Evaluating Equity and Justice Impacts of Energy Efficiency Projects

Efficiency Vermont R&D Project: Justice

December 2023

Katie Kinstedt

Efficiency Vermont

20 Winooski Falls Way
Winooski, VT 05404

Contents

Executive Summary

Energy equity, as it is understood in the energy industry, is the fair and impartial distribution of clean energy services and technologies supported by the work to create more just processes, outcomes, and systems. It is integral to Efficiency Vermont's work. Equity metrics can help identify and address disparities in how the benefits of energy efficiency programs are being distributed and the financial burdens customers must assume from energy use. Equity metrics can also address energy system challenges. Knowing the metrics can lead to improved program design, increased program participation, and greater trust with outside stakeholders.

Efficiency Vermont has investigated those metrics, and derived a framework of insights and intersections of equity and environmental justice. This report describes the investigation and its analyses, and presents findings with relevance for both residential and the commercial and industrial sectors.

The 2022 research in evaluating equity and justice impacts from Efficiency Vermont programs identifies, quantifies, and explores the application of equity metrics. The research project objective has sought to ensure that Efficiency Vermont's work aligns customer priorities with VEIC's equity goals and Vermont's environmental justice (EJ) goals.[1] This 2023 research project determined which equity metrics could provide the greatest insight into equitable program design—by pairing available program data with external datasets to carry out an equity analysis.

Insights from distributional equity analysis. A method referred to as *geographic proxy distributional equity analysis* (GP-DEA) pairs (1) demographic and equity data at the neighborhood block group or U.S. Census tract level with (2) program impacts aggregated for matching geographic areas and adjusted for population size.

The research team determined the correlation coefficient and p-value of univariate linear regression between each variable. The team then created a secondary multivariate linear regression model and adjusted it for the multi-collinearity of the structural equity metrics—for example, the intersectionality of race and income.

The team extended the equity metrics and analysis work to examine how Efficiency Vermont could remove participation barriers for residential customers, while continuing to align programming with commercial and industrial (C&I) customers' equity values and business priorities. The team based its tangible recommendations on the barriers to energy efficiency participation by low-income (LI), moderate-income (MI), and renter households. The recommendations ensured the longer-term affordability benefits of energy efficiency and equity as the transition to cleaner energy proceeds throughout Vermont.

[1] VEIC is the operator of Efficiency Vermont, and has organizational goals relating to equity.

The research team integrated equity questions into Efficiency Vermont's brand survey work, surveying approximately 250 small, medium-sized, and large businesses. The survey contained questions specifically targeting equity considerations, with multiple-select and open-ended response options. Overall, respondents were polarized when asked about the role of equity in energy efficiency, ranging from strong enthusiasm and support to confusion, to outright negative reactions. One key finding was a trend for Vermont businesses to conflate *equity* with *equality* and non-discriminatory human resources policies. These results solidified the importance of basing equity work on relationships and in-depth knowledge of commercial customers, rather than on industry-specific terminology and policy priorities that came across as confusing or polarizing.

Introduction

Energy equity is defined by Efficiency Vermont and other industry leaders such as American Council for an Energy-Efficient Economy (ACEEE) as the work to address the embedding of diversity, equity and inclusionary considerations into programs, policies, and investments, such that we can improve and expand determination of, access to, and utilization of impactful clean energy services and technologies for underserved groups while creating more just processes, outcomes, and systems.

Efficiency Vermont strives to equitably deliver energy cost savings to customers and energy supply and distribution savings to the state's energy system and the grid. This commitment goes beyond equal access to programs and strives for equal program outcomes across demographics. The program recognizes that it must be intentional in overcoming gaps in service delivery for specific customer populations, such as those that do not use much energy, have low incomes, and face significant barriers to program participation. Efficiency Vermont has demonstrated a steadfast commitment to advancing equity. It has also been recognized by ACEEE for innovation in advancing equitable program design. Further, Efficiency Vermont's equity work regularly exceeds regulatory requirements, and plays a significant role in guiding the clean-energy industry's evolution in equity performance metrics.[2]

Equity metrics help identify and address disparities in customer benefits and in energy system constraints. They can inform ways to improve program design for focused populations and for general programming. Successfully overcoming participation barriers often provides best practices and improves program design for all participants. Another benefit of tracking and reporting equity metrics is the fostering of relationships with outside stakeholders, helping to build trust and gleaning valuable insights that can be incorporated into program design and improve program impacts.

Equity metrics can go beyond simply tracking the distribution of program benefits. They also inform historical and ongoing inequities by quantifying the distribution of energy system burdens, applying principles of environmental justice.[3] For the application of equity metrics, it is important to define focus populations and to use distributional equity analysis (DEA) tools to understand and quantify the benefits and burdens of programs or policies for those populations. DEAs can point to disparities in the time-specific distribution of benefits and burdens, and can inform the design of more equitable programs and policies.

---

[2] Energy Equity: A Framework for Efficiency Vermont's work in 2024 and beyond. Filed by Efficiency Vermont in Vermont Public Utility Commission Case No. 22-2954-PET on January 24, 2023.

[3] *Energy system burdens* in this report comprise extra societal and grid-related costs associated with such phenomena as pollution from power plants, land use changes, poor quality of electricity delivery, fuel availability, and severe effects of greenhouse-gas-driven climate change.

Equity and Environmental Justice in Vermont

Environmental justice in Vermont

The Vermont Environmental Justice Bill, Act 154, signed into law in May 2022, requires State agencies to integrate environmental justice (EJ) considerations into their decision-making so that all individuals have equitable access to and distribution of environmental benefits and burdens—and have meaningful participation in decision-making processes. State agencies must:

1) Identify and assess EJ communities that are disproportionally exposed to environmental hazards and have limited access to environmental resources
2) Consider the impact of their decisions on EJ communities
3) Provide opportunities for public participation and input on EJ issues
4) Report progress on EJ efforts, including across the three bullet points above.

The aim of Act 154 is to increase public participation in decision making processes,[4] and identify, reduce, and eliminate environmental health disparities to improve the health and well-being of all Vermont residents.

Vermont Act 154 Definitions

1) *Environmental benefits* means the assets and services that enhance the capability of communities and individuals to function and flourish in society.
   - Examples: access to a healthy environment and clean natural resources, including air, water, land, green spaces, constructed playgrounds, and other outdoor recreational facilities and venues; affordable clean renewable energy sources; public transportation; fulfilling and dignified green jobs; healthy homes and buildings; health care; nutritious food, etc.
2) *Environmental burdens* means any significant impact to clean air, water, and land, including any destruction, damage, or impairment of natural resources resulting from intentional or reasonably foreseeable causes.
   - Examples: climate change impacts; air and water pollution; improper sewage disposal; improper handling of solid wastes and other noxious substances; excessive noise, etc.
3) *Environmental justice* means all individuals are afforded equitable access to and distribution of environmental benefits; equitable distribution of environmental burdens; and fair and equitable treatment and meaningful participation in decision-making processes, including the development, implementation, and enforcement of environmental laws, regulations, and policies.

[4] *Participation,* as defined in the law, offers contexts for *meaningful participation* and *maximum participation.* The law characterizes this term fully throughout its text.

Equity approach at Efficiency Vermont

In its residential programs, Efficiency Vermont's equity initiatives predominantly center on income-based programs and bonuses. Geographic equity efforts ensure that program spending is proportionately distributed across all Vermont communities. As such, current equity metrics primarily address the proportion of program spending that benefits income-qualified populations (often labeled *Low Income Spend*, or *LI Spend* in program reporting) and proportion of program benefits that impact residents across Vermont's geographic and utility regions. In Efficiency Vermont's C&I portfolio, equity initiatives have created incentives and bonuses for specific types of businesses. Furthermore, Efficiency Vermont must meet minimum participation requirements for small business customers as outlined in Efficiency Vermont's Triennial Plan.

Efficiency Vermont's 2023 Energy Burden Report identified the distribution of energy cost burdens across Vermont, recognizing that income, energy efficiency, and access to affordable energy are not evenly distributed. Efficiency Vermont designs programs to overcome participation barriers by targeting incentives, and by affirmative marketing and support for well-researched populations of focus.

Efficiency Vermont equity work supports the aims of Vermont's EJ bill. Specific programs intentionally prioritize low-income households and provide additional support and outreach to households that have difficulty expressing themselves in English, and those with high energy burdens. Efficiency Vermont also carries out focused support to flood- and pandemic-affected businesses. The program also intentionally supports women- and BIPOC-owned businesses. Further, programs have provided extra support to businesses and households in communities with higher prevalences of vulnerability indicators such as income, language, and education and higher energy burdens.

Using a two-pronged strategy, Efficiency Vermont has worked with community partners to promote its programs and has increased customized incentives. In 2024, Efficiency Vermont will greatly increase community outreach and stakeholder engagement to advance procedural equity even further.

Ongoing work on equity metrics, including the 2022 - 2023 R&D project described in this report, identifies EJ communities, and assesses the distribution of program benefits. In addition to distributional equity metrics, the 2022 research explored structural and procedural equity metrics, 74 of which merited further consideration, in service to meeting goals.

Distributional Equity Analysis

A DEA compares program impacts and energy system burdens for specific focus populations. Unlike the traditional energy efficiency benefit-cost analysis (BCA), which compares quantitative costs and benefits across all customers on average, the DEA looks at effects on specific populations. NESP research documents the benefits and shortcomings of using BCA to advance energy equity work. Although BCAs look at an overall program or at specific participants, they do not provide information on how those effects are distributed among different populations. DEAs,

on the other hand, measure the effects of a program on different populations to determine if any one population experiences a disproportionate benefit or burden as a result of the program. In essence, a DEA disaggregates the benefits and costs of a program for different populations.

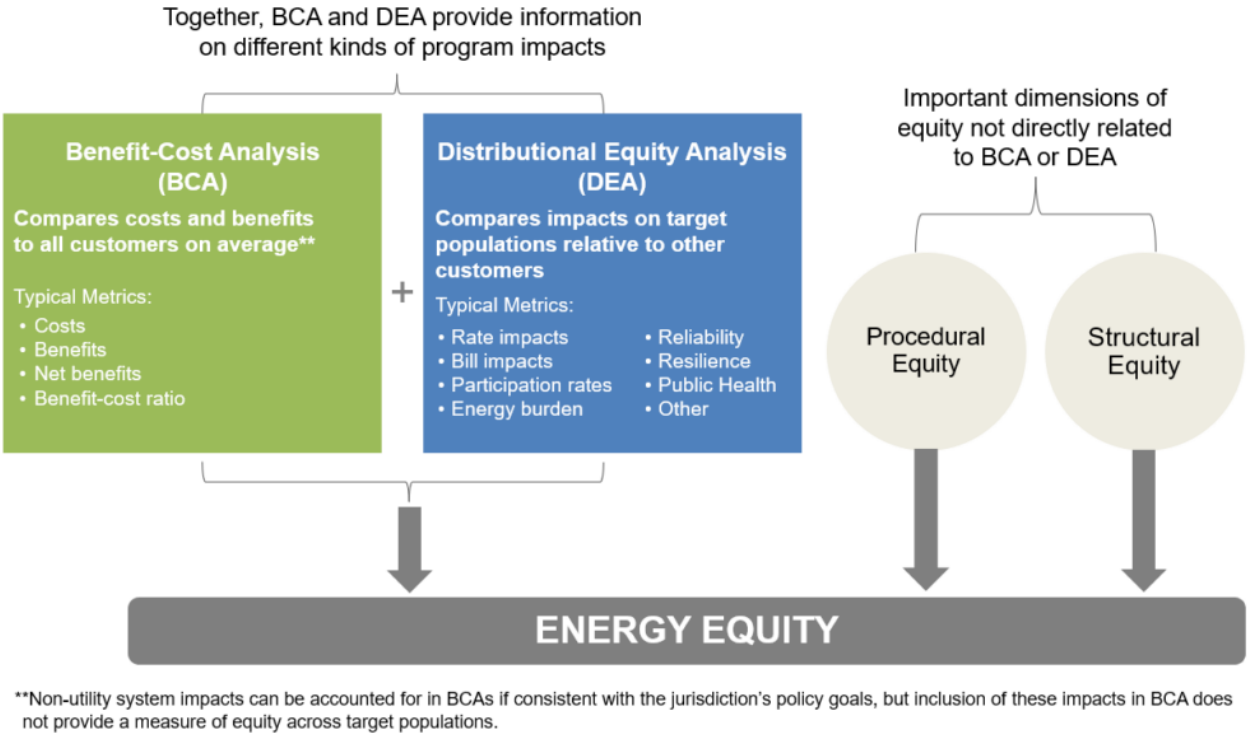


Figure 1. NESP conceptual framework comparing DEA to BCAs.

Identifying the focus population

A DEA initially identifies focus populations and determines whether data are available for analysis. The analysis begins with existing program data available in Efficiency Vermont's program database such as the geographic location of every project. Additional layers of information are considered when available, but are not universally collected for all programs. For example, income data for customers are available only when required for program participation. In some cases, the research team can presume income qualification if two identical programs are offered, one requiring income qualification, and one without income restrictions.

For example, if there is a low- or moderate-income bonus for an electric vehicle or heat pump purchase, the analyst can assume that households that do not receive the income-qualified bonus fall in the high-income category.[5] Similarly, if Efficiency Vermont extends additional program support for renters / landlords, the research team has assumed that participants who

[5] Although the assumption about customers outside the income-qualified pool of participants is valid, internal research on weatherization programs in Vermont has shown that some households incorrectly self-identify as ineligible for low-income programs, when they in fact meet income qualification criteria.

do not receive the tailored support for rental properties are in fact owner-occupied single-family homes. In these two examples, the assumed population demographics are relatively binary (mutually exclusive indicators of *participant* or *non-participant*).

Another way to assume or assign population demographics is to survey existing program participants to determine the proportional participation (as a percent) of a population compared to the expected participation if program benefits or participation were proportionally distributed among groups. Under these circumstances, however, a statistically determined margin of error would suggest the survey results are not perfectly reflective of the full program. The three approaches to participation measurement—collected data, binary assumptions or determinations, and survey-based allocations—provide DEA results that quantify distributional equity.

Alternatively, when data are not available, proxy approaches can evaluate statistically significant differences among populations. If data are not collected or cannot be disaggregated for a focus population, the final option for quantifying the DEA impact on that population is to find a proxy variable that closely approximates participation or impact. A proxy variable correlates with the variable of interest, but is easier to measure. For example, if data on income are considered unreliable because of monthly and annual fluctuations, a proxy variable can come into play. An example of this is the education level of the head(s) of household.

Another approach is to determine a proxy variable from available data known to be highly correlated to the metric of interest. Such a proxy will certainly be less accurate than directly recording the desired data. However, direct measurement is sometimes impossible to achieve, or it is detrimental to program design or diminishes customer trust. For example, upstream processing of heat pump rebates overcomes cost, time, complexity, and financing challenges encountered by households, but it sacrifices the ability to collect specific household demographic information. In such a case, a researcher can intentionally decide to prioritize the removal of known barriers for a focus population over collecting additional information necessary to conduct a DEA. Protecting customer privacy and personally identifying information is another reason direct customer demographic data are sometimes unavailable or undesirable.

To overcome data limitations for Efficiency Vermont, this research has used geographic aggregation as a proxy approach to conduct a DEA for various focus demographics, referred to as a *geographic proxy DEA*, or *GP-DEA*. The purpose of this research is two-fold. First, it has looked at statistical relationships among population groups and program benefit metrics through univariate regression analyses to identify statistically significant differences among those groups. Second, the team has further analyzed the results for the univariate regression with a multivariate analysis. This has made it easier to understand the intersectionality of various population characteristics (for example, income and housing tenure) and to prioritize individual and shared characteristics (geographic boundaries or composite metrics, such as social vulnerability scores, for example).

Methods

The research team sequenced the following methods:

1) External research scan to characterize and rank barriers to program participation
2) External research scan of demographic and environmental justice datasets / maps
3) External research scan of definitions of environmental justice, program benefits, and energy system burdens
4) External research scan of existing DEA methods
5) Internal research scan of market survey data
6) Primary research to carry out stakeholder interviews
7) Primary research on C&I value drivers
8) Organization of internal and external data to carry out a DEA
9) External and internal research scan of solutions to address primary barriers

External research scans on barriers, datasets, methods, and definitions

The research team reviewed internal and external research, surveys, and datasets. This work considered research formats such as podcasts, webinars, research papers, working group meeting notes, and published datasets from the ACEEE[6], the Consortium for Energy Efficiency (CEE)[7], the National Energy Screening Project (NESP), Lawrence Berkeley National Lab (LBNL), Clean Energy States Alliance (CESA), and the U.S. Department of Energy (DOE). The research team also looked at material from consulting firms and academic institutions carrying out energy equity research: the University of Michigan, Carnegie Mellon University, Illume Consulting, and the Cadmus Group. The team referred also to Vermont and national policy (Vermont Environmental Justice Act 154 and the federal Justice40 Initiative). Finally, the research team consulted internal reports, surveys, and program data from the Efficiency Vermont Tracker system. The team summarized the resource material via research notes and intermediate research deliverables (PowerPoint presentations, summary documents, and tables).

The scans

- The first external research scan characterized and ranked barriers to energy efficiency and clean-energy program participation.
- The second research scan defined and characterized energy program benefits and energy system burdens through an environmental justice lens. The results from the first two scopes of research are summarized in subsequent sections of this report.
- The third scope of the external research scan was to identify outside datasets that reported on demographics and environmental justice indicators at the Census tract or

[6] The ACEEE material can be found at these sites: ACEEE: Advancing Equity Through Energy Efficiency Resource Standards: ACEEE: Leading with Equity Initiative: Key Findings and Next Steps: and ACEEE: Meeting the Challenge: A Review of Energy Efficiency Program Offerings for Low-Income Households.

[7] The announcement of the CEE papers, "Characterization of Non-Energy Impacts" and "Equity Landscape Analysis Report" can be found here.

neighborhood block level. Where possible, the team used geographic boundaries of the 2020 Vermont Census. The scope of research characterized demographic and environmental justice datasets and mapping tools.

- The fourth external research scan, an internal scan, examined methods for carrying out a DEA.
- The fifth research scan, an internal scan, reviewed Efficiency Vermont market survey data that addressed program participation barriers for both residential and C&I markets, and the equity and social justice priorities of businesses.
- The sixth research scan, an external scan, identified solutions to overcome the primary participation barriers.

The research team used the results from the five external and one internal research scans as a foundation for the research and development of the analytical methods.

Stakeholder interviews on participation barriers for energy programs in Vermont

The research team conducted five stakeholder interviews with internal Efficiency Vermont staff and representatives of Burlington Electric Department, the Vermont State Employees Credit Union, and Vermont Gas Systems.

The questions

1. What are the most significant barriers you have observed for each of the three following groups: low income, moderate income, and renters?
2. How would you rank each of the barriers per group, based on the most significant impacts a barrier poses to each group?
3. Do you have any examples of programs that have addressed or are working to address these barriers? If possible, share which groups each initiative addressed?
4. Was there any internal / organizational or external evaluation of the program? If yes, could you either share verbally or provide any available documentation?
5. Do you have any available documentation of work / barrier analysis, either specific for one of these three groups, or with more general application? If so, could you please share?
6. Is there an external stakeholder the research team should interview about this topic, as they can represent the voice of Efficiency Vermont customers?

Method for selecting the primary participation barriers

The research team examined participation barriers for three segments of residential customers, taking into consideration program experience and future program design needs. The team used the results from the eight-subject matter expert (SME) interviews and the three-Efficiency Vermont market research surveys (the 2021 Residential Brand Survey, the 2020 Weatherization Survey, and the 2019 Appliance Survey) to prioritize the 18 identified barriers (see **Appendix A**) by

residential population: low income, moderate income, and renters. The team weighted the results at 60 percent from staff input and 40 percent from survey results. The team recorded the top two barriers, by population, for each individual or survey. The primary barrier for each received two points, and the secondary barrier received one point.

Method for market survey to explore C&I value drivers

The research team also integrated C&I value driver-specific questions related to equity metrics into two Efficiency Vermont brand surveys. One targeted large businesses; the other targeted small to medium-sized businesses (SMBs).

The survey of large businesses used a Qualtrics online format field; 241 large businesses received invitations to participate, and 27 percent (65 customers) responded. The team administered the SMB survey over the phone, with the measure app MSR. Despite recruitment challenges, the team collected 179 complete responses, and 211 partial survey completions (that is, participants terminated their responses before completing all the questions in the phone interview). For both surveys, the team did not initially reveal Efficiency Vermont sponsorship, and both surveys used several multiple-choice questions and several open-ended-response questions.

Method for distributional equity analysis

The primary objective of this year's work has been the identification of equity metrics that provide a high level of insight from available program data, using external datasets to carry out an equity analysis to inform equitable program design. The research team worked from the strong foundation of its 2022 equity metrics R&D work, which described a strategy and its results in identifying priority equity metrics.[8] The research team further pared down the 2022 list of equity metrics by basing the metric rankings on potential insights and availability of data. This method resulted in a shortlist of 6 distributional and 9 structural / recognition equity metrics for additional analysis, as shown in **Table 1**.

[8] The University of Michigan's Energy Equity Project Framework greatly influenced Efficiency Vermont's 2022 R&D work.

Table 1. Prioritized distributional and structural equity metrics

		Metric
Distributional	D1	Program investment level
	D2	Energy cost savings lifetime (level of energy cost—utility or fuel bill—savings for program participants)
	D3	Program benefits (total resource benefits, or TRB)
	D4	Energy burden
	D5	Air quality (composite value at the community level)
	D6	Participation rate (measure of the level of program participation, or as a comparison between a focus population and other customers)
Structural / recognition	R1	Firmographic groupings (business size)
	R2	Renters
	R3	Mobile homes
	R4	Social Vulnerability Index (SVI) status
	R5	Households where English is not the primary language
	R6	Households without internet access
	R7	Age of housing (affects efficiency and exposure to toxics)
	R8	BIPOC status
	R9	Income (<80% of area median income)
	R10	Education level
	R11	Elderly (> 65 years old)

The team prioritized distributional equity metrics D1-D3 for inclusion in the GP-DEA as these three metrics are available through direct program data. Direct program data were not available for several prioritized structural equity metrics. The team used GP-DEA methods to overcome the lack of structural equity data available at the project / site level, and analyzed program impacts. Data for R1, firmographic groupings (business size), were not available at the block group level, and were thus not included in the final analysis.

The research team analyzed program impact metrics (lifetime customer cost, energy savings, TRB, and incentive payments) with clearly defined internal dataset parameters for:

- Geography
- Years
- Funding source
- Program data / metrics
- Program type

The team carried out these design parameters in close consultation with internal SMEs on program data analytics, and with VEIC SMEs on equity metrics. **Appendix B** contains full details on the selected internal parameters. Efficiency Vermont's Business Insights team examined the

data pull and compiled an Excel spreadsheet of more than 250,000 rows of data entries at the site address level. Approximately 100,000 of the addresses were incomplete, because several programs collected only ZIP Codes. The team removed these entries, leaving a dataset of approximately 151,000 addresses.

Next, the team used a geographic information systems (GIS) tool to assign a Vermont 2020 block group Federal Information Processing Standards (FIPS; National Institute of Standards and Technology) code. The team achieved a match rate of 85 percent, and discarded unmatched addresses from the dataset. The team constructed a pivot table to aggregate results at the relevant Census block (FIPS). The team then formatted information available at the Census block level and the larger tract level from outside datasets, to provide compatibility with the pivot table of results from the internal dataset. **Appendix C** contains full details on the external datasets considered and those used for the distributional equity analysis, and an excerpt of this table.

The research team aggregated residential and C&I energy and cost savings benefits for each Census block group and further adjusted to a per-capita value by dividing the total benefits for the block group by the population of the block group. The team has presented cost savings as lifetime values, or cost savings life (CSL). This approach normalized the results by residential population density. However, the residential population density of a Census block does not always correspond to the business density of the same geographic area. To adjust for business density, the team used data from the U.S. Census report CB2000CBP on business establishments per capita at the ZIP Code level. The team used the ZIP Code data to estimate the business density at the block groups using ZIP Code Tabulation Areas (ZCTAs).

The research team adjusted C&I values at the ZIP Code level using a ratio of Census block jobs per capita to the average jobs per capita across Vermont. The team chose the number of jobs per capita instead of the number of businesses, to weigh the effects of business size more accurately (in general, the larger the business, the more employees). The adjustment resulted in increased values per capita for areas with lower business density and decreased the values per capita for areas with high business density.

For example, before the adjustment, many poorer downtown areas were showing disproportionately high levels of C&I investment per capita (when measured by residents), but the adjustment helps to reflect the investment per business (there are often greater numbers of businesses in downtown cores) instead of per-person values for area residents. Conversely, some affluent residential areas showed lower C&I benefits before the adjustment, but when adjusting for the business density, the level of investment per business was aligned with average spending per business.

The team carried out a correlation analysis in Excel to determine the correlation coefficient and p-value of univariate linear regression between each individual variable (each benefit separated by residential and C&I and each structural equity metric). For C&I benefits, only 2 weak positive correlations pertained to the structural equity metrics: BIPOC and second language spoken. Thus, the team did not carry out additional analysis beyond the univariate analysis. For residential

program benefits, there were several strong correlations, so the team performed additional analysis. The team further evaluated residential benefits that correlated to a structural equity metric with a p-value greater than 0.05 for a univariate regression. For these relationships, the team created a secondary multivariate linear regression model and adjusted for the multicollinearity, such as the intersectionality of race and income, of the structural equity metrics. For this work, the team used Python's Pandas (library for data manipulation and analysis), NumPy (library for Python programming), Statsmodels (statistical modeling) and sklearn (machine learning) packages. Variables with a variance inflation factor (VIF) greater than 10 signified significantly higher intervariable correlation; the team eliminated these from the multivariate analysis and final model.

C&I Value Drivers

Results of C&I value drivers survey

Previous Efficiency Vermont R&D work in 2022 explored ways to advance equity in the C&I sector. The work recommended further exploration of business drivers, barriers, and values. It especially called for a deeper investigation of the intersection of core business values with Efficiency Vermont's equity objectives. Building from the recommended follow-up work, the 2023 research team collected multiple-choice and open-ended responses from approximately 200 Vermont SMBs and 50 large businesses (LB) from July and August 2023. The team obtained important insights into business priorities, challenges, and views about energy efficiency and equity.

Both SMBs and LBs listed *energy efficiency* as important, but not business customers' top-of-mind challenge or concern—among the 10 business challenges listed. LB and SMB participants ranked "hiring challenges & finding qualified employees" as the top business challenge. However, LBs ranked operations challenges at 71 percent lower (20 percent vs. 69 percent) and SMBs ranked them at 52 percent less (12 percent vs. 25 percent).

When specifically asked about energy efficiency, 87 percent of SMBs considered energy efficiency when managing budgets (58 percent said "often," and 29 percent said "sometimes"). But only 51 percent of SMBs considered energy efficiency as contributing to business profitability. For LBs, 95 percent considered energy efficiency for managing budgets, and 69 percent said energy efficiency contributes to profitability.

These contrasts highlight the relative difference in prioritizing energy efficiency projects by business size. This decreased prioritization is likely associated with reduced knowledge, since 40 percent of SMBs were unsure or not considering any energy projects. In comparison, fewer than 6 percent of LBs were not considering or planning any projects. Further, only 21 percent of SMBs thought about Efficiency Vermont for energy projects, whereas 82 percent of LBs did. This was likely due to the program's tailored account management offered to LBs to help lower their significantly large energy bills.

When asked about barriers to implementing energy programs, 45 percent of both types of business stated the lack of money was a barrier. Next on the list of barriers was volatility in the supply chain and prices; 35 percent of SMBs and 26 percent of LBs cited it as a top concern. Finally, SMBs were less likely than LBs to own their buildings; 25 percent of LBs were renting their space, compared to 42 percent of SMBs, making them more vulnerable to split incentives between their ability and interest to invest in equipment upgrades.

Questions related to equity evoked polarized responses from LB and SMB respondents. SMBs especially conflated equity with non-discriminatory human resources policies and treating employees and customers equally (equality). Some respondents gave negative responses—ranging across confusion, frustration, and anger—to questions concerning equity, and over half of SMB respondents chose not to answer equity questions at all, or answered, "I don't know." LBs were much more likely to respond to the survey question to define *equity* and to articulate definitions, goals, and initiatives using vocabulary aligned with Efficiency Vermont's equity initiatives.

Further, LBs were much more likely to report working with underserved communities (63 percent said they did) than SMBs (49 percent); LBs also reported they "actively consider / implement equity-related initiatives" at a rate of 57 percent, compared to SMBs' 28 percent. Both SMBs and LBs answered in similar portions (26 percent and 28 percent, respectively) that "Yes, there is a relationship between investing in equity objectives and business growth / profitability." Finally, both groups showed they supported Efficiency Vermont's equity initiatives (68 percent of LBs and 85 percent of SMBs). But 48 percent of SMBs and 34 percent of LBs conditioned this support on cost effectiveness, stating they supported Efficiency Vermont equity measures "only if they can be accomplished without reducing the overall energy savings."

Discussion of C&I value drivers

The business survey results showed differences between LBs' and SMBs' knowledge and attitudes toward both energy efficiency and equity. The results confirmed SMBs face several barriers to energy efficiency program participation: split incentives, program knowledge, and access to contractor networks. The research team recommends further work to measure program disparities, and to understand SMB participation barriers sufficiently well to lower or remove them. The results also showed different attitudes between LBs and SMBs in their awareness of and actions to advance equity. Overall, the prioritization and knowledge of equity was higher for LBs than SMBs. The survey did not explore the root causes of this discrepancy, but the team knows it is likely that LBs have greater exposure to equity training and prioritization from corporate offices with the mission and funds to advance this work.

This project has shown the importance of exercising caution on equity messaging and promotion, and to prioritize (1) building relationships, (2) increasing understanding of business priorities, and (3) ensuring shared vocabulary when addressing equity to avoid any associated confusion and relationship damage. Further, it will be important for Efficiency Vermont to create and test new messaging on equity initiatives to ensure customers understand the values and

intention of the work, and to ensure that messaging aligns with, rather than estranges, customer values.

Barrier Analysis

Results of the barrier analysis

An analysis of surveys and SME interviews identified the primary barriers the low-income, moderate-income, and renter customer populations faced. **Table 2** summarizes the results.

Table 2. Ranking of primary barriers to residential participation, by population type

Barrier	Low income	Moderate income	Renter	Total
1. Upfront cost (affordability / access to capital)	20	16	13	49
2. Split incentive	0	0	15	15
3. Lack of understanding of program benefits	6	5	0	11
4. Administrative (complexity and time)	2	3	1	6
5. Customer preference	2	3	0	5

The primary barrier for low-income and moderate-income populations is upfront cost, both in terms of affordability and access to capital. For renter populations, the primary barrier is a split incentive between the landlord and the tenant, where the tenant is financially responsible for energy bills, but the landlord controls all equipment / system investment decisions. **Table 3** and **Table 4** summarize the solutions and the benefits, and the challenges for implementing the solutions.

Table 3. Solutions to overcoming the upfront cost barrier

	Solution	Benefit	Challenges
Traditional	Existing financing channels (HELOC,[9] personal loans, auto loans / leasing for electric vehicles [EVs], personal credit cards)	Existing options; do not require new programs	High credit score and equity (HELOC) required for affordable rates
	EEU[10] financing	Can integrate rebates more easily	Can be expensive for EEU; some (for example, via Vermont Gas Systems) require home liens
Simplification	One-stop shopping, contractor, device, incentive, and financing	Simplifies both the financing and the administrative challenges of energy efficiency projects	Contractors can have predatory interest rates, no solution for federal tax credits
	Emergency appliance replacement	Addresses the need for an immediate replacement	Electrification might require permits that cannot be obtained for tight installation turnaround
	Qualification for financing by address	May be able to circumvent income certification	Might not meet the regulatory requirements for income-qualified programs
Credit hurdles	On-bill financing	Might be able to circumvent need for credit score; added into existing utility bill	Utility bill might increase, increasing the risk for arrearages and disconnection
	Float assistance	Credit qualification is easier if all incentives (including energy efficiency rebates) can be considered upfront. This allows financial institutions to qualify the borrower by net cost, which can ease debt-to-income ratios.	One party must carry the risk and costs associated with 30-60 days of float assistance. All three possible parties—Efficiency Vermont, financing institutions, and contractors—encounter issues with this approach. Third-party funding can help (such as those from the Vermont Community Funds for the 2023 flood response)
	Energy service agreement (ESA)	Pay-for-performance, off-balance sheet financing that can circumvent credit scores and other financing requirements	Very limited experience in the residential space
	Property-assessed clean energy (PACE) programs	Land-secured financing can qualify households challenged by traditional financing	Mired history, PACE can cause administrative challenges for the homeowner, especially upon the sale of the home. Mortgage lenders might also view this unfavorably, because their loans could become subordinated, should the home go into foreclosure.

[9] Home equity line of credit.
[10] Energy efficiency utility, of which Efficiency Vermont is one of three in the state; The others are the efficiency programs operated by Burlington Electric Department and Vermont Gas Systems (VGS).

Table 4. Solutions for overcoming the split incentive barrier

	Solution	Benefit	Challenges
Inconvenience - tenant	Relocation assistance / options for building inhabitants	Choice of hotel, stipend (stay with family) or pre-furnished local apartment	Reduces impacts on renters, but still poses an inconvenience to tenants
	Tenant protections from green gentrification could be tied to financial incentives or the issuance of a rental unit certificate of occupancy	Might alleviate concerns about rent increases	Challenging to implement at the patchwork municipal level; legislation at the statewide level will be difficult to enact and enforce. Requires tenant awareness of protections and reporting of violations.
Inconvenience – owner	Legislative requirements for energy efficiency and electrification readiness	Does not rely on the goodwill of the landlord to act altruistically for environmental or tenant benefit. Codes can ensure new construction is energy efficient before tenant occupancy.	Enforcement can be challenging and might still pose significant inconvenience to tenants (both parties dissatisfied).
	Landlord incentive (such as contractor incentives), a payment to the landlord for program participation	Helps compensate for the landlord's time / investment	There might still be challenges with landlord awareness.
Financing	On-bill financing eligibility for renters	Cost should be offset by future savings; can transfer to future tenants	Not all projects qualify from energy savings alone if periodic capital investment is required for equipment (e.g., HVAC), and some projects provide comfort or decarbonization benefits (e.g., ductless heat pumps) that cannot be offset from an existing bill.
	Energy service agreement (ESA)	Pay-for-performance, off-balance sheet financing available for multi-family buildings.	Inconsistency in tenant appetite for the work.
Awareness	Tailor incentives to tenants based on appropriate technologies	Ensures tenants are aware of portable solutions (can be uninstalled and reinstalled if they change homes) and solutions with very short payback period (< 1 year).	Many of the greatest opportunities for energy efficiency could be missed if the program offers only technologies that allow the tenant to circumvent working with their landlord.
	Dual outreach approach: SMB creates relationships with property owners whereas customer service works with renters	Ensures buy-in from both parties.	Difficulty in matching the pace of both outreach efforts and achieving consistency in tenant interest in the work.
	Work with tenant advocacy organizations	Integrates tenant voice and perspective into program design.	May not be fully representative of tenant priorities.

Discussion of addressing barriers to residential service

Residential programs encourage program participation via customer engagement, customer relationship building, market development (for example, workforce development, supply chain training, and technology demonstrations), and specific customer support. This support can be technical, financial, and / or administrative. Market support especially can be broadly deployed, and it sometimes can be designed to overcome challenges encountered by a particular population. Advancing equity requires several initiatives and varying levels of targeting.

To further explore opportunities for advancing equity for Efficiency Vermont customers, the research team identified a primary barrier for each of the three residential populations. The primary barrier should not be interpreted as the first, only, or even most significant barrier that a customer encounters. Instead, the team identified barriers with the most significant contribution to non-participation for a given segment of the population and at a given moment. Customers often concurrently encounter several barriers to program participation; effective solutions to overcome one barrier might still result in program non-participation if another barrier arises that cannot be overcome.

For example, a program for low-income participation might be very well designed to address the upfront cost by providing a generous subsidy. However, if the eligible participants are not aware of the program, non-participation results. Similarly, if eligible participants are aware of the program and the program is designed to overcome cost barriers, but participants must invest a great amount of time in paperwork and program qualification requirements,[11] they may decide not to participate. In this last example, effective program design might have shifted the primary barrier from *upfront cost* to *administrative burden*, but failed to result in the desired outcome of program participation.

Efficiency Vermont intentionally designs programs in the context of a "customer journey." This helps designers understand program participation barriers in a broad context and supports effective and equity-centered program design. Efficiency Vermont accompanies customers along their journeys to participation. A program might address a focus population's primary barrier, but the program designer should view the primary barrier only as the most common pitfall for a particular group, not the first, only, or most significant barrier. **Table 5** presents the barrier stages. A prospective customer must advance through each stage before successfully participating in a program.

[11] Classic examples of this are (1) the need to take time off from work for contractor visits and (2) inconvenient customer service hours overlapping with work hours.

Table 5. Recognition of barrier stages in the customer journey

Customer stage	Consequence of not advancing	Possible solutions
1) Knowledge of program benefits	Initial engagement with potential customers is not possible	Customer outreach and training or information sharing
2) Technology match / appropriateness	Customer disappointment or disengagement	Customer insights and emerging technology research
3) Desire (overall value proposition and affordability)	Incentives or ulterior motivation needed to pursue the project	Incentive level; better information for the customer
4) Ability to cover the project's upfront cost	Desire to participate but delays and other reasons prohibit participation	Financing options
5) Administrative (time, hassle, trust)	The customer drops out before completing the project	Simplify the process, shorten the time

Table 5 presents the stages as discrete and linear, but a customer journey is fluid and continuous, and often not linear. Efficiency Vermont seeks ongoing relationships with customers to support their energy needs beyond a single purchase or program. This encourages participation in several programs over time because it serves a customer's energy journey. Appendix E presents additional information beyond the scope of this research, discussing Efficiency Vermont's strategy and support for customer journeys.

Distributional Equity Analysis

Results of the distributional equity analysis

The research team consolidated the results to 9 distributional equity metrics and 10 structural equity metrics analyses. The team separated the distributional equity results to differentiate C&I and residential results, and thus to clarify the connections between program investments targeted at the two audiences and structural equity metrics. Both investments bring advantages to a community, but residential investments directly benefit households, whereas C&I investments indirectly benefit the community (because they support jobs, availability of services, and income for business owners). The distributional equity metrics of total impact measure the combined effects of both investments.

Whereas C&I customer cost savings life (CSL) exceeds residential CSL by 13 percent, residential spend (Efficiency Vermont investment) exceeds C&I spend by 24 percent and TRB are approximately equal between the two. Thus, the team weighted residential and C&I impacts equally for the total analysis (via a simple summation of both values). Table 6 shows the results.

Table 6. Correlation matrix for GP-DEA at the block group level for 2017-2022

		# VT SVI Flags	% Population < 80% AMI	% Renters	% Homes Built before 1980	% BIPOC	%Mobile Homes	% Limited English Proficiency HHs	% Without Internet Access	% Associate Degree or Higher	% Aged 65 and Older
C&I	C&I Cust Cost Savings Life					0.13				-0.10	
	C&I TRB					0.12					
	C&I EVT Investment										
Res	Residential Cust Cost Savings Life	-0.22	-0.11	-0.14	-0.12		-0.10	-0.11	-0.10	0.27	0.22
	Residential TRB	-0.22	-0.13	-0.16	-0.14		-0.10	-0.13	-0.12	0.28	0.23
	Residential EVT Investment	-0.11					-0.10			0.21	0.15
Total	TotalCust Cost Savings Life				-0.11	0.12					
	Total TRB				-0.11	0.10					
	Total EVT Investment										

The GP-DEA for C&I showed weak positive correlations between CSL and TRB for the percent of BIPOC customers, and a weak negative correlation for the percent of people with an associate's degree or higher. There were no statistically significant correlations between Efficiency Vermont investment in C&I programs and structural equity metrics.

The GP-DEA for the residential sector showed weak negative correlations between CSL and TRB and the following structural equity metrics at the block group level:

- Number of Vermont SVI flags
- Percent of mobile homes
- Proportion of the population at less than 80 percent of the Vermont AMI
- Percent of renters
- Percent of housing stock built before 1980
- Percent of people who are BIPOC
- Percent of households with limited English proficiency
- Percent of households without Internet access

The analysis showed weak negative correlations between Efficiency Vermont investment and the number of SVI flags and percent of mobile homes. For all 6 subsequent structural equity metrics with weak correlations between CSL and TRB, the correlation for Efficiency Vermont investment was even weaker and not statistically significant.

At the total portfolio level, the analysis showed only 2 statistically significant relationships. The first was a weak negative correlation between the percent of the housing stock built before 1980 and CSL and TRB (with no statistically significant relationship for investment). The second was a weak positive correlation between percent of BIPOC customers and CSL and TRB (with no statistically significant relationship for investment).

After the 90 univariate regression analyses, the team conducted additional analysis to understand better the relationship among structural equity metrics, and the intersectionality between metrics. For example, both renter status and income are indicators of vulnerability, and one is predictive of the other; but what is the impact when a household is a member of both populations?

The first step in better understanding the intersectionality between structural metrics was to conduct 45 univariate analyses among the 10 structural equity metrics. Table 7 shows the results of the analysis. As anticipated, these values are highly correlated. Most indicators of vulnerability are cumulative, so if one has a negative correlation with program benefits, it is likely to correlate to other metrics that also have a negative correlation.

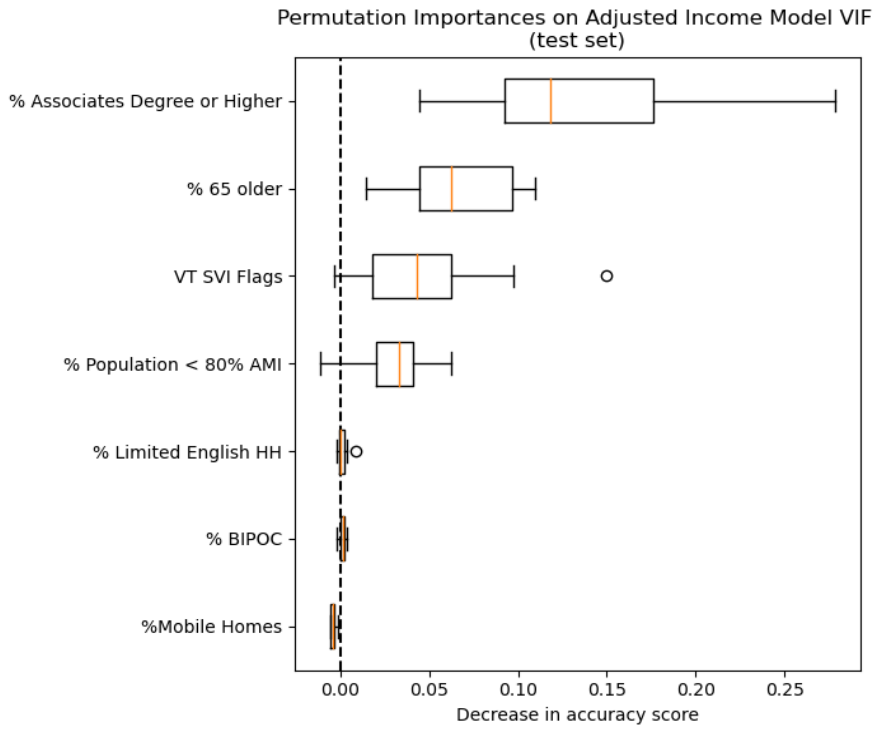
Table 7. Correlation matrix for Vermont structural equity metrics in 2020

	# VT SVI flags	% population < 80% AMI	% renters	% homes built before 1980	% BIPOC	% mobile homes	% limited English proficiency house	% without Internet access	% associate's degree or higher	% aged 65 and older
# VT SVI flags	1.00									
% population < 80% AMI	0.37	1.00								
% renters	0.41	0.57	1.00							
% homes built before 1980	0.26	0.44	0.41	1.00						
% BIPOC	0.22	0.06	0.23	-0.06	1.00					
% mobile homes		0.08	-0.27	-0.20	-0.13	1.00				
% limited English proficiency household	0.14	0.19	0.25	0.00	0.21	-0.11	1.00			
% without Internet access	0.18	0.49	0.19	0.23		0.11	0.00	1.00		
% associate's degree or higher	-0.16	-0.48	-0.04	-0.24	0.09	-0.37	-0.06	-0.44	1.00	
% aged 65 and older	-0.09	-0.06	-0.23		-0.13	0.07	-0.16	0.12	0.00	1.00

Overall, each of the 10 indicators is expected to predict vulnerabilty and show positive correlations with other indicators of vulnerablilty. But the results showed 3 exceptions. The first exception was the percent of people with an associate's degree or higher. The team found a negative correlation with indicators of vulnerability, which was anticipated as households with higher levels of education are associated with higher income levels. An unexpected finding was that areas with higher percentages of households with one or more persons over the age of 65 tended not to align with certain indicators of vulnerability. There was no relationship among income, housing stock age, percent of people living in mobile homes, and education. Further there were negative correlations with SVI flags, percent of renters, percent of BIPOC households, and percent of people with limited English proficiency. The only positive correlation between older households and vulnerability was households without Internet access.

To further quantify the intersectionality, the team determined the multi-collinearity of the structural equity metrics, and eliminated variables with a VIF score greater than 10 from the multivariate analysis. **Figure 2** shows the results of this analysis.

Features	VIF score
VT SVI flags	2.38
% population < 80% AMI	8.19
% associate's degree or higher	6
% aged 65 or older	9.28
% mobile homes	1.75
% BIPOC	2.18
% limited English proficiency	1.24



Model Results in an Adjusted R^2 Value of 0.107

Figure 2. Multivariate model results for the 2017-2022 GP-DEA.

Discussion of the distributional equity analysis results

The results for the GP-DEA showed several interesting univariate relationships between structural equity and distributional equity metrics. The presence of a statistically significant correlation is an indicator of inequity for the focus population. If the correlation is positive, a net increase in benefit exists for the population of interest, compared to the baseline. If the correlation is negative, a discrepancy exists between the population of interest and the baseline. If results are equally shared between a population of interest and the baseline (rest of the population), the

correlation would be close to zero and statistically insignificant. There is always some degree of noise in data, so a perfectly distributed sample with a correlation of exactly zero is not to be expected, either.

Overall, the number and significance of the relationships were greater for residential indicators of program benefit than either C&I or overall benefit. This can be partially explained by the fact that the selected structural equity metrics are primarily indicators of household level demographics. And although residential benefits are directly related to the household, benefits that go to businesses are only indirectly related to the community demographics and prosperity. For example, business owners can invest in socially disadvantaged areas while they themselves reside in a more affluent area with fewer SVI indicators. Further, the owners and employees of a business (arguably the two strongest beneficiaries of business benefit) might not reflect the demographics of the inhabitants of the Census block where their business is located. Additional analysis could involve collecting and analyzing firmographic data for business owners. But for this project, such analysis was beyond the scope of available data for the GP-DEA at the Census block level.

Another positive sign from the GP-DEA is that although the team found 13 statistically significant correlations between customer cost savings and structural equity metrics, the team found only 4 statistically significant correlations between Efficiency Vermont investment and structural equity metrics.[12] The team somewhat expected this because Efficiency Vermont regularly strives to meet its income-based and geographic equity spending targets. As shown in the multivariate analysis and the univariate correlations between structural equity metrics, income is highly correlated with other structural equity markers of vulnerability; any action taken to close a spending gap for one population of interest might also close other inequities. Overall, the results show that equity initiatives to date have helped close the spending gap, and additional metrics that go beyond spending might help to close the gap further.

The negative correlations at the Census block level between older households and other indicators of vulnerability paint a picture of how older households might not be a strong indicator of vulnerability. This observation is further supported within the context of Efficiency Vermont programs by the presence of a positive correlation among older households and residential cost savings, TRB, and the level of Efficiency Vermont investment. The data and analysis do not conclusively explain this discrepancy, but it is likely due to the fact that older households are more likely to have more time to invest and established connections through family, friends, and community to overcome the adminstrative challenges of program participation. Further, they are more likely to be homeowners. The team has also posited that such households fill a niche of lower-income homeowners, because their age and homeownership status have allowed them to accumulate wealth, even though their retirement status means they might have a low income.

The results showing a positive correlation among C&I, total customer cost savings, and TRB are more difficult to explain. The data do not point to any significant underlying correlations that help

[12] The team also found 12 statistically significant correlations between TRB and structural equity metrics.

to explain this relationship. The best explanation is perhaps that Efficiency Vermont has been intentional in investing in certain communities of interest; one significant driver determing which communities they choose was its racial composition. The team speculates that this intentional investment to support disenfranchised communities has positively promoted higher levels of investments in communities with a higher number of BIPOC residents.

It cannot be assumed that there is an even distribution of impacts within a geographic area for the GP-DEA. There are certain factors such as environmental pollution that are relatively evenly distributed at a smaller geographic area. But there are also other factors where the variation in the distribution makes it difficult to attribute impact using GP-DEA. One assumption is that at a small enough geographic level, the effects are relatively uniform and can be assumed to be distributed relatively evenly. Even at Census block groups of approximately 2,000 individuals, the team did not observe even distribution. For example, a community might have a relatively high median income, but in a rural area this could lump together extremely poor households such as migrant farm workers with very affluent households owning a large home with many acres. In this case, an urban neighborhood might be relatively consistent in terms of income (a smaller distribution), whereas a rural area might not.

The value of the GP-DEA is to identify where programs should invest more to understand and address population disparities and to measure internal progress to over disparities in program participation between populations. Analysts should not use a "pass" result of the GP-DEA to claim that no disparity exists between populations of interest, but simply that the approach could not measure a disparity. Similarly, a "fail" result offers valuable insight into program disparities, but it does not necessarily indicate the root cause of the inequity. For example, the root cause could be homeownership status. Therefore, a program targeting low-income households and communities with a higher percentage of low-income residents could help close the income inequities of an energy efficiency program. But a better way to address a root cause might be to expand program eligibility to include renter households.

Discussion of the multivariate analysis and model

The purpose of the multivariate analysis was to guide the selection of structural equity metrics to measure program process. The research team wanted to identify the right number of structural equity metrics to track to define focus populations. The specific aim was to recommend a balanced number that could accurately measure progress in overcoming service inequities for focus populations. Creating a predictive model further defined structural equity metrics that can add insight and definition to equity goals, without being either repetitive[13] or too narrow.[14] By contrast, the combination of SVI, income, age, race, English proficiency and mobile home residency can explain 11 percent of the variation between Census block groups.

[13] An example of repetition: Internet access is highly determined by income to afford service.
[14] An example of "too narrow": Considering only income when income accounts for merely 1.5 percent of the variation between Census block groups (the adjusted R^2 value).

Overall, the main constraint of this analysis is that it relies on data aggregated at the Census block level, and not at the household or business level. With this limitation in mind, it is not surprising that even the best multivariate model can explain only 11 percent of the variation. If data were available for each of the structural equity metrics at the customer account level, the analysis would provide more real-world, insightful, and conclusive results.

The next step for the analysis should be the collection of additional structural equity metric data at the customer account level, balancing trust, customer privacy, and resource expenditure (this recognizes that collecting extensive data can increase the cost, time, and complexity of project record keeping). Business firmographics should be collected to evaluate the equity of C&I programs, and household demographics for residential programs. The modeling work provided some insight into prioritizing demographic metrics. Fortunately, one of the most powerful indicators, the number of SVI flags, can be calculated from the address alone. Other structural equity metrics to consider are income, education, number of renters, and number of mobile homeowners.

The results of the multivariate analysis show how some indicators of vulnerability are so highly correlated to one another that they prove redundant for other indicators. In cases where certain indicators are easier to determine at the address level, this can help overcome data availability challenges. For example, collecting income information is quite challenging because income level can be short term (that is, a given household could have significant fluctuations in income from one year to the next). This is further compounded by the fact that income is a very sensitive piece of personally identifiable information. Other parameters such as renter and mobile home demographics are much more likely to be available in public zoning information, and to remain consistent over the years for a given address.

Conclusion and Next Steps

The research team recommends a multi-pronged strategy for addressing equity in the C&I market: (1) provide additional support to SMBs, especially those facing significant barriers to program participation and those in disadvantaged communities; (2) identify businesses with an equity mission and mindset, and communicate Efficiency Vermont's work to advance equity and support businesses in advancing their equity initiatives; (3) identify sources of firmographic data to conduct a deeper DEA for C&I customers.

To overcome the gaps in residential equity uncovered through the GP-DEA in this research, the team recommends collecting additional structural equity metric data for at least a year, and to conduct a new distributional equity analysis with direct data. This subsequent analysis can provide valuable additional insight into this project's preliminary analysis using the GP-DEA method. The team recommends the following parameters and sources:

- **SVI**: Based on the address and Census block of the customer account
- **Income**: Based on program verification (when required for program eligibility), or presumed benefit if verification cannot be obtained

- **Homeownership status**: Based on customer attestation or presumed benefit
- **Home occupancy type** (whether manufactured homes, and approximate age of home): Based on customer attestation or public records
- **English proficiency**: Based on the need for language interpretation services

In circumstances of *presumed benefit,* the easiest approach would be to assume an allocation of a demographic based on post-participation surveys (for example, quantifying the percent of homeowners benefiting from the residential heat pump program and apply that percentage to the full program). This assumption also would involve seeking more opportunities for clarification to improve the quality of the data.[15]

The final recommendation is to continue to pilot and expand program designs that help to address the special barriers for low-income, moderate-income, and renter populations. The research team recommends program attention to renter populations, both to increase ways to measure residential program participation rates for renters, and to continue to design, evaluate, and expand programs that help overcome the renter participation gap. Programs that overcome the split incentive, and financing (such as on-bill financing programs) show great promise. Because many renters also have low incomes, the team recommends continuing Efficiency Vermont's strong track record of designing and implementing programs that work specifically with low-income populations. For moderate-income populations, the team recommends removing administrative and knowledge barriers to unlock additional sources of funding (such as Inflation Reduction Act tax credits). Finally, programs that address the energy efficiency and financing of affordable homeownership, such as modular Zero Energy Ready Homes (ZERHs) promise benefit for all three focus populations.

[15] An example of this is adding a question of whether the equipment eligible for a midstream rebate will go toward a mobile home, owner-occupied single-family residence, or a multifamily rental property.

Appendix A: Program Participation Barriers

The research team grouped the barriers into four categories.

1) Financial
    a. Financing
        i. High upfront cost
        ii. Lack of access to financing
        iii. Lack of flexibility to pay the full cost upfront, and thus wait for rebates
    b. Affordability
        i. Benefits extend beyond energy savings, and energy savings alone do not justify the cost
    c. Tax liability
        i. Households might not have the tax liability to benefit from, or the financial means to wait for financial incentives from federal tax credits[16]
    d. Split incentives
        i. Inability to influence or fully benefit from capital purchase decisions (tenants)
2) Knowledge, attitudes and behaviors
    a. Lack of awareness of program offerings
    b. Lack of understanding of program / participation benefits
    c. Inconvenience of new habits required
        i. Example: electric vehicle charging or heat pump operation with a remote vs. central thermostat
    d. Consumer preferences
        i. Form factor of new technologies
            1. Wall units for heat pumps
        ii. Perceived comfort
            1. "Cold" heat from heat pumps
3) Administrative
    a. Time
    b. Hassle associated with tax / utility rebates or relocation
    c. Language
    d. Trust
    e. Complexity of the process
    f. Regulatory barriers
4) Physical
    a. Workforce constraints
    b. Equipment availability

[16] Nearly all non-refundable federal Home Energy Tax Credits available to households require that the household's tax bill (liability) exceed the amount of the tax credit.

c. Technical feasibility (panel upgrades)
d. Inadequate electric infrastructure
    i. Example: distribution transformer upgrade required
e. Safety (inability to work in home due to lead, asbestos, and mold)

Appendix B: DEA Parameter Selection

Data pull parameters

The requested data pull, defined below, was integral to carrying out the GP-DEA for the 2023 Equity R&D analysis.

Fixed parameters

1) Geography: all locations in Vermont, excluding the City of Burlington
2) Years: 2017-2022

Metrics

1) Customer cost savings (lifetime, gross)
2) Total Resource Benefits (gross)
3) Trade ally incentive
4) Program incentive to customer
5) Customer investment
6) Fee
7) Project distinct count
8) MWh savings (gross)
9) MMbtu savings (gross)
10) MWh lifetime savings (gross)
11) MMBtu lifetime savings (gross)

Data pull 1 – C&I electric

Fixed parameters above, columns for the reported metrics, and the following parameters below:

a) **Funding source**: Electricity savings from projects funded by the Energy Efficiency Charge (EEC) on utility bills
b) **Jobs**: Efficiency Vermont cost codes for project categories: 6012 (business retrofits), 6013 (businss equipment replacement), and 6014 (business new construction)

Data pull 2 – C&I thermal

Fixed parameters above, columns for the reported metrics, and the following parameters below:

a) **Funding source**: Thermal savings from the Thermal Energy and Process Fuels fund as well as American Rescue Plan Act (ARPA) and Weatherization funds.
b) **Jobs** Efficiency Vermont cost codes for project categories: 6012 (business retrofits), 6013 (businss equipment replacement), and 6014 (business new construction)

Data pull 3 – Residential electric

Fixed parameters above, columns for the reported metrics, and the following parameters below:

a) **Funding source**: Electricity savings from projects funded by the EEC on utility bills
b) **Jobs**: Efficiency Vermont cost codes for project categories: 6017 (low-income multifamily retrofit), 6018 (low-income multifamily new construction), 6034 (low-income single-

family retrofit), 6041 (low-income single-family new construction), 6019 (market-rate multifamily new construction), 6020 (market-rate multifamily retrofit), 6032 (efficient products), 6036 (market-rate single-family retrofit), 6038 (single-family new construction)

Data pull 4 – Residential thermal

Fixed parameters above, columns for the reported metrics, and the following parameters below:

a) **Funding source**: Thermal savings from the Thermal Energy and Process Fuels fund as well as ARPA and Weatherization funds.
b) **Jobs**: Efficiency Vermont cost codes for project categories: 6017 (low-income multifamily retrofit), 6018 (low-income multifamily new construction), 6034 (low-income single-family retrofit), 6041 (low-income single-family new construction), 6019 (market-rate multifamily new construction), 6020 (market-rate multifamily retrofit), 6032 (efficient products), 6036 (market-rate single-family retrofit), 6038 (single-family new construction)

Expected output format

Two to four Excel files with a row for each user site (site ID), containing the street address and ZIP Code and the town / city, with data for the corresponding 13 columns from the data pull (11 metrics plus funding source and year). Note that the jobs do not need to be disaggregated, so all metrics for the jobs listed can show up as a combined value for each of the 11 metrics above.

Appendix C: GP-DEA Data Sources and Results

Table C.1: Data sources for GP-DEA Structural Equity Metrics

Census report	Analysis metric	Census report description
B25003	% renter	Tenure
B25034	% home built before 1980	Year structure built
B01003	Population	Total population
B03002	% BIPOC	Hispanic or Latino origin by race
B25032	% renters in multifamily building; % mobile homes	Tenure by Units in Structure
B25003H	% BIPOC homeowners	Occupied housing units with a householder who is White alone, not Hispanic or Latino
C16002	% limited English households; % second language spoken	Household language by limited English speaking status
B28011	% Internet access	Internet subscriptions in household
B15003	% associate's degree or higher	Educational attainment for the population 25 years and older
B11007	% 65 or older	Households by presence of people 65 years and older, household size and household type
B19013	Median Income	Median household income in the past 12 months (in 2020 inflation-adjusted dollars)
B19025	Average Income	Aggregate household income in the past 12 months (in 2020 inflation-adjusted dollars)
B19001	% Less 80 AMI	Household income in the past 12 months (in 2020 inflation-adjusted dollars)
CB2000CBP	Business Establishments per Capita	County Business Patterns (Census data, available Code level

Appendix D: Barrier Interview Guide

Interview questions for EEU partners

1. Of the list of barriers, are there any major categories or barriers missing?
2. What are the most significant barriers you have observed for each of the three following groups: low income, moderate income and renters?
3. How would you rank each of the barriers per group based on the most significant impacts a barrier poses to each group?
4. Do you have any examples of programs that have addressed or are working to address these barriers?

Interview questions for internal stakeholders

5. What are the most significant barriers you have observed for each of the three following groups: low income, moderate income and renters?
6. How would you rank each of the barriers per group based on the most significant impacts a barrier poses to each group?
7. Do you have any examples of programs that have addressed or are working to address these barriers? If possible, share which groups each initiative addressed?
8. Was there any internal/organizational or external evaluation of the program, if yes, could you either share verbally or provide any available documentation?
9. Do you have any available documentation of work/barrier analysis either specific for one of these three groups, or with more general application? If so, could you please share?
10. Is there an external stakeholder I should interview about this topic as they can represent the voice of our customers?
11. If needed, external stakeholder interviews will be carried based on the results of the internal interviews and external scans. Approximately 3 high quality stakeholders will be identified for a further interview as a part of component 1. Questions 1-5 above will be posed to these stakeholders.

Appendix E: Discussion of the Customer Journey

Efficiency Vermont carries out marketing and program design in the context of a customer journey. The graphic in **Figure E.1** shows customer engagement that aligns with each phase of the customer journey.

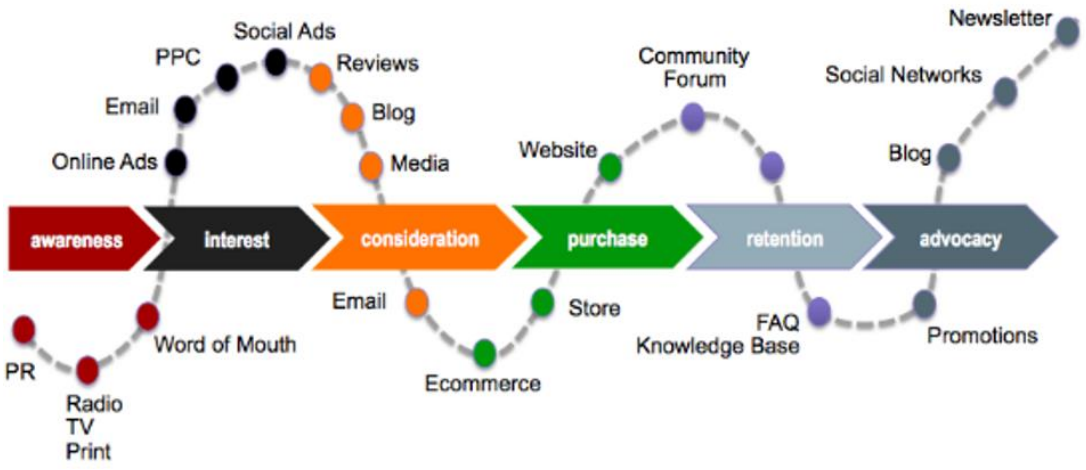


Figure E.1. Customer engagement activity supporting the customer journey

Within Efficiency Vermont's services, some programs are designed purely as a customer engagement program (with no energy or cost savings accruing). Once a customer is engaged, however, the hope is to build trust and motivate the customer to participate in more programs across the customer's lifetime, as shown in **Figure E.2**.

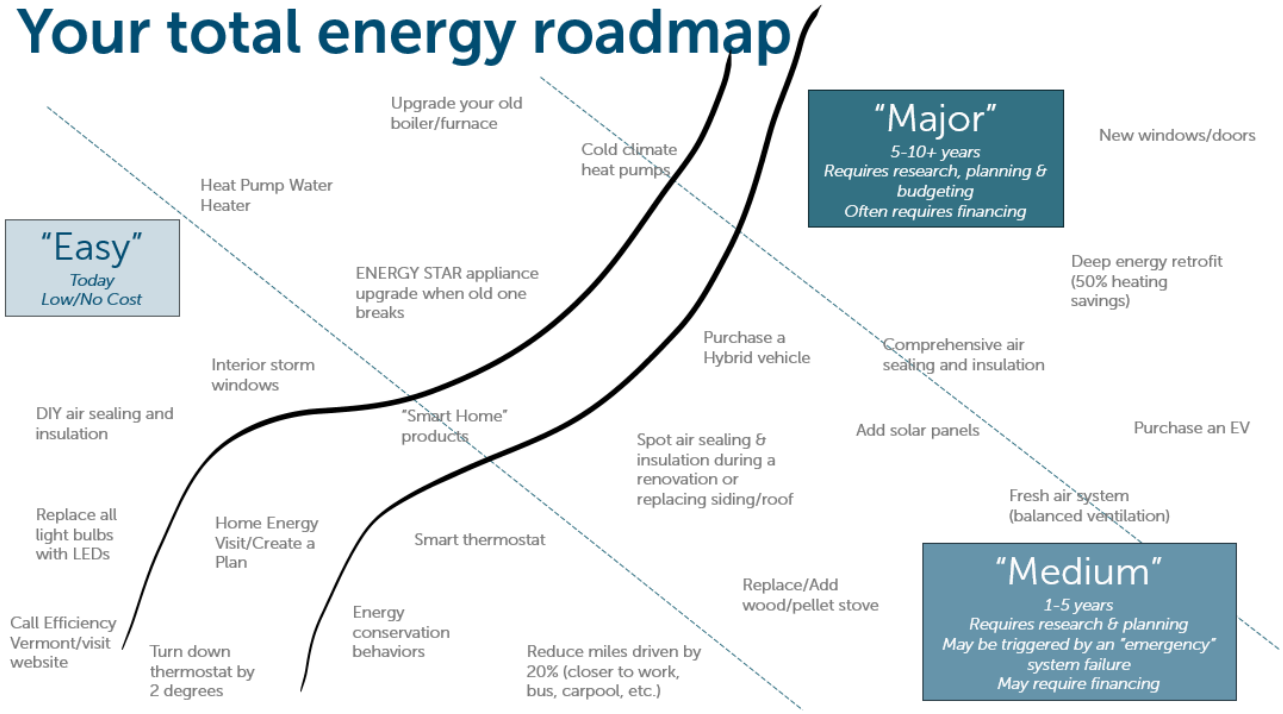


Figure E.2. Customer activity and product engagement roadmap

Although **Figure E.1** is an overview of the phases and activity for customer engagement, **Figure E.2** shows specific actions a customer might be encouraged to take with Efficiency Vermont. Typically, a customer will begin with "easy" activities that can be completed immediately, requiring little time and financial investment. The customer then progresses to "medium" and "major" projects. An additional layer in program design, but not shown **Figure E.2,** is the extra support to different populations, helping to ensure equitable participation. Altogether, **Figure E.1, Figure E.2** and **Table 7** offer a glimpse of Efficiency Vermont's strategies for supporting equitable and mutually beneficial customer journeys.