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[bw] RESEARCH PARTNERSHIP

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Acknowledgements

This Clean Energy Industry Report is the ninth in a series of reports conducted and written by BW Research Partnership, Inc. under commission by the Clean Energy Development Fund (CEDF) of the Vermont Department of Public Service (PSD).

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Opening Letter

The COVID-19 pandemic continued to have a dramatic impact on Vermont's clean energy market in 2021, however there were signs of recovery compared to 2020 with an increase in overall jobs in the sector. The clean energy sector recovered in 2021 at the same rate, 2.8%, as Vermont's overall economy.

The *2022 Vermont Clean Energy Industry Report* provides a snapshot of data on Vermont's clean energy employment in the first quarter of 2022. The report documents the changes over the past nine years. After losing about 1,400 jobs in 2020, this report shows a gain of nearly 500 clean energy jobs in 2021.

The *2021 Vermont Clean Energy Industry Report* is the 9th of a series produced by BW Research Partnership commissioned by the Clean Energy Development Fund at the Department of Public Service. The report's survey of clean energy businesses was completed in the winter of 2022. The survey was delayed from the fall of 2021 when it would have normally happened due to requirements from the U.S. Department of Energy (DOE). This Vermont report draws from the data collected as part of DOE's *U. S. Energy & Employment Report* (USEER) and its well-established methodology used to characterize nationwide energy employment.

This year's Vermont report finds that the clean transportation sub-sector grew by almost 20 percent, adding over 280 jobs in Vermont. Even as these new positions were added to payrolls, 91 percent of the state's clean energy employers experienced hiring difficulty—up nine points from two years ago.

This year includes detailed information from 25 firms in the emerging energy storage sub-sector and on the opportunity to add new clean energy industry jobs related to energy storage. This promising and active industry has a solid footing in Vermont and this report provides a baseline for the sector with information on needs and challenges. As with other sub-sectors in the clean energy industry, firms find it challenging to attract people with specific knowledge, skills, and experience in battery storage systems.

Vermont's expanding clean energy industry is a key component to meeting the energy and greenhouse gas reduction requirements while building a vibrant local economy. As the sector expands, the clean energy industry can help make Vermont more affordable, provide economic opportunities around the state, and protect the state's most vulnerable people.

A sustained focused on a low carbon future will require economic growth in clean energy. As policy makers and implementation partners advance new energy, labor, and economic development programs to achieve state energy-related requirements and goals, the *Vermont Clean Energy Industry Report* provides a tool for monitoring progress across the state.

Sincerely,

June E. Tierney, Commissioner **Andrew Perchlik, CEDF Director**

Executive Summary

This year's *Vermont Clean Energy Industry Report* is the ninth in a series of annual clean energy industry reports that track the progression of Vermont's clean energy labor market. This year's report is unique in that it is the first publication since the COVID-19-induced economic recession ended, and thus is a benchmark for the recovery of Vermont's clean energy economy after unprecedented job losses rocked the state, including its clean energy sub-sectors. The 2022 report covers calendar year 2021, highlighting the recovery of clean energy businesses across the state after the sudden economic downturn that resulted in the loss of 1,400 clean energy jobs in 2020.

Vermont's clean energy industry continues to set an example for the rest of the nation. Vermont has the highest clean energy employment per capita in the nation at 6 percent, employing 17,984 clean energy workers at the end of 2021. Between the last quarters of 2020 and 2021, clean energy jobs in Vermont increased by 2.8 percent compared to the previous year's 17,500—a gain of almost 500 jobs in 12 months—indicating that the state's clean energy economy has begun to recover from the unprecedented job losses witnessed in 2020.

However, this job growth has not been enough for a full recovery, and clean energy employment in Vermont remains at roughly 2016 levels. Clean energy businesses grew at the same rate as overall statewide employment growth; both clean energy employment and total employment increased by 2.8 percent between 2020 and 2021.

Surprisingly, most job gains between 2020 and 2021 did not come from the renewable energy generation and energy efficiency sectors, which comprise the majority of clean energy employment in Vermont and shed the most jobs between 2019 and 2020. These sectors were responsible for less than 40 percent of new jobs between 2020 and 2021. Instead, clean transportation added 283 jobs to the clean energy economy, comprising about 59 percent of the job growth. This uneven distribution of new jobs means the state's renewable energy and energy efficiency sectors are still hundreds of jobs behind their 2020 employment levels while the clean transportation sector has reached an all-time high in its employment.

This year's report includes a new battery storage section which examines the role of the nascent sub-sector in Vermont's clean energy economy. The section explores Vermont's policy goals and incentives surrounding battery storage. It then identifies companies, utility providers, and projects that act as the state's current leaders in energy storage technologies. This section also quantifies the 25 companies in Vermont conducting work with battery storage technologies by the company's technological focus and industry focus, finding that 52 percent of battery storage companies also work with other clean technologies and 68 percent are only involved in the installation phase of project development.

Between February 16 and March 25, 2022, a series of interviews was conducted between with battery storage companies to contextualize the drivers of Vermont's battery storage market and to understand business needs and future projections. The interviews showed that statewide consumer interest in

battery storage installation is growing, but it is still an expensive investment for both residential and commercial customers. Additionally, as statewide consumer interest grows, battery storage has become an increasingly important part of the business strategy for solar installation, software, distributor, and project developer firms. However, firms have found it hard to find people with specific knowledge, skills, and experience in battery storage systems and tend to rely on word-of-mouth to hire local talent. Companies identified potential supports to help grow the battery storage industry, including expanding incentives for commercial customers and partnering with local electric utilities to drive prices down and provide more options for consumers to choose from.

Clean Energy Policy Landscape

Vermont is a clean energy leader in the United States. It consistently ranks within the top three states on the American Council for an Energy Efficient Economy's *State Energy Efficiency Scorecard*, just behind California and Massachusetts.[1] The state had the most clean energy jobs per capita and fourth highest number of solar jobs per capita in 2021.[2] It was also one of the first states in the country to put greenhouse gas emissions goals in place in 2005 and continues to lead the nation in climate policy today.[3]

Recently the state legislature passed the Vermont Global Warming Solutions Act in 2020 (GWSA), creating a requirement to lower the state's greenhouse gas emissions. The GWSA requires reducing emissions to at least 26 percent below 2005 emission levels by 2025, at least 40 percent below 1990 emission levels by 2030, and at least 80 percent below 1990 emission levels by 2050.[4] The legislation also established the Vermont Climate Council to identify and evaluate programs that could reduce greenhouse gas emissions in the state.[5] The Climate Action Plan, adopted in December 2021, centers its strategies around five areas:

- Decreasing emissions created by transportation, buildings, electricity, agriculture, and industrial processes
- Capturing carbon from the atmosphere and storing it in plants or soil
- Preparing natural and working lands for climate change
- Protecting people and infrastructure from the effects of climate change
- Investing in community and workforce development[6]

Throughout 2021, the Department of Public Service worked in parallel with the Climate Council to update the state's Comprehensive Energy Plan (CEP), which was released in January 2022. The CEP provides recommendations for achieving State energy goals equitably, affordably, reliably, and in an environmentally sound manner. The development of the Energy Plan informed and is designed to meet the emissions reduction requirements set by the GWSA and to be consistent with the Climate Action Plan. The high-level goals outlined by the CEP include using renewable sources to meet 25 percent of energy needs by 2025, 45 percent of energy needs by 2035, and 90 percent of energy needs by 2050.

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[1] American Council for an Energy-Efficiency Economy. State and Local Policy Database, Vermont. https://database.aceee.org/state/vermont.

[2] Department of Energy. 2022 U.S. Energy and Employment Report. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

[3] National Conference of State Legislatures. Greenhouse Gas Emissions Reduction Targets and Market-based Policies. September 2021. https://www.ncsl.org/research/energy/greenhouse-gas-emissions-reduction-targets-and-market-based-policies.aspx.

[4] 10 V.S.A. § 578

[5] 10 V.S.A. § 591

[6] State of Vermont. Vermont Climate Action Plan Summary. December 2021. https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/VT%20CAP%20Summary%20FINAL.pdf.

The CEP covers all energy sectors (electric, thermal, and transportation), and sets the following new goals for each sector:

- **Thermal Sector:** Meet 30 percent of energy needs from renewable energy by 2025, and 70 percent by 2042
- **Transportation Sector:** Meet 10 percent of energy needs from renewable energy by 2025, and 45 percent by 2040
- **Electric Sector:** Meet 100 percent of energy needs from carbon-free resources by 2032, with at least 75 percent from renewable energy

According to the initial Vermont Climate Action Plan, the thermal sector is responsible for over a third of the state's total GHG emissions.[7] By increasing the thermal efficiency of buildings in the state, weatherization can play an important role in reaching the GWSA's emission reduction requirements. To meet an increased demand for weatherization, one assessment estimates that Vermont's weatherization workforce must increase by five times its current size.[8] Another pathway to meeting the GWSA requirements estimates that Vermont's weatherization workforce must increase by 25% to 43% annually through 2027 to complete 120,000 weatherization projects by 2030.[9]

In response to the need for weatherization workers, the Vermont Legislature included new provisions in the state's fiscal year 2022 appropriations (Act 74 of 2021). The legislation created a Weatherization Workforce Group (WWG) for the "coordinated delivery of a statewide Building Sciences curriculum that includes weatherization".[10] The WWG then designed a framework for training both entry-level and experienced workers for a career in weatherization, creating the Vermont Weatherization Installer certification for entry-level workers and allowing the state to add additional levels of certification for more experienced workers. The WWG's training framework should help the industry increase the number of workers in the thermal energy efficiency sector.[11] Additionally, Vermont has recently

[7] Vermont Climate Council. Initial Vermont Climate Action Plan. December 2021. https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/2021-12/Initial%20Climate%20Action%20Plan%20-%20Final%20-%2012-1-21.pdf.

[8] Energy Action Network. Workforce Development in Vermont's Thermal Sector: Challenges and Opportunities for Meeting Vermont's 2030 climate goals. August 2021. https://www.eanvt.org/wp-content/uploads/2021/09/Raquel-Smith-Workforce-Development-Final-Report-EAN.pdf.

[9] The Cadmus Group and Energy Futures Group. "Vermont Pathways Analysis Report 2.0". February 2022. https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/2022-03/Pathways%20Analysis%20Report_Version%202.0.pdf.

[10] Vermont Legislature. Act No. 74 of 2021. https://legislature.vermont.gov/Documents/2022/Docs/ACTS/ACT074/ACT074%20As%20Enacted.pdf.

[11] Efficiency Vermont. Weatherization Workforce Plan. Laura Capps. October 1, 2021. https://www.efficiencyvermont.com/Media/Default/docs/white-papers/Weatherization-Workforce-Plan.pdf.

allocated an unprecedented amount of funding to weatherization, which may drive workers to enter the state's thermal energy efficiency sector.[12]

With the transportation sector creating 39.7 percent of the state's total emissions, the initial Climate Action Plan found that transitioning to electric vehicles is an affordable and effective way to work towards the GWSA's emission requirements. The state's Legislature passed many incentives that will increase economic activity in the clean transportation sector and increase the jobs in this sector in the future. These incentives, along with other measures like an expansion of the state's electric vehicle charging network, are also supported by the Comprehensive Energy Plan.

Because electrification is a key component in decarbonizing the state's thermal and transportation sectors through electric vehicle and heat pump adoption, Vermont's electric sector plays a critical role in meeting the requirements of the GWSA and the CEP. The CEP specifically places a focus on grid evolution and modernization, outlining strategies and tradeoffs associated with modernization including implementing smart grids, flexible load management, and integrating solar photovoltaics. Several organizations throughout the state, including the Department of Public Service and utilities like Green Mountain Power created initiatives to help modernize the state's grid system and support greater demand for electricity. Increased funding and demand resulting from electrification may drive an increased need for electric sector workers in the state.

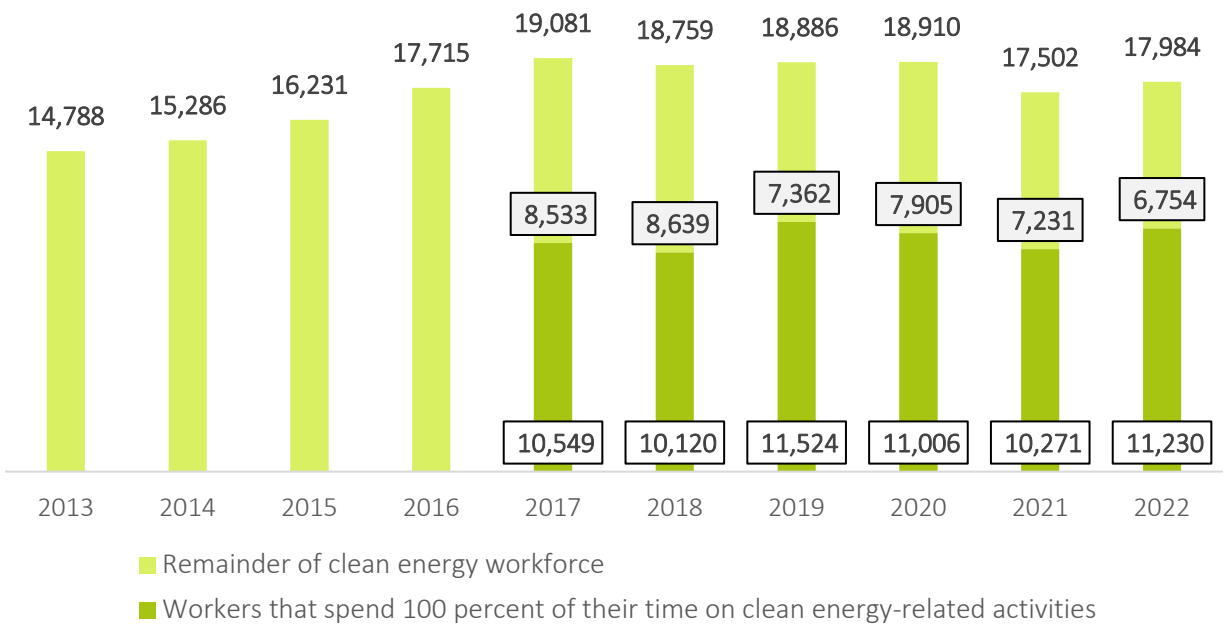
[12] The Vermont Legislature allocated $80 million for weatherization services for low- and moderate-income Vermont households in 2021 and 2022. For more information on weatherization funding, visit https://vnrc.org/80-million-in-weatherization-investments-bring-greater-access-and-affordability-for-low-and-moderate-income-vermonters/.

Clean Energy Employment in Vermont

Overall Clean Energy Jobs

As in the last two reports, Vermont leads the nation in clean energy jobs per capita at 6 percent, employing 17,984 clean energy workers at the end of 2021. Between 2020 and 2021[13], clean energy jobs in Vermont increased by 2.8 percent compared to the previous year's 17,500—expanding by almost 500 jobs in 12 months—indicating that the state's clean energy economy has begun to recover from the unprecedented job losses witnessed in 2020. Despite this growth in employment, the state's clean energy industry has not yet returned to pre-pandemic employment levels after shedding roughly 1,400 jobs during the 2019 through 2020 data years.

FIGURE 1. CLEAN ENERGY EMPLOYMENT, 2013-2022

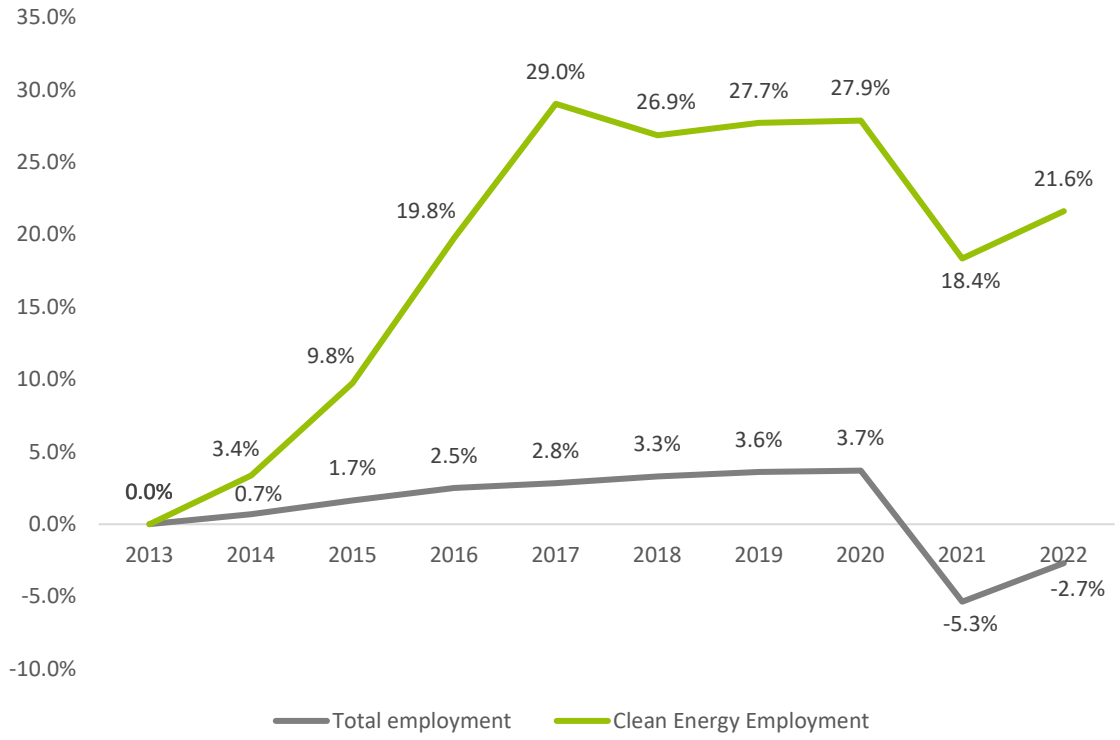


Between 2013 and 2017, Vermont's clean energy employment changed much more than its overall employment. Total employment in that period remained relatively stable; total employment in 2017 was only 2.8 percent greater than it was in 2013. At the same time, clean energy employment was 29 percent higher than its 2013 levels. Since 2018, total employment and clean energy employment exhibited more similar rates of change.

[13] Clean energy job growth is calculated using employment data from Q4 of 2020 and Q4 of 2021.

In 2021, the clean energy industry saw a smaller decrease in its employment (7.4 percent) than the state's total labor market (8.7 percent). Clean energy employment in 2021 was still 18.4 percent higher than it was in 2013 while total employment fell 5.3 percent below 2013 levels. Though the clean energy industry contracted less than the state's total labor market at the onset of the pandemic, this doesn't mean that clean energy employment is recovering faster than total employment; in 2022, clean energy employment and total employment in the state both increased by 2.8 percent. This places clean energy employment 21.6 percent above and total employment 2.7 percent below their respective 2013 employment levels.

FIGURE 2. CUMULATIVE PERCENT CHANGE, TOTAL JOBS & CLEAN ENERGY JOBS IN VERMONT[14]



The number of workers that dedicate 100 percent of their labor hours to clean energy activities increased by 9.3 percent or 959 jobs between the last quarters of 2020 and 2021 (Figure 1). At the same time, the proportion of renewable energy and energy efficiency workers that spend between 50 to 99 percent of their time on clean energy-related activities increased by three and two percentage points, respectively (Table 1). This indicates that both total jobs and overall clean energy activity in the state increased between 2020 and 2021.

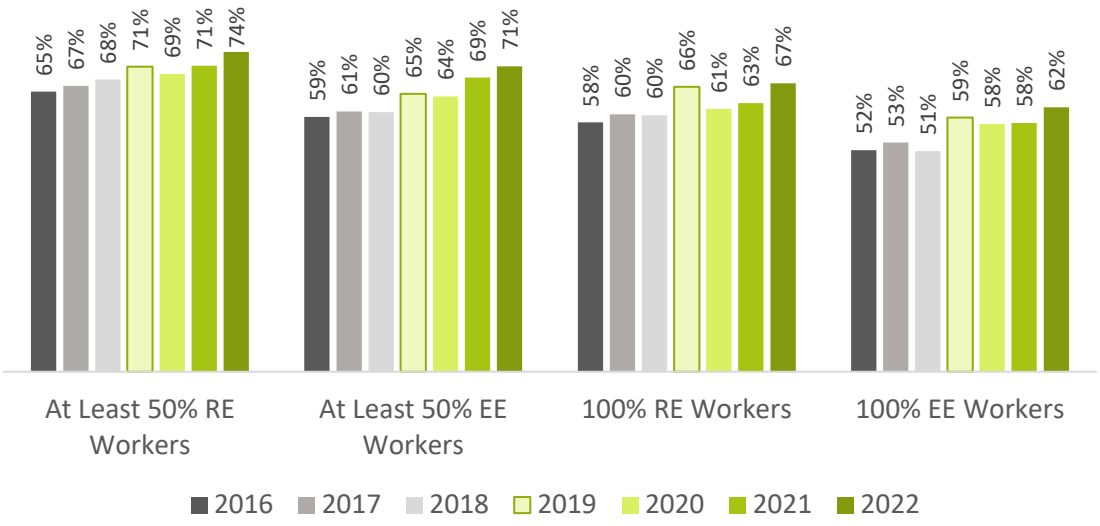
[14] U.S. Bureau of Labor Statistics. Quarterly Census of Employment and Wages. Series Id: ENU5000010010.

TABLE 1. CLEAN ENERGY EMPLOYMENT THRESHOLDS BY TECHNOLOGY SECTOR, 2016-2022

	Workers that spend at least 50 percent of their time							
	2016	2017	2018	2019	2020	2021	2022	
Renewable Energy	65%	67%	68%	71%	69%	71%	72%	74%
Energy Efficiency	59%	61%	60%	65%	64%	69%		71%

	Workers that spend 100 percent of their time							
	2016	2017	2018	2019	2020	2021	2022	
Renewable Energy	58%	60%	60%	66%	61%	63%	64%	67%
Energy Efficiency	52%	53%	51%	59%	58%	58%		62%

FIGURE 3. CLEAN ENERGY EMPLOYMENT THRESHOLDS BY TECHNOLOGY SECTOR, 2016-2022



Full-Time Equivalent Clean Energy Workers

Figure 1 above highlights the total number of "100 percent" clean energy workers—those that spend their whole work week, or all their labor hours, dedicated to clean energy-related services. However, not all clean energy workers spend 100 percent of their labor hours on clean energy activities. Full-time equivalent clean energy jobs (FTEs) estimate the total amount of clean energy labor performed in the state.[15]

In addition to those that spend 100 percent of their time working on clean energy activities, the FTE metric weights employment for the following categories as well: those that spend 0 to 49 percent of their time on clean energy work and those that spend 50 to 99 percent of their time on clean energy work. A worker that spends 0 to 49 percent of their time on clean energy activities receives a weight of 0.25 in the final FTE employment estimate, while a 100 percent clean energy worker is weighted as one FTE clean energy job.[16]

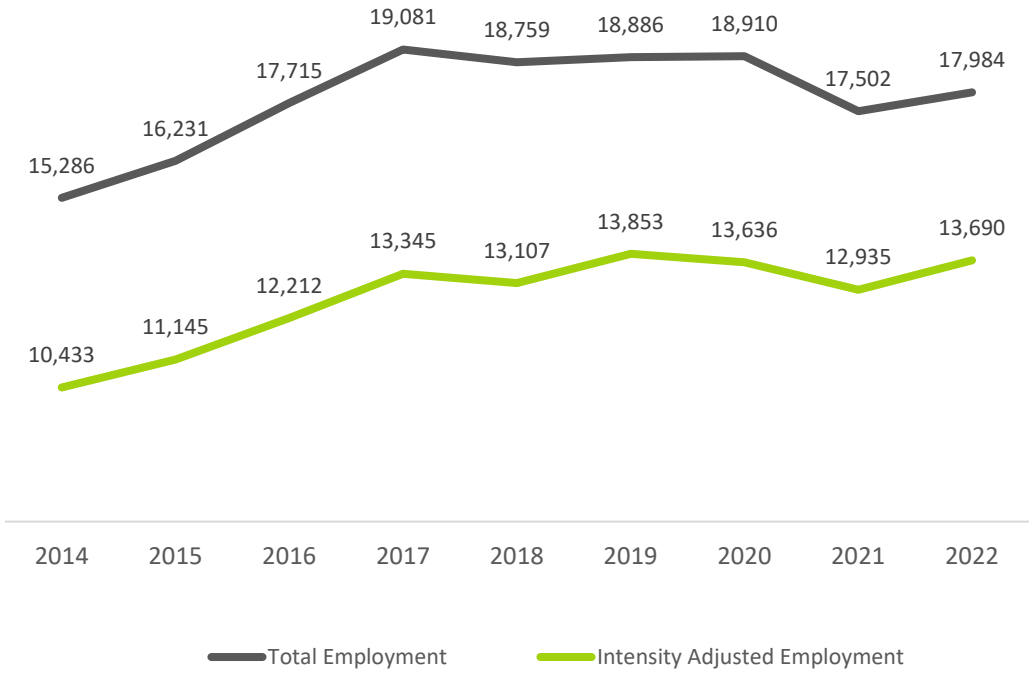
At the end of 2021, there were 13,690 full-time equivalent clean energy jobs in Vermont. Full-time equivalent jobs increased by almost 6 percent compared to the end of 2020; this represents an increase of 755 FTE jobs in 12 months. With this increase, Vermont surpassed the number of clean energy FTE jobs in the state at the end of the 2019 report year and recouped the FTE jobs lost at the onset of the pandemic.

"Vermont surpassed the number of clean energy FTE jobs in the state at the end of the 2019 report year and recouped the FTE jobs lost at the onset of the pandemic."

[15] For more information on full time equivalent employment, see 100 Percent & Full-Time Equivalent Jobs.

[16] This metric measures the proportion of total labor hours dedicated to clean energy activities and is unrelated to the total number of hours worked in a week. A part-time clean energy employee who works 20 hours a week with 100 percent of these hours dedicated to clean energy activities would be counted as one FTE clean energy job.

FIGURE 4. TOTAL & FULL-TIME EQUIVALENT CLEAN ENERGY EMPLOYMENT, 2014-2022[17]



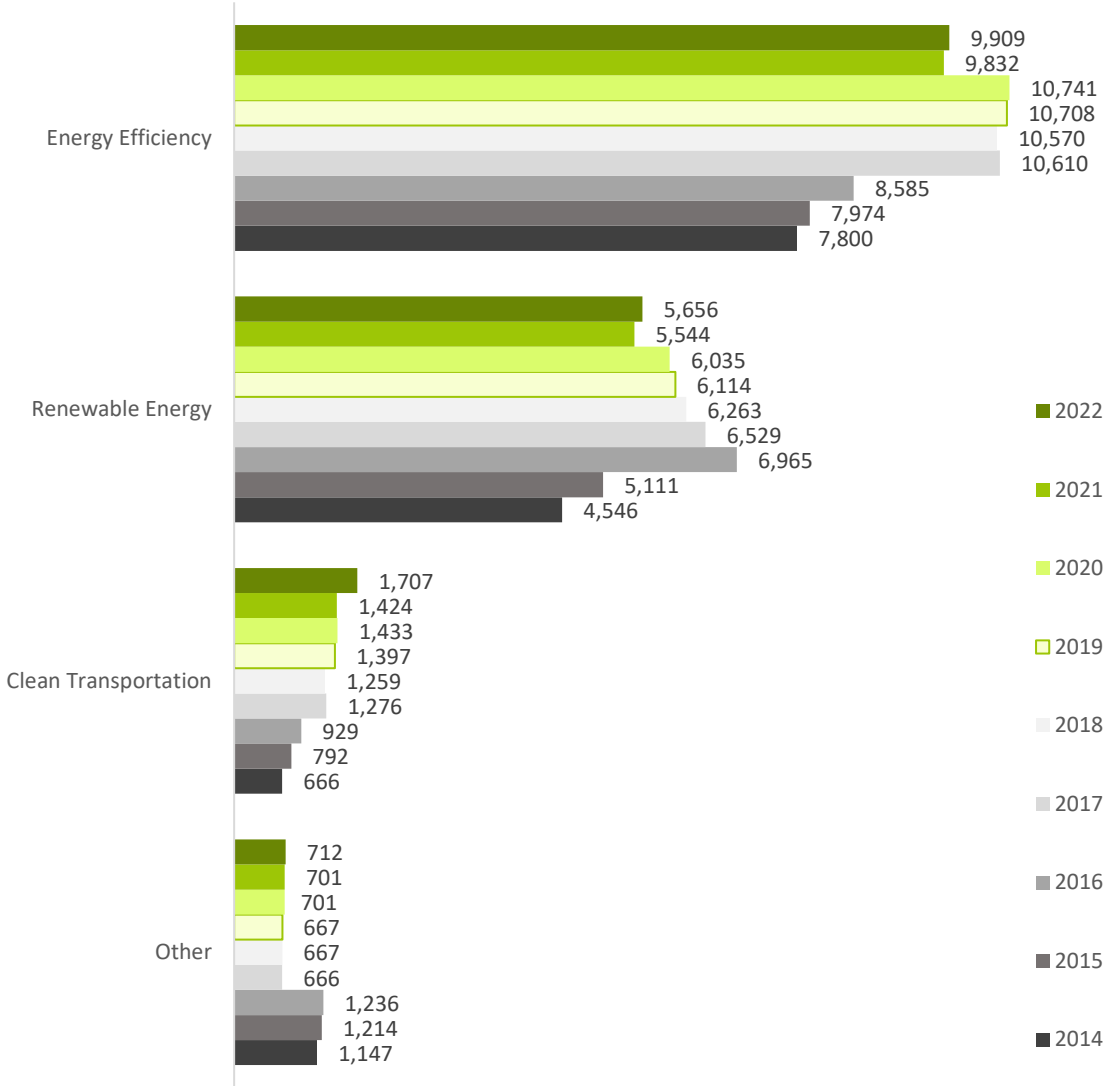
[17] In an attempt to reconcile the Vermont-specific methodology that has historically been used for these reports with the methodological updates to other clean energy reports, the research team revised both the 100 percent and FTE employment figures in last year's report and moving forward. As such, the 100 percent employment estimates presented in this report for 2017, 2018, and 2019 will not match previous Vermont Clean Energy Industry Reports (VCEIRs). However, this methodological update provides a more accurate representation of clean energy activity in Vermont and allows for comparison across other state-level clean energy reports. For more information, please refer to the Research Methodology in Appendix A.

Clean Energy Jobs by Sector

Between 2021 and 2022, every sector within Vermont's clean energy industry saw employment growth. The clean transportation sector had the biggest gain in employees, increasing by 283 employees or 19.9 percent. The renewable energy and energy efficiency sectors had more modest gains during this period, growing by 2 percent and 0.8 percent respectively.

While clean transportation employment in Vermont reached an all-time high in 2022, the renewable energy and energy efficiency sectors have still not recovered fully from employment losses incurred during the start of the COVID-19 pandemic; both sectors still have employment below their pre-pandemic levels.

FIGURE 5. CLEAN ENERGY EMPLOYMENT GROWTH BY TECHNOLOGY SECTOR, 2014-2022



Clean Energy Employment by Sector

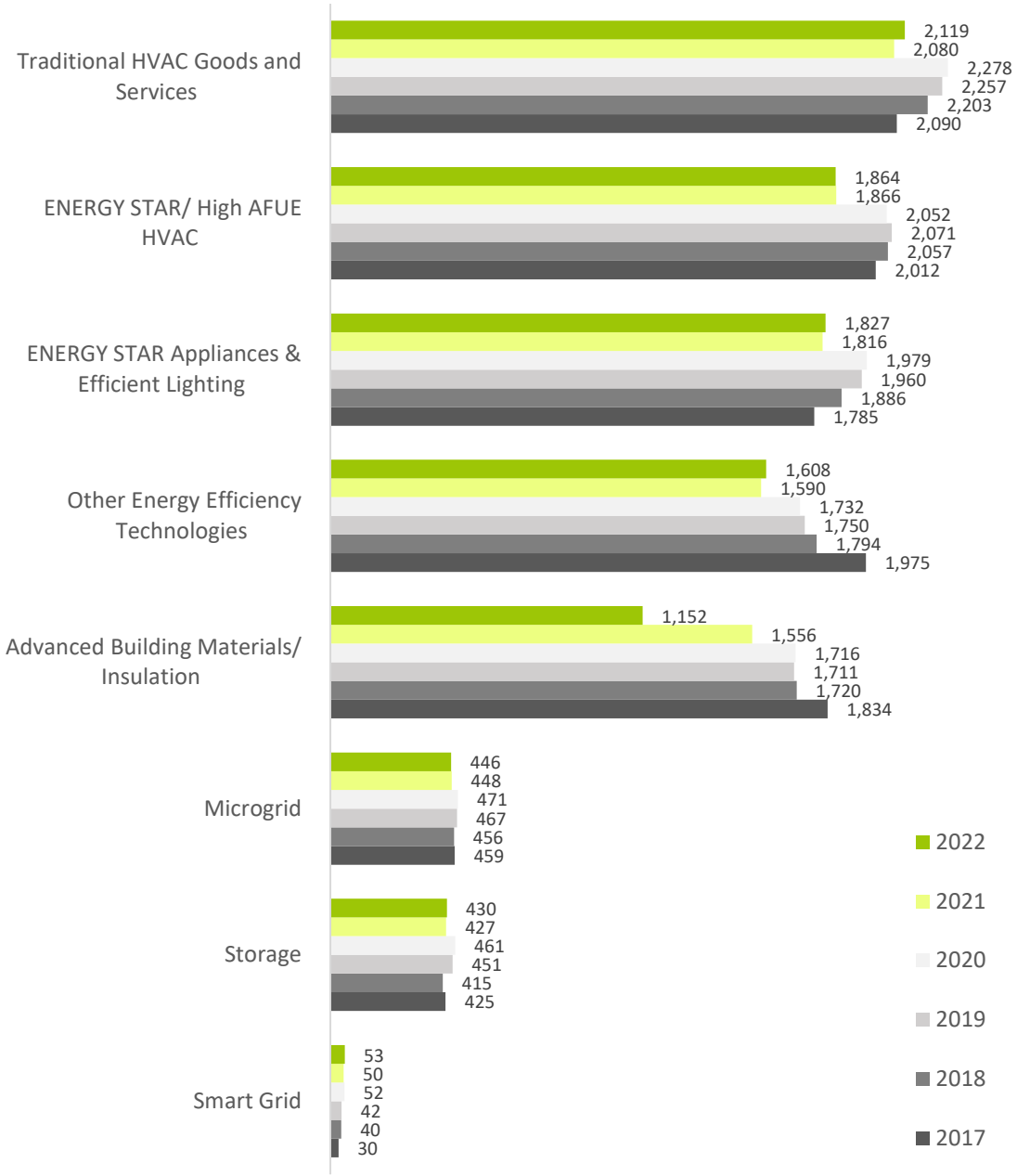
Energy Efficiency

Within energy efficiency, the sub-sector that gained the most jobs from 2020 to 2021 is traditional HVAC goods and services, growing by 39 jobs or 1.9 percent.

Employment within the smart grid, ENERGY STAR appliances and efficient lighting, microgrid, smart grid, ENERGY STAR or high-efficiency HVAC, and storage sub-sectors remained fairly steady from 2020 through 2021. The change in their employment ranged from a decrease of less than one percent to an increase of 0.7 percent, or an overall change in 2 to 11 employees.

The only sub-sector that experienced a loss in employment during this period was advanced building materials/insulation. Firms within this sub-sector shed over a quarter (26 percent) of their jobs between 2020 and 2021, losing 404 jobs in total. This is a larger decrease than the sub-sector experienced from 2019 through 2020.

FIGURE 5. ENERGY EFFICIENCY EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2022[18]

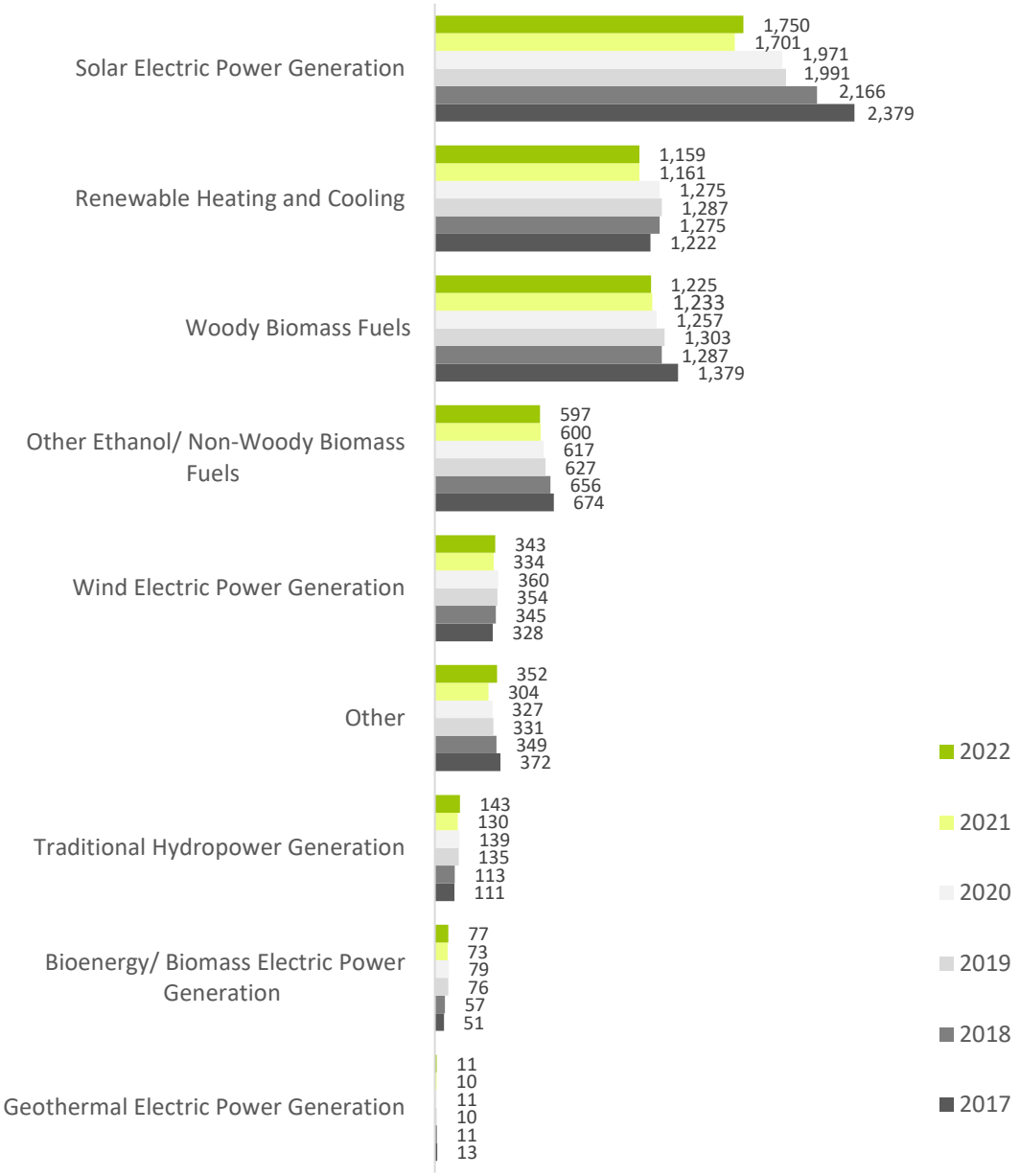


[18] "Other energy efficiency technologies" include variable speed motors, other design services not specific to a sub-technology, software not specific to a sub-technology, energy auditing, rating, monitoring, metering, and leak detection, energy efficiency policy not specific to a sub-technology, LEED certification, consulting not specific to a sub-technology, and phase-change materials.

Renewable Energy Generation

Most job gains within the renewable energy generation sector came from the solar electric power generation sub-sector and the “other” category. Solar firms across Vermont gained 49 jobs between 2019 and 2020—an increase of 2.9 percent—while the “other” category gained 48 jobs, for an increase of 15.8 percent. Employment within the remaining sub-sectors in renewable energy generation remained stable from 2020 to 2021.

FIGURE 6. RENEWABLE ENERGY GENERATION EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2022[19]



[19] While "low-impact hydropower" is included in Vermont's clean energy technology definition, it is not pictured on this graph because there were no captured jobs in in Vermont.

Vermont's Battery Storage Market

Overview

Vermont is rapidly growing its energy storage capacity. In fact, the U.S Energy Information Administration (EIA) identified Vermont as one of the states with the most small-scale battery storage capacity (Figure 7).[20] As defined by the EIA, small-scale battery storage refers to storage at facilities that have less than 1 MW of generating capacity. As of 2019, Vermont ranked second in the nation behind Hawaii in terms of small-scale storage capacity (excluding California).[21] According to EIA, Green Mountain Power Corporation reported the largest amount of direct-connected battery storage capacity, totaling 12.1MW of capacity in 2019.[22] As of September 2021, Vermont had about 50 MW of total installed storage[23] (which includes utility-scale and small-scale installations)[24], an increase of 23.5 MW from 2019.[25]

[20] U.S Energy Information Administration: Battery Storage in the United States: An update on Market Trends https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage_2021.pdf.

[21] California is excluded from EIA's small-scale storage capacity ranking because the amount of small-scale storage capacity in the state is much greater than that of any other state. According to EIA's Battery Storage in the United States report, California was responsible for 83 percent of reported small-scale storage capacity in the U.S. in 2019. Such an extreme value would warp the axis scale in Figure 7.

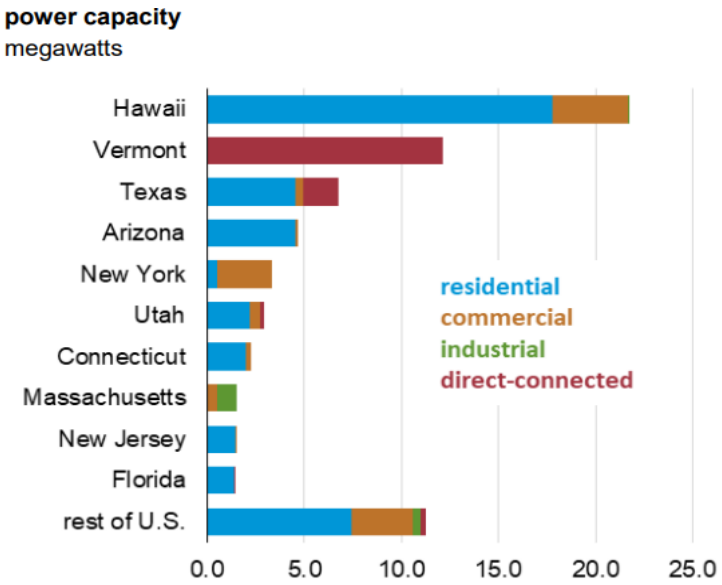
[22] According to the U.S. Energy Information Administration (EIA), direct-connected storage power capacity is storage capacity directly connected to the utility grid as opposed to residential, commercial, or industrial power storage capacity.

[23] While the EIA labels all of Vermont's small-scale storage capacity as direct-connected, it is likely that a portion of the 50 MW of total installed storage in the state comes from behind the meter residential systems such as powerwalls.

[24] Vermont Department of Public Service: 2022 Vermont Comprehensive Energy Plan https://publicservice.vermont.gov/sites/dps/files/documents/2022VermontComprehensiveEnergyPlan_0.pdf

[25] Vermont Department of Public Service: Act 31 Storage Regulation – Final Recommendations https://publicservice.vermont.gov/sites/dps/files/documents/Act%2031%20Legislative%20Recommendations_Final_0.pdf

FIGURE 7. SMALL-SCALE ENERGY STORAGE CAPACITY OUTSIDE OF CALIFORNIA BY STATE & SECTOR (2019)[26]



Policy Goals & Incentives

As stated in the 2022 Vermont Comprehensive Energy Plan, Vermont has a goal to reach 90 percent of the state's energy needs through renewable sources by 2050.[27] However, the state currently has no explicit goals regarding the increase of storage technologies and facilities. Instead, with storage resources of approximately 10 percent of the state's annual peak, and further flexible resources becoming available, the state is exploring how to ensure a secure and affordable modernized grid system that can optimize resources, enhance resilience, and reduce greenhouse gas emissions by pursuing several foundational steps related to rate design, rules and regulations, grid communications and infrastructure, and distributed energy resource integration. Statewide incentives may or may not be appropriate or necessary if market signals through rates, and regulatory procedures and requirements are thoughtfully designed.

Load flexibility is a critical component in creating a flexible, reliable, affordable, and efficient grid in Vermont. Efficiency Vermont has partnered with many organizations throughout the state in recent

[26] U.S Energy Information Administration: Battery Storage in the United States, an Update on market Trends https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage_2021.pdf.
[27] Vermont Department of Public Service: 2022 Vermont Comprehensive Energy Plan https://publicservice.vermont.gov/sites/dps/files/documents/2022VermontComprehensiveEnergyPlan_0.pdf

years—including the Vermont Department of Public Service[28], Green Mountain Power[29], Vermont Electric Cooperative[30], and Washington Electric Co-op[31]—to create load flexibility programs. Load flexibility programs implemented across the state increase grid flexibility by offering financial incentives to encourage homeowners and commercial and industrial customers to shift their electricity use away from peak demand times when power is dirtiest and most expensive. These load flexibility programs can improve reliability by reducing demand for electricity when stress on the grid is high, improve affordability by helping customers use less electricity when prices are high, and improve efficiency by adjusting power usage to utilize renewable energy sources when they are available.

During the period covered by this report, the solar federal investment tax credit (ITC) allocated up to a 26 percent tax credit for the cost of a solar battery storage system. Participants can use the ITC for a home battery purchase if the battery is charged from renewable energy sources, like rooftop solar.[32] Though Vermont does not offer any statewide financial incentives for battery storage systems, Green Mountain Power[33], the state's largest utility, and Vermont Electric Cooperative[34] both incentivize battery storage adoption for their customers.

Current Leaders

COMPANIES

The following companies were selected as current leaders in Vermont's battery storage industry based on their overall high market presence and engagement in Vermont's energy and battery storage projects:

- Dynapower, a South Burlington based company, is a global leader in microgrid energy storage systems. Dynapower designs and manufactures utility scale and microgrid battery storage systems. The South Burlington company boasts 900 megawatts of energy storage commission globally, with products installed in 5 continents.[35]

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[28] For more information on the Vermont Public Service Department's allocation of $5 million into grid flexibility, visit https://publicservice.vermont.gov/sites/dps/files/documents/VT%20PSD%20RFI%20-%20Flexible%20DER%20and%20Control%20Platforms%202021-12-10_0.pdf.

[29] For more information on Green Mountain Power's Flexible Load Management pilot program, visit https://greenmountainpower.com/news/new-program-helps-vermont-businesses-save-money-improve-efficiency/.

[30] For more information on Vermont Electric Cooperative's flexible load program, visit https://vermontelectric.coop/flexible-load.

[31] For more information on Washington Electric Co-op's Project PowerShift, visit https://www.efficiencyvermont.com/powershift.

[32] https://www.energysage.com/local-data/storage-rebates-incentives/vt/

[33] For more information on Green Mountain Power: https://greenmountainpower.com/rebates-programs/home-energy-storage/

[34] For more information on Vermont Electric Cooperative: https://vermontelectric.coop/energy-transformation-programs

[35] https://dynapower.com/

- KORE Solutions, located in Waterbury Vermont, is a leader in custom power and energy storage solutions, with 40+ years of experience.[36] KORE Solutions designs and manufactures energy storage systems for utility scale, commercial, and residential levels. The company also provides engineering and field support, maintenance, controls, and monitoring software. Vermont is the first state in the nation to back up its state Capitol building with a battery storage system, provided by KORE Solutions battery storage systems. This storage system became especially useful during a power outage in March 2021, where the battery system powered the statehouse.[37]
- WEG Electric Corporation, a global industrial electrical technologies company with an energy storage business based in Barre, Vermont, designs, develops, and manufactures energy storage systems in its Barre facility. WEG acquired Northern Power Systems (NPS), where they became the sole owner of NPS energy storage assets.[38] WEG currently provides a 2 MW utility-scale battery energy storage system to VEC, allowing energy to be stored for use during peak demands.

The following distribution electric utilities are currently key leaders in developing the storage sector in Vermont:

- Vermont Electric Cooperative began operating a utility-scale lithium-ion battery in July, which has already saved its over 30,000 members over $90,000 in peak capacity market costs.[39]
    - Vermont Electric Cooperative signed a 10-year lease with Viridity Energy Solutions in 2018 for access to 400 kilowatt-hours of storage.
    - They have enacted a 1-megawatt/4 megawatt-hour system which allows VEC to discharge 400 MWhs onto the grid when it is needed most to reduce peak capacity market costs.
- Green Mountain Power (GMP) is moving toward a more decentralized approach utilizing networks of utility-connected devices and new cheaper battery storage systems meant to protect against massive power outages and hasten a transition away from fossil fuels.[40]
    - They have connected storage attached to a solar power plant to a “microgrid” in order to distribute electricity to parts of the nearby community in case they get cut off from the main energy network due to power outages.
    - GMP has expanded its own “virtual power plant” (VPP) initiative, investing about $30 million to sign up more than 2,000 homes in one of the largest utility-coordinated home battery programs in the country.

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[36] The interview was conducted with Northern Reliability Inc. (NRI) before NRI merged with KORE Power at the end of March 2022 to become KORE Solutions.

[37] https://www.northernreliability.com/

[38] https://www.weg.net/institutional/US/en/

[39] https://www.electric.coop/energy-storage-pays-off-for-vermont-electric-cooperative

[40] https://time.com/6082973/vermont-electric-grid/

PROJECTS

In 2021, Northern Reliability Inc provided Vermont's state capitol building with a battery storage system, the first statehouse in the nation to have battery backup power. The battery storage system is expected to save Vermont taxpayers $44,000 and GMP customers an additional $18,000 over ten years.[41] The state enlisted two Vermont-based companies to provide the battery storage system, Norther Reliability provided the 250-kWh battery, and Dynapower provided the inverter.[42]

GMP launched the Stafford Hill Solar Farm and Microgrid in 2015. The project's inception stemmed from tropical storm Irene in August 2011, which left 117,000 customers (one-sixth of the state's population) without power.[43] The project includes 7,700 solar panels, producing 2.5 MW of clean electricity, and 4 MWh of battery storage. During construction, GMP hired many Vermont based companies for equipment and installation. The solar farm was installed on a former Rutland City landfill, the first known project to make use of this type of site. [44] GMP uses the energy stored during peak demand times to lower costs, and the battery storage system also supplies backup power to a public emergency shelter at Rutland high school.

In late 2021, Encore Renewable Energy based in Burlington, Vermont, began working with Middlebury College and GMP on a solar and energy storage project. The project helps Middlebury College achieve its Energy 2028 plan of using 100 percent renewable energy. Encore is contracted to produce a 5 MW solar project accompanied by a 2 MW battery storage system.[45]

Defining the Storage Universe

The universe of companies in Vermont conducting work with battery storage technologies identified for this report totals 25 firms to date. The majority of these firms work across numerous clean technologies in addition to energy storage, such as solar, wind, heat pumps, and electric vehicle charging technologies. There are no known "storage-only" firms in Vermont. Table 2 and Table 3 measure the percent distribution of storage company's technological and industry focus to provide a composition of the battery storage industry in Vermont.

Table 2 quantifies storage companies located in Vermont by the company's technological focus, which includes companies primarily involved in storage and other clean technologies, storage and solar only, or electrical vehicle charging. For the slight majority of firms in Vermont (52 percent), battery storage is just one of many technologies in their project portfolios. Eleven firms—or 44 percent of the universe—work exclusively with solar and battery storage technologies, and one firm is primarily engaged with EV charging technologies.

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[41] https://greenmountainpower.com/vermonts-statehouse-is-first-in-nation-with-groundbreaking-battery-backup-power/
[42] https://www.revermont.org/rev-members-team-with-state-of-vt-to-install-battery-backup-system-at-the-statehouse/
[43] https://www.cleanegroup.org/wp-content/uploads/Stafford-Hill-Case-Study.pdf
[44] https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/stafford-hill/
[45] https://encorerenewableenergy.com/project/middlebury-college-solar-plus-storage/

Table 3 quantifies storage companies located in Vermont by the company's industry focus: installation, installation and other, manufacturing, and sales and distribution. Most firms that work with storage technologies in Vermont are involved in the installation phase of project development (17 companies or 68 percent of the universe). Sixteen percent of companies conduct installation as well as other phases of project development, including engineering, maintenance, sales, or design. About three firms in Vermont manufacture battery storage technologies and one firm is exclusively engaged in the sales and distribution of these technologies.

TABLE 2. STORAGE COMPANIES IN VERMONT BY TECHNOLOGY

Technology Focus	Total Firms	% of Total
Storage & other clean techs[46]	13	52%
Storage & solar only	11	44%
EV Charging	1	4%

TABLE 3. STORAGE COMPANIES IN VERMONT BY INDUSTRY/SUPPLY CHAIN SEGMENT

Industry Focus	Total Firms	% of Total
Installation	17	68%
Installation & other[47]	4	16%
Manufacturing	3	12%
Sales & distribution	1	4%

[46] Other clean energy technologies include solar, wind, heat pumps, geothermal, electric vehicle charging, hydrogen, hydrogen fuels, and hydropower.

[47] Other supply chain segments include engineering, maintenance and repair, sales, design, manufacturing, and research, development, and innovation.

Battery Storage Companies Employer Feedback

INTRODUCTION

Vermont's Department of Public Service engaged BW Research to support Vermont's policy goals by acquiring more knowledge of the battery storage industry in Vermont. In addition to secondary research into Vermont's battery storage industry, BW Research also conducted extensive interviews to gather qualitative data from industry professionals. From these interviews—which were administered via phone or video conferencing between February 16 and March 25, 2022—BW Research sought to contextualize the drivers of the battery storage market and to understand business needs and future projections. Ten companies were interviewed for this portion of the research.

KEY FINDINGS

The following subsections provide key findings from the executive interviews conducted with professionals in the battery storage industry. Quotes from the conversations with battery storage professionals are included to support each trend that emerged.

Market Climate & Drivers: Demand

As statewide consumer interest grows, battery storage has become an increasingly important part of the business strategy for solar installation, software, distributor, and project developer firms. While some firms incorporated battery storage into their business strategies from the beginning, all the firms interviewed reached a consensus on the importance of battery storage to their business. Installers cited customer curiosity and inquiries as reasons for incorporating storage while distributors, software firms, and developers cited shifting market trends.

"Compared to the beginning when one in ten of our customers asked about battery storage, one hundred percent of our customers ask about it now."

"We have at least one call per week coming from an off-grid customer… they've been increasingly expressing interest in storage over the past decade."

"We began integrating storage technologies in 2013 which was when they became widely available, and our adoption was primarily driven by customer interest... we've seen customer interest grow a lot since then."

"Almost all the roof mounts we schedule come with a battery installation request… in fact, we're doing a roof mount with a battery installation today…"

"Our uptake of battery storage was a strategic move to help us stay relevant in the changing market…"

"We see energy storage as a key value adder product for our customers and an extension of the renewable energy field."

"As less intrusive batteries with better technology came out, it made sense for the business to view [battery storage] as the next step"

High visibility garnered from partnerships between battery storage suppliers and local electricity utilities has helped increase customer interest in battery storage installations. Installation firms, in their assessment of the positive or negative impacts of storage demands to their business, credited increased customer interest as being key to fostering those partnerships.

"Customers have been increasingly asking us about (battery storage supplier) because they've received messaging from (local electric utility) about these batteries…"

"(Local electric utility) has been great with spreading the word and making these batteries accessible to a lot of people who wouldn't have thought about it before."

"(Battery storage supplier) brand name recognition helped with interest in battery storage..."

Firms highlighted growing client concerns about climate change and the need for resiliency as reasons why customers seek out battery storage installations. Customers have cited the need for a dependable energy resource to meet their needs in the case of weather-related or other outages

"… what with climate change and the possibility that the grid could become less reliant… people want to be independent."

"Folks want backup… depending on your zip code or where your home is located, the grid just isn't reliable… people just want to be independent from that."

"Battery storage doesn't make sense for people who experience power outages that last one hour or less… but with all these climate disruptions, people are worried…"

Business/Hiring Needs

Vermont has no statewide solar installation certification (and no battery installation certifications by extension). Installers must be certified by each battery supplier to install their own batteries. There is a high demand for professionals who are certified by the National American Board of Certified Energy Practitioners (NABCEP). Firms are more than willing to train their hires in battery storage and support hires in obtaining NABCEP certification.

"We hire electricians and journeymen with NABCEP certification... we can offer training opportunities if we find someone with enough drive and focus to join us... they can do the training while they begin the work they are qualified to do."

"VT does not have any statewide training programs… [it] would be helpful for them to have a training force. Right now, we're training people and then they leave, leaving us out to dry…"

"Most solar installers we hired prior to this year had no battery experience but we hope storage will become part of the training strategy this year... I try to find NABCEP-certified talent but it's hard."

"Each battery storage company we work with requires that we get certified to install its product... they do this for warranty purposes. We're currently certified to install two battery brands."

"(Battery storage supplier) certification is company-wide, all our installers are experienced electricians... we train our hires to do it."

There is a general shortage of talent in solar and finding people with specific knowledge, skills, and experience in battery storage systems has been hard for firms. Individuals with certifications from the North American Board of Certified Energy Practitioners (NABCEP)— which offers individuals and companies accreditation programs for solar heat installers, photovoltaic system installers, technical sales, and other renewable energy professions— are preferred and highly sought after. Because NABCEP certified installers are in short supply, installation firms have resolved to hire experienced electricians and support them through the accreditation process. Installation firms have also partnered with battery storage companies to become certified installers of the company's product. Companies undergo technical product training and when certified, can train individuals on installing specific storage products.

"We just hired a guy, an experienced electrician, with no battery storage experience so he's still in training... we have a battery install today actually and he's tagged along. Hoping he's going to be skilled soon given the training."

"We haven't gotten a NABCEP-certified person in years. We have to hire skilled electricians and train them so they can get certified to do the solar installations."

"There is a widespread need for software engineers in the industry and we've found the hiring process challenging... it's hard to find qualified engineers with relevant skills... we're currently focused on growing our software engineering team, but we might consider hiring a battery systems expert in the future."

[In response to a question on the biggest challenge for battery storage firms in Vermont] "*Workforce shortages. We'll need more electricians to install and service the batteries."*

"We've had trouble finding applicants in this climate and that's despite the fact that we have a low bar for who we'll reach out and talk to... NABCEP-certified people are hard to come by... we're desperate for those kinds of hires... we've had to train installers on battery so none of our hires have come with battery storage experience so far."

"Our hiring process is not very effective right now... we lost over 50 people and we've only managed to hire less than a dozen... the labor market is tough right now."

"You need some significant electrical training and right now that is really hard to find. The low unemployment rate has caused many companies to compete for the same talent."

Most talent is local, and firms identified word-of-mouth as the most effective hiring channel. Firms identified online job boards (e.g., Indeed, LinkedIn, ZipRecruiter, etc.) as some channels they use to find talent, and some have adopted more creative and personalized recruitment efforts.

"Most of our hires come from word of mouth... some people have expressed interest when I've made postings on Indeed... I also have a big sign outside my company, and we are located near a busy highway so we can get more eyes on our postings that way."

"We use LinkedIn and Indeed for most of our hires and resort to recruiters; we have two that we work with when we're in a tight spot and are desperate for a hire."

"I just posted on Indeed and there have been a couple of bites already."

"We're currently hiring right now; our hiring process is simple. We have two installer positions open... we just hired an administrator, and it was hard to even find her and get her on board with us... we've made the postings on LinkedIn and ZipRecruiter which have worked for us in the past and I'm hoping will help us fill the installer positions we have."

"I, personally, contact my past colleagues at prior engagements when we've had open positions... you want to make the company attractive without poaching them from the great work that they are doing but you also want to stress what a great area of opportunity this is..."

Market Climate & Drivers: Battery Storage Supply

Battery storage is still an expensive investment for both residential and commercial customers. The price of equipment also presents a hurdle for installation firms.

"The batteries are expensive ($15,000 - $20,000) which is also another point that makes storage a hard sell. Unless there are financial incentives—which residential buildings have few to none— it's going to be hard to convince people that they need the batteries."

"Prices are high... one would expect prices to go down as demand/deployment goes up, but this has not been the case."

"A lot of customers are interested in batteries but only a few of them end up getting the batteries installed in their homes... the costs and benefits of getting one just don't line up in the end."

"Price has to come down, batteries are expensive for us and the customers."

"Just like they did for solar, they could lower the price for these batteries... that might help with uptake."

"Ten percent of the business is storage. I do expect that to increase but not significantly if we continue to see pricing pressure."

The Covid-19 pandemic put a wrench in the supply chain and presented some issues for some installation firms. Firms widely cited slow or no deliveries and poor communication as disruptive to their installation plans.

"(Battery storage supplier) is very hard to work with... they view us as the competition and so they've prioritized their own installs over supplying us with batteries... some batteries never came."

"Right now, the supply chain is the worst it's been since the beginning of the pandemic."

"Supply has been a non-issue for us, unlike (battery storage supplier) service which has been unsatisfactory for other installers because of supply chain issues which were exacerbated by Covid. There's been a two-week wait time from requesting the battery to delivery [for us while other installers have] had batteries arriving months later or never arriving at all for some installers who work with (battery storage supplier)."

"(Battery storage supplier) just announced a partnership with (local electric utility) and we're hoping this will help with the supply chain issues we've had."
[To a question on the climate of battery storage] "overpromise is the word that comes to mind"

[When asked to characterize the climate of the battery storage industry in Vermont] "It's frustrating having to work with the vendors and manufacturers whose devices are approved. Deal with about 5 companies. Right now, the supply chain is the worst it's been since the beginning of the pandemic."

Battery storage suppliers are based in other states, and they have distribution centers Vermont. Firms indicated having good working relationships with local distributors who source the batteries from suppliers/vendors with a national presence or that are based in other states.

Future Projections & Areas of Opportunity

Clarifying incentives for residential customers and expanding incentives for commercial customers will help with uptake of battery storage in both markets.

"Keep subsidies and incentives alive, like the BYOD and tax credit programs"

"Customers do not receive great value for the energy they are able to provide, and the lease programs do not offer fair compensation to installers that allow an installer to build a business."

"Greater adoption of incentive programs among local utilities that will promote grid connected and shared storage."

"It may make sense to push for a program that incentivizes customer-controlled peak shaving."

"There needs to be comprehensive policy support like a clean peak standard, Massachusetts is doing that, and modifying renewable energy portfolios at hourly rates."

"Clarifying incentives (BYOD, tax credits) for residential customers; giving commercial customers more incentives... In general, decrease weatherization incentives while increasing incentives for those who choose to electrify their homes."

"Battery storage is not as popular for commercial because there aren't as many incentives (tax credit or BYOD) … commercial customers usually express interest in batteries to help with peak shaving but since there are no incentives, uptake is generally slower."

Companies identified varied sources of growth for the battery storage industry in Vermont in the next five years. Lower equipment prices will lessen the burden for installation firms and save customers money when they decide they want a battery in their home. Developers also indicated that people are enthusiastic for this market and a lot of clarification is needed before people widely adopt this. Firms are ready for a diversified selection of battery storage suppliers in partnerships with local electric utilities to drive the prices down and help consumers have more options to choose from. Some firms indicated they need more support in the form of funding, clearer policy goals, and a better educated workforce.

"VT can provide support for early-stage startups through local accelerators (like UVM Innovation) to support battery storage innovation and adoption."

"Market signals are needed... we have plenty of private capital but there's currently little to no return on investment."

"Potential decrease in battery costs, though current market forces are sending things in the wrong direction."

"VT does not have any statewide training programs… would be helpful for them to have a training force."

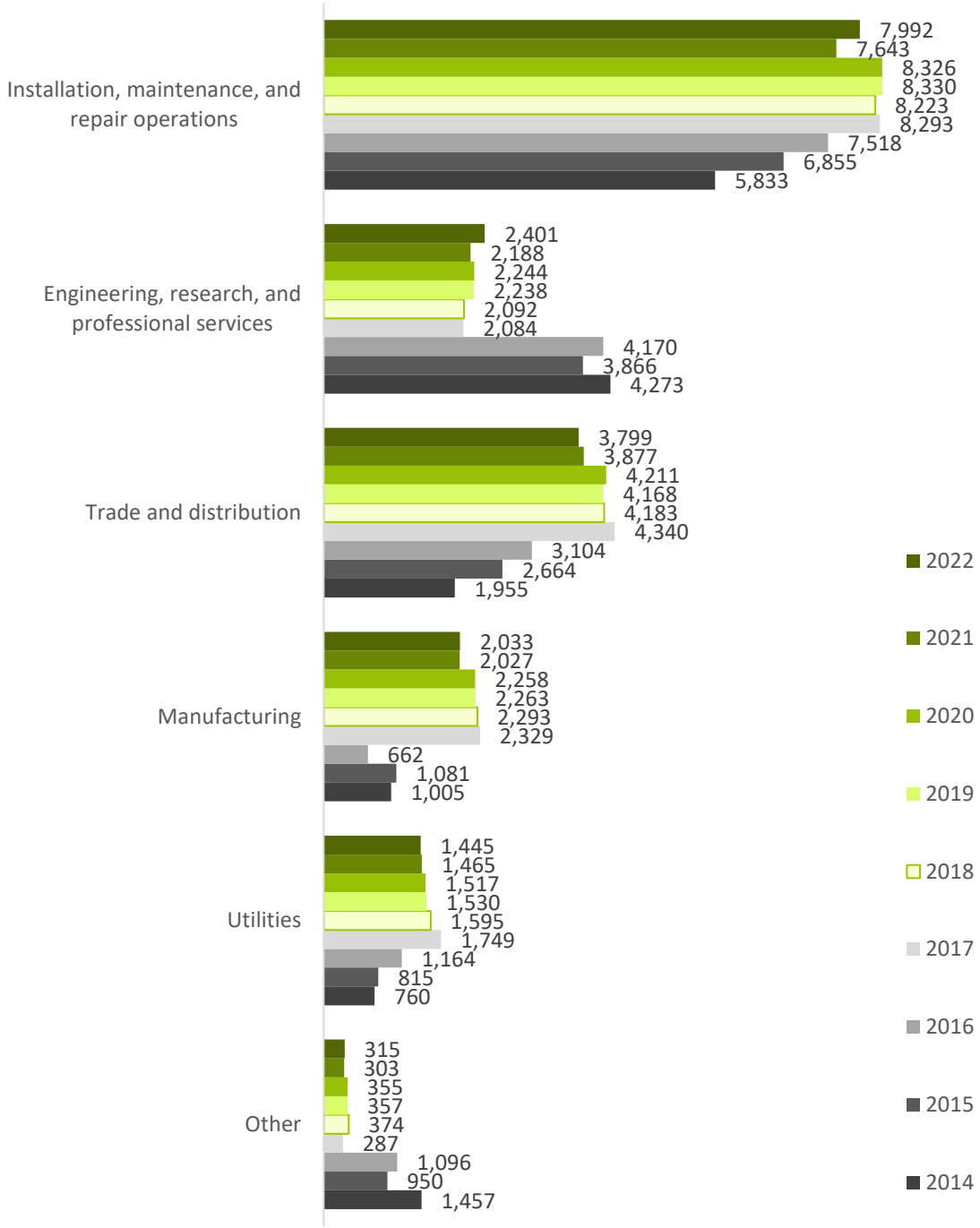
"We generally need better literacy in the trades and the state could begin with supporting high school education across the state; technical schools like Stafford High come to mind."

Clean Energy Value Chain Employment

The value chain sectors that experienced the largest job growth between 2020 and 2021 were installation, maintenance, and repair operations and engineering, research, and professional services. Altogether, installation, maintenance, and repair operations gained 349 jobs, for an increase of 4.6 percent from last year's report. Engineering, research, and professional services gained 213 jobs, for an increase of 9.8 percent from last year's report. While employment in the installation, maintenance, and repair value chain sector still falls below pre-pandemic levels, employment in the engineering, research, and professional services sector surpassed its pre-pandemic levels this year.

Of the remaining value chain sectors, the trade and distribution sector and utilities sector both saw job losses over the past year, shedding 78 and 20 jobs and decreasing by 2 percent and 1.3 percent respectively. Manufacturing employment remained steady during this time.

FIGURE 8. CLEAN ENERGY EMPLOYMENT BY VALUE CHAIN SEGMENT, 2014-2021

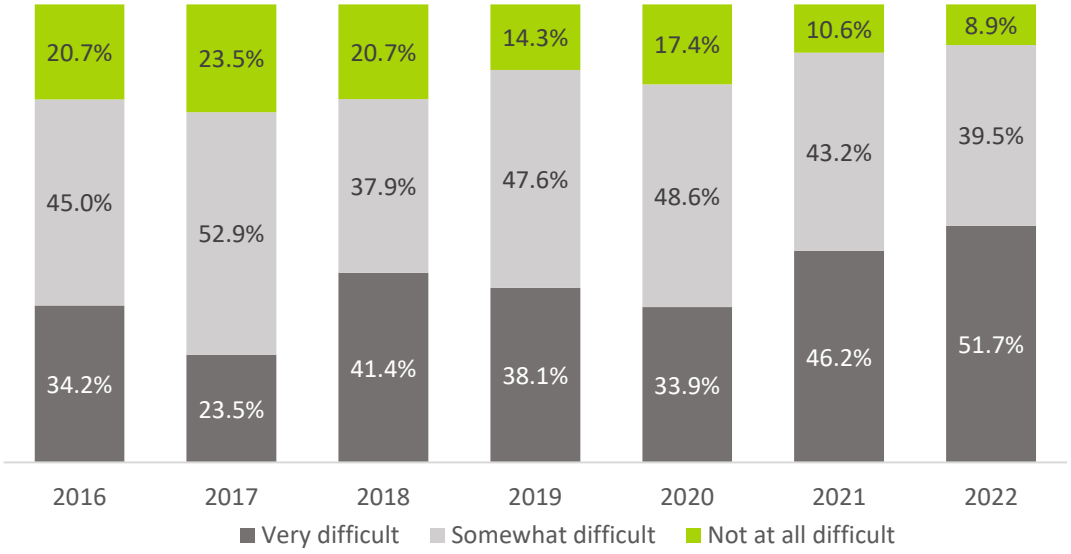


Clean Energy Hiring

About nine in ten (91.1 percent) employers who were hiring in 2021 reported overall difficulty—the sum of very and somewhat difficult—between 2020 and 2021. This represents a two-point increase from last year's reported hiring difficulty, but a nine-point increase from hiring difficulty two years ago. The proportion of employers that reported hiring had been very difficult over the year increased from 46 percent to almost 52 percent—5.5 points higher compared to last year and 17.8 points higher than it was two years ago.

"More than half of employers reported hiring had been very difficult over the year."

FIGURE 9. EMPLOYER-REPORTED HIRING DIFFICULTY, 2016-2022



Appendix A: Research Methodology

EMPLOYMENT DATA

In congruence with previous reports, this year's Clean Energy Industry Report is based on the 2022 United States Energy and Employment Report (USEER). The 2022 USEER utilized data from the Bureau of Labor Statistics Quarterly Census of Employment and Wages (BLS QCEW 2021 Q3), the BLS Unemployment Situation Table B-1 monthly reports, together with a detailed supplemental survey of business establishments. The survey was designed and implemented by BW Research Partnership in partnership with the Department of Energy (DOE). For the past decade, national, state, and local energy-related data collection and analysis efforts have used this survey methodology.

The survey uses a stratified sampling plan based on industry code (North American Industry Classification System or NAICS), establishment size, and geography to determine the proportion of establishments that work with specific energy related technologies, as well as the proportion of workers in such establishments that work with the same. These data are then analyzed and applied to existing public data published by the BLS QCEW, effectively constraining the potential universe of energy establishments and employment.

The survey was administered by phone and by web from January 2022 through April 2022, with more than 6,700 outbound calls, more than 1,000 emails, and 78 invite letters with DOE letterhead sent to participants across Vermont. The phone survey was conducted by ReconMR. The web instrument was programmed internally, and each respondent was required to use a unique ID in order to prevent duplication.

The sample was split into two categories, the known and unknown universes. The known universe includes establishments that have previously identified as energy-related, either in prior research or some other manner, such as membership in an industry association or participation in government programs. These establishments were surveyed census-style, and their associated establishment and employment totals were removed from the unknown universe for both sampling and resulting employment calculations and estimates. Over the summer of 2021 BW Research cleaned, deduplicated, added to, and refined its database to reflect churn (companies out of business, moved, no longer in energy), unverified (no answer, answering machine, fast-busy, disconnect, etc.), verified, and other available demographic tags (industry, technology, sub-technology, size, etc.).

In addition to cleaning the original known energy database, BW Research also supplemented with industry association contact lists by technology (biofuels, coal, oil, and gas, energy storage, energy efficiency, solar, and wind), new companies from the unknown database that took the 2021 survey and contact lists from subcontractors. BW Research also appended contact information, including six-digit NAICS codes, contact, employment, and location information.

The unknown universe includes thousands of businesses in potentially energy related NAICS codes, across agriculture, mining, utilities, construction, manufacturing, wholesale trade, professional services, and repair and maintenance. Each of these segments and their total reported establishments (within the BLS QCEW) were carefully analyzed by size (employment – provided by the Census Bureau's County Business Patterns) and state to develop representative clusters for sampling.

In total, 386 business establishments in Vermont participated in the survey effort. These responses were used to develop incidence rates among industries as well as to apportion employment across various industry categories in ways currently not provided by state and federal labor market information agencies. The margin of error is +/- 4.86 percent for Vermont at a 95 percent confidence interval.

With clean data files in place, BW Research developed a general methodology for state employment estimation that has a few variations depending on sub-technology. Steps in the process are listed below.

100% NAICS A
These are NAICS codes where 100% of the reported employment is energy related AND 100% are allocated to a specific sub-technology. Examples include solar electric power generation, hydroelectric power generation, and motor vehicle manufacturing.

Actual Survey Responses
These include the reported sub-technology employment totals by company location. Responses from establishments in 100% NAICS codes are excluded.

Known Database
Employment is allocated by location for verified establishments in the known when the following conditions are met: 1) Have InfoUSA or DatabaseUSA appended data; 2) did not take survey (or actual survey response would be used), and 3) are not in a 100% NAICS.

Remainder
This represents remaining employment based on statistical extrapolation.

Industry Mix
Industry mix is the national proportion of industries that contribute to sub-technology employment. The mix of these industries (by 6-digit NAICS) is used to create proportions by state and remainder employment is allocated by these proportions. This "industry mix" was developed by analyzing completed survey incidence nationally for all clean energy sub-technologies.

100 PERCENT & FULL-TIME EQUIVALENT JOBS

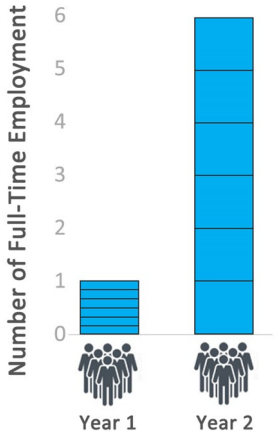
Full-time equivalent (FTE) jobs are extrapolated using state employment thresholds by technology weighted on census division and previous year's data. These thresholds are adjusted for response bias

between our known and unknown universes, then the proportion of firm revenues from energy projects are incorporated. Employment thresholds are survey data from questions asking what percent of a firm's employment spends at least 50 percent of their time working on energy-related activities and what percent spend all their time on clean energy activities. Using the adjusted thresholds, employment by state is then split into three groups, those that spend all (100 percent) of their time on energy-related activities, those that spend a majority (50 to 99 percent) of their time, and those that spend less than a majority (0 to 49 percent) of their time. These employment groups are weighted 0.25 on the less than a majority group, 0.75 on the majority group, and 1 on the 100 percent group. FTE jobs are the sum of these products.

Because the 100 percent employment estimates are a subset of the overall FTE metric, these employment figures have also been updated accordingly using the above methodology.

FIGURE 10. FULL-TIME EQUIVALENT CLEAN ENERGY JOBS EXPLAINED

An example can illustrate the importance of tracking FTE clean energy employment. If a Heating, Ventilation, and Air Conditioning (HVAC) firm had 6 installers in 2019 who occasionally installed heat pumps, and now has 6 installers who exclusively do so, there would be no change in the total number of clean energy workers reported. However, because the number of labor hours working with heat pumps has increased, FTE jobs would show a corresponding increase.



Appendix B: Clean Energy Technology List

A clean energy job is defined as any worker that is directly involved with the research, development, production, manufacture, distribution, sales, implementation, installation, or repair of components, goods, or services related to the following sectors: Renewable Energy Generation; Clean Grid and Storage; Energy Efficiency; Clean Fuels; and Clean Transportation. These jobs also include supporting services such as consulting, finance, tax, and legal services related to energy.

The State of Vermont categorizes sub-technologies differently from the USEER data collection effort and reports. The below lists identify which sub-technologies are specific to Vermont's clean energy definition. They are placed in their respective USEER category, with additional in-text and footnote explanation as to where they would fall for the Vermont Clean Energy Industry Report.

RENEWABLE ENERGY GENERATION

Renewable energy generation jobs cover all utility and non-utility employment for renewable electricity-generating technologies. Included in these employment estimates are any firms engaged in renewable energy facility construction, generation equipment manufacturing, wholesale parts distribution, and professional and business services such as consulting, finance, administrative, and legal support for the following renewable energy generation sub-technologies:

- Solar Photovoltaic Electric Generation
- Concentrated Solar Electric Generation
- Wind Generation
- Geothermal Generation
- Bioenergy/Biomass Generation
- Low-Impact Hydroelectric Generation, including wave/kinetic generation
- Traditional Hydroelectric Generation
- Combined Heat and Power
- Other Renewable Electric Power Generation
- Renewable Heating and Cooling[48]
    - Solar Thermal Water Heating and Cooling
    - Other Renewable Heating and Cooling (geothermal, biomass, heat pumps, etc.)

[48] For Vermont, "renewable heating and cooling" is included under the "renewable energy generation" sector, while for USEER data collection, this sub-technology is categorized under "energy efficiency".

RENEWABLE FUELS[49]

These jobs encompass all work related to the production of clean fuels. Fuels employment spans industries such as agriculture and forestry, manufacturing, professional and business services, wholesale trade, transportation, and construction.

It is important to note the difference between bioenergy electricity generation jobs and woody biomass fuels jobs. The former includes workers that are involved in the utility generation of electricity from materials derived from biological sources or any organic material, while the latter encompasses those workers who are engaged in fuel development from these materials such as manure, vegetable oil, trees and woody plants, and other living matter. Bioenergy generation workers are expressly involved in the electricity-producing component (including the construction of facilities and manufacture and wholesale trade of generators or turbines) while woody biomass workers are involved in the production, refinement, and distribution of those fuels used to produce the electricity. Vermont includes the following renewable fuel sub-technologies under the overall renewable energy generation sector:

- Woody Biomass, including cellulosic biofuel
- Non-Woody Biomass, including biodiesel

ENERGY EFFICIENCY

- Traditional HVAC goods, control systems, and services
- ENERGY STAR Certified Heating Ventilation and Air Conditioning (HVAC), including boilers and furnaces with an AFUE rating of 90 or greater and air and central air conditioning units of 15 SEER or greater
- ENERGY STAR® Appliances & Efficient Lighting
    - ENERGY STAR Certified Appliances, excluding HVAC
    - ENERGY STAR Certified Electronics (TVs, Telephones, Audio/Video, etc.)
    - ENERGY STAR Certified Windows and Doors
    - ENERGY STAR Certified Roofing
    - ENERGY STAR Certified Seal and Insulation
    - ENERGY STAR Certified Commercial Food Service Equipment
    - ENERGY STAR Certified Data Center Equipment
    - ENERGY STAR Certified LED Lighting
    - Other LED, CFL, and Efficient Lighting
- Advanced Building Materials/Insulation
- Other Energy Efficiency
    - Reduced Water Consumption Products and Appliances
    - Recycled Building Materials

[49] For Vermont, “non-woody biomass” and “woody biomass” are included under the “renewable energy generation” sector, while for USEER data collection, these sub-technologies are categorized as “fuels”.

CLEAN GRID & STORAGE[50]

Electric Power Transmission and Distribution

- Smart Grid
- Microgrids
- Other Grid Modernization

Storage

- Pumped Hydropower Storage
- Battery Storage, including battery storage for solar generation
    - Lithium Batteries
    - Lead-Based Batteries
    - Other Solid-Electrode Batteries
    - Vanadium Redox Flow Batteries
    - Other Flow Batteries
- Mechanical Storage, including flywheels, compressed air energy storage, etc.
- Thermal Storage
- Biofuel, including ethanol and biodiesel storage

CLEAN TRANSPORTATION

- Hybrid Electric Vehicles
- Plug-In Hybrid Vehicles
- Electric Vehicles

[50] For Vermont, these are included under the "energy efficiency" sector, while for USEER data collection, these sub-technologies are categorized under "transmission, distribution, and storage" (or clean grid and storage for clean energy-specific industry reports).