

ELECTRIFYING THE WORKFORCE



December 2024

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About the NIAC

The President’s National Infrastructure Advisory Council (NIAC or the Council) is composed of senior executives from industry and state and local government who own and operate the critical infrastructure essential to modern life. The Council was established by executive order in October 2001 to advise the President on practical strategies for industry and government to reduce complex risks to the designated critical infrastructure sectors.

At the President’s request, NIAC members conduct in-depth studies on physical and cyber risks to critical infrastructure and recommend solutions that reduce risks and improve security and resilience. Members draw upon their deep experience, engage national experts, and conduct extensive research to discern the key insights that lead to practical Federal solutions to complex problems.

For more information on the NIAC and its work, please visit: <https://www.cisa.gov/niac>.

I. Executive Summary

Capacity, resilience, diversification, and redundancy of the nation’s critical infrastructure is vital to national prosperity, preparedness, security, health, and welfare. Strength across United States (U.S.) critical infrastructure sectors is also paramount to the U.S.’s global competitiveness and status as a world leader in electrification and climate mitigation. Money alone cannot buy back that leadership; the currency required is the nation’s people. In addition to physical structures, systems, equipment, and services, America requires a current and future-ready workforce with the capacity to design, manufacture, install, operate, and maintain world-class systems that will meet the demand for electrification and its confluence with achieving net-zero goals by 2050.


This report to the President conveys an urgency to focus on immediate actions the Federal government can take to address the people-readiness challenges faced by the U.S. energy sector and bolster the nation’s electricity infrastructure, which is essential to achieving the nation’s clean energy transition across all critical infrastructure sectors and achieve a more sustainable energy future.

The recommendations below serve as a roadmap to retake America’s international leadership in technology and infrastructure by advancing U.S. strategic advantage: the American people – engaging *all* its people and communities – to propel the U.S. into the future.

The nation is facing a workforce crisis with an aged labor force and a significant shortage of people to take on front-line positions in critical infrastructure and specifically the career paths and jobs that support electrification. The outlook for growing the workforce to meet near-term, medium, and long-term demand for workers has become more acute in the wake of the COVID-19 pandemic. The first step in addressing any challenge is understanding the nature of the challenge. After six months of briefings, the NIAC has highlighted eight challenges and opportunities to accelerate workforce development efforts and close the gap between supply and demand, outlined below.



Finding 1
No Comprehensive National Strategy



Finding 2
Need for Cross-Sectoral Collaboration



Finding 3
Gaps in Secondary and Higher Education Curriculum, Training and Access



Finding 4
Education Deserts




Finding 5
Funding Availability and Use



Finding 6
Social Contracting/Community Benefits



Finding 7
Diversity, Equity and Inclusion



Finding 8
Clearinghouse for Workforce Development Program Information and Data

After hearing from a broad cross-section of critical constituencies and stakeholders addressing various aspects of workforce development and people-readiness – government at all levels, public and private

sector employers, organized labor, education and training institutions, and community-based organizations – it became apparent that there is no shortage of workforce development programs and initiatives in this country. However, those programs must be well-resourced and promoted to adequately sustain workforce diversification and inclusion.

With passage of the Infrastructure Investment and Jobs Act (IIJA), the Inflation Reduction Act (IRA), and the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, this is a period of historic Federal investment in workforce development programs.¹ However, the U.S. lacks a comprehensive national plan, coordinated national strategies, and accountabilities across Federal agencies to ensure that local programs and practices are known, shared, well-resourced, and have the reach necessary to help achieve workforce diversification and inclusion.

While the U.S. has made progress in interagency coordination, notably since passage of the IIJA, the U.S. maintains an urgent need for significantly increased Federal action to require cross-sectoral coordination and collaboration. The NIAC developed two recommendations for immediate Federal action and six additional recommendations addressing major obstacles to building a current and future-ready workforce to meet the challenges faced by our nation’s clean energy transition.

Recommendations for Immediate Federal Action



Develop a National Infrastructure Workforce Plan, starting with the electricity subsector, that is data-informed; elevates the U.S.’s national image and public awareness of the 21st century career opportunities, value, and importance of people-readiness across the nation’s critical infrastructure sectors; establishes national priorities and strategies for addressing essential scarce-skills positions, performance measures, and reporting; and builds in accountabilities.

Build on the approach outlined in the [National Cyber Workforce and Education Strategy](#). This strategy outlines a comprehensive approach to address both current and future cyber workforce needs through building foundational cyber skills that prepare future generations for the cyber workforce. Akin to the National Cyber Workforce strategy, the national infrastructure workforce plan for electrification should also introduce a convening body to spearhead implementation and collaboration across sectors and stakeholders. Implementation must have a planning system that helps to integrate people-readiness for “essential”² positions into existing safety, asset management, conditions, and risk management reporting. This includes robust engagement of diverse stakeholders, important constituencies, and new voices who are engaged in employment, education, and training across our nation’s critical infrastructure sectors. Expand outreach and engagement that will help tap historically under-represented groups.³

Advocate for Federal policies that advance the nation’s focus on broadening, diversifying, developing, and training U.S. workforce to include *all* communities – with emphasis on essential positions. Consider immigration practices that support workers who help to address documented workforce shortages. Expand support for important wrap-around services, universal access to reliable and affordable internet service to

¹ Workforce Matters. “Workforce 101: Infrastructure of the Public Workforce System.” 2021.

² CISA. “Guidance on the Essential Critical Infrastructure Workforce.” 2021.

³ ONCD. “National Cyber Workforce and Education Strategy: Unleashing America’s Cyber Talent.” 2023.

minimize barriers, and access to lifeline educational institutions in predominately rural and smaller communities – including regionally significant electrification services and facilities.

Leverage Federal leadership at the highest levels to inform, convene, incentivize, and support high return “K to Gray” workforce development programs at the national, regional, and local levels, including public, private, organized labor, and philanthropic initiatives. Create a national clearinghouse for best practices, to include promising and innovative cross-sectoral approaches; a database of funding, program, and training opportunities; technical assistance and support services resources; proven worker engagement, advancement, and retention strategies; state, regional, and local education policy initiatives that support workforce development and energy stewardship, and recommended metrics for performance evaluation. Advocate for Federal policies that advance the nation’s focus on broadening, diversifying, developing and training our workforce to engage all communities.



Recommendation 2
**Cross-Sectoral
Collaboration**

Cross-Sectoral Collaboration, Partnerships, Education, Recruitment and Retention Strategies

While the energy sector is a major electrification workforce driver, the nation requires a workforce that is cross-sectoral, multi-disciplinary, predominately technical and skills-based to achieve an electrification transition and clean energy future. The jobs include electro-mechanical, manufacturing and fabrication, construction, operation and maintenance, and a host of engineering specialties. Convene a national task force to bring the electrification workforce job-relevant training and educational

expertise to the table – coupled with trusted community and worker voices – to be active leaders in developing a diverse national electrification talent stream, connecting employers, workers, and communities. Coordination, cross-sector collaboration, and expanded formal and informal partnerships are necessary to develop an effective national clean energy workforce development plan of action.

Additional Report Recommendations

The remaining recommendations in the report support the development and implementation of a national workforce development plan and the required cross-sectoral collaboration necessary to meet future demands in a manner that is sustainable and leverages the full talent and potential that exists.

Recommendations 3 through 8 convey approaches to turn barriers into opportunities.



Recommendation 3
Secondary and
Higher Education,
Curriculum, Training




Recommendation 4
Educational
Lifelines



Recommendation 5
Funding
Availability
and Use



Recommendation 6
Social Contracting/
Community
Benefits



Recommendation 7
Diversity,
Equity and
Inclusion



Recommendation 8
Establish Program
and Data
Clearinghouse

2. Introduction

2.1. The NIAC's Charge

At the December 13, 2023, National Infrastructure Advisory Council (NIAC) Quarterly Business Meeting, President Joseph Biden tasked the NIAC with developing recommendations to expand the workforce to ensure American capacity to design, manufacture, install, and maintain critical infrastructure. The NIAC Expanding Workforce for Critical Infrastructure Subcommittee is tasked with the following:

- The NIAC will build on the 2021 NIAC [Workforce and Talent Management Study](#) to focus on developing and training the workforce in the electricity infrastructure field to increase American production and manufacturing.
- What investments, programs, and/or training can the Federal government provide to ensure the skillsets of the American workforce meets growing cross-sectoral needs?
- How can the government aim to broaden and diversify the workforce to engage all communities in the clean energy transition?
- The NIAC will also build on the Workforce Development recommendation (5.2.3) in the 2023 [Managing the Infrastructure Challenges of Increasing Electrification](#) report, in which the NIAC recommended advancing education policy initiatives that support workforce development and energy stewardship as key professional and civic competencies for both new and tenured employees.

The NIAC established the Expanding Workforce for Critical Infrastructure Subcommittee to undertake this task. The Subcommittee is led by Co-Chairs Beverly Scott, Beverly Scott and Associates, and Raymond Daddazio, Thornton Tomasetti. A list of the 15 Subcommittee members can be found in [Appendix A](#).

2.2. Subcommittee Activities

The Subcommittee held meetings on the following dates:

February 22, 2024 – The Subcommittee held its kickoff meeting to begin discussions on the approach to address the tasking from the White House.

March 5, 2024 – Subcommittee meeting focused on the NIAC's previous related work.

March 19, 2024 – The Subcommittee discussed briefer suggestions.

April 2, 2024 – Subcommittee meeting focused on the impacts on the electrical power sector. Briefings on the subject were provided by the following:

- Jacqueline Hall, Scholars Programs Manager, Semiconductor Research Corporation (SRC)
- Paige Shevlin, Strategic Advisor for Infrastructure Workforce Development, U.S. Department of Transportation
- Roger Millar, Secretary of Transportation, Washington State Department of Transportation
- Earl Key, Senior Director Transportation Equity, Washington State Department of Transportation
- Jeff Pelton – Assistant Secretary for Finance and Administrative Services, Washington State Department of Transportation

April 16, 2024 – The Subcommittee received briefings from the following:

- Tom J. Kriger, Director of Education and Research, North America’s Building Trades Unions (NABTU)
- Jamaine Gibson – Director for Workforce Development and Apprenticeship, Amalgamated Transit Union (ATU)
- Cherise Myers, Director of Workforce Development, American Public Transportation Association (APTA)

April 30, 2024 – The Subcommittee received briefings from the following:

- Madeline Janis, Jobs to Move America
- Missy Henriksen, Center for Energy Workforce Development (CEWD)
- Donnie Colston, International Brotherhood of Electrical Workers (IBEW)

May 14, 2024 – The Subcommittee received briefings from the following:

- Rachel Lipson, Senior Policy Advisor, CHIPS Program Office, U.S. Department of Commerce
- Gabriela Cruz Thompson, Senior Director, University Research and Collaboration, Intel Corporation

May 28, 2024 – The Subcommittee received briefings from the following:

- Cierra Mitchell, Division Director, Division of Industry Engagement and Strategic Partnerships, Department of Labor

June 18, 2024 – The Subcommittee received briefings from the following:

- Jim Means, Education Program Specialist, Department of Education (ED), Office of Career, Technical and Adult Education, College and Career Transitions Branch

June 25, 2024 – The Subcommittee received briefings from the following:

- Maya Goodwin, Workforce Strategy Lead, Department of Energy (DOE), Office of Energy Jobs
- James Strange, Director of Equity, Labor, and Economic Prosperity, DOE, Office of Energy Justice and Equity

July 9, 2024 – The Subcommittee received briefings from the following:

- Veronica Grantham, Regional Operations Director, North Carolina Department of Commerce (DOC), Division of Workforce Solutions

July 30, 2024 – The Subcommittee received briefings from the following:

- Jalonne White-Newsome, Senior Director for Environmental Justice, White House Council on Environmental Quality
- Charles T. Wallace-Thomas IV, Senior Advisor for Justice 40, White House Council on Environmental Quality

August 6, 2024 – The Subcommittee held an administrative discussion.

August 13, 2024 – The Subcommittee received briefings from the following:

- Jerome Lavelle, North Carolina State University
- Hessam Ghassemi, North Carolina State University
- Kim Roberts, North Carolina University
- Randal Kreuz, Customer Care Network, Inc.
- Jennifer Worth, American Association of Community Colleges

August 27, 2024 – The Subcommittee received briefings from the following:

- Jason Chung, Hawaii Defense Alliance
- Jennifer Sabas, Hawaii Defense Alliance
- Tremaine Mitchell, Youth Action Project
- Lisa Krueger, West Seneca Central School District

October 15, 2024 – The Subcommittee held an administrative discussion.

October 22, 2024 – The Subcommittee held an administrative discussion.

October 29, 2024 – The Subcommittee held an administrative discussion.

November 14, 2024 – The Subcommittee held an administrative discussion.

2.3. Organization of this Report

The remainder of this report is organized into the following four sections:

Electrification and Workforce Needs: This section provides context for the findings and recommendations in this report. This report builds upon two previous NIAC studies on workforce readiness for the nation’s critical infrastructure systems and the challenges of workforce readiness for electrification. It details the trends and opportunities for electrification and jobs required for electrification. It also provides examples of workforce development efforts to address short and long-term demands to expand a diverse, equitable, and inclusive workforce.

Findings: This section identifies eight findings that detail the challenges and opportunities to building a strong workforce that meets the electrification needs of the future.

Recommendations: This section presents and describes eight recommendations to prepare a diverse workforce that meets the needs of the nation’s energy sector and the energy transition to electrification. Two of the eight recommendations require immediate Federal action.

Call to Action: The report concludes with a call to action focused on people first, which highlights the actions the President may take to begin addressing the gap in workforce needs for electrification and to make the U.S. more competitive.

In this unprecedented period of recovery, global transformation, and historic national investment in U.S. infrastructure and a sustainable, clean energy future – the U.S. must collectively seize the opportunity to smartly invest in our greatest resource, the American people.

This once-in-a-lifetime national investment will create millions of jobs and generational wealth opportunities that will shape the future for every person and community across the nation today and for generations to come. This requires clear national direction, Federal interagency collaboration and coordination, and local implementation support – including readily accessible information, flexibility, and supportive services.

The nation’s sustainable clean energy future is dependent upon a massive electrification transition. At a time when the electricity subsector is experiencing people-readiness challenges and shortages, this report provides several major findings, recommendations, and specific Federal policy recommendations.

A National Infrastructure Workforce Plan is the missing link and Federal action is needed to help achieve and accelerate the electrification transition today and clean energy future-ready workforce. This workforce plan must include a focus on advancing cross-sectoral collaboration and partnerships across Federal agencies and diverse external constituencies and stakeholders.

3. Electrification: Overview and Workforce Needs

The NIAC’s 2021 *Workforce and Talent Management Study* underscores the importance of the people who make critical infrastructure systems and assets function. The report further notes that the supportive services that workers rely on are also essential to the workforce equation. Likewise, the NIAC’s 2023 *Managing the Infrastructure Challenges of Increasing Electrification* report reviews the challenge of workforce readiness with a specific recommendation on workforce development (5.2.3). This recommendation underscored the importance of advancing education policy initiatives that supports workforce development and energy stewardship. This report highlights similar findings to those found in the NIAC’s previous [reports](#).

Since 2021, there has been major progress in overall infrastructure investment, including elevated emphasis on workforce development and people-readiness with a focus on diversity and inclusion. Through electrification efforts in this country, there is an opportunity to achieve shared prosperity for all. The briefers and other reading resources cited in this report provide clear examples at all levels of government, industry, non-profit and other sectors, but implementation remains the challenge. Connecting implementation at the local level with all the resources and opportunities that exist is key to having a workforce that is fit for now and the future.

The goal of this report is to summarize the findings and recommendations relative to expanding the workforce to ensure American capacity to design, manufacture, install, and operate and maintain critical infrastructure, specifically related to developing and training the workforce to meet the demands of electrification and the needs of the electrical infrastructure field. There is strong evidence that a confluence of three trends—reshoring of industry, artificial intelligence (AI)-driven database expansion, and broad-based electrification—will drive a sustained period of electric demand growth.

As part of the NIAC’s research, the Council set out to answer the following questions:

- What investments, programs, and/or training can the Federal government provide to ensure the skillsets of the American workforce meet growing cross-sectoral needs?
- How can the government aim to broaden and diversify the workforce to engage all communities in the clean energy transition?

To best answer these questions, recognize barriers, and develop recommendations, the need must be appropriately framed to specify which workforce is needed for what jobs/opportunities and in what timeframe.

3.1. Electrification: Trends and Opportunities

The NIAC’s 2023 *Managing the Infrastructure Challenges of Increasing Electrification* report lays out the trends and opportunities in electrification in a manner that is important to mirror in this report. The rise and reliance on electricity has doubled the expected annual growth rate over the past several years. The shift in electrification is attributed to four factors: technical innovation, consumer preferences and cost savings, corporate policies and investor preferences, and policy imperatives. According to the North American

Electric Reliability Corporation (NERC), there is an expected forecast representing a total 15 to 20% increase in electricity demand over the next 10 years.⁴

The scale of the electrification workforce challenge includes both the supply of, as well as the demand for, electricity and all downstream uses. This includes conversion of appliances, installation of batteries, solar panels, and other devices to modernize homes, and energy efficiency projects for residential, commercial and industrial users. The growing need for manufacturing, installation and maintenance presents a significant need to scale the workforce and offers even greater opportunities for high quality technical jobs and innovation.

As the DOE also forecasts, the U.S. is returning to a period of rising electricity demand which is in part due to technology transformations such as the rise in the use of AI, new and expanded data centers, increased domestic manufacturing, and electrification in different sectors from transportation (electric vehicles) and space heating to water, coupled with the economy-wide goal of reaching net-zero emissions by 2050. The desired shift to clean energy as a means of mitigating climate change intersects with the upward trend of electrification as shown in **Figure 1**.⁵

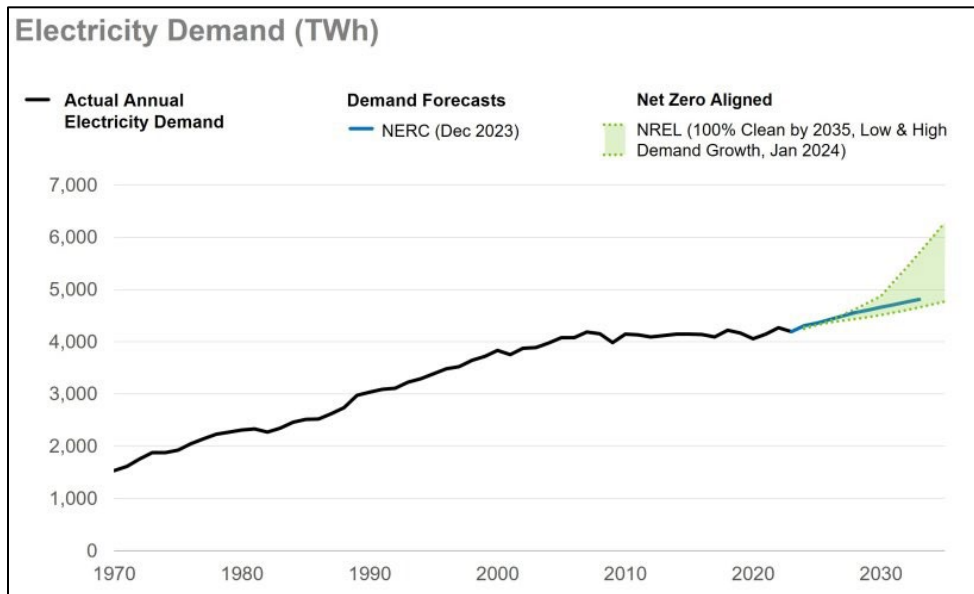


Figure 1: U.S. Electricity Demand (1970-2035)

Notably, the rise in electrification is cross-sectoral, with identified impacts and interdependencies across select critical infrastructure sectors: electric, water, transportation, oil, natural gas, industrial manufacturing, financial services, and communications.⁶

Though the rise in electrification and the addition of new jobs is evident, there are barriers to growth in the sector. In a briefing with Randal Kreuz, Customer Care Network, Inc., he shared that there will be a sustained demand for power transformers over the next 25 years. He also shared there are critical supply shortages, and the U.S. is still dependent upon foreign suppliers as long as the production in the U.S. remains stunted,

⁴NERC, “Electricity Supply & Demand.” 2019.

⁵ U.S. DOE. “Clean Energy Resources to Meet Data Center Electricity Demand.” 2024.

⁶ NIAC. “Managing the Infrastructure Challenges of Increasing Electrification.” 2023.

in part by the lack of workforce in certain regions. There is a need for replacement workers due to an aged workforce or those transitioning to other jobs. Companies of all sizes are finding it difficult to find the workers necessary for production and construction because there still are not enough trained people. Distribution transformer plants in rural areas are having difficulty expanding without the human capital in striking distance of the plants.

3.2. Semiconductors and Beyond: Jobs Required for Electrification

Supporting the global movement towards electrification requires investing in semiconductor production. The advancements and investments in power semiconductors enable the transition to green energy sources and beyond that, electrification across the critical infrastructure sectors. The 2022 CHIPS and Science Act was enacted by Congress and signed into law by President Biden for the purpose of incentivizing implementation of a strategy to revitalize domestic manufacturing, create American jobs at good wages, strengthen supply chains, and be competitive in the semiconductor industry. The act authorized nearly \$280 billion in new funding to increase domestic activities related to semiconductors, of which \$13 billion is for semiconductor research and workforce training.⁷

As required by the CHIPS Act, the DOC and DOD collaborated to establish the National Semiconductor Technology Center (NSTC) to grow the domestic semiconductor workforce because of the crucial role semiconductors play in the energy sector from optimizing the flow of electricity across the system and serving as important components in electronics devices.⁸

Semiconductor Research Corporation (SRC)

Currently, the SRC Talent Factory prepares nearly 20% of the semiconductor PhD workforce in the U.S. and has the capability to increase output by three to five times to meet growing demand.

The semiconductor workforce hires workers with broad skillsets through various points of entry. The jobs related to semiconductor production range from those requiring degrees like research and development specialists, various types of engineers and scientists, business development and marketing, and academia to non-degree occupations like field installation and maintenance technicians, linemen, manufacturing, and packaging.

More broadly, from generation, transmission, and distribution of electricity to transportation, commercial, industrial, and residential consumption, there is an urgent need to equip as many as 17 million replacement workers and 15 million new workers over the next decade.⁹

There is a need to shift from a more labor-intensive coal mining and petroleum and natural gas production, refining, and transportation workforce to a workforce that is centered around renewable generation. There are short-term construction jobs to long-term operation and maintenance jobs and the traditional career development pipelines are falling short of ensuring that the workforce is future-ready.

The briefing from the SRC stressed that industry involvement is critical, social contracting is required, and other funding mechanisms in addition to the CHIPS Act is necessary.

⁷ The White House. "FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China." 2022.

⁸ CHIPS Research and Development Office. "A Vision and Strategy for the National Semiconductor Technology Center." 2023.

⁹ Joseph W. Kane. "The Incredible Shrinking Infrastructure Workforce — and What to Do about It." 2023.

3.3. Diversity, Equity, and Inclusion

A recurring theme through each of the briefings was the importance of expanding a diverse and inclusive workforce through any workforce development efforts. Those delivering critical infrastructure services should mirror the communities in which they work. The growing gap between workforce supply and demand cannot be closed without expanding opportunities to underrepresented demographics and communities across the United States.

Executive Orders and legislation under the Biden-Harris Administration have enacted several policies and initiatives which speak to the prioritization of investing in infrastructure and the workforce in disadvantaged and underserved communities including rural and tribal communities. In a briefing from Dr. Jalone White-Newsome, White House Council on Environmental Quality, she shared the framework of policies that were meant to drive diversity, equity and inclusion starting with Executive Orders 14008 and 14096. Dr. White-Newsome's briefing highlighted the alignment of these executive orders with workforce development. She shared that building an equitable, inclusive, and sustainable economy is grounded in these executive orders. Impacted communities must be engaged early. As the nation's electrification infrastructure expands it is critical to engage various groups from environmental advocates to those in the communities where new facilities and infrastructure are being constructed. Inequitable access to job opportunities must be eliminated, understanding there is no uniform approach, while considering regional differences and availability of various renewable and non-renewable industries driving the types of jobs available.

Executive Order 13985, Advancing Racial Equity and Support for Underserved Communities Through the Federal Government

Established that affirmatively advancing equity, civil rights, racial justice, and equal opportunities is the responsibility of the whole of our government and stated the policy of the Biden Administration to “cultivate a workforce that draws from the full diversity of the workforce.”

Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, established the Justice 40 Initiative

“Federal investments might be made toward a goal that 40 percent of the overall benefits flow to disadvantaged communities. The recommendations shall focus on investments in the areas of clean energy and energy efficiency; clean transit; affordable and sustainable housing; training and workforce development.”

Executive Order 14096, Revitalizing Our Nation's Commitment to Environmental Justice for All, was established to pursue a whole-of-government approach to environmental justice

“By investing in and supporting culturally vibrant, sustainable, and resilient communities in which every person has safe, clean, and affordable options for housing, energy, and transportation.”

While the energy sector may be more diverse than other infrastructure sectors, the focus on developing a workforce to meet the electrification needs of this country must consider diversity, equity, inclusion, and belonging. The critical infrastructure sectors must benefit from all the talent that is available in the U.S. to address workforce deficits in the nation's rural and urban centers.

As shown in **Figure 2**,¹⁰ the share of female and African American workers in clean energy was far less than the national averages across all sectors. The briefing from the CHIPS Program Office supported this assertion that the industry workforce is currently aging, and Black and Hispanic workers as well as women have historically been underrepresented in the semiconductor workforce. This is an opportunity the CHIPS Program office is seizing, having developed a full-time diversity and inclusion team with recent CHIPS workforce events at Historically Black Colleges and Universities (HBCU).

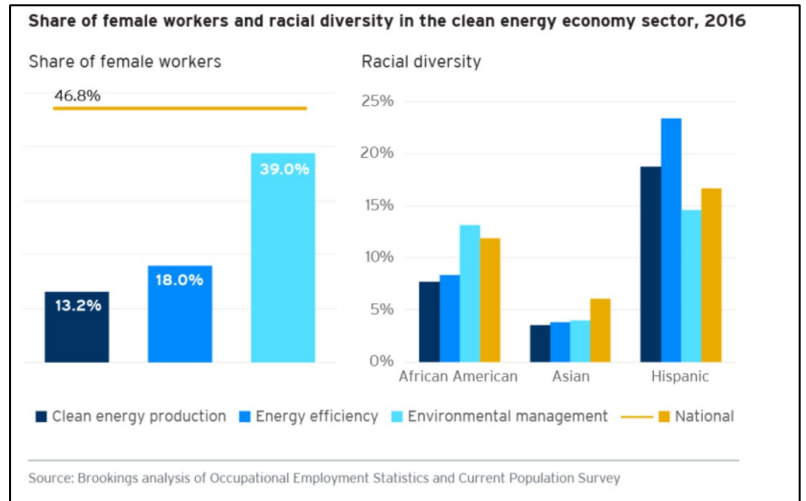


Figure 2: Share of Female Workers and Racial Diversity in Clean Energy Economy Sector, 2016

It is evident that innovations in technology; energy sector infrastructure investments; and state, local, and Federal energy and climate policies continue to spur the creation of millions of jobs for electrification. Yet data from various sources, including the Center for Energy Workforce Development, suggest that these benefits have not extended equitably across the energy sector workforce, which lags on gender and ethnic and racial minority representation particularly within the skilled trades,¹¹ technology innovation and commercialization, and upper-level management of high-growth industries such as renewable energy development.¹²

In 2002, Dr. Melvin E. Bayne, Jr, Morgan State University’s first Doctor of Engineering graduate from the Department of Electrical and Computer Engineering, defended his research dissertation on his approach to using neural networks to model high-electron-mobility transistor (HEMT) devices, a type of semiconductor. The purpose of the research was to develop an innovative approach to modeling the behavioral characteristics of semiconductor devices to optimize designs. Dr. Bayne's reflection, from that time, was that there was limited awareness and availability of opportunities that would have leveraged his expertise in that area of research in all parts of the country. However, today, he is direct evidence that diverse talent and the skillsets needed for the electrification workforce do exist and are available to meet the demand in such a way that there is beneficial impact on all communities.

Electric generating resources and the grid are moving from a heavily centralized system to a more decentralized system to improve efficiency in meeting the needs of all communities, including proximity to reliable and resilient clean energy sources. This shift to decentralized systems has created a need and opportunity to build the necessary workforce in all parts of the country. This effort to grow the workforce to meet the urgent demand for workers will not be successful if unrepresented or underrepresented groups are not a central part of any strategy; specifically, rural and smaller communities, and the opportunities, awareness and much needed resources do not reach all communities.

¹⁰ Mark Muro et al. “Advancing Inclusion through Clean Energy Jobs.” 2019.

¹¹ National Association of State Energy Officials and BW Research Partnership. “Diversity in the U.S. Energy Workforce.” 2021.

¹² Kapur Center. “Tech Workforce – the Leaky Tech Pipeline.” 2024.

4. Findings

Based on the briefings and discussions with subject matter experts from various organizations, the Subcommittee identified several barriers to building a strong workforce to meet the electrification needs of the U.S. By observation, there are two sides to electrification workforce development needs: supply and demand.

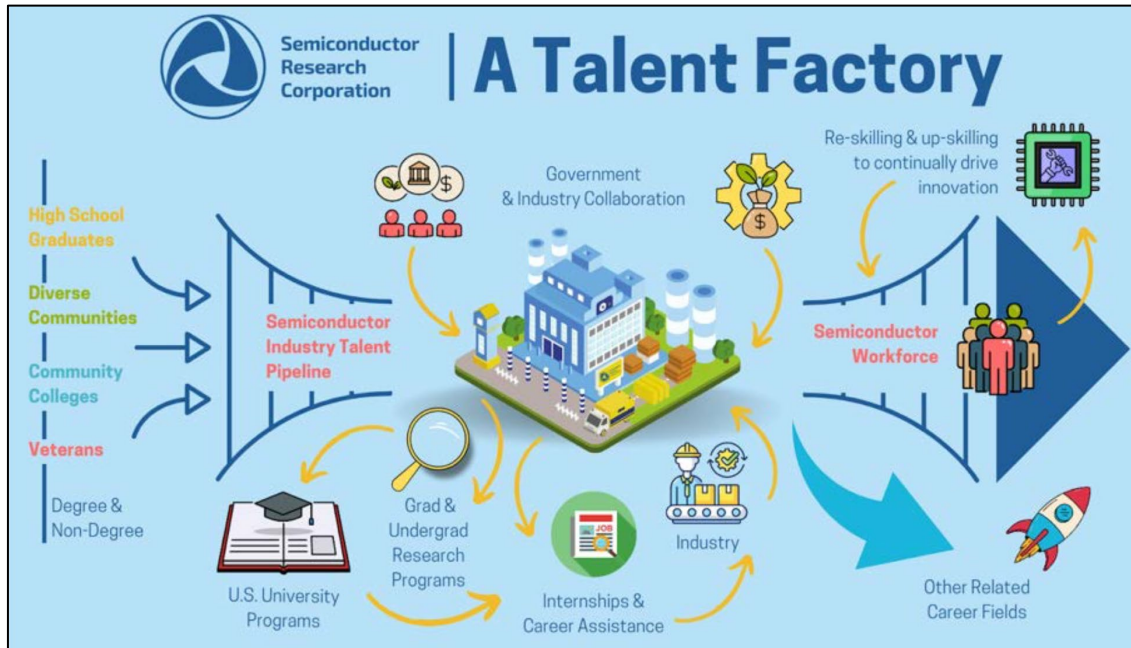


Figure 3: A Talent Factory - A Special Entity for Research and Workforce Development

Well-depicted in the SRC’s “Talent Factory” (**Figure 3**), on the supply side, there is a need to engage high school graduates, those who are unemployed or underemployed, and underrepresented communities and individuals— including degreed and non-degreed veterans— to set up pipelines, provide education and training, and connect individuals from all parts of the country with the opportunities that exist. On the demand side, there is a need for collaboration between government, labor organizations, and industry; a need to fund education and people-readiness programs; a need to amplify opportunities that exist to ensure that individuals are aware; and a need to remove barriers, enhance internship and apprenticeship opportunities, and connect the diverse workforce with the spectrum of career opportunities. Employers across all sectors and community-based organizations are seeking to determine where to source or grow talent to meet the demand for skilled and professional workers. The U.S. DOC, CHIPS Program Office briefed the Subcommittee on the CHIPS for America objectives to reestablish the U.S. as a leader in semiconductors. As much as \$50 billion across two component programs and four integrated programs requires a scaled-up workforce. CHIPS investments alone are expected to generate 256,000 new jobs in construction and manufacturing. It is estimated that 67% will be in manufacturing and 33% in design: a mix that is expected to shift. The barriers to entry are low with an expected 60% of manufacturing jobs available to those without a four-year degree. CHIPS investments are expected to yield skilled prevailing wage construction jobs.

This section of the report highlights eight findings that present the most significant challenges and opportunities for expanding the workforce— from realization of the impacts of a comprehensive national

strategy with supporting policy measures to the lack of awareness. The findings also serve as the basis of the recommendations to meet the objectives of the NIAC’s tasking.

4.1 No Comprehensive National Strategy



Finding I
No Comprehensive National Strategy

The [Workforce Innovation and Opportunity Act](#) (WIOA) of 2014 formed a Federal, state, and local workforce development structure to improve the national public workforce system and connect Americans— particularly those who are dislocated and/or have barriers to employment and youth— with high-quality jobs and careers. WIOA was also meant to help employers hire and retain skilled workers. The public workforce system framework (**Figure 4**) supported by WIOA is anchored by the Department of Labor (DOL) at the Federal level with the DOL’s Employment and Training Administration, which administers over 2,500 American Jobs Centers, a physical and online resource for job seekers to find career paths and training opportunities. Other agencies, including the Departments of Education, Health and Human Services, Housing and Urban Development, Veterans Affairs, and the Small Business Administration, encompass the Federal workforce ecosystem by providing training or wrap-around services, funding, and support to help prepare individuals for employment.

At the state level, each state, U.S. territory, and the District of Columbia has a state workforce agency such as the North Carolina DOC’s Division of Workforce Solutions. Additionally, each state has a workforce development board which is responsible for administering the WIOA requirements.

Likewise, at the local level, WIOA provides funding for local workforce development

boards to perform certain functions to carry out authorized WIOA programs and functions. It is important to note that Federal funding for workforce development, training, and supportive services programs largely flow through this structure.¹³

Similarly, a national framework—though fragmented as noted in the NIAC’s 2021 *Workforce and Talent Management Study*— exists for workforce development in the energy sector with various programs focusing on the clean energy transition, which is spurred by the CHIPS and Science Act of 2022 and Executive Order 14080.¹⁴ The Steering Council is comprised of State, Treasury, Defense, Commerce, Labor, Energy, Office of

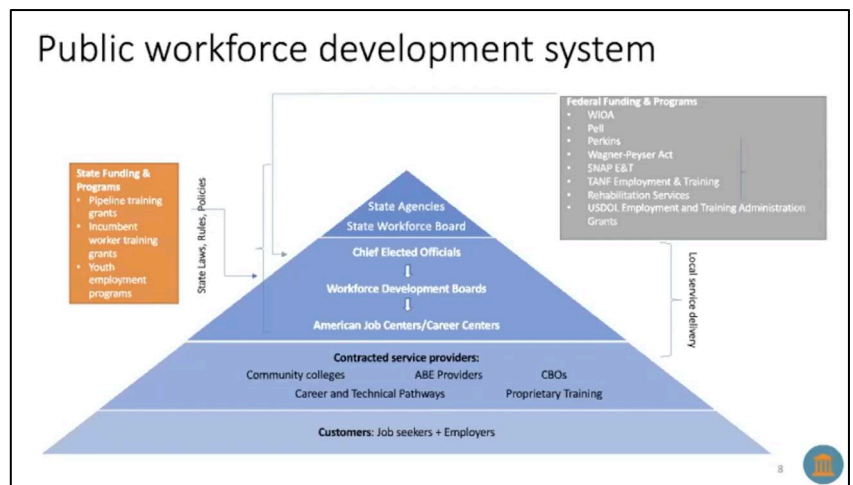


Figure 4: Public Workforce Development System

¹³Lindsay Johnson. “Beginner’s Guide to Understanding the Public Workforce System.” Camoin Associates. 2023.

¹⁴ Executive Order 14080 established the CHIPS Implementation Steering Council within the Executive Office of the President to create well-paying, high-skilled jobs in construction, manufacturing, and maintenance.

Management and Budget, National Intelligence, Council of Economic Advisors, and the National Science Foundation (NSF).

The Subcommittee heard from several briefers directly supporting the objectives of the CHIPS and Science Act and Executive Order 14080's focus on increasing an inclusive and diverse STEM workforce.

The CHIPS for America program has established a whole-of-society call to action, with established objectives to: double the U.S. Semiconductor workforce overall; triple the number of graduates in semiconductor-related fields including engineering; train 100,000 new technicians through apprenticeships, career and technical education; expand recruitment of more people from underserved communities including women, those with disabilities and veterans; and train and hire one million women in construction to meet the demand for CHIPS projects. These are well-placed objectives that are best achieved as part of a national strategy.

Two workforce planning guides offered by CHIPS for America include the *CHIPS Workforce Development Planning Guide* (i.e., wrap-around services, National/Regional/Local Partnerships, curriculum needs, toolkits for Job Quality) and the *CHIPS Women in Construction Framework*, both of which provide examples of components for a national strategy that are replicable.

The DOE, at the forefront of the energy transition in the U.S., is also essential to growing the energy and electrification workforce in parallel to those efforts. The DOE Office of Energy Jobs shared the activities the Department has engaged in to execute the clean energy transition. The Office's priorities include growing American jobs and attracting and retaining skilled workers by prioritizing quality jobs and diversity, equity, inclusion, and access to good jobs in the energy workforce. Given the DOE's role in the energy sector, the Department has established these priorities to help broaden and sharpen its workforce strategy to essentially mirror the scale of change in the sector. While the workforce strategy has begun to reflect this shift, it is not at the scale necessary to meet the demand. This is in part due to the focus of its workforce development investments on undergraduate and graduate students. Conversely, the DOL has invested significantly in registered apprenticeships, growing the electrification-related registered apprenticeship programs by 49% over 74 programs in the last five years. The challenge has been one of awareness, with the lack of private sector and public awareness about the programs being a major gap.

While progress has been made at the Federal level to establish initiatives, leverage available funding, and link policies and frameworks to workforce development, there is often a disconnect in implementation at the local level. However, the NC Works and Charlotte Works programs presented by the North Carolina DOC are strong models at the state and local levels that are providing job training for high demand fields specifically related to electrification. The strategy of NC Works is one that can be replicated as part of a national strategy with a focus on alignment and coordination of workforce development programs, having a customer-focused system that is responsive to the needs of the state's economy and a system that prepares

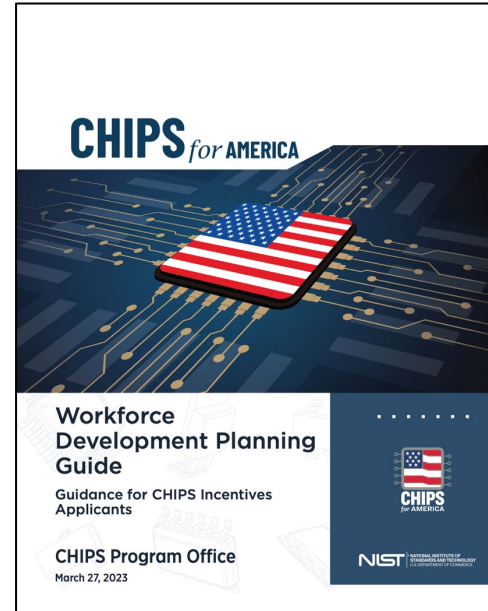


Figure 5: CHIPS for America Workforce Development Planning Guide

From 2011 to 2022, the DOE invested \$2.3 billion in 158 distinct workforce development programs; 80% of these programs supported undergraduate and graduate students.

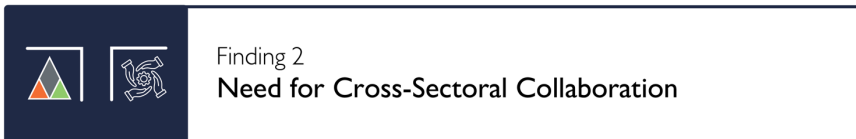
workers for continued success and up-skilling. The Charlotte Works program was born out of a recognized need for one comprehensive strategy and alignment of various workforce development efforts.

The briefings demonstrated that while there are excellent workforce development programs at various levels and across multiple sectors, there is an absence of a comprehensive unifying national strategic workforce framework that leverages the nation’s public workforce structure and the successful regional or state programs that can be replicated, specifically for the clean energy transition and electrification. There is consensus that the workforce is likely the most limiting factor to meeting the policy and economic competitiveness objectives of this time, requiring strategic alignment from the Federal level to frontline implementation.

There is an expectation that multiple critical infrastructure sectors will be engaged in electrification, transformative regulatory guidance/policies will be driving the push for electrification, record-levels of Federal funding will be made available, and there will be a need to fill as many as 800,000 positions in the next several years. Given this expectation, a clear framework and alignment of existing programs informed by a well-defined national strategy will be key to effectively preparing the supply and meeting the demand. A strategic national framework focused on 21st century people-readiness as the foundation would connect the work at every level of government. There is a need for a unifying strategy to coordinate the efforts of non-profit and community-based organizations, labor organizations, government agencies, special advisory groups, and learning institutions. This strategy must also be memorialized in policy.

The consequences of gaps— including a continued lack of an overarching National Infrastructure People-Readiness Plan to inform and unify policy directives and implementation strategies, improve data collection and analysis, coupled with a lack of accountabilities— have a bearing on the enormity of current workforce challenges.

4.2 Need for Cross-Sectoral Collaboration



The nation’s clean energy transition and electrification efforts are cross-sectoral and multi-disciplinary in nature. This poses added levels of complexity in terms of coordination and collaboration to expand the workforce necessary to ensure American capacity to design, manufacture, install, and operate and maintain critical infrastructure. This tasking brings a focus to developing and training the workforce in the electricity infrastructure field, to increase American production and manufacturing, recognizing that investments, programs, and training must meet the growing cross-sectoral needs of electrification.

A current need exists to de-fragment the landscape of workforce development programs and establish a national strategy. Further, the framework must be cross-cutting to engage all levels of government, public and private industry subject matter experts, leadership in all critical infrastructure sectors, academia, local programs, and the labor community.

The NIAC’s 2023 *Managing the Infrastructure Challenges of Increasing Electrification* report emphasized the need for collaboration among different sectors to create cohesive workforce development strategies, and this was further amplified in the briefings from the SRC, CEWD, and Intel, as well as IBEW, NABTU, and the National Governors Association.

Though most critical infrastructure sectors have specific organizations, trade associations, and/or labor unions that are focused on workforce development for their sectors, there are also organizations that focus on the skills and job training that cut across critical infrastructure sectors. These intermediaries have well planned programs and community-level partnerships with educational institutions at all levels, unions, and the employers, both public and private. They offer proven strategies, and they have a capability to adapt to changing workforce requirements and to innovate and pilot approaches.

The need for industry partners and government agencies to better coordinate and collaborate with educational institutions is also evident as a measure to inform curriculum changes necessary to prepare graduating students to enter the opportunity pipeline. The benefits of cross-sector multi-stakeholder collaboration were highlighted most prominently in the SRC's partnerships.

The SRC is itself a consortium of three government agencies, 26 companies, over 100 colleges and universities, 900 industry liaisons, and over 17,000 researchers and practitioners. Chartered to manage academic research on behalf of government and industry, the consortium has placed at the center of its Microelectronics and Advanced Packaging Technologies (MAPT) Roadmap workforce development as the critical enabler. The roadmap provides a three-pronged approach to overcome the workforce gap challenges such as interest and motivation, a time lag compared to the need, the cost and scale of the effort, and ownership, which goes back to the need for a comprehensive national strategy and approach. The roadmap demonstrates the need for cross-sectoral collaboration to address all elements of the ecosystem.

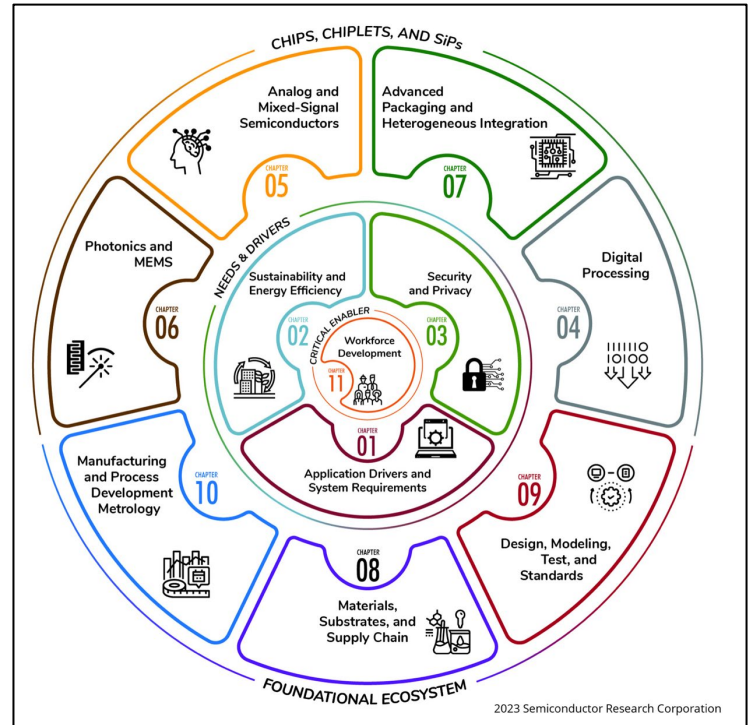
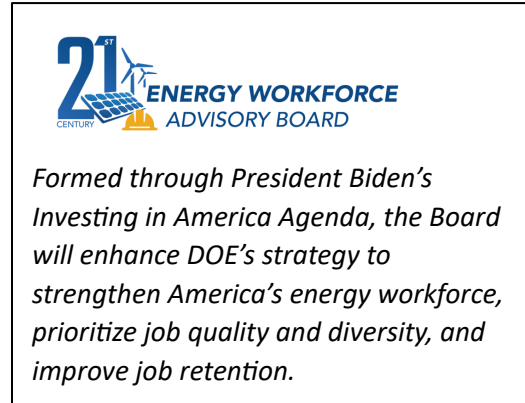


Figure 6: SRC MAPT Framework

NABTU, the Amalgamated Transit Union, and the American Public Transportation Association provided a trio of briefings that further highlighted the focus on preparing skilled workers specifically in the building trades, transit, and bus operations career paths. NABTU represents 11% of the construction industry and, since 2007, has implemented a Multi-Craft Core Curriculum¹⁵ to overcome the decline in vocational education and increase the participation of women and people of color and retention of apprenticeship programs. NABTU spoke to private funding of their apprenticeship training programs and the partnerships with community colleges and high schools for implementation of MC3. Where electrification advances continue in the transportation sector, the need to reskill trained workers persists as a priority. This is evidence that the workforce development focus is not just attracting new talent to the pipeline but retaining existing talent in jobs that are tangential to the energy transition.

¹⁵ The Multi-Craft Core Curriculum is a comprehensive pre-apprenticeship training curriculum. It was developed and approved by the Building Trades National Apprenticeship and Training Committee in 2008.

The Center for Energy Workforce Development presented a macro-industry response as a national, neutral workforce intermediary that engages the IBEW among 140 other stakeholders inclusive of utilities, contractors, labor, national trade associations, and educators. CEWD provided four references that inform the work of the Energy Workforce Advisory Board and its recommendations to the DOE: An Energy Workforce Blueprint, Energy Workforce Primer, Energy Industry Fundamentals, and the DE&I Roadmap for Change. Intel demonstrated its successful partnership with the state of Ohio to grow a workforce in parallel with its commitment to focus on investing in domestic manufacturing. Intel is a private industry cross-sectoral partner to DOE, CEWD, CHIPS program and others to develop a semiconductor workforce by investing in academic collaborations to educate, train, and upskill.

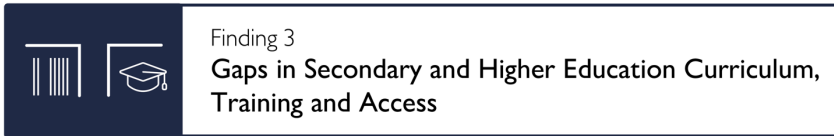


Faced with a required workforce increase of 42% to fill jobs needed by the Department of Defense (DOD) in Hawaii during 2018-2022, Hawaii created the Pacific Intelligence & Innovation Initiative (P3I). P3I is an example of the cross-sectoral collaboration required to build workforce to support any critical infrastructure, including the electric system. P3I brought together Federal, state and local, academia, union, industry and DOD stakeholders to create and enable an ecosystem that could build the workforce pipelines to meet DOD needs. Much of what P3I is doing mirrors this report's recommendations including:

- Expanding the narrative that jobs and high-value careers are available and in reach through outreach programs to diverse groups including students (as young as middle school), women, veterans, disadvantaged workers, and displaced workers.
- Developing pathways from high school and GED programs to 2- and 4-year degree programs, certificate programs, internships, apprenticeships, externships, and into real world job placements provided by industry and government.
- Continuing to expand academic, industry, government, union, and nonprofit partnerships to support and grow the capability of the workforce pipeline ecosystem. Partners include the U. S. Indo-Pacific Command, Pacific Air Forces, U. S. Space Force, University of Hawaii, Chaminade University, Hawaii ED, Hawaii Army National Guard, U. S. Pacific Fleet, U.S. Marine Corps Forces Pacific, Naval Information Warfare Center Pacific, Chamber of Commerce of Hawaii Military Affairs Council representing both industry and unions, National Security Agency/Central Security Service Hawaii, Hawaii Department of Business, Economic Development & Tourism.

This program was seeded through Federal government funding and leveraged through cross-sectoral, community-wide partnerships.

4.3 Gaps in Secondary and Higher Education Curriculum, Training, and Access



The American education system is intended to focus largely on basic skills building and workforce preparedness.¹⁶ However, there appears to be a lag in updating educational curriculum to include new and emerging technologies, which is crucial for keeping the workforce relevant and competitive. Not only is there a gap in educational curriculum, but many institutions have gaps in faculty with the knowledge to teach and provide guidance on these career alternatives for students. The DOL has collaborated with the ED on K-12 programs, specifically addressing the teacher shortage through teacher apprenticeship training programs. Given the high demand, scarce skills, and competitive work environment for persons possessing expertise in these areas will also entail keeping a close eye on competitive pay in these high-demand areas to both attract and retain qualified teachers.

In SRC’s briefing they presented the leaky pipeline concept, wherein they noted 87% of highschoolers are lost to other industries and non-STEM related fields. Yet, the fastest growing opportunities seem to be in the manufacturing, construction, operations and maintenance related jobs that do not require a four-year degree. In fact, CEWD shared that 70% of the new jobs to be created over the next decade will be non-degreed/skilled/craft/ technical occupations.¹⁷ As part of the national strategy, schools should inform high school students well before the senior year of all available options following graduation, as some students choose an alternative path that does not lead to college. Key challenges that need to be addressed include math proficiency, increasing graduation rates, and better equipping career counselors. Pre-apprenticeships were discussed as preparation required by some students to be successful in completing registered apprenticeship training programs.

Additionally, more funding, equipment, software, and other resources are needed to support and implement curriculum and content development. Access to advanced training and educational opportunities is limited, particularly for non-traditional students and those from underserved communities.

The key to expanding the workforce to build the capacity necessary for design, manufacture, installation, and maintenance of critical infrastructure systems is in the preparation of potential candidates. **Figure 6**¹⁸ provides a relative overview of the preparation required by labor category as adapted from several sources by the Subcommittee. The NIAC tasking requested recommendations for training the workforce in the electricity infrastructure field to increase American production and manufacturing.

¹⁶ Justin van Fleet and Rebecca Winthrop. “To Be Globally Competitive, We Must Be Globally Competent.” Brookings Institute. 2010.

¹⁷ Robert Pollin et al., “Employment Impacts of New U.S. Clean Energy, Manufacturing, and Infrastructure Laws.” Political Economy Research Institute. 2023.

¹⁸ U.S. Department of Energy Office of Policy, “U.S. Energy & Employment Jobs Report (USEER).” 2024.

Labor Category	Percentage	Education
High School Education Only	15%	High School
Skilled Trades and Technicians	30%	High School + Apprenticeship
Technicians and Grid Maintenance	25%	Community College, Certificate or Associate Degree
Engineers and System Designers	20%	Bachelor’s Degree
Advanced Research and Policy	10%	Master’s Degree/Doctorate

Figure 7: Workforce Breakdown for Electrification of the Grid

The Subcommittee meetings emphasized the necessity for continuous curriculum updates to keep pace with industry changes and emerging technologies. Knowledge and skill requirements are changing with innovations such as AI— including generative AI— widespread electrification, and advanced manufacturing. These changes drive a need for multidisciplinary training programs that cover the spectrum of required jobs and services including professional engineering services, project management, and regulatory compliance.

Intel provided examples of direct investments in semiconductor education and research at \$50 million with a \$50 million match from the NSF providing more than 2,300 scholarships for higher education and collaboration with more than 80 institutions between 2022 and 2025 for semiconductor education and research. In 2023, Intel launched a one-year certificate program to help build the local talent pipeline across several states and in collaboration with several institutions, another way of diversifying access and pathways to entry.

ED’s data suggests by 2027, 70% of jobs will require some form of post-secondary education or training beyond high school. The ED’s Raise the Bar initiative is meant to ensure every student has a pathway to college and career. As part of this initiative, every high school graduate will have a career plan for their future work-based learning experiences and a workforce credential to provide momentum to complete postsecondary certificate or degree programs to enter a good job.¹⁹

The NIAC emphasizes the importance of training programs that are responsive to the needs of the energy sector, including registered apprenticeships and sector-specific training curriculums. The need for flexible educational pathways and reskilling opportunities was discussed during various briefings in the Subcommittee meetings, highlighting the importance of making training accessible to a broader demographic, including advanced training for a wide range of disciplines necessary for grid electrification.

4.4 Education Deserts



With the demographic decline²⁰, smaller— both rural and urban— and less selective educational institutions who serve many students in vulnerable communities are going to close at an ever-increasing rate. When institutions close, half of their students do not resume their studies elsewhere²¹. Hence, closure of these

¹⁹ U.S. Department of Labor. “The Good Jobs Initiative.” 2022

²⁰ Dan Bauman. “Colleges Were Already Bracing for an ‘Enrollment Cliff.’ Now There Might Be a Second One.” 2024.

²¹ Associated Press. “When Colleges Close, Students Are Left Scrambling. Some Never Go back to School.” 2024

institutions will create higher education deserts. Rural and urban, first-generation, low socio-economic, non-traditional, racial/ethnic minority students may find it difficult if not impossible to physically access a larger more selective institution in an urban or suburban area due to challenges with transportation, as well as managing work and/or family responsibilities. Even if they do, these students are less likely to succeed at larger more selective institutions because they may get lost, lack a supportive culture or strong sense of belonging, and have access to less individual support and attention. Relying on online courses, certification, and degree programs will not solve these issues due to the digital divide. Many rural areas lack internet access. Low socio-economic underserved communities in both rural and urban areas are more likely to lack affordable and adequate internet access or computing resources or to have the digital skills needed to succeed in an online educational environment.²² Consequently, failure to support these less-selective institutions— both public and private— and their financial viability will undermine all other efforts to educate and expand the future engineering workforce.

4.5 Funding Availability and Use



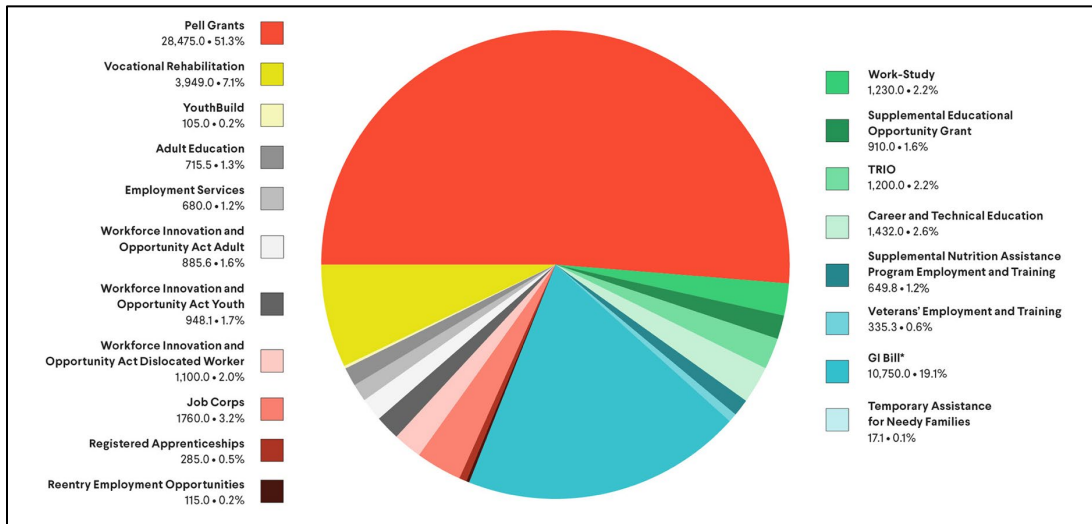
Finding 5 Funding Availability and Use

A common theme across all briefings to the Subcommittee was the need, availability, and use for funding. As a starting point, WIOA is the primary Federal legislation that funds investments in workforce development programs but is itself significantly underfunded based on the general need of the American public, let alone the scale of this effort and the framework through which funding flows is not without challenges. A briefing by Jobs for the Future noted that the U.S. has an array of postsecondary education, skills training, and workforce development programs that provide vital learning and employment services for workers. However, these systems are not adequately funded, and they are not agile enough to fully meet the skill needs of the workforce.

In addition to Pell Grant funding, WIOA funds 17 programs that provide education and training assistance helping millions of Americans to pursue post-secondary education, apprenticeship training, or other short-term training programs for credentialing and licensure. As shown in **Figure 7**²³, the funding for WIOA state formula grants in fiscal year 2023 was \$3.3 billion for all states, with roughly half being spent on Pell Grants and the remaining funding being spent on dislocated worker, youth, and adult training programs and resources.

²² Emily A. Vogels. “Digital Divide Persists Even as Americans with Lower Incomes Make Gains in Tech Adoption.” Pew Research Center. 2021.

²³ Jobs for the Future. “Recommendations for a Fully Funded and Transformed Workforce Development System.” 2024.



**Figure 8: Workforce vs. Pell Grant Funding:
FY23 Federal Funding for Workforce-Related Education and Training Programs**

The ED’s Office of Career, Technical, and Adult Education briefed the Subcommittee on the Strengthening Career and Technical Education for the 21st Century Act (Perkins V) and other programs that aim to expand opportunities, develop skills, and prepare students for high-wage, high-skill, and high-demand occupations. The briefing highlighted fiscal year 2024 appropriations of over \$1.45 billion in formula grants and other programs, including the Native American and Native Hawaiian Career, Technical, and Adult Education (CTE) programs, and for tribally controlled post-secondary institutions with a focus on innovation and modernization. In the case of the Perkins Innovation and Modernization grant program, the funding is specific to improving and modernizing career and technical education to ensure workforce skills that are taught in CTE programs funded under Perkins V are aligned with the labor market needs.

Specific to the energy transition, climate mitigation, and electrification, the CHIPS and Science Act, the IJIA, and the IRA all have measures that allow or specifically identify funding to invest in workforce development and training programs. The Justice40 initiative includes investment in workforce diversity, equity, and inclusion as a consideration. Several of the workforce development programs showed private sector funding from utilities or other industry corporations and intermediaries.

Since the start of the Biden-Harris Administration, the DOL has invested over \$446 million in Federal funding to support efforts to expand, modernize, and diversify Registered Apprenticeship programs. These investments include grants to states, competitive grants, and the national apprenticeship infrastructure. According to CHIPS for America, at least ten states have dedicated new funding to support workforce training for semiconductor jobs. Additionally, as part of the CHIPS project’s terms for construction, modernization, or expansion of manufacturing facilities, funds must be dedicated for workforce development.

Federal legislation under the Biden-Harris Administration has authorized historic levels of funding for investment in infrastructure across all sectors, with provisions for workforce development. However, there is no clearinghouse of information on all sources of funding and the criteria for use. For local and community-based programs, it is important to understand how and where to access funds. Public sector agencies struggle to access the funding that is available based on the eligibility criteria or match funding that may be required. Likewise, it is important for colleges and universities—including community colleges, public institutions and HBCUs— to leverage funding for academic scholarships to attract students and keep them enrolled. Scholarships for higher education institutions are needed, particularly for those that are income-constrained, under-employed or unemployed, or otherwise lacking the means to pay for secondary education. Private sector partnerships— such as the partnership between Intel and the state of Ohio— are making significant investments with private capital providing semiconductor education and research scholarships. Intel has also provided \$50 million in matching funds to further invest in education and research for semiconductors.

In terms of uses of funding, the Subcommittee’s briefings highlighted various uses of funds from apprenticeship training to research and development as well as direct funding to individuals as highlighted in ED’s briefing on several program initiatives. Under the [CTE Momentum Annual Challenge Series](#)³⁸, high school students are prepared for rewarding careers by increased access to career and technical education with a \$50k challenge for students to explore clean energy careers and pathways. In the Career Z Challenge, work-based learning opportunities are provided to students grades 9-12 leveraging a prize pool of \$3 million. Semi-finalists for the program have come from 34 states.

However, as highlighted in the briefing on Justice40 and Jobs to Move America, it is important to engage communities and individuals in communities to find out the best ways to leverage existing funding and to provide what is needed to thrive as part of the electrification workforce. A common theme across the briefings was the need to fund essential needs and supportive services to meet individuals where they are, including funding for training support, transportation, and day care. While funding discussions tend to focus on types of funding to pay directly for education and training, many of the funding programs do not readily address the key barriers to enrolling in programs for post high school education or training for new types of jobs. The key barrier for many— particularly in underserved communities— has been the need to have support funding for themselves and often a family while pursuing higher education or participating in

APPRENTICESHIP USA

Major Areas of Registered Apprenticeship Investment

Grants to States

- State Expansion Grants

Competitive Grants

- Pre-Apprenticeship
- Equity in Apprenticeship
- Youth Apprenticeship
- Apprenticeship Hubs

National Infrastructure

- Industry Intermediaries
- Youth Apprenticeship Intermediaries
- Registered Apprenticeship Technical Assistance Centers of Excellence
- Apprenticeship.gov and e-tools

training/retraining programs. Apprenticeship programs in an earn and learn style provide some assistance but may not fully close the financial need gap.

4.6 Social Contracting/Community Benefits



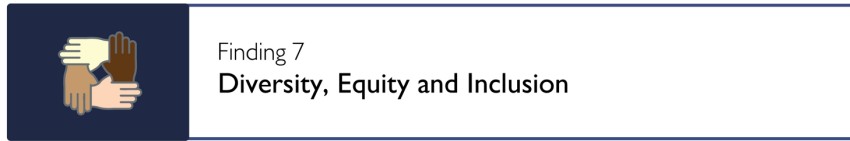
Early on, the Subcommittee received a briefing from Paige Shevlin, U.S. Department of Transportation, who relayed the importance of social contracting. Following that briefing, several other briefers continued to build on this theme and underscored the need to consider comprehensive support services. Ms. Shelvin explained that support services provide the most successful worker development for two specific groups: those who are transitional workers, between jobs, unemployed, underemployed, and displaced; and those who are in high school, community college or just entering the workforce. Returning citizens also require support to avoid recidivism.

There is a notable absence of integrated support services, such as transportation, childcare, soft skills training, and job placement assistance, which are essential for the workforce to thrive, often due to the cost and allowances of funding programs. In the briefing from CHIPS for America, the briefer referenced an employer-driven approach, one that is community guided and with measurable investments. The briefer emphasized the importance of accessible childcare for the semiconductor/construction workforce, as well as transportation assistance indicating a broader need for support services to reduce barriers to workforce participation. Assertion of this need for supportive services to facilitate workforce participation was also discussed in the NIAC's 2023 *Managing the Infrastructure Challenges of Increasing Electrification* report.

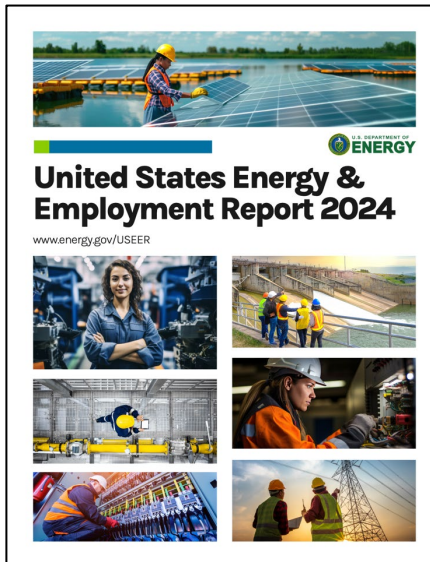
While several programs touched on the need for supportive services, the Washington Department of Transportation (WSDOT) demonstrated the effectiveness of several programs under the Highway Construction and Maritime Trades Scholarships including the on-the-job training support services, Pre-Apprenticeship Support Services Program (PASS), and the Career Opportunity Maritime Preparation and Support Services program, which all showed replicability and scalability to support women and people of color joining the construction and maritime industries. The PASS program has grown from \$750k to \$3 million in support assistance for over 2,000 people since 2015. The Unhoused to Highways Program is providing opportunities for unhoused community members to gain stability by joining a sustainable career path.

WSDOT reported having incorporated childcare for the children of construction workers into recent Project Labor Agreements and the agency is currently evaluating childcare options for the next round of PASS grants.

4.7 Diversity, Equity, and Inclusion



Finding 7 Diversity, Equity and Inclusion



According to the 2023 *U.S. Energy and Employment Report*, as cited by CEWD, 26% of the industry’s workforce were women, 18% of the energy workforce was Latino, 9% were Black, and 9% were Veterans. Based on the 2024 *U.S. Energy and Employment Report*, 76% of employers polled as having less trouble finding people this year than in previous years, and there is a positive shift in representation in some demographics; however, as shared in [Section 3](#), women and people of color continue to lag compared to the overall workforce in the U.S. The Subcommittee recognized that— with myriad efforts and policies driving a focus on diversity in the workforce and inclusion of underrepresented populations like veterans and second-chance citizens— the workforce is incrementally moving in the right direction. However, unless funding, awareness, and access challenges are addressed, there will be difficulty finding enough qualified workers.

Figure 9: DOE United States Energy & Employment Report Cover

A review of Bureau of Labor Statistics (BLS) data demonstrates the need to attract more women and minorities into the profession to close the gap on filling critical engineering related roles.²⁴ In 2023, there were 342,000 civil engineers in the U.S. BLS projects 6% growth in civil engineers over the 10 years, implying an increase to 363,000 in 2033. BLS projects that there will be about 23,000 openings for civil engineers on average through 2033 with many of the openings expected to be a result of the need to replace workers who transfer to different occupations or exit the labor force in retirement or otherwise. According to the 2022 [Engineering and Engineering Technology by the Numbers](#) report from the American Society for Engineering Education (ASEE), a total of 17,205 civil engineering degrees were conferred (12,678 Bachelor’s degrees, 3,656 Master’s degrees, and 871 Doctorate degrees). With roughly 72% of the graduating engineers entering the engineering workforce by 2033, there will be a shortage of 100,000 workers leaving 30-33% of the demand unfilled. By expanding the talent pool and increasing diversity, the civil engineering field can better meet the growing demand, reduce this shortfall, and ensure a sustainable workforce. This gap analysis underscores the need for:

- Increased recruitment efforts to attract more students to civil engineering;
- Retention strategies to keep experienced civil engineers in the profession;
- Addressing diversity gaps to tap into underrepresented groups and increase the available talent pool; and
- Better understanding of the project workforce to make sure that we don't have engineers doing jobs that technicians and skilled labor could be doing.

²⁴ U.S. Bureau of Labor Statistics. “Civil Engineers Occupational Outlook Handbook.” 2018.

Without addressing these factors, the civil engineering profession will struggle to meet both the growth in demand, the leakage in the profession, and the replacement of retiring engineers as represented in **Figure 8**. The work that civil engineers do has an outsized impact on society. Civil engineers design and maintain the infrastructure that serves as community building blocks; however, there is a need to increase the number of women and underrepresented minorities in all engineering disciplines. Diversity efforts are not just philosophical—they are about ensuring the long-term sustainability of the profession in a changing society.

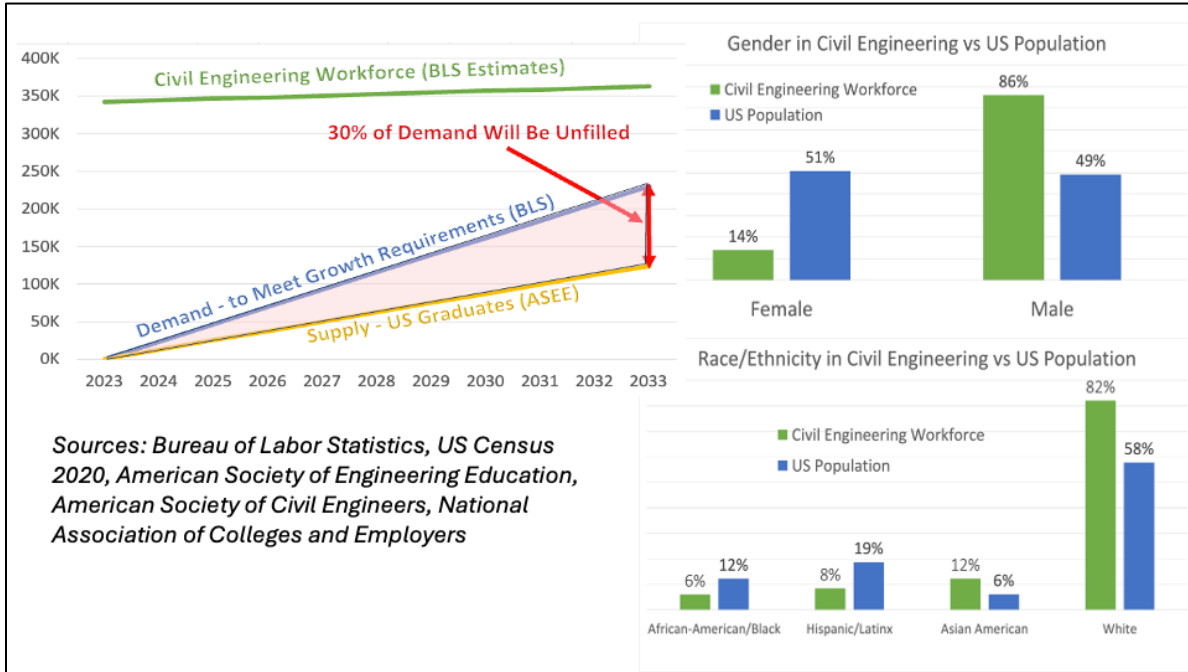


Figure 10: Diversity in Civil Engineering Workforce

The Subcommittee heard from briefers who suggested efforts to diversify the workforce are insufficient, with significant underrepresentation of women and minorities in the energy and semiconductor sectors. The underrepresentation of Black, Hispanic, Native American, and female workers in the semiconductor industry is highlighted, along with initiatives aimed at increasing participation from these groups. For example, the WSDOT presented a suite of workforce development initiatives that are guided by three key areas: resilience, workforce development and diversity, and equity and inclusion, which has led to an increase in overall staffing levels to the highest in six years. The percentage of people of color increased by 4.9% between 2020 and 2024 in part due to the programs that have included a focus on supportive services. The North Carolina DOC prepared a Climate Change Workforce Diversity Report in response to an Executive Order with recommendations to grow a diverse and talented workforce to address the impact of climate change. As part of the implementation strategies, the NC WORKS program has focused on partnerships with both industry and educational institutions including the 11 HBCUs in the state. North Carolina’s Executive Order 303 established a unified, whole of

In January 2022, the Governor of North Carolina signed Executive Order 246 to advance an equitable and just clean energy economy, including the formation of a workgroup to develop strategies to diversify the occupations and industries that are critical to understanding and addressing climate change. This order recognized that the negative impacts of climate change will be felt disproportionately by communities of color, rural communities, and those living in low-income areas.

government approach to improve the education, rehabilitation, and reentry services for incarcerated and formerly incarcerated people. The executive order recognized that people of color are incarcerated at disproportionate rates and face barriers to successful reentry; however, access to education, technical training, and employment opportunities increase the ability to find and keep good paying jobs.

The NIAC’s 2023 *Managing the Infrastructure Challenges of Increasing Electrification* report stresses the importance of equitable and inclusive workforce development efforts, as did Dr. White-Newsome in her briefing on Justice40. She specifically stressed the need to engage community to understand directly what is needed to diversify the workforce based on lived experience and to identify culturally appropriate implementation measures.




Figure 11: Youth Action Project's Pathways to Parity Initiative

The Subcommittee heard from Youth Action Project (YAP), one community-based program. YAP is a community-based nonprofit in southern California’s Inland Empire with over 20 years of experience providing direct academic support, mentoring, youth development, and wrap around services to opportunity youth and families. In the aftermath of COVID-19, YAP worked with state, regional and local partners to fund and launch a region-wide, worker-led and community-supported “Pathways to Parity” initiative (Figure 9) which envisions an equitable and inclusive regional economy and emphasizes closing wealth and ownership gaps for Black residents in the region.

YAP expanded their traditional youth and family programming to include meaningful performance standards and a career awareness and outreach program – emphasizing what they deemed as good jobs and generational wealth creation opportunities – across the top three priorities for Inland Empire regional development, including transportation/logistics, clean energy, and cybersecurity.

Their current work is supported and funded by a diversified mix of local partners, including the California Workforce Development Board via High-Road Training Partnerships (H RTP) funding (through the U.S. DOL), Southern California Edison, The James Irvine Foundation via H RTP matching funds, and a supplemental Flexible Project Support Grant, the Inland Empire Black Equity Fund—fiscally sponsored by the Inland Empire Community Foundation and the Webb Family Fund. Briefing discussions also emphasized the need for targeted recruitment and support for underrepresented groups.

4.8 Clearinghouse for Workforce Development Program Information and Data



Finding 8

Clearinghouse for Workforce Development Program Information and Data

Often the barrier to entering the workforce in a particular career path is the awareness of the opportunities as well as the awareness of the education, training, and experience requirements. High school graduates often have very little concept of available career opportunities or the education and training requirements necessary. This is also true at the college level in technical, business, and other degree programs. In general, students, young adults, and transitioning workers are not given a strong sense of job/industry trends that are important to understand in planning a career path or seeking opportunities to reskill.

This finding bookends the first in that it speaks to the need for a clearinghouse of workforce development programs and data to support implementation of a national framework and plan. This gap makes it particularly challenging for even the most practiced to know what is available and how best to access available programs and funding. The National Academy of Sciences recognized that Americans are responsible for finding their own path, based on their preferences, capacities, and means.²⁵

The absence of a national strategy mirrors the absence of a national clearinghouse or compendium of workforce development program information, electrification workforce focused labor statistics data, and funding sources. With programs at every level of government and programs through non-profits and private companies, it would be helpful to have all these opportunities catalogued in one place for effective implementation at the local level. Various sectors, briefers, and Subcommittee members highlighted that there is a lack of awareness about the career opportunities that exist – further exacerbated by prevalent image issues and outdated understanding of major changes in the electrification work, work environment, and workforce of the 21st century. The result is that job seekers spend significant time trying to find these employment opportunities, in addition to accessing and affording training and development programs – particularly by those who require them the most.

Electrification-related employment opportunities across all critical infrastructure sectors and across every state need heightened awareness, particularly in communities that are disconnected from these opportunities. There are programs like NC WORKS, CHIPS for America, Center for Energy Workforce Development, and the Hawaii Defense Alliance that provide detailed online information and serve as good examples of programs that drive awareness. Without exposing more of the potential workforce to the job opportunities that exist and workforce development and training programs, the U.S. will find it difficult to meet the demand for an electrification workforce.

²⁵ National Academies Press. “The Complex U.S. System of Workforce Education and Training.” 2017.


5. Recommendations

The NIAC’s recommendations address the challenges and opportunities that were identified. The following eight recommendations promote awareness, diversity, and inclusion in cross-sector collaboration, workforce development, training, education, and funding and is related to jobs that immediately support electrification needs. These recommended measures address the tasking as follows:

Tasking	Recommendations
The NIAC will build on the <i>2021 NIAC Workforce and Talent Management Study</i> to focus on developing and training the workforce in the electricity infrastructure field, to increase American production and manufacturing.	1, 2, 3, 4, 5, 6, 7, 8
What investments, programs, and/or training can the Federal government provide to ensure the skillsets of the American workforce meets growing cross-sectoral needs?	1, 2, 3, 5, 6, 7, 8
How can the government aim to broaden and diversify the workforce to engage all communities in the clean energy transition?	1, 3, 4, 7
The NIAC will also build on the Workforce Development recommendation (5.2.3) in the <i>Managing the Infrastructure Challenges of Increasing Electrification</i> report, in which the NIAC recommended advancing education policy initiatives that support workforce development and energy stewardship as key professional and civic competencies for both new and tenured employees.	1, 3 4

This important work will need to be data-informed, based on market demands, and future projections at the national, regional, and local levels. Accomplishing the recommendations will need input and buy-in from the critical constituencies that will need to drive acceptance, resource support, and implementation (i.e., private and public sector employers, organized labor, academia/education/training institutions at all levels, standards organizations, with the initial priority on workforce development related to urgent/near-term electrification/transformer workforce needs).

5.1 Develop Comprehensive National Plan



Recommendation 1

Develop Comprehensive National Plan

Leverage the leadership potential of the Federal government to inform, incentivize, and support high-return workforce development programs at the national, regional, and local levels— including public and private initiatives— applying high standards for performance metrics. Leverage the nation’s complex system of private and public sector employers including manufacturers, organized labor and professional associations, and philanthropic and community-based institutions – both formal and informal – that provide and promote education, counseling, training, and innovation at all levels to clearly define the supply and demand needs for electrifying the workforce.


In the near term, prepare a workforce-centered national electrification report patterned after the [American Society of Civil Engineers’ \(ASCE\) Report Card for U.S. Infrastructure](#) to help elevate public awareness regarding our urgent electrification people-readiness challenges and opportunities. Stimulate greater career

awareness and interest in “good” jobs and begin the work to integrate people-readiness into Federal decision-making and current reporting (i.e., safety, asset management, risk management, and conditions reports).

Utilize this as a model to elevate the overall importance of people-readiness across the critical infrastructure sectors and prepare a recurring national assessment of this people-readiness condition across the critical infrastructure sectors. Collaborate with the Center for Energy Workforce Development, U.S. DOE, DOL, U.S. DOC, NABTU, ASCE, National Society of Black Engineers, Society of Women Engineers, VA, and other relevant Federal agencies.

Use the results of this tasking to advance development of an actionable national strategic workforce framework and unified plan of action with emphasis on best practices, scalability and replicability, lessons learned, emerging trends, new technologies, and promising innovations. Ensure the active engagement of a knowledgeable, diverse mix of public and private sector employers, organized labor, industry, education, and training, non-profit and community-based organizations, encompassing both lived and learned experience. Focus on basic building blocks, including: a common lexicon on occupations and skills, knowledge, and experience requirements that are work-relevant; increased data for comparability; a common database for market needs and demand projections; identified gaps and recommended solutions; performance measures, communications and reporting both internally and externally, and greater accountability. The national strategy should be based on a phased approach that pairs with the timing of electrification job needs. The strategy should also be supported by updating Federal policies that drive implementation, funding, and other actions to support states and local communities and advance national progress.

5.2 Cross-Sectoral Collaboration



Recommendation 2

Cross-Sectoral Collaboration

While there has been notable progress in Federal interagency collaboration, there remains critical need for significantly increased Federal action to require further cross-sectoral coordination, collaboration, and partnerships. Establish a national task force to develop a common workforce development framework that prioritizes job needs and associated essential skills; re-assesses essential education, training, and experience based on 21st century needs; and eliminates unnecessary barriers to crossover training, hiring portability, and stackable credentials.

Build on best practices and lessons learned by applying the [NIST Cybersecurity Workforce Framework](#)²⁶ as a model. Include government agencies; industry partners; and educational institutions, both formal and informal; organized labor and professional associations; as well as cutting-edge research alliances to

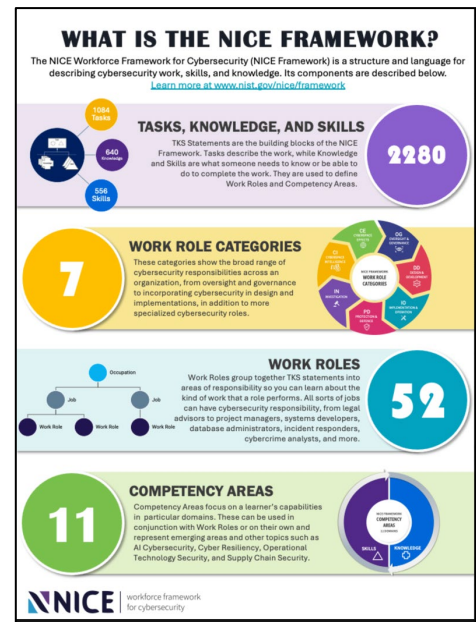


Figure 12: NIST Cybersecurity Workforce Framework

⁴⁴ National Institute for Standards and Technology. “Workforce Framework for Cybersecurity (NICE Framework).” 2023

create this new model and new paths to qualify for jobs. Incentivize development and implementation of these new strategies by the stakeholders.

5.3 Secondary and Higher Education, Curriculum, Training



Recommendation 3 Secondary and Higher Education, Curriculum, Training

This recommendation builds on the Workforce Development recommendation (5.2.3) in the NIAC’s 2023 *Managing the Infrastructure Challenges of Increasing Electrification* report, in which the NIAC recommended advancing education policy initiatives that support workforce development and energy stewardship as key professional and civic competencies for both new and existing employees.

The NIAC further recommends leveraging community colleges; enhancing industry partnerships and networks; expanding work-based learning and experiential learning opportunities; and incentivizing creation of new models of education that offer new content, new models, and new partnerships for infrastructure education through interdisciplinary approaches and expanded career pathway opportunities and access to no/low-cost workforce development tools. Promote affordable, reliable digital access and literacy.

Specific measures of this recommendation include:

- Greater emphasis on— and resources for— community colleges, tribal colleges, technical institutes, and apprenticeship programs.
- Development/implementation of a national infrastructure career awareness/education track for K-12 (emphasis on middle and high schools) related to the nation’s electrification/clean energy transformation.
 - Include pre-apprenticeship programming/entry-level certifications as part of high school curriculum offering, including paid experiential, work-study programs, internship/externship opportunities, mentoring, and industry exposure.
- Focused review of exiting curriculum and support for instructional staff at all levels, including classroom teachers/instructors and guidance counselors to provide training that keeps staff current, knowledgeable, and familiar with the overall programming and curriculum. This would include regular interaction with industry professionals, exposure to the rapidly evolving work environment, and basic employment eligibility and market compensation levels for their respective locales and competitive market compensation levels for their respective levels to support recruitment and retention.
- Promotion of ALL-IN K to Gray continuous learning as a critical element to meet current U.S. competitiveness plans and ensure a future-ready workforce.
- Update of undergraduate engineering and engineering technology curriculum to prepare graduates for the 21st century workplace and improve access, inclusivity, and pathways for students, as outlined in the NSF-funded ASEE inclusive Mindset Report.²⁷

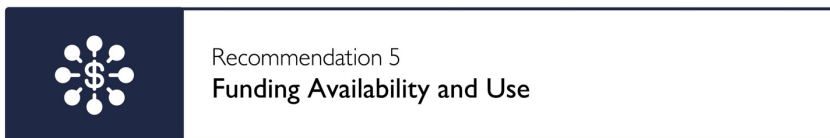
²⁷ American Society for Engineering Education. “The Engineering Mindset Report: A Vision for Change in Undergraduate Engineering and Engineering Technology Education.” 2024.

5.4 Educational Lifelines



Invest in educators and career guidance counselors as well as training the trainers. Create Federal subsidies to incentivize infrastructure career development choices, including differential tuition reduction in academic institutions; rewarding employers who offer paid student internships, meaningful part-time jobs compatible with workers staying in school; and training programs that upskill and reskill workers for electrification and clean energy transition careers, meeting workers where they are in their preparation, providing workers with sustainable income and family-needs support, and addressing training location availability including high quality, affordable internet access. Expand access to advanced training by increasing funding for community colleges, tribal colleges, and vocational training programs, focusing on flexible pathways and support for non-traditional students. Update and expand educational curriculums to incorporate new technologies and practices and emphasize the importance of non-technical skills—such as business, communication, teaming, etc.—supported by Federal funding and industry partnerships. Keeping curriculums current is essential for maintaining a competitive workforce, as highlighted by Intel's curriculum development initiatives.

5.5 Funding Availability and Use



As part of the national strategy and implementation framework necessary to meet electrification workforce demands, NIAC recommends the government:

- Publish a compendium of relevant Federal, state, local, private and philanthropic funding sources and criteria to address deficiencies in awareness.
- Increase alignment of available funding streams for workforce development with critical infrastructure investments, particularly related to climate mitigation, energy transition, and electrification measures across all critical infrastructure sectors.
- Assess and remove limitations on existing funding programs to maximize the use of all relevant funding streams for education, training, skills development, and supportive services to achieve affordable access, sustained engagement for completion of education and training programs, and drive diversity and inclusion.
- Increase Federal student aid and private funding for scholarships and grants for education to increase opportunities for more students to enter and complete science, technology, engineering, and mathematics (STEM) degree programs.
- Fund continuing education opportunities to support K-12 teachers including providing adequate materials and increased financial support throughout the year to allow teachers to focus on student development and STEM encouragement.

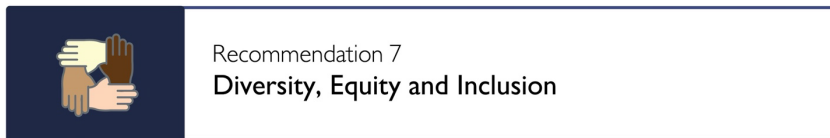
5.6 Social Contracting/Community Benefits



Use the CHIPS for America workforce development model to create a Federal initiative to offer comprehensive student support into workforce development programs including family-care and job placement assistance, with forward-leaning support for four-year and graduate programs to support the complete spectrum of workforce needs. *(Also see Recommendation 4 above.)*

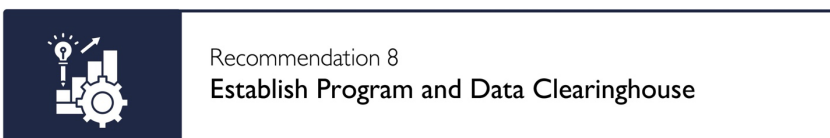
Promote local institutional and community awareness and implementation of the IJJA, Justice40 equity initiatives, and other Federal equity and environmental justice Executive Orders, regulations, and Federal guidance that can be utilized to provide legally enforceable—such as Community Benefits Agreements, new OMB— Federal procurement guidance permitting local hire, and elimination of geographic preference restrictions, consistent with state law, are potentially powerful local workforce development, diversity, and inclusion initiatives.

5.7 Diversity, Equity, and Inclusion



Recognizing the urgency of creating an expanded and diverse workforce for the national electrification push, the national strategy must incorporate training that leads to deemed good jobs with long-term employment and generational wealth creation opportunities. The national strategy should incentivize workers with benefits and opportunities to build financial security, and a sustainable workforce that also raises well-being across the nation. The recommendation for diversity, equity, and inclusion promotes expanded stakeholder engagement and targeted outreach to respected and trusted advocacy and community-based organizations serving under-represented and underserved communities, veterans, priority populations, special needs, and justice-impacted individuals.

5.8 Establish Program and Data Clearinghouse



As part of the Subcommittee’s deliberations, programs like the U.S. Navy’s partnership for the Build Submarines initiative were highlighted as examples of cross-sectoral partnership and as national awareness campaigns for workforce development and recruitment.

Efforts are needed to engage guidance counsellors at high schools, placement programs at colleges/universities, and workforce development boards throughout the country to develop awareness and potential worker motivation to join the electrification workforce. Finding 8 underscored the need for greater insight by all communities across the country into the skill development opportunities and workforce pathways that exist as early as possible. A key cultural goal is to shed light on the spectrum of potential hopeful pathways for youth that will provide a sustained livelihood and allow for greater societal contributions.

To eliminate gaps and support a sustained national awareness campaign, this recommendation is focused on creating a user-friendly national repository for best practices; promising and innovative cross-sectoral approaches; a database for the funding compendium (Recommendation 5); program and training opportunities; successful approaches for new worker recruitment, engagement, advancement, and retention; technical assistance and supportive wrap-around services with resource information; state, regional, and local education policy initiatives that support workforce development and inclusion and energy stewardship; and recommended metrics for performance evaluation.

6. Call to Action

People First: The Greatest National Resource and Unfinished Business

In this unprecedented period of recovery, global transformation, and historic national investment in U.S. infrastructure and a sustainable, clean energy future, the U.S. must collectively seize the opportunity to smartly invest in our greatest resource – the American people.

Ensure that every American can contribute to and achieve their full potential and participation in this great nation. This once-in-a-lifetime, national investment will create millions of jobs and tremendous generational wealth, creating opportunities that will shape the future for every person and community, across the country today and for generations to come. To accomplish this will require clear national direction, Federal interagency collaboration and coordination, and local implementation support, including readily accessible information, flexibility, and supportive services.

The nation’s sustainable, clean energy future is dependent upon a massive electrification transition, especially at a time when our electricity subsector is experiencing people-readiness challenges and shortages.

The missing link and further Federal action most needed to help achieve and accelerate our electrification transition today and clean energy future-ready workforce is a National Infrastructure Workforce Plan. Advancing cross-sectoral collaboration and partnerships – working relationships across Federal agencies and proactive engagement of diverse external constituencies and stakeholders – is increasingly important in this interconnected world. This will help rebuild and update the image, important value, and public service element of these careers, with emphasis on essential frontline positions and other priority needs. This must include robust engagement of diverse stakeholders and important constituencies and new voices who engage in employment, education, and training across the nation’s critical infrastructure sectors.

To support this critical work, the NIAC advocates and elevates support for Federal policy and continued action in the following areas:

- Broaden, diversify, develop, and train our workforce to include all communities – with emphasis on essential positions.
- Expand support for important wrap-around services.
- Increase universal access to reliable and affordable internet service to minimize barriers.
- Increase access to lifeline educational institutions in predominately rural and smaller communities – including consideration of regionally significant electrification services and facilities.
- Support immigration practices that support workers who help to address documented workforce shortages.

Appendix A: Acknowledgements

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Appendix B: Definitions

Term	Common Definition
Electrification	The replacement of fossil fuel energy sources with electric alternatives to achieve improvements in efficiency, performance, cost, energy sovereignty, air quality, and greenhouse gas emissions.
Energy Sector	The energy sector refers to a multifaceted web of electricity, oil, and natural gas resources and assets to maintain steady energy supplies and ensure the overall health and wellness of the nation.
Critical Infrastructure Sectors	The systems and assets, whether physical or virtual, so vital to society that the incapacity or destruction of such may have a debilitating impact on the security, economy, public health or safety, environment, or any combination of these matters.
K - Gray	The education and training pipeline from kindergarten through the mature workforce that is the target for generating interest, engagement, and knowledge building to enter pathways for a particular workforce.
Good Jobs Principles	From DOL and DOC, “good jobs principles” provides a framework for expanding quality jobs. The framework focuses on eight areas: recruitment and hiring; benefits; diversity, equity, inclusion, and accessibility (DEIA); empowerment and representation; job security and working conditions; organizational culture; pay; and skills and career advancement.

Appendix C: Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
ASEE	American Society for Engineering Education
ATU	Amalgamated Transit Union
AI	Artificial Intelligence
BLS	Bureau of Labor Statistics
CBA	Community Benefits Agreements
CEWD	Center for Energy Workforce Development
CHIPS	Creating Helpful Incentives to Produce Semiconductors and Science Act
CTE	Career Technical and Adult Education
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
DEIA	Diversity, Equity, Inclusion, and Accessibility
ED	Department of Education
EO	Executive Order
ETA	Employment and Training Administration
HRTTP	High-Road Training Partnerships
IBEW	International Brotherhood of Electrical Workers
IIJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
MAPT	Microelectronics and Advanced Packaging Technologies
MC3	Multi-Craft core curriculum

NABTU	North America’s Building Trades Unions
NERC	North American Electric Reliability Corporation
NIAC	The President’s National Infrastructure Advisory Council
NSTC	National Semiconductor Technology Center
OMB	Office of Management and Budget
P3I	Pacific Intelligence & Innovation Initiative
PASS	Pre-Apprenticeship Support Services Program
SRC	Semiconductor Research Corporation
STEM	Science, Technology, Engineering, and Mathematics
WIOA	Workforce Innovation and Opportunity Act
WSDOT	Washington Department of Transportation
YAP	Youth Action Project

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