Inventory of Clean Energy Education and Workforce Programs in Connecticut's I-91 Corridor

May 22, 2024

Allison Moe, Sika Gadzanku, Ryan Shepard, Heidi Tinnesand, and Elizabeth Gill

National Renewable Energy Laboratory

Produced for the U.S. Department of Energy by the National Renewable Energy Laboratory (NREL).

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List of Abbreviations

BREP	Bridgeport Regional Energy Partnership
CTE	Career and Technical Education
DOE	Department of Energy
EE	Energy Efficiency
EWD	Education and Workforce Development
HVAC	Heating, Ventilation, and Air Conditioning
IBEW	International Brotherhood of Electrical Workers
IRA	Inflation Reduction Act
LEAP	Local Energy Action Program
NREL	National Renewable Energy Laboratory
SOW	Scope of Work
TA	Technical Assistance
U.S.	United States

Executive Summary

This document reports on the findings of an inventory of the educational and workforce development resources in a four-county area on the I-91 corridor in Connecticut. Connecticut established a goal to achieve net-zero carbon electricity supply by 2040 (EIA, 2023). Meeting this goal will require many more workers than the county currently has in clean energy fields. The overarching goal of this exercise is to help the local workforce leaders in Bridgeport, Connecticut optimize their training programs to support the county's clean energy transition. The inventory generally finds that Fairfield County, where Bridgeport is located, lacks adequate education and training programs compared to other surrounding counties with similar populations. More than half of Fairfield County's programs occur through high school or career technical education (CTE) programs, suggesting that there are minimal opportunities for workers who are not currently high school students. Much of the existing focus within Fairfield County is on general construction or plumbing and electrical skills. There is room to expand by offering more programs focusing on energy efficiency (EE) and renewable energy (RE) skills. The document outlines some potential next steps and questions for consideration for the local workforce leaders in Bridgeport.

Bridgeport is a city located within Fairfield County in southwestern Connecticut. It is the largest city in Connecticut with an estimated population of 150,000. Through the U.S. Department of Energy-funded Communities LEAP (Local Energy Action Program), the National Renewable Energy Laboratory (NREL) conducted an analysis of existing education and workforce development (EWD) programs located in Fairfield County that align with (or could support) the worker pipeline for occupations related to building energy efficiency (EE), renewable energy (RE), and clean energy manufacturing.[1] The analysis also looked at EWD offerings in nearby counties in Connecticut as a point of comparison. Some key takeaways are described below:

- Fairfield County has 23 training, education, and support programs provided by 10 entities. About half of those programs are in general construction, nearly one-third of those programs are related to EE or heating, ventilation, and air conditioning (HVAC), and 9% are in advanced manufacturing. The other programs provide general and wrap-around employment support services such as interview preparation support. There are no RE training programs in the county.
- Most of Fairfield County's programs are through high school career and technical education programs.
- Fairfield County has far fewer programs available compared to Hartford and New Haven Counties, despite similar population levels.
- Potential opportunities for Fairfield County include (1) incorporating building science content into existing community college and trade school programs, and (2) adding more advanced/clean energy content to existing high school and community college manufacturing programs. Another opportunity is to develop solar skills training programs. The community can have direct conversations with local industry and employers before moving forward in any expansion of training or education programs.

[1] Although RE and clean energy in many cases are used interchangeable, they are distinct technology areas. RE refers specifically to energy generation projects that focus solely on renewable sources, such as solar PV, wind energy, biofuels, or hydroelectric. Clean energy refers to both energy generation or energy efficiency projects that help reduce pollution by greenhouse gases or other byproducts of conventional fossil fuel infrastructure.

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Introduction

This document summarizes part of the work performed under Activity 6 ("Community Capacity Cataloging and Gaps Assessment") in the Scope of Work (SOW) between the technical assistance leads from the National Renewable Energy Laboratory (NREL) and the Bridgeport Regional Energy Partnership (BREP). This work is part of Bridgeport, Connecticut's participation in the Communities LEAP (Local Energy Action Program) Pilot Technical Assistance program facilitated by the United States (U.S.) Department of Energy (DOE).

During the scoping process, BREP expressed a need to benchmark the readiness of their community's education and workforce development (EWD) resources to help Bridgeport and Connecticut accomplish their clean energy goals. In response, NREL performed an inventory in the summer of 2023 of the region's EWD resources. This document summarizes the findings of that inventory and analyzes potential capacities and gaps in the region's EWD resources. The overall goal of this activity is to inform plans and discussions among leaders from BREP, the City of Bridgeport, Fairfield County, and the State of Connecticut for the future development of the local, regional, and statewide workforce for the clean energy transition currently underway.

The inventory sampled a four-county area within Connecticut along the I-91 corridor. These counties include Fairfield, Hartford, Middlesex, and New Haven. The inventory collected the following data for each EWD resource:

- □ Name
- □ Address
- □ Web URL
- □ Technology focus area (i.e., wind, solar, energy efficiency, manufacturing, plumbers and electricians, general construction, or general workforce/other)
- □ Program/audience type (i.e., K-12/career and technical education (CTE), community college, technical school, college/university, corps, nonprofit, general job seekers, economic/business services, industry associations, or union/skilled trades)
- □ Type of training offered (i.e., online training, in-person training, work-based learning, apprenticeship, professional development, mentorship, support/wrap-around services, or other)
- □ Degrees/certifications offered (i.e., high school diploma/GED, AA/AS, BA/BS, MA/MS, certification, continuing education credits, job/work experience, or other).

Discussion of Analysis

Fairfield County

Our analysis found 10 companies, institutions, or organizations located in Fairfield County that offer 23 different training and education programs. As shown in Figure 1, almost half of these programs are in general construction or other trades, which we defined as plumbers and electricians. Almost one- third are in energy efficiency (EE) and heating, ventilation, and air conditioning (HVAC), with six of those seven programs in HVAC and only one specific to home energy retrofit/efficiency work.[2] Nine percent (two programs) are in traditional manufacturing, with no programs specific to advanced or clean energy manufacturing practices. There are no education or training programs we found in the county that specialize in renewable energy (RE) education or hands-on installation specifically. The remaining programs are general workforce and wrap-around service providers, which can be engaged to supplement workforce development efforts by other training organizations, particularly if their is a goal to recruit new workers from underserved or disadvantaged communities.

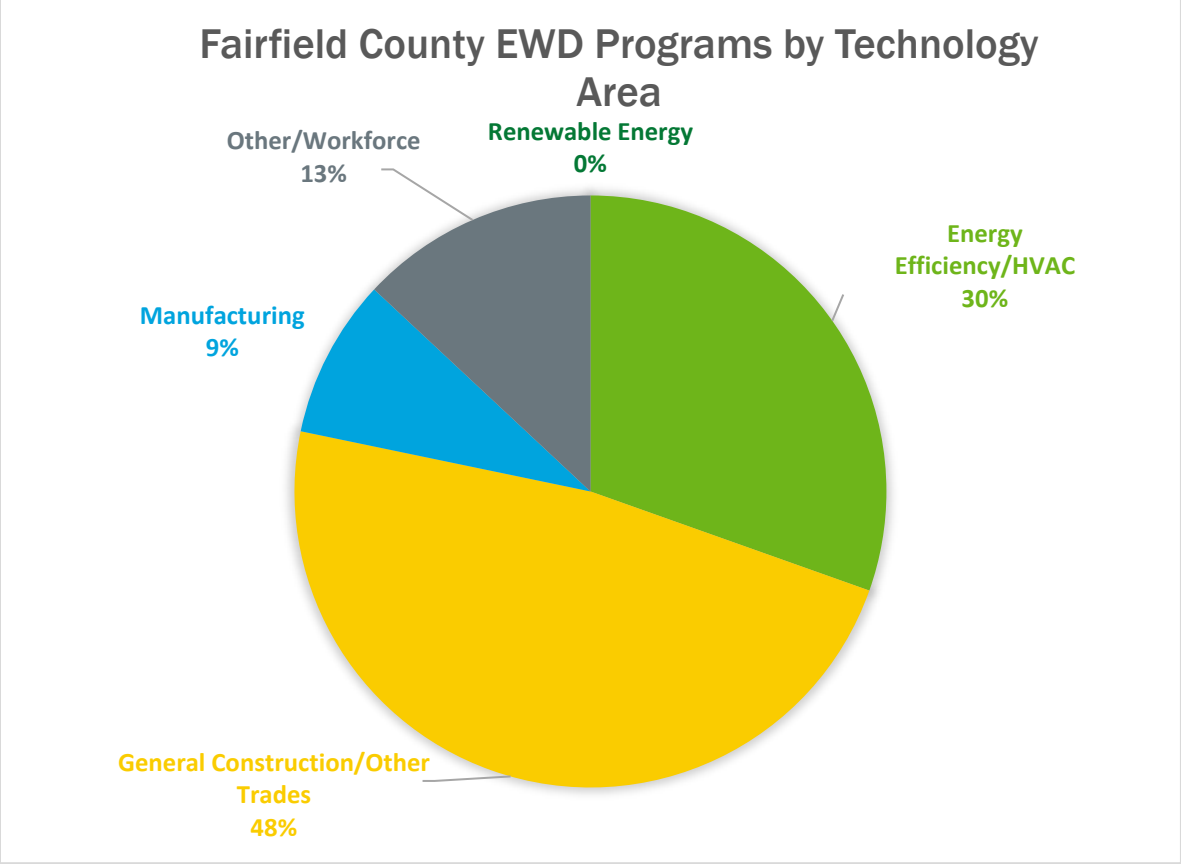

Figure 1. Fairfield County EWD Programs by Technology Area

[2] The State's Technical Education and Career System program does include Building Performance Institute's Building Science Principles certification for the Carpentry, HVAC, Electric, and Plumbing and Heating pathways, as well as in its Architecture pathway (not included in this inventory).

Most of the programs in Fairfield County (13) are part of the state's career technical education (CTE) system, with an additional three programs through private technical schools, and one through a community college. There is one union program in the County (the International Brotherhood of Electrical Workers (IBEW) Local 988).

Comparisons with Other Counties

As a point of comparison, this analysis also inventoried EWD programs in Hartford, Middlesex, and New Haven Counties. The inventory identified 79 total programs provided by 35 organizations in these other counties. Based on population, Fairfield County has fewer programs per 100,000 people than any of the comparison counties. It has a similar number to Middlesex County, which has a significantly smaller population overall. Key technology/industry areas where Fairfield County has fewer training programs compared to these others is manufacturing and HVAC; none of the community colleges in the county offer programs in these areas in particular. A summary of programs is provided below. Figure 2 shows a map of Connecticut with the four-county study area highlighted and the general locations of EWD resources by the type of provider. Table 1 displays the number of EWD resources for each of the four counties by the type of technology area and also shows the overall density of EWD resources in each county based on population. Table 2 shows the number of EWD resources for each of the four counties by the type of intended target population (e.g., community college, general job seekers, union/skilled trades) and overall total of programs for each county.

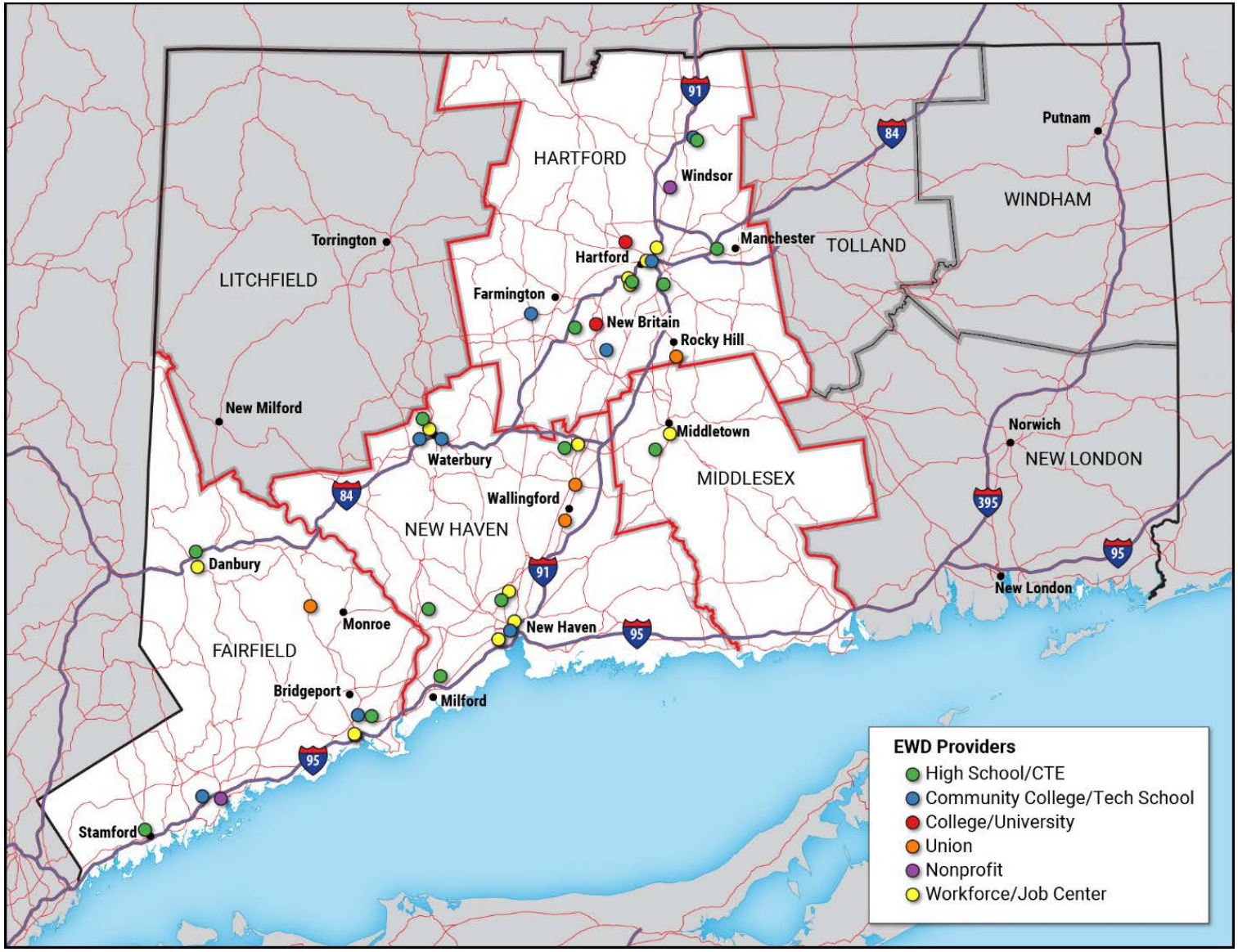

Figure 2. Map - EWD Ecosystem - County Comparison

Table 1. Number of EWD Resources by County by Resource Focus Area

County	Population	Wind	Solar	Energy Efficiency / Green Building	Manufacturing	Plumbers and Electricians	General Construction/Other Trades	Other	Total	Programs per 100,000 People
Fairfield	959,768	0	0	1	2	7	4	3	23	2.4
Hartford	896,854	0	0	2	6	6	5	5	35	3.9
Middlesex	164,759	0	0	0	0	1	1	1	4	2.43
New Haven	863,700	0	0	2	8	8	5	6	40	4.63
Total	2,855,081	0	0	5	16	25	15	15	102	3.54

Table 2. Number of EWD Resources by County and Audience Type

County	Population	Audience Type									Total
		K-12/CTE	Community College	Technical School	College / University	Job Corps	Nonprofit	General Job Seekers	Industry Association	Union / Skilled Trades	
Fairfield	959,768	13	1	3	0	0	0	3	2	1	23
Hartford	896,854	13	2	5	6	1	2	2	0	4	35
Middlesex	164,759	3	0	0	0	0	0	1	0	0	4
New Haven	863,700	23	5	3	0	0	0	6	0	3	40
Total	2,855,081	52	8	11	6	1	2	12	2	8	102

No RE programs are available in any of the counties investigated. Some university engineering programs may offer coursework related to specific RE technologies but there are no training programs or programs of study that specifically focus on RE. In addition, we found only three programs in these counties with a focus on advanced or clean energy manufacturing, all of which are located in Hartford: Electromechanical Engineering programs at the University of Hartford, a Manufacturing Engineering program at Central Connecticut State University, and an Aerospace Component Manufacturing Technology CTE program at A.I. Prince Technical High School.

Capacity Catalog and Gaps Analysis

This section reviews the findings of the EWD inventory and identifies areas where local and regional workforce resources have capacity or have gaps in their ability to facilitate a clean energy economy and transition.

Gaps Identified

The following are gaps identified in the current EWD landscape, either within Fairfield County or in the larger four-county study area:

- **Fairfield County lacks sufficient EWD capacity**. While Fairfield County and Bridgeport, Connecticut are, respectively, both the most populous county and city in the state, Fairfield County has the lowest per-capita number (2.4) of EWD resources per 100,000 residents. Middlesex County has 2.43 resources per 100,000 residents but has less than one-fifth of Fairfield County's population. New Haven County, on the other hand, has a similar though slightly smaller population than Fairfield County's but has almost twice the per-capita number of programs at 4.63 resources per 100,000 residents.
- **No programs offering solar/wind energy technology expertise**. Of the 104 EWD resources and 45 EWD providers in the four-county area along the I-91 corridor, none currently offer any training or courses specifically focusing on solar or wind energy technologies. There are only five EE/green building programs in the study area and only one of them (The "Building Energy Technology and Design" course by Steven Winter Associates) is in Fairfield County.
- **Limited manufacturing EWD capacity**. Of the 23 EWD resources in Fairfield County, only two touch on manufacturing specifically. Other resources may include manufacturing content to an extent, but this is not the same as a course or training with manufacturing as its primary focus. Since BREP has expressed an interest in clean energy manufacturing, this could be an area of future expansion.
- **Limited K-12 opportunities.** Comparatively, there are limited K-12 programs that introduce high school students to EE and the trades. In Fairfield County, there are 13 EWD resources focusing on K-12 audiences and only six focus on trades[3] and none focus on EE. Given that Fairfield County has the highest population in the state, we would expect more programs to exist. Fairfield County only accounts for one-quarter of all K-12-focused EWD resources in the four-county area sampled. By contrast, New Haven County, with a similar population to Fairfield County's, has 23 programs focused on K-12 audiences, comprising nearly half of all K-12-focused EWD resources in the four-county area. Of these 23, 13 EWD resources focus on the trades— more than twice the amount in Fairfield County.
- **Accessibility to EWD opportunities.** This analysis indicates that except for unions, there are limited low- or no-cost robust training opportunities outside of the K-12 education system, especially in the building sectors. Almost all identified programs are paid and/or short-term (one-day trainings). Compared to apprenticeship programs which are paid multiyear on-the-job training opportunities, individuals having to pay to obtain short-term training could be a

[3] In this context, the "trades" refer to EWD resources focusing on "plumbers and electricians" or "general construction."

barrier to participation. The Regional Urban Energy Jobs Program is a new pre-apprenticeship program that may try to address this potential barrier.

- **Limited wrap-around services.** While professional development services are available, few offer wrap-around services that would otherwise reduce the barrier to entry, such as being a parent, or having transportation access challenges.

Aligning with Clean Energy Workforce Needs

Workforce leaders in Bridgeport and Fairfield County could implement several strategies to increase their EWD capacity to meet the workforce needs of the ongoing clean energy transition more adequately and close identified gaps in its current EWD ecosystem.

First, as most of the existing EWD resources in Fairfield County target construction jobs, workforce leaders in the county could focus new EWD resources on job training that supports other phases of clean energy projects, such as planning, design, manufacturing, or operations and maintenance. Although a future increase in clean energy projects will increase the demand for the local construction workforce, additional or new EWD resources on construction may not be necessary, as the providers of the existing construction EWD resources may instead simply expand or re-tool these courses or trainings to account for RE and EE considerations.

Secondly, although jobs that support the construction phase of RE and EE projects are currently the most common jobs created by clean energy projects, they tend to be low-paying, short-term, or one-time jobs that will likely not support the kind of permanent and local workforce that BREP desires for Bridgeport (ICF 2023). **On the other hand, the highest-paying jobs (pre-planning professional services) could help increase wages and provide different working opportunities for the community (ICF 2023).** In Fairfield County specifically, there are two EWD resources that offer this kind of training: (1) Steven Winter Associates: Building Energy Technology and Design and (2) Norwalk Community College: Construction Management. Elsewhere in the state, these kinds of programs and trainings are more common, such as Hartford County's Central Connecticut State University and University of Hartford, which have programs in:

- Manufacturing Engineering
- Mechanical Engineering
- Architectural Design and Technology, Sustainable Design Concentration
- Construction Management and Technology
- Electromechanical Technology; Mechanical Engineering.

Finally, Fairfield County and Bridgeport could benefit from an increase in EWD resources focusing on skills for post-buildout jobs (i.e., facility manager, energy auditor, solar technician) as these jobs are the longer-lasting and tend to be localized (ICF 2023). Two current EWD resources in this field exist in neighboring areas. These include: (1) Hartford County's Tunxis Community College's Energy Management Certificate Program and (2) New Haven County's Local Insulators 33's apprenticeship program where participants learn to perform 3E[4] audits. These existing out-of-county resources could help inform the development of similar in-county training programs for post-buildout-focused jobs.

Opportunities

If Fairfield County is interested in supporting additional training programs to support building EE, RE technology, or clean energy manufacturing, there are existing models within the county, the state and in neighboring states. For building efficiency/home energy retrofit work, most of the workforce

[4] An energy audit conducted with the 3E software owned by the North American Insulation Manufacturers Association that focuses on improvements to building insulation.

nationally requires less than a four-year degree, and many skills are highly transferable to other trades (Muro et al. 2023). The county's existing CTE programs include a Building Science Principles certification, which is foundational to the home performance industry. Opportunities exist to incorporate this and similar training models into local community colleges, whether integrated into degree programs or as stand-alone trainings (Pennsylvania College of Technology 2012).

As with building efficiency, most work in RE does not require a four-year degree (U.S. Department of Energy 2018; Weinstein 2023). Nationally, education and training programs are offered through a variety of providers, including nonprofits, technical and community colleges, and online (North American Board of Certified Energy Practitioners 2023). Many "bootcamp"-style trainings incorporate accredited classroom learning with hands-on skills training and employer connections or internships (Philadelphia Energy Authority 2022; GRID Alternatives 2018). **However, with any program it is important to ensure that jobs are available or anticipated before developing new training programs.** Nevertheless, it could be valuable to engage local universities, especially those with engineering programs, to identify specific courses or programming that could support clean energy careers.

For advanced and clean energy manufacturing training, this often needs to be highly specialized to the local manufacturer, since specific component manufacturing can be highly unique. High school CTE programs, technical schools, and community colleges can often be very nimble in responding to the training needs of local employers. Since existing manufacturing programs do exist in high schools and community colleges in Fairfield and neighboring counties, there is opportunity to build on these existing programs, while incorporating and responding to the needs of local employers.

Next Steps

Some guiding questions that could inform next steps are:

- □ Are there specific jobs that are of interest to the county? That is, is there more interest in installation, operations and maintenance, or manufacturing roles, etc.? That can help inform whether the EWD strategy focuses more on four-year institutions versus trades schools and the trades in general.
- □ Are there emerging clean energy hubs in Fairfield and neighboring counties that suggest the need for targeted EWD efforts? For example, there is an interest in clean manufacturing—is this general clean manufacturing or manufacturing to support specific sectors like solar, wind, batteries, etc.? This again can help inform which employers and EWD partners to engage with.
- □ What is the general workforce outlook in the county and region? Are most individuals in the county looking to stay local for jobs, is there interest and ability to travel outside the county for work, and how do these overlap with the inventory showcased above?
- □ Are there any federal and state incentives that can support any priority areas identified? For example, to what extent could the current Inflation Reduction Act prevailing wage and apprenticeship requirements help support growth for local jobs in EE, RE, and clean manufacturing in the county?

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Appendix A. Occupational Data for Clean Energy Jobs

The following data and charts come from the "Clean Energy Employment Impacts" or the "Clean Energy Impacts and Occupational Analyses" reports produced by ICF for NREL and the Communities LEAP Technical Assistance Pilot (ICF 2023; Brown et al. 2023). The accompanying text, which paraphrases the charts and data, is from NREL. NREL provided the original source material to BREP in November 2023. These data are included in this appendix for the readers' convenience and reference as some of the data form the basis for gaps analysis conclusions.

In terms of jobs that create local impacts, small-scale solar photovoltaics (PV) and small-scale energy efficiency retrofit projects are the most likely to employ the greatest number of local workers. By contrast, land-based wind projects are the least likely to employ local workers.

In terms of long-term and locally based jobs, any job that focuses on post-buildout activities (e.g., operations and maintenance or site/facility management) is likely to last multiple years and rely on workers that are within the community or the region. These jobs require workers to physically visit and engage with the energy project and the jobs will generally run the length of the project, whether it is a new energy generation facility or an energy auditing initiative across the community. By project type, any energy efficiency project—whether it is new construction, small-scale retrofit, or commercial scale—will generate the largest relative number of post-buildout jobs. Land-based wind is the least likely to generate a large number of post-buildout jobs.

In terms of pay, the highest projected median annual income by project phase for any project type occurs during pre-buildout, where the median income is $78,000 per year. This is higher than the median annual income for buildout phase projects at $49,210 per year or post-buildout phase projects at $63,540 per year. By project type, solar projects tend to create the highest overall incomes across the entire project at a median annual income of $72,080 per year. This is compared to the median annual income of $63,745 for land-based wind projects and a range of $47,500 to $55,000 per year for incomes from energy efficiency projects.

Over time, a large concentration of smaller scale renewable energy or energy efficiency projects in Bridgeport could generate a stable employment base of operations/maintenance/inspection/review jobs. The pay range for these occupations varies greatly:

- **Wind Site/Plant Manager**: $49,680 to $125,340
- **Solar PV Technician**: $36,320 to $72,080
- **Residential Energy Auditor**: $43,000 to $106,000
- **Commercial Energy Auditor**: $55,000 to $105,000
- **Facilities Manager**: $55,000 to $175,000.

A.1 Employment Impacts Summary

Table A-1 paraphrases and compares the findings of the ICF Clean Energy Employment Impacts report in terms of the three clean energy technologies (land-based wind, solar PV, and energy efficiency) by each technology's level of outsourcing, amount of local workforce utilization, and example jobs with the median salary.

Table A-3. Comparison of Employment Impacts of Clean Energy Projects

Measure	Land-Based Wind	Solar PV	Energy Efficiency
Level of outsourcing to specialized firms	Most of the pre-construction work is typically outsourced (more than half of total jobs). Some imported specialized installers.	Most of the pre-construction work is typically outsourced, which makes up less than half of total jobs for utility-scale solar, and significantly less than half of total jobs for small-scale projects.	New construction and large-scale retrofits may rely on outsourced professional services (about one-third of total jobs). Smaller retrofit projects more likely to use local design and professional services.
Local impacts	Few long-lasting job opportunities apart from operations and maintenance.	For larger-scale projects, about half of jobs are in construction, which can be local but also more likely to be short term. Smaller-scale (e.g., rooftop) projects are likely to be implemented gradually over time, providing more long-term construction employment.	Most planning, construction, and inspection work is likely to be local workforce. The majority of large project jobs are in construction, which can be local but also more likely to be short term. Smaller retrofit projects are likely to be implemented gradually over time, providing more long-term construction employment.
Example jobs by median salary	Wind Resource Engineer ($48,600 to $150,760) Wind Technician ($46,420 to $77,810) Site/Plant Manager ($49,680 to $125,340)	Project Developer ($105,060) Solar PV Installer ($36,320 to $72,080) Solar PV Technician ($36,320 to $72,080)	Junior Architect ($42,000 to $78,000) Residential Energy Efficiency Technician ($37,440 to $52,000) Facilities Manager ($55,000 to $175,000)

A.2 Comparing Job Median Pay by Project Phase

Looking at the pay by job type created by each of the three technologies and by project phase can help Bridgeport community leaders determine which job types to prioritize over others. The "Clean Energy Employment Impacts" report shows among the three project phases ((1) pre-buildout, (2) buildout, and (3) post-buildout), that the occupations pertaining to pre-buildout (i.e., project planning, sales, professional services) generate the highest wages for workers at a median annual income of $78,000. From among the three energy project types ((1) land-based wind, (2) solar, or (3) energy efficiency), solar jobs tend to generate the highest median annual incomes (i.e., $72,000) across the three project phases, compared to land-based wind and energy efficiency (ICF 2023). Table A-2 shows the median annual income per each energy project type by project phase.

Table A-4. Comparison of Median Job Pay by Project Phase

Project Phase	Occupational Sector	Land-Based Wind Jobs	Solar Jobs	Energy Efficiency Jobs		Median Annual Income
				Small-Scale Residential	Commercial/Major Renovation	
Pre-Buildout	Project Planning; Sales; Professional Services	Wind Resource Engineer ($48,600 to $150,760)	Project Developer ($105,060)	Junior Architect ($42,000 to $78,000)	Registered Architect ($48,700 to $137,620)	**$78,000**
Buildout	Construction; Installation	Wind Technician ($46,420 to $77,810)	Solar PV Installer ($36,320 to $72,080)	Residential Energy Efficiency Technician ($37,440 to $52,000)	Commercial Energy Efficiency Technician ($31,200 to $52,000)	**$49,210**
Post-Buildout	Operations & Maintenance; Inspection/Review	Site/Plant Manager ($49,680 to $125,340)	Solar PV Technician ($36,320 to $72,080)	Residential Energy Auditor ($43,000 to $106,000)	Commercial Energy Auditor ($55,000 to $105,000) Facilities Manager ($55,000 to $175,000)	**$63,540**
	Median Annual Income	**$63,745**	**$72,080**	**$47,500**	**$55,000**	

A.3 National Energy Efficiency Workforce Outlook

The "Clean Energy Employment Impacts and Occupational Analyses" report prepared by ICF identified the current outlook for the kinds of industries and technologies that are creating jobs for U.S. workers focusing on energy efficiency (Brown et al. 2023).

By industry, more than half of all energy efficiency jobs are construction related. Roughly equal workers are employed in the manufacturing and trade or professional services and other industries. Figure A-1 shows the relative proportions of U.S. energy efficiency workers employed by industry or project phase.

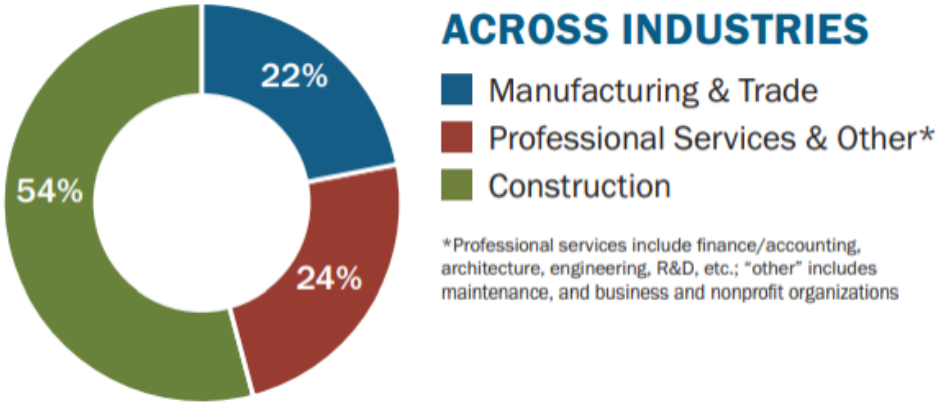

Figure A-3. U.S. Energy Efficiency Workers by Industry

Source: Brown et al. 2023

By technology, high-efficiency/renewable HVAC-deployment projects employ about half of energy efficiency workers. Non-HVAC home appliances/fixtures/lighting projects employ about one in four energy efficiency workers. The remaining project types (i.e., materials, energy audits, software) employ more than one in four energy efficiency workers. Figure A-2 shows the relative proportions of U.S. energy efficiency workers employed by technology or project type.

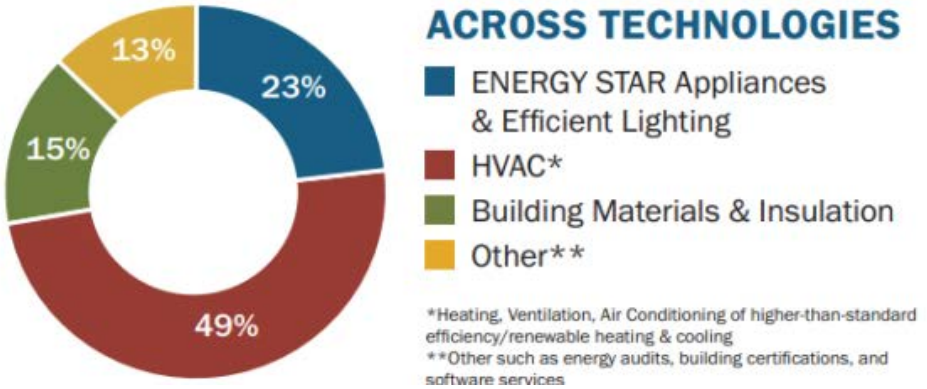

Figure A-4. U.S. Energy Efficiency Workers by Technology

Source: Brown et al. 2023

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