%20-%205-15-17.pdf

83 Neff, C. R. (2017). *Manufacturing employer engagement with high impact work-based learning programs of career academy high schools: A qualitative grounded theory study.* [Doctoral thesis, University of Wisconsin, Stout]. https://minds.wisconsin.edu/bitstream/handle/1793/83157/2017neffc.pdf?sequence=1&isAllowed=y

84 Fuller, J. B., & Raman, M. (2022). *The partnership imperative: Community colleges, employers, and America's chronic skills gap.* Harvard Business School. https://www.hbs.edu/managing-the-future-of-work/Documents/research/The%20Partnership%20Imperative%2012.12.2022.pdf

85 Cross, F. (2017, May). *Teacher shortage areas nationwide listing 1990-1991 through 2017-2018.* U.S. Department of Education Office of Postsecondary Education. https://tsa.ed.gov/#/faqq

86 Kosloski, M. F., Reed, P. A., Loya, R., & Abdelhamid, M. (2022). Career and Technical Education teachers' perceptions of their profession and willingness to encourage students to enter a CTE teaching career. *Journal of Research in Technical Careers, 6*(2), 21. https://doi.org/10.9741/2578-2118.1118

87 Perkins Collaborative Resource Network. (2022). *State profiles.* https://cte.ed.gov/profiles/national-summary

88 Ingraham, K. (2022, December 12). *Teacher certification and uniform salary schedules hinder CTE staffing.* Thomas B. Fordham Institute. https://fordhaminstitute.org/national/commentary/teacher-certification-and-uniform-salary-schedules-hinder-cte-staffing

89 Leibert, A. (2022, March). *Females in Career and Technical Education (CTE).* Minnesota Department of Employment and Economic Development. https://mn.gov/deed/assets/FemalesinCTE_tcm1045-521680.pdf

90 Feldman, D., Dummit, K., Zuboy, J., & Margolis, R. (2022, July 12). *Summer 2022 solar industry update.* National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy22osti/83718.pdf

91 Economist Impact World Ocean Initiative. (2022, March 24). *Women of the ninth annual World Ocean Summit: Breaking barriers in the blue economy.* https://impact.economist.com/ocean/sustainable-ocean-economy/women-of-the-9th-annual-world-ocean-summit-breaking-barriers-in-the-blue

92 Butrymowicz, S., Amy, J., & Fenn, L. (2020, October 22). How Career and Technical Education shuts out Black and Latino students from high-paying professions. *Hechinger Report.* https://hechingerreport.org/how-career-and-technical-education-shuts-out-black-and-latino-students-from-high-paying-professions/

93 Kuersteiner, S., & Ordal, H. (2023). Disparities in green jobs by race and ethnicity. *Sustainability and Climate Change, 16(2),* 136–149. https://www.liebertpub.com/doi/10.1089/scc.2022.0112

94 Gottfried, M. A., & Plasman, J. S. (2018). From secondary to postsecondary: Charting an engineering career and technical education pathway. *Journal of Engineering Education, 107*(4), 531–555. https://doi.org/10.1002/jee.20236

95 NY State Climate Action Council. (2022, December). *New York State climate action council scoping plan.* https://climate.ny.gov/-/media/project/climate/files/2022-12-15-Draft-Final-Scoping-Plan.pdf

96 MDRC. (2023). *P-TECH 9-14 evaluation: Project overview.* https://www.mdrc.org/project/p-tech-9-14-evaluation#overview

97 Wagner, C. (2013). Adult learning meets the green economy: Lessons from a green jobs education project. *Adult Learning, 24*(1), 14–21. https://doi.org/10.1177/1045159512467324

98 Wagner, C. (2013). Adult learning meets the green economy: Lessons from a green jobs education project. *Adult Learning, 24*(1), 14–21. https://doi.org/10.1177/1045159512467324

99 U.S. Department of Energy. (n.d.). *Renew America's schools.* https://www.energy.gov/scep/renew-americas-schools

100 Patnaik, A., Son, J., Feng, A., & Ade, C. (2020, August 15). *Racial disparities and climate change.* Princeton Student Climate Initiative. https://psci.princeton.edu/tips/2020/8/15/racial-disparities-and-climate-change

101 Duckett, E., & Beller, A. (2022, November 2). *A new state solution for teacher shortages: Apprenticeships.* American Institutes for Research. https://www.air.org/resource/blog-post/new-state-solution-teacher-shortages-apprenticeships

ABOUT MDRC

MDRC, a nonprofit, nonpartisan social and education policy research organization, is committed to finding solutions to some of the most difficult problems facing the nation. We aim to reduce poverty and bolster economic mobility; improve early child development, public education, and pathways from high school to college completion and careers; and reduce inequities in the criminal justice system. Our partners include public agencies and school systems, nonprofit and community-based organizations, private philanthropies, and others who are creating opportunity for individuals, families, and communities.

Founded in 1974, MDRC builds and applies evidence about changes in policy and practice that can improve the well-being of people who are economically disadvantaged. In service of this goal, we work alongside our programmatic partners and the people they serve to identify and design more effective and equitable approaches. We work with them to strengthen the impact of those approaches. And we work with them to evaluate policies or practices using the highest research standards. Our staff members have an unusual combination of research and organizational experience, with expertise in the latest qualitative and quantitative research methods, data science, behavioral science, culturally responsive practices, and collaborative design and program improvement processes. To disseminate what we learn, we actively engage with policymakers, practitioners, public and private funders, and others to apply the best evidence available to the decisions they are making.

MDRC works in almost every state and all the nation's largest cities, with offices in New York City; Oakland, California; Washington, DC; and Los Angeles.