Appendix B. Energy Efficiency & Electrification Soft Costs in New York

2023 ASHP Update

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Acronyms and Definitions

Acronyms	Definition
ASHP	Air-source heat pump
CI	Confidence interval
DIY	Do-it-yourself
DPS	Department of Public Service
ESCO	Energy service company
Hard Costs	Materials and equipment costs, excluding any contractor markups
HID	High intensity discharge
HVAC	Heating, ventilation, and air conditioning
IQR	Interquartile range
LED	Light-emitting diode
Multifamily	Buildings with five or more attached units
NYSERDA	New York State Energy Research and Development Authority
QA/QC	Quality assurance and quality control
Residential	All dwellings consisting of one to four units
RTU	Rooftop unit (type of HVAC system)
SAC	Strategic Advisory Committee
SIC	Standard Industrial Code
Soft Costs	Project-related costs excluding materials and equipment, such as marketing and acquisition, project/system design and development, installation labor, transaction costs, project financing and cash flow, supply chain/stocking, and quality assurance
VFD	Variable frequency drive
VRF	Variable refrigerant flow (type of ASHP HVAC system)

Executive Summary

On April 26, 2018, the New York State Department of Public Service (DPS) and NYSERDA published the *New Efficiency: New York* report,[1] which describes plans to accelerate the state's energy efficiency goal by 40%. The report calls for 185 trillion British thermal units of cumulative annual site-specific energy savings, relative to forecasted 2025 consumption. The target is based on savings in buildings and the industrial sector across all fuel sources (electricity, natural gas, heating oil, and propane). The Climate Leadership and Community Protection Act (Climate Act), signed July 2019 and effective January 1, 2020, formally adopted this energy efficiency target and puts the State on a path to complete carbon-neutrality across all sectors of the economy, including power generation, transportation, buildings, industry and agriculture.

Project Goals & Approach

To achieve New York's energy goals, it is critical to investigate cross-cutting market barriers and opportunities that impact the soft costs associated with energy efficiency and electrification project development. Soft costs represent a substantial portion of project costs—over 50% in some cases. Soft cost reductions are part of New York's strategy to make energy efficiency and electrification more affordable, inclusive, and accessible to residents and businesses in New York, thus supporting the State's transition to a clean and equitable energy economy. Soft costs encompass all project-, marketing-, and staff training-related costs—including marketing and customer acquisition, project design, project installation labor, transaction costs (training, certifications, permits), quality assurance, and recruiting/hiring.[2] NYSERDA contracted with Cadmus ("the Market Evaluation Team") to conduct research to quantify soft costs across the residential, multifamily, and commercial sectors, estimating costs for seven energy efficiency and electrification "prototypical projects." The Market Evaluation Team completed an initial version of this study (the 2019 study) to set a market baseline for soft costs of energy efficiency and electrification projects, and follow-up studies in 2021 and 2024 to update the cost estimates.

This report presents results from the third iteration (2023) in this longitudinal study to quantify soft costs for two of the original energy efficiency and electrification projects—residential and commercial HVAC replacements. This was conducted to assess changes in soft costs for high-priority project types between the full waves of the study and is provided as an appendix to the 2024 study.

Though research to date has enabled NYSERDA to develop detailed estimates of energy efficiency soft costs across key market sectors and project types, results from the 2021 and 2023 studies revealed a market in flux due to the drastic impacts of the COVID-19 pandemic and the economic environment in general (e.g., high levels of inflation). As a result of these fluctuations, it is important to try to isolate general market impacts when possible to remove outside sources of cost volatility. Nonetheless, research findings provide insights that NYSERDA (or other entities) can leverage to influence or assist

1 NYSERDA and Department of Public Service. April 2018. *New Efficiency: New York*.

2 See the *Soft Cost Categories* section for a detailed definition of soft costs.

market actors in reducing soft costs, though the direct impacts of interventions in the current environment remain uncertain.

The period between the three studies—2019 to 2023—was a time of drastic change, not just in the energy efficiency and electrification market in New York State but also across the world. The COVID-19 pandemic upended the economy and supply chain causing delays in receiving products, labor shortages, and changes in consumer behavior driving a measurably increased cost of doing business across most economic sectors. The Market Evaluation Team observed these changes in the 2021 study, and while some may have stabilized, they have persisted through the 2023 study period. This, combined with other economic factors, led to significant inflation: according to the U.S. Bureau of Labor Statistics, since 2021, the residential and nonresidential Producer Price Index increased by 13.9% and 13.0%, respectively.[3] Even absent these wider economic changes, many of the technologies studied in this work are comparatively new to the market, and thus subject to wider swings in costs than more established technologies. Altogether, these factors cannot easily be isolated or controlled for in the analysis, and accordingly, they have had a substantial impact on the results of this study, likely driving an increase in both soft and hard costs. The Market Evaluation Team took these factors into consideration when drawing insights from the study's results.

Key Findings

In both residential and commercial prototypical projects, total project costs estimated using a top-down approach (i.e., asking for total cost and then the percentage for equipment to calculate hard and soft costs) continued to increase from 2021. For example, the increase in total project costs in the residential sector was 20%, with soft costs increasing 24% and hard costs increasing only 15% from 2021 to 2023. In the commercial sector the increases were smaller (and not statistically significant) —total costs increased by 4.2%, soft costs by 5.8% and hard costs by 2.0%.

When estimated using a bottom-up approach (i.e., asking for hour and dollar estimates and calculating costs), residential and commercial sector soft cost estimates by category were not significantly different from 2021 (see Table 1 and Table 2). The difference between these estimates and the top-down estimates indicates that the work required to complete HVAC replacement projects did not increase but what contractors charged did. Thus, factors stemming from the COVID-19 pandemic, ongoing market recovery, and the general economic environment cited above likely impacted the total cost of these HVAC replacements.

When examined on a soft cost component level, some results remained relatively consistent with those of 2019 and 2021. Installation labor was the largest component of project cost, comprised

3 U.S. Bureau of Labor Statistics. "*Producer Price Index by Commodity – Inputs to Industry.*" https://www.bls.gov/ppi/tables/. Accessed October 2023. Time period for change is July 2021 to July 2023. The Producer Price Index measures the average change over time in the prices domestic producers receive for their output and is considered a measure of price changes at the wholesale level. For example, the hard costs measured in this study are part of the Producer Price Index. This differs from the Consumer Price Index (CPI), which measures the changes in the price of goods and services paid by consumers.

approximately one-half of soft costs within the residential sector and three-quarters within the commercial sector in 2023. Following this was marketing and customer acquisition costs, which decreased slightly (but not significantly) in both sectors. While transaction and recruitment costs make up a smaller portion of total project soft costs, both saw decreases from 2021 to 2023, with the change in transaction costs significant at the 80% confidence interval.

Table 1. Residential HVAC Replacement Soft Costs 2019-2023

Soft Cost Category	2019 (n = 69-98)	2021 (n = 43-55)	2023 (n = 43-61)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Marketing and Customer Acquisition	$1,215	$1,973**	$1,885	-$88	-4%
Project Design and Development	$248	$319*	$388	+$70	+22%
Installation	$2,337	$2,671*	$2,886	+$214	+8%
Transaction Costs	$582	$884*	$708*	-$176	-20%
Quality Assurance	$251	$282	$311	+$29	+10%
Recruiting and Hiring	$68	$138**	$94	-$44	-32%
Total Soft Costs [a]	**$4,702**	**$6,268**	**$6,272**	**+$4**	**+0.1%**

The following notation denotes statistical significance at the different confidence levels compared to the prior period (i.e., notation in the 2021 column denotes significance compared to 2019): * $p < 0.20$, ** $p < 0.10$, *** $p < 0.05$

[a] Due to the calculation method for total soft costs (summing of individual cost buckets, with sample differences across the set), it is not possible to test statistical significance for total soft cost changes across study periods. Instead, Cadmus recommends looking for statistically significant differences at the soft cost category level. If several soft cost categories show statistically significant differences in the same direction in a given period, that is a good indication that the difference in total project soft costs is different as well.

Table 2. Commercial HVAC Retrofit: VRF Soft Costs 2019-2023

Soft Cost Category	2019 (n = 12-20)	2021 (n = 26-48)	2023 (n = 24-34)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Marketing and Customer Acquisition	$8,755	$10,440*	$8,164	-$2,276	-22%
Project Design and Development	$4,213	$4,112	$2,727	-$1,385	-34%
Installation	$50,471	$51,997	$64,968	$12,971	+25%
Transaction Costs	$5,437	$8,335	$5,739	-$2,596	-31%
Quality Assurance	$3,690	$3,945	$3,506	-$439	-11%
Recruiting and Hiring	$151	$792***	$661	-$131	-17%
Total Soft Costs [a, b]	**$72,718**	**$79,622**	**$85,764**	**$6,142**	**+8%**

The following notation denotes statistical significance at the different confidence levels compared to the prior period (i.e., notation in the 2021 column denotes significance compared to 2019): * $p < 0.20$, ** $p < 0.10$, *** $p < 0.05$

[a] Due to the calculation method for total soft costs (summing of individual cost buckets, with sample differences across the set), it is not possible to test statistical significance for total soft cost changes across study periods. Instead, Cadmus recommends looking for statistically significant differences at the soft cost category level. If several soft cost categories show statistically significant differences in the same direction in a given period, that is a good indication that the difference in total project soft costs is different as well.

Across both sectors, the Market Evaluation Team found positive correlations between design costs and QA/QC costs. That is, when design costs increase, so do QA/QC costs. That is, when a contractor spends more on project design, they also tend to spend more on QA/QC. This trend is consistent with trends seen in 2019 and 2021 for other prototypical projects, demonstrating that this is likely a cross-sector trend.

Finally, the Market Evaluation Team found an opposite trend with contractor experience level in the residential and commercial sectors. In the residential sector, contractors with less than 12 years of experience (the sample median) estimated more time for installation (16% increase) and bid development (70% increase) than did contractors with more experience than average. In the commercial sector, the opposite is true—experienced contractors estimated design costs over twice as high as did less experienced contractors.

The Market Evaluation Team hypothesizes that there are different "levels" of experience between these sectors—as residential ASHP installations have become more common over the years, a greater share of contractors have the skills to complete an installation. In contrast, VRF systems are less well-established and thus have a smaller set of eligible contractors capable of completing an installation. A contractor with deep residential ASHP experience but limited commercial VRF experience may underestimate the time needed for various aspects of the installation, relying on their experience with a technology that is similar on the surface but different in practice.

In the residential sector, contractors who have just entered the market and have less experience with ASHPs are likely less familiar with the technology overall (in either the residential or commercial sector) and may overestimate the effort required for specific tasks, building in time for them to learn the technology.

Key Considerations for New York State Energy Programs

Building on the findings above, the Market Evaluation Team identified the following key considerations that could be implemented to support strong growth development of New York's energy programs. Please note, in several cases, the Market Evaluation Team also built on key considerations identified in the 2021 report. Full details on these considerations and NYSERDA's responses can be found in the *Conclusions and Recommendations* section.

- **Continue market condition monitoring and consider qualitative research with engaged contractors.** Several market forces have had a significant impact on energy efficiency and building electrification projects in New York, likely contributing to observed increases in hard and soft costs. To stay abreast of relevant market conditions, NYSERDA should continue the market monitoring noted in the 2021 report (annual surveys with participating contractors, memberships with various trade organizations, and general market condition monitoring). Additionally, if not already completed, NYSERDA could consider conducting qualitative research with engaged contractors to identify market factors that have the largest impact on energy efficiency and electrification projects and use this data to inform future program design decisions and market intervention opportunities.

- **Review the set of standardized bid packages and consider expanding to a wider audience.** Total soft costs are highly impacted by the cost associated with project design and installation work, which account for nearly half of total project soft costs across all sectors. These costs are also widely dispersed (i.e., contractors vary in how long it takes to complete a prototypical project installation). Experience level was correlated with contractor estimates for various components of residential and commercial sector projects. To help improve contractor experience levels, NYSERDA could expand promotion of the standardized bid packages of envelope improvements to a broader set of contractors beyond the pilot program group. As noted in the 2021 report, NYSERDA was working to add additional building typologies to the set of standardized bid packages. Should those be ready, NYSERDA should ensure they are updated on a regular basis to keep up with any changes in best practices or incentive program design. Additionally, NYSERDA might consider creating a version for a basic commercial HVAC retrofit if there is sufficient market demand.
- **Ensure project design and QA/QC best practices are known to the market.** In both the residential and commercial sectors, the Market Evaluation Team found a positive correlation between project design costs and QA/QC costs. NYSERDA may want to review project installation best practice guidelines and ensure that appropriate system design and QA/QC are thoroughly covered. If these elements are not already included, it might be helpful to add checklists of items for contractors to cover during program design and complete during QA/QC.
- **Encourage service providers and manufacturers to provide resources to end-use commercial customers that educate them on appropriate system operation and maintenance**, such as standardized hands-on training at the customer site upon installation of the new system. When asked why respondents believed customer acquisition costs are higher for commercial VRF systems than other HVAC technologies, service providers cited more equipment required/higher equipment costs (10 responses) and increased customer education efforts (nine responses) associated with commercial HVAC retrofit projects.

Introduction and Background

On April 26, 2018, the New York State Department of Public Service (DPS) and NYSERDA published the *New Efficiency: New York* report,[4] which describes plans to accelerate the state's energy efficiency and electrification goal by 40%. The report calls for "185 trillion British thermal units of cumulative annual site energy savings, relative to forecasted 2025 consumption." The Climate Leadership and Community Protection Act (Climate Act), signed in July of 2019 and effective January 1, 2020, adopted this energy efficiency target and puts the State on a path to implement carbon-neutrality across all sectors of the economy, including power generation, transportation, buildings, industry, and agriculture. The new target is based on savings in buildings and the industrial sector across all fuel sources (electricity, natural gas, heating oil, and propane). Investigating cross-cutting barriers and opportunities across market sectors will help NYSERDA support buildings that are more energy efficient.

NYSERDA and Cadmus ("the Market Evaluation Team") completed an initial version of this study (the 2019 study) to set a market baseline for soft costs of energy efficiency and electrification projects. That research found that energy efficiency and electrification projects can incur significant soft costs—in some cases costs that are well over half of an energy efficiency or electrification project's total installed cost. The 2019 study also found significant variability in soft costs within specific energy efficiency or electrification project types, which has helped demonstrate that opportunities exist for soft cost reduction. The 2019 study included several recommendations for the areas in which NYSERDA can look for soft cost reduction opportunities.

The Market Evaluation Team completed the next version of the study in 2021 to assess changes compared with the baseline study. Between the 2019 and 2021 studies, the energy efficiency and electrification market in New York had been affected by several factors, specifically related to its status as a nascent market, to program administration and design changes, and to the general market impacts resulting from the COVID-19 pandemic. Thus, though findings in the 2021 study corroborated many of the trends observed in the 2019 and 2021 study, the unprecedented confounding factors had a major role in soft cost changes. Thus, NYSERDA commissioned an additional wave of research ('the 2023 study') to study the soft costs of high-priority building electrification projects—residential and commercial HVAC replacements. NYSERDA selected only two prototypical projects out of the broader set for this interim study in order to focus efforts on technologies that can have an outsized impact on the state's climate goals.

For the 2023 study, the Market Evaluation Team used the same definition of soft costs as in the 2019 and 2021 study (i.e., marketing and acquisition costs, project/system design and development, installation labor, transaction costs, project financing and cash flow, supply chain/stocking, and quality assurance/quality control [QA/QC]).

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4 NYSERDA and New York State Department of Public Service. April 2018. *New Efficiency: New York*.

In contrast, hard costs are defined as the cost for equipment (e.g., air-source heat pump [ASHP] and light fixtures) and materials (e.g., insulation and other raw material inputs) needed to complete an energy efficiency and electrification project. A final update to this study is planned for 2024.

The following research questions guided this research:

- How are various soft cost categories defined and prioritized (by impact/size) in each sector?
- What are the most significant (in dollar value) soft cost categories affecting high-priority energy efficiency and electrification projects (residential and commercial HVAC replacements) in New York by sector? How do soft costs change over time?
- What percentage of total project costs for high-priority energy efficiency and electrification projects (residential and commercial HVAC replacements) are represented by soft costs? What is the trend of this soft cost percentage?
- What degree of variation exists for each major soft cost category for high-priority prototypical energy efficiency and electrification projects[5] (residential and commercial HVAC replacements) in each sector?
- To what extent do soft costs differ across geographical areas in New York State? How does this compare with other states or regions?
- Are there opportunities to reduce soft costs and, if so, what are they?

This report begins by describing the methodology the Market Evaluation Team employed, including the research design, data collection methods, sample composition, and data analysis approach. The bulk of the report covers the detailed findings from assessing results, trends, and drivers for high-priority energy efficiency and electrification projects (residential and commercial HVAC replacements) when the sample size allows. The report closes with the conclusions and recommendations section, which synthesizes conclusions drawn from the findings and presents the Market Evaluation Team's recommendations for NYSERDA's path forward.

[5] See the definition of a "prototypical project" in the *Methodology, Prototypical Projects* section.

Methodology

This section describes the study's overall research design, research methods used, sample composition and how to interpret results, and analysis methodology.

Research Design

Using the work completed in the 2019 and 2021 Energy Efficiency & Electrification Soft Costs studies, the Market Evaluation Team held initial meetings with NYSERDA to determine the scope of work for this study. Because of the substantial market impacts that occurred between the 2019 and 2021 studies, NYSERDA felt it would be beneficial to conduct an additional round of research for high-priority prototypical projects—residential and commercial HVAC replacements. The Market Evaluation Team used the same study design and prototypical project specifications as in the 2021 study.

Prototypical Projects

The Market Evaluation Team explored two prototypical projects through this work—residential HVAC replacement and commercial HVAC replacement. The residential sector captures only buildings with one to four units. These prototypical projects, listed in Table 3, received rigorous testing during the baseline study with a variety of stakeholders, from NYSERDA, the Market Evaluation Team, and experts in New York State.

Table 3. Finalized Prototypical Project Descriptions

Prototypical Projects Used in Service-Provider and Decision-Maker Surveys		
Residential Sector		
HVAC System Replacement	Building Type	Single-family home; family of 3 (2 adults, 1 child) living there year-round
	Building Size	2,000 sq. ft., 2-story home—living and kitchen downstairs with bedrooms upstairs Colonial, 50 years old
	Existing Conditions	**Fuel type**: Gas **Equipment**: Standard efficiency, gas-powered condensing boiler for heating; window air conditioning units for cooling
	Equipment Installed	**Fuel type**: Electric **Equipment**: Ductless heat pump with 1 outdoor unit and 3 indoor heads. Indoor heads will be installed in the kitchen, living room, and bedroom (on second floor). Existing gas boiler retained in place as backup heat.
Commercial Sector		
HVAC Retrofit: VRF	Building Type	Commercial office building
	Building Size	30,000 sq. ft.
	Existing Conditions	**Fuel type**: Gas **Equipment**: Four (approximately 10-ton) packaged rooftop air-conditioning units with gas-fired heating, each controlling a single zone
	Equipment Installed	**Fuel type**: Electric **Equipment**: VRF system with 1 main outdoor unit and 10 indoor zones Assume significant updates to the electric service will not be required

Soft Cost Categories

Throughout the study, the Market Evaluation Team refers to two categories of costs: hard costs and soft costs. Hard costs are defined as materials and equipment costs, excluding any markups contractors add when selling to customers. Soft costs, by contrast, are non-equipment costs.

Table 4 presents the final soft cost categories and components used in the study. During the baseline study, the Market Evaluation Team revised these soft cost category definitions through rigorous testing with subject matter experts from the Market Evaluation Team, external advisors, and NYSERDA experts and program managers.

The Market Evaluation Team also asked service providers about supply chain/stocking costs and project financing/cash flow. Experts had recommended not quantifying these soft costs because they are often determined by non-project-specific factors (such as a company's financial health or a facility's size). Therefore, the Market Evaluation Team asked a series of qualitative questions to understand some key facets of these soft costs that can have an impact on a contractor's soft costs. The Market Evaluation Team asked some service providers other questions of interest to NYSERDA, such as the differences between whole-home and supplemental ASHP installations in the residential sector.

Table 4. Soft Cost Categories for Quantification (Service Providers)

Category	Component
Marketing and Customer Acquisition	**Marketing and/or customer education costs** (hours), including dedicated marketing staff
	Preparation for each bid, including time spent on building assessment and system sizing before the project has been contracted, which may include initial audits to gather necessary building information
	Project signing and contracting
	Other marketing or customer education costs (dollars), such as email marketing, advertising, or trade show visits
Project/System Design and Development	**Designing, scoping, and customizing the project** for an individual, including energy modeling (if needed), after the project has been contracted
Installation Labor	**Installation labor** to install the system and manage the installation, including both the contractor's staff and any subcontractors
Transaction Costs	**Obtaining permits** to complete work compliant with local, state, and federal regulations
	Obtaining licenses necessary to execute [PROTOTYPICAL PROJECT] installations
	Acquiring and maintaining the training and certifications necessary to execute [PROTOTYPICAL PROJECT] installations
Quality Assurance/ Quality Control (QA/QC)	**Quality assurance and quality control activities** to ensure that the work has been completed per agreed-upon project design and standards
	Required callbacks to the customer to assist with equipment issues/servicing
Recruiting and Hiring	**Recruiting and hiring employees** with the skills and expertise to execute [PROTOTYPICAL PROJECT] installations

Research Methods

To complete the Energy Efficiency and Electrification Soft Costs study, the Market Evaluation Team used surveys to gather the necessary data. This section describes the approach to conduct the surveys, including design, sampling, and analysis.

Surveys

The Market Evaluation Team conducted a quantitative survey with energy-service providers in New York State to collect data on the breakdown of installed costs (including soft costs) and on additional project topics related to equipment stocking and customer acquisition. Energy-service providers are defined as contractors or energy service companies (ESCOs) that work within the residential, commercial, or multifamily sectors to provide energy efficiency and electrification upgrades or equipment replacements to improve efficiency. Service providers across the three sectors include electrical contractors, insulation contractors, general contractors, HVAC contractors, controls contractors, plumbers, and ESCOs. For this study, only contractors with experience conducting residential ASHP or commercial VRF installations qualified.

The Market Evaluation Team invited contacts with valid email addresses to complete the survey online then followed up with a reminder email to nonrespondents.

To develop the energy-service providers' sample frame, the Market Evaluation Team used data from Data Axle (formerly InfoGroup) and Exact Data as the primary sources, supplemented with contacts from these additional sources:

- NYSERDA's contractor lists: Multifamily Building Solutions Network, Home Performance Contractors, Real Time Energy Management (RTEM) Qualified Vendors, NYSERDA technical reviewers, EmPower Contractors, and NYS Clean Heat Contractors
- Manufacturer qualified contractor lists: Mitsubishi, Daikin Comfort, LG, KMC Controls, Automated Logic, Computrols, and Alterton
- Relevant trade associations: New York State Plumbing-Heating-Cooling Contractors Association, and Northeast Sustainable Energy Association

Table 5 in the next section, *Sample Composition and Interpretation*, shows the targeted number of completions *versus* the achieved number of completed service-provider surveys.

Sample Composition and Interpretation

The Market Evaluation Team collected survey data from a total of 123 service providers. Table 5 shows the distribution of the sample by prototypical project. When including partial responses (which in this survey is more common than in other surveys[6]), the Market Evaluation Team achieved its sample size targets. The Market Evaluation Team kept the same sample size targets as in 2021.

Table 5. Final Sample Composition (2023)

Prototypical Project	Service Providers	
	Completions (+ partial)	Goal
Residential HVAC: ASHP	53 (+21)	68
Commercial HVAC: VRF	30 (+19)	34
Total	**83 (+40)**	**102**

As noted in the *Surveys* section above, the Market Evaluation Team sampled from multiple sources. Some of these sources, such as manufacturer or NYSERDA's qualified contractor lists, introduce an element of bias into the sample. For example, some contractors are likely to have lower customer acquisition costs because of the free advertising they receive through their presence on one of NYSERDA's qualified contractor lists. The Market Evaluation Team and NYSERDA discussed the benefits and drawbacks of using each sample source and ultimately decided to use the sample sources listed even though the sample was not truly random.

Residential sampling resulted in a significant number of completed surveys, which meant the Market Evaluation Team could conduct robust statistical analyses to identify the drivers of soft costs. Because the residential sector also had the strongest sample size during the baseline study and 2021, the Market Evaluation Team was able to compare changes across periods. The sample size for the commercial HVAC prototypical project was not as robust, making it more challenging to compare results across periods or to split the sample into stratum.

Analysis Methodology

The Market Evaluation Team used several methods to analyze the drivers of soft costs, including statistical comparisons of group means, standard deviations, inter-quartile ranges (IQRs), and correlation analyses.

Approach to Quantifying Soft Costs

The Market Evaluation Team used survey data as the primary source to generate the soft cost estimates presented in this study. The survey was designed to ask about specific soft cost components in a manner easy for contractors to quantify. As detailed in the main report's Appendix A, questions about each soft cost component used the most appropriate units (labor hours, dollars, percentage, or a combination), timeframe (per project or per year), and reference point (past year or hypothetical project), as

[6] Cadmus hypothesizes that this is caused by the complex nature of the questions, requiring respondents to think more deeply about their responses than other surveys. This can cause longer response times and subsequently a higher rate of partially completed surveys. Cadmus included partial responses in the data analysis.

determined by initial research with experts during the baseline study. The Market Evaluation Team mapped each of these questions to a soft cost component and category for the final calculation.

To calculate soft costs using all applicable data (hours and dollars), the Market Evaluation Team transformed labor hours into dollars using the same methodology as in the baseline study. As detailed in the main report's Appendix A, the Market Evaluation Team used labor rates from RSMeans, along with several customizations for the trade type, the location where a contractor worked, the prototypical project, and the specific soft cost category the question referenced. This led to a set of blended labor rates that the Market Evaluation Team used in the calculations, presented in Table 6. Compared with the 2021 study, labor rates rose by between 1% to 3% across the Residential and Commercial HVAC prototypical projects. This shows the stabilization of the labor market after the impacts from the COVID-19 pandemic.

Table 6. Final Blended Labor Rates Used for Quantification (2023)

Soft Cost Category	Commercial HVAC: VRF	Residential HVAC
Upstate		
Marketing and Customer Acquisition	$67.12	$65.20
System Design	$72.24	$70.32
Installation Labor	$72.24	$70.32
Transaction Costs	$60.31	$59.16
Training and Certifications	$73.92	$71.23
QA/QC	$79.37	$76.30
Downstate		
Marketing and Customer Acquisition	$101.23	$98.33
System Design	$108.96	$106.07
Installation Labor	$108.96	$106.07
Transaction Costs	$90.97	$89.23
Training and Certifications	$111.49	$107.44
QA/QC	$119.71	$115.08

After completing data collection, the Market Evaluation Team cleaned the data using a two-step process that first removed errors and then "substantial outliers." The process began by removing any data points that were clearly errors or unrealistic for the given question (e.g., either zero or 50,000 hours for residential HVAC installation labor). By removing these data points, the Market Evaluation Team was able to calculate more-accurate summary statistics, such as the mean and IQR. The Market Evaluation Team acted as conservatively as possible in this step, removing only data points clearly entered in error.

The Market Evaluation Team then used John Tukey's (1977) method for removing outliers known as "Tukey fences." These are bounds set on a dataset to identify data points that fall far outside the IQR. Tukey proposed the bounds outlined in Equation 1 for fences to determine outliers.

Equation 1. Tukey's Fences

$$-Q_1 - k(Q_3 - Q_1), Q_3 + k(Q_3 - Q_1)$$

where k=1.5 indicates an outlier and k=3 indicates data that are "substantial outliers"

The Market Evaluation Team selected the Tukey fence value of k=3 to take a more conservative approach with the data-cleaning process, specifically because no benchmark data were available for comparisons. This method proved impossible for prototypical projects with very small sample sizes (<15) as not enough responses were available to reliably determine if one was an outlier. In these instances, the Market Evaluation Team used only the initial process of removing responses that were clearly errors or not realistic. Appendix A in the main report provides a full description of the soft cost quantification methodology.

Multiple Linear Regression

The Market Evaluation Team used multiple linear regression to assess the degree to which variations in contractors' soft costs can be explained by firmographic variables, collected by and constructed from the survey data. In other words, the models assess correlations between one firmographic variable and the contractors' soft costs, controlling for other firmographic variables included in the model. In each prototypical project, as sample size allowed, the Market Evaluation Team regressed each soft cost category (y/dependent variable) against a set of explanatory variables (x/independent variables). In these models, the Market Evaluation Team used the x variables listed in Table 7.

Table 7. Linear Regression Variable Definitions and Scales

Variable	Definition	Coefficient Interpretation [a]
Intercept	Baseline soft costs of operation when all independent variables in regression set to 0	Not used for interpretation—exists only to scale the model appropriately
Region	Upstate or downstate contractor indicator variable (=0 if downstate contractor, =1 if upstate contractor)	The average difference in soft costs for a contractor in upstate New York relative to a contractor in downstate New York
Employees	Number of employees working for the firm in New York State	The average incremental change in soft costs for a firm with one additional employee
Installations	Number of yearly installations completed for the specific prototypical project/job type	The average incremental change in soft costs for a firm with one additional annual installation
Percentage revenue bin (1-5)	The percentage of the firm's yearly revenue coming from the prototypical project/job type installations; bins are 1: <20%, 2: 20-39%, 3: 40-59%, 4: 60-79%, 5: 80%+	The average incremental change in soft costs for a firm one revenue bin level higher
Win rate [b]	The percentage of bids a firm reports winning from all bids they create for prototypical project installations	The average incremental change in soft costs for a firm with a one percentage point higher win rate
Fixed effects	Control for differences in means soft cost values among prototypical projects	-

Variable	Definition	Coefficient Interpretation [a]
n	Sample size	-
R^2	Explanatory power of the regression (i.e., how much of the change in the dependent variable can be explained by the variables in the model)	-

[a] Note: "All else equal" implied for all coefficient interpretations.

[b] Win rate is determined by two questions in the survey: the number of bids a contractor creates for the example prototypical project in the past 12 months and how many of those bids resulted in a contract. The win rate variable is calculated by dividing the number of winning bids by the total number of bids. As such, there are a few cases where the Market Evaluation Team omitted win rate from a regression due to its interaction with the dependent variable by the way win rate is calculated.

Detailed Findings

This section describes findings from the research activities described above in the following order:

- **Market Forces and Changes:** summary of forces impacting the New York energy efficiency and building electrification market during the study period and changes from the prior period
- **Residential HVAC:** results for the residential HVAC prototypical project
- **Commercial HVAC:** results for the commercial HVAC prototypical project

Each section contains data from both service providers and decision-makers, as applicable, with the soft cost quantification data sourced from the service provider surveys.

Fluctuations in Market and Economic Conditions

The energy efficiency and electrification market in New York State experienced drastic changes from the baseline evaluation period (2019) to the current period (2023). These changes led to several confounding factors that influenced energy efficiency and electrification project cost estimates across the study periods. This section examines the major market changes and the impact of those changes on this study. This section also summarizes the fluctuations in market conditions that impacted the 2021 study and the changes in those impacts through the current period.

Summary of Impacts from 2021 Study

In the 2021 Energy Efficiency and Electrification Soft Costs Study, the Market Evaluation Team discussed three key factors impacting soft costs:

- **Nascent Market for Electrification Technologies**: Many of the electrification and efficient technologies included in the study, especially heat pumps and building controls, are technologies that are rapidly developing and changing. These technologies interject a degree of uncertainty for service providers who install them, resulting in increased soft costs. Heat pumps and other building electrification technologies are still in an early phase of development, with heat pumps representing 17.4% of the residential units sold in 2017,[7] and with penetration of 12% for split systems and 2% for unitary systems in the commercial market[8] as of 2019. As the heat pump and building electrification markets mature, volatility in hard and soft costs is expected. Additionally, the Market Evaluation Team found that new contractors were entering the market: the average number of years of experience for residential HVAC contractors who responded to the survey in 2019 was 16.7; in 2021, this dropped to 11.3. Less experienced contractors tend to take more time for project installations than their more experienced peers and may buffer their estimates to build in time for learning on the job given their lack of familiarity with a specific technology.

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7 NYSERDA. September 27, 2019. *2019 HVAC Market Characterization Residential Building Stock Assessment.* Accessed September 2021.

8 NYSERDA. *Commercial Baseline Study HVAC Market Assessment*. Accessed September 2021.

- **Program Changes**: Incentive programs can have a large impact on both hard and soft costs for energy efficiency and electrification projects. In New York State, incentive programs underwent significant changes from the baseline study to 2021, namely a change in administration of the heat pump incentive programs from NYSERDA to the individual utilities. Any change in program administration, no matter how smooth, can lead to confusion in the market among both service providers and decision-makers. When service providers face uncertainty, they are likely to increase costs to cover any change in margin or additional work that may occur to handle the change.
- **Pandemic and General Economy Impacts**: Since the baseline study was completed in 2019, the New York market and economy has undergone several changes, many exacerbated by the COVID-19 pandemic. Specifically, impacts to the acquisition of goods, the labor market, and consumer behaviors have led to a different market.
    - **Acquisition of Goods**: Lockdowns and labor shortages resulted in decreased production, shipping delays, restricted supply, and increases in the costs of both raw materials and fully assembled equipment. The price of materials, such as metal, has increased dramatically, forcing manufacturers of metal products to also increase prices. This is reflected in the residential and nonresidential Producer Price Index, which saw increases of 24.7% and 26.4% since 2019, respectively, according to the U.S. Bureau of Labor Statistics.[9]
    - **Labor Market**: Due to impacts from the COVID-19 pandemic, the labor market saw a greater need for recruiting and hiring to meet demand across all aspects of the supply chain. Prioritization of health, safety, and family among laborers led to higher and unmet demand in the labor market, especially for jobs that relied on in-person interaction. This resulted in an increase in labor rates between 2019 and 2021 ranging from 5.3% to 7.1% as firms struggled to recruit and hire qualified workers.[10] According to The Construction Association, 61% of surveyed firms that experienced project delays in 2021 cited workforce shortages as the top reason.[11] These changes led to higher labor costs, which were passed on to customers.
    - **Consumer Behaviors**: COVID-19 lockdowns and restrictions and/or mandates increased the time spent inside the household, both from a leisure and a business perspective. As a result, consumers were more likely to know which areas in their home had poor performance (i.e., drafty rooms) and where energy was being used. During the pandemic, U.S. households accumulated approximately $2.7 trillion in excess savings, roughly 13% of GDP.[12] This greater understanding of home energy performance, along with the extra household savings, likely

9 U.S. Bureau of Labor Statistics. Accessed September 2021. "*Producer Price Index by Commodity – Inputs to Industry*". https://www.bls.gov/ppi/tables/.

10 RSMeans. 2021. Accessed September 2021.

11 The Construction Association. Accessed March 2022 *2021 Workforce Survey Analysis.*. https://www.agc.org/sites/default/files/2021%20Workforce%20Survey%20Analysis.pdf.

12 TD Economics. *Where the Road of Excess [Saving] Leads.* https://economics.td.com/us-excess-savings#:~:text=Highlights,to%20roughly%2013%25%20of%20GDP. Accessed September 2021.

increased the demand and ability to pay for home improvements that involved energy efficiency and electrification projects.

Factors Impacting the 2021-2023 Study Period

Over the course of the past two years (the time between the 2021 and 2023 studies), several of the factors detailed above continued to impact the market. First, the market for electrification technologies has grown and evolved, with rapid advancement in technology and deployment of new products, which are signs of a nascent market. While penetration of heat pumps has continued to increase, it is still far below that of other HVAC technologies in New York, as evidenced by the building stock assessment data cited above.

Next, the pandemic issues listed above, namely supply chain issues impacting acquisition of goods and a tight labor market, continued to impact the market throughout the study period. Although some of the most serious challenges eased, the trends from the 2021 study continued through to 2023. For example, the cost to acquire goods for residential and nonresidential construction continued to rise: residential and nonresidential Producer Price indices increased by 13.0% and 13.9%, respectively, since 2021, according to the U.S. Bureau of Labor Statistics.[13] The continued increase in construction inputs impacts not only hard costs, but soft costs as well—if contractors pay more for the materials that they use on projects, they will likely need to raise rates to continue making a profit.

The labor market for contractors continues to face a shortage of workers. According to Associated Builders and Contractors, the United States needs to fill 546,000 construction jobs across all industries to keep pace with demand in 2023.[14] Falling short of this quota will lead to increases in costs for projects because firms will need to pay higher wages to attract labor. Alternatively, not meeting the quota could also lead to firms not increasing wages but charging more for projects given the excess demand, with more money going to company profit.

The broader economy has also experienced cost increases during this time. Over the time period between the two studies (July 2021 to July 2023), the CPI for the Northeast region increased by 10.1%.[15] For comparison, the same CPI measure increased by less than half of that level – 4.5% – during the July 2017 to July 2019 period. This increase in prices, a measure of inflation across the economy, shows that everyday life has gotten more expensive for all consumers—including both service providers installing equipment and decision-makers upgrading their HVAC systems. Thus, it is reasonable to assume that

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13 U.S. Bureau of Labor Statistics. "*Producer Price Index by Commodity – Inputs to Industry*". https://www.bls.gov/ppi/tables/. Time period for change is July 2021 to July 2023. Accessed October 2023.

14 Associated Builders and Contractors. "Construction Spending and Employment Forecast". https://www.abc.org/News-Media/News-Releases/construction-workforce-shortage-tops-half-a-million-in-2023-says-abc. Accessed October 2023.

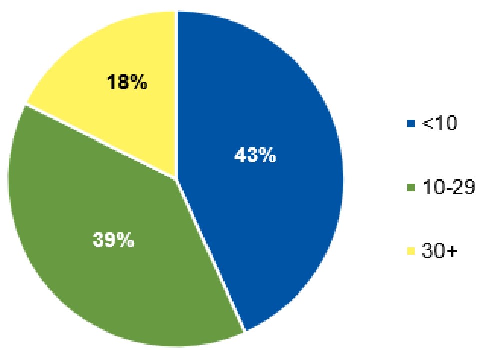
15 U.S. Bureau of Labor Statistics. "*CPI for all Urban Consumers - Northeast*". https://data.bls.gov/pdq/SurveyOutputServlet?data_tool=dropmap&series_id=CUUR0100SA0,CUUS0100SA0. Time period for change is July 2021 to July 2023. Accessed October 2023.

these increases will extend to the prices service providers charge and homeowners pay for energy efficiency and electrification upgrades.

Residential Sector - HVAC Replacement

This section presents soft costs for residential HVAC replacement projects for 2023, with details of prototypical project soft cost estimates, drivers, and other related topics. The Market Evaluation Team gathered responses from 74 residential service providers who completed an HVAC replacement project within the previous 12 months. Of these, 60 (81%) contractors were located upstate, and 14 (19%) were located downstate. Forty-three percent worked for a company with fewer than 10 employees, which is less than the 52% of contractor respondents in 2021 who worked for a company with fewer than 10 employees.

Figure 1. Number of Employees for Residential Service Providers



Source: Residential Contractor Survey Q F1: "Including yourself, approximately how many employees work for your company in New York state?" (n=74).

A summary of key findings from the residential sector research is presented below. The full details are in the subsequent sub-sections within this section.

Key Findings: Residential HVAC Replacement
• When estimated using a top-down approach (i.e., asking for total cost and then the percentage of the total cost for equipment), both soft and hard costs rose for HVAC replacement projects, but soft costs rose faster than hard costs. Market conditions likely played an outsized role in cost increases. • When estimated using a bottom-up approach (i.e., asking for hour and dollar estimates and using those to calculate costs), soft cost estimates by category were generally not significantly different from 2021. The difference between this and the top-down estimates indicates that the work required to complete HVAC replacement projects did not increase but what contractors charged did. That is, the hours contractors estimated for specific residential HVAC replacement

Key Findings: Residential HVAC Replacement
tasks were not different from 2021, but when asked to give an overall price for the work, they cited a higher price. • Downstate contractors continue to have higher soft costs—specifically in marketing/customer acquisition, installation, and transaction costs.[a] • Contractor experience with ASHP installations drives a difference in cost estimates. Less experienced contractors estimated more time for installation (22% more than experienced contractors) and bid development (62% more than experienced contractors).[a] • Both upstate and downstate contractors face issues acquiring equipment for HVAC replacement projects, though some contractors saw improvement over the last year. • As expected, HVAC replacement projects completed in a supplemental capacity typically cost contractors less time and money compared with those completed in a whole-home capacity. [a] These differences were not statistically significant and should be interpreted as directional.

Prototypical Project Cost Estimates

When presented with the residential HVAC prototypical project, contractors provided estimates of both hard and soft costs, as defined in Table 8.

Table 8. HVAC Replacement Prototypical Project Details (2023)

Attribute	Definition
Building Type	Single-family home; family of three (two adults, one child) living there year-round
Building Size	2,000 sq. ft, two-story home—living room and kitchen downstairs with bedrooms upstairs Colonial, 50 years old
Existing Conditions	Standard efficiency, gas-powered condensing boiler for heating; window AC units for cooling
Equipment to Be Installed	Ductless heat pump with one outdoor unit and three indoor heads. Indoor heads will be installed in the kitchen, the living room, and the bedroom (on the second floor). Existing gas boiler retained in place as backup heat.

Table 9 summarizes the high-level results. For an average installed project cost of $18,426, 48% of costs were hard (equipment-related) costs and 52% were soft costs. These ratios are relatively consistent with those in 2021, where soft and hard costs each comprised approximately 50% of the total project cost.

Table 9. HVAC Replacement Top-Down Hard and Soft Cost Estimates (2023)

Component	Average Cost Per Project	Standard Deviation	First Quartile	Third Quartile	Sample Size
Average Total Installed Cost	$18,426	$7,556	$13,500	$21,000	53
Percentage Soft Costs	52%	14.3%	40%	65%	53
Value Soft Costs	$9,858	$5,666	$6,000	$13,000	53
Percentage Hard Costs	48%	14%	35%	60%	53
Value Hard Costs	$8,569	$3,285	$6,300	$10,800	53

Compared with 2021, average total project costs in 2023 increased by $3,069 per project, or 20%, when estimated with a top-down methodology (Table 10).[16] Both hard and soft cost categories saw statistically significant increases during the two-year period. The increases in hard and soft costs were likely related to sustained consumer interest in heat pump technologies, persistent inflation, continued shortages of HVAC equipment and raw materials, scarcity of labor, and supply chain disruptions brought about by the COVID-19 pandemic. See the *Fluctuations in Market and Economic Conditions* section for more details on these impacts.

Table 10. HVAC Replacement Prototypical Project Cost Estimate 2019-2023 Comparison

Cost Category	2019 (n = 97-102)	2021 (n = 56)	2023 (n = 53)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Hard Costs	$5,387	$7,430	$8,569	+$1,139***	+15%
Soft Costs	$6,722	$7,927	$9,858	+$1,931***	+24%
Total Project Costs	$12,109	$15,357	$18,426	+$3,069***	+20%

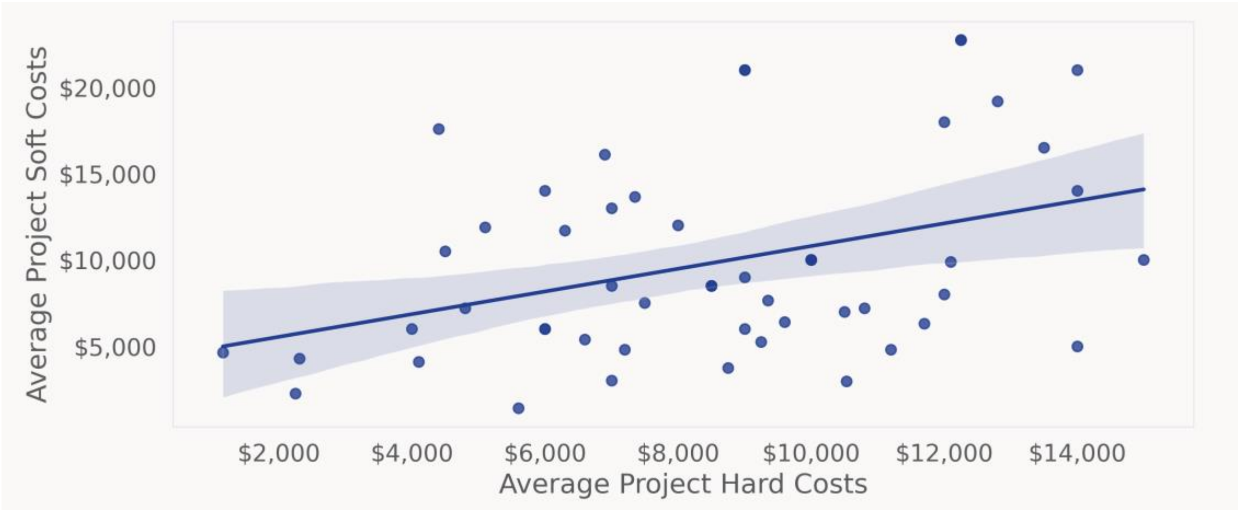
The following notation denotes statistical significance at the different confidence levels: * $p < 0.20$, ** $p < 0.10$, *** $p < 0.05$

Figure 2 presents a trend from 2023 that is consistent with 2019 and 2021 results. When plotting a specific service provider's estimate of hard and soft costs, there is a weak positive relationship between the two when using a linear model to add a best-fit line. That is, service providers with higher soft costs tend to have slightly higher hard costs. The lack of a strong relationship between hard and soft costs shows that not all service providers use the same amount of effort to complete various steps of an energy efficiency or electrification project.

For example, if two service providers have similar hard costs (around $9,000) but different soft costs ($6,000 for one and $8,000 for the other), an opportunity exists for more-expensive service providers to find efficiencies in their work and to lower the cost for project delivery. Considering this example across an entire market shows that opportunities remain to reduce soft costs.

[16] "Top-down" estimation refers to asking contractors the total cost for the prototypical project installation and then to estimate the percentage of the total cost hard costs comprised. This contrasts with a "bottom-up" methodology, where Cadmus asks contractors to estimate hours and dollars for specific tasks related to the prototypical project. Cadmus employs both "top-down" and "bottom-up" estimation to provide a holistic view of prototypical project soft costs.

Figure 2. Contractor HVAC Replacement Cost Estimates: Hard vs. Soft Costs (2023)



The Market Evaluation Team collected data to construct estimates for the six specific soft cost categories that contribute to the total soft cost estimate, as shown in Table 11. In 2023, installation costs were the highest, at $2,886 per HVAC replacement project (46% of the estimated project soft costs). Marketing costs, including bid preparation, were the second highest, at $1,885 per project (30%). These two categories also contributed the highest share of total project soft costs in 2019 and 2021, as shown in Table 12. The remaining one-quarter of prototypical project soft costs comprised all other soft costs.

Table 11. HVAC Replacement Soft Cost Component Estimates (2023)

Soft Cost Category	Soft Cost Component	Per Project Cost	Per Project %	Component Cost	Standard Deviation	First Quartile	Third Quartile	Sample Size
Marketing & Customer Acquisition	Marketing and/or customer education	$1,885	30%	$682	$927	$85	$856	59
	Bid preparation			$933	$1,094	$369	$1,118	59
	Project signing/contracting			$270	$224	$130	$326	49
Project Design	Designing, scoping, and customizing the project	$388	6%	$388	$307	$211	$563	51
Installation	Installation labor	$2,886	46%	$2,886	$2,048	$1,406	$4,019	51
Transaction Costs	Obtaining permits	$708	11%	$381	$289	$172	$552	43
	Acquiring and maintaining training, certifications, and licenses			$327	$476	$64	$400	61
QA/QC	QA/QC activities	$311	5%	$183	$94	$115	$268	47
	Required callbacks to the customer to assist with equipment issues/ servicing			$127	$185	$19	$147	50
Recruiting & Hiring	Recruiting and hiring employees	$94	2%	$94	$154	$0	$89	50

Table 12. HVAC Replacement Soft Cost Category Shares, 2019-2023

Soft Cost Category	HVAC Replacement		
	2019 (n = 69-98)	2021 (n = 43-55)	2023 (n = 43-61)
Marketing and Customer Acquisition	26%	31%	30%
Project Design	5%	5%	6%
Installation	50%	43%	46%
Transaction Costs (Trainings, Certifications, Permits)	12%	14%	11%
Quality Assurance	5%	4%	5%
Recruiting and Hiring	1%	2%	2%
Total Soft Costs	**$4,702**	**$6,268**	**$6,272**

In 2023, total soft costs remained consistent with those in 2021 as shown in Table 13. Although soft costs were not significantly different from 2021 to 2023, there were directional shifts in specific cost categories. Installation costs saw the largest absolute change, increasing by $214, while transaction costs saw the largest and only statistically significant decrease compared to 2021, $176 (80% confidence interval). Marketing, transaction, and recruiting costs saw declines, while project design, installation, and quality assurance costs continued to grow in 2023. Transaction costs, the soft cost category that experienced the largest decrease, was primarily influenced by the reduced costs associated with acquiring and maintaining trainings, certifications, and licenses as shown in Table 14 (significant at the 90% confidence interval). While the Market Evaluation Team did not conduct research to identify a cause, it's possible that this is an outcome of the high project load for HVAC service providers across the state. When project capacity is tight, service providers are likely to prioritize paying work over trainings or continuing education, unless it is a requirement to keep their license.

Table 13. Soft Cost Category Absolute Value Estimates, 2019-2023

Soft Cost Category	2019 (n = 69-98)	2021 (n = 43-55)	2023 (n = 43-61)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Marketing and Customer Acquisition	$1,215	$1,973**	$1,885	-$88	-4%
Project Design and Development	$248	$319*	$388	+$70	+22%
Installation	$2,337	$2,671*	$2,886	+$214	+8%
Transaction Costs	$582	$884*	$708*	-$176	-20%
Quality Assurance	$251	$282	$311	+$29	+10%
Recruiting and Hiring	$68	$138**	$94	-$44	-32%
Total Soft Costs [a,]	**$4,702**	**$6,268**	**$6,272**	**+$4**	**0%**

The following notation denotes statistical significance at the different confidence levels compared to the prior period (i.e., notation in the 2021 column denotes significance compared to 2019): * $p < 0.20$, ** $p < 0.10$, *** $p < 0.05$

[a] Due to the calculation method for total soft costs (summing of individual cost buckets, with sample differences across the set), it is not possible to test statistical significance for total soft cost changes across study periods. Instead, Cadmus recommends looking for statistically significant differences at the soft cost category level. If several soft cost categories show statistically significant differences in the same direction in a given period, that is a good indication that the difference in total project soft costs is different as well.

Table 14. HVAC Replacement Project Transaction Costs, 2019-2023

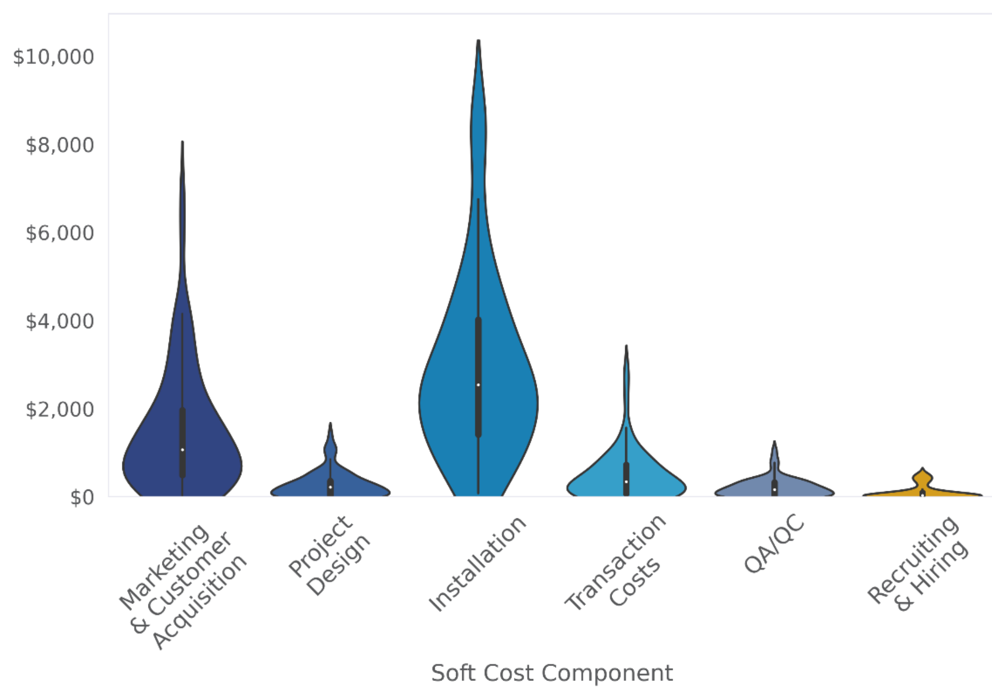
Soft Cost Category	2019 (n = 90-93)	2021 (n = 46-50)	2023 (n = 43-61)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Transaction Costs	**$582**	**$884**	**$708***	**-$176**	**-20%**
Obtaining Permits	$320	$347	$381	+$34	+10%
Acquiring/Maintaining Trainings, Certifications, and Licenses	$261	$538	$327**	-$211	-39%

The following notation denotes statistical significance at the different confidence levels compared to the prior period (i.e., notation in the 2021 column denotes significance compared to 2019): * p < 0.20, ** p < 0.10, *** p < 0.05

The other soft cost component that experienced a statistically significant increase between 2021 and 2023 was part of the Quality Assurance category: callbacks to the customer to assist with equipment issues/servicing. While it comprises a small portion of total soft costs, it increased from $84 per project in 2021 to $127 per project in 2023, a 51% increase that is significant at the 80% confidence level. While the Market Evaluation Team did not conduct research to identify a cause, the Team hypothesizes that this is due to an increase in heat pump penetration across the state, which can lead to more callbacks from customers after having their system installed.

Figure 3 shows the distribution of HVAC replacement soft costs, with the largest spread of soft costs for installation, marketing and customer acquisition, and transaction costs. These three cost categories had the consistently largest spread in 2019 and 2021 as well, showing consistency in the overall results.

Figure 3. HVAC Replacement Soft Costs Violin Plot



Soft Cost Drivers

This section investigates what is driving the differences in soft costs. Specifically, this section examines the correlation of soft costs with several explanatory variables.

The Market Evaluation Team used linear regression models to assess the degree to which residential sector soft costs can be explained by the firmographic variables collected. Table 15 shows regression estimates for HVAC prototypical project soft costs, regressed on firmographic variables. Except for the number of employees in a service provider's firm, firmographic variables included in the regression model had little explanatory power over total soft costs in the residential sector. In other words, a contractor's region, the number of installations that contractor completed in the prior year, and the contractor's win rate do not correlate with total soft costs. The estimated "Employees" coefficient suggests that for every additional employee residential service providers spend an average of $12 more per project, all else being equal. This suggests that adding head count can increase cost, perhaps because the firm has higher overhead costs. Added headcount also means a firm may be conducting additional work beyond project installations, such as marketing, which can increase cost.

Table 15. HVAC Total Soft Costs Regression Estimates

Dependent Variable: Total Soft Costs			
Independent Variable	**Coefficient**	**Standard Error**	**P-value**
Intercept	$782.68	$386.09	0.048***
Region (=Upstate)	-$286.14	$325.38	0.383
Employees	$12.39	$6.55	0.064**
Installations	-$1.65	$2.54	0.517
Win Rate	-$0.85	$4.69	0.857
n	59		
R^2	0.106		
Adjusted R^2	0.039		

Note: Standard errors in parentheses. * p < 0.20, ** p < 0.10, *** p < 0.05.

Regional Differences

The Market Evaluation Team found that the total project costs (estimated using a top-down approach) in both upstate and downstate regions were almost identical in 2023. As shown in Table 16, in 2023 the average HVAC replacement project cost was $18,451 upstate compared with $18,288 downstate—a $164 difference and statistically identical. This contrasts with results from 2021, when there was a difference of $1,239 between upstate and downstate, with costs higher downstate. While the difference in 2021 was also not statistically different, the decrease in the gap between upstate and downstate may indicate a maturing heat pump market across the state, service providers integrating enhanced heat pump incentives into their pricing, persistent market impacts (as noted in the *Fluctuations in Market and Economic Conditions* section), or a combination of the three. However, the Market Evaluation Team cautions against drawing conclusions from this data due to the small sample sizes.

Table 16. Top-Down HVAC Replacement Project Soft Cost Estimates by Region (2021-2023)

Cost Category	Upstate (2023 n = 45) (2021 n = 43)	Downstate (2023 n = 8) (2021 n = 13)	Difference
2023			
Hard Costs	$8,489	$9,020	+$531
Soft Costs	$9,962	$9,268	-$695
Total Project Costs	**$18,451**	**$18,288**	**-$164**
2021			
Hard Costs	$7,578	$6,940	-$638
Soft Costs	$7,491	$9,368	+$1,877
Total Project Costs	**$15,069**	**$16,308**	**+$1,239**

The box-and-whisker plot in Figure 4 illustrates the range of reported hard and soft costs by location (upstate and downstate New York). Each box represents the interquartile range of the data. The solid line in the middle of the box is the median, and the small white box is the mean. Unlike 2019 and 2021, downstate contractors show a tighter spread of costs, which is expected given the small sample size.

Figure 4. HVAC Replacement Prototypical Project Cost Estimates: Box and Whisker Plot by Region

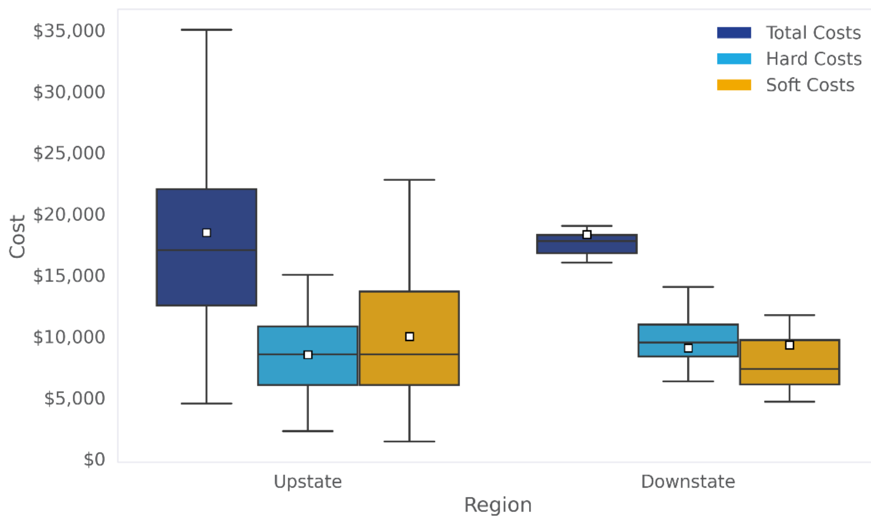
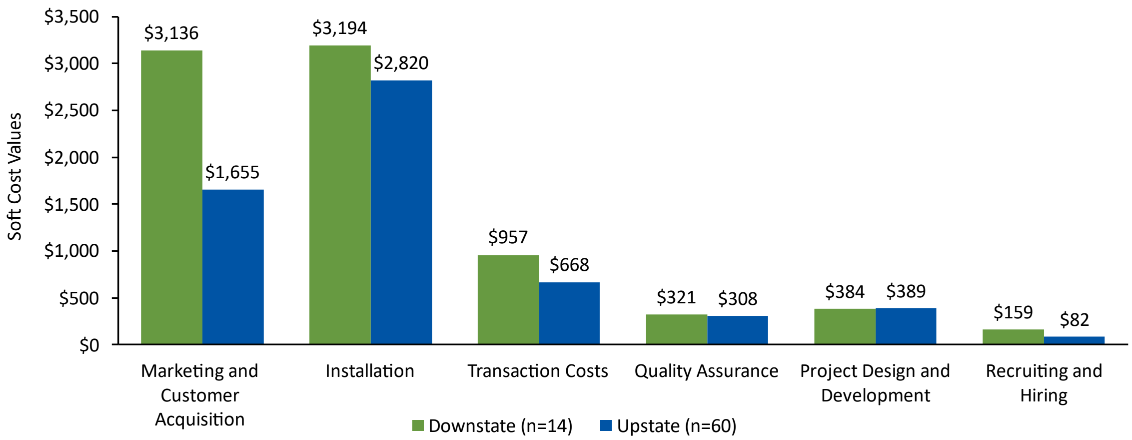


Figure 5 shows individual soft cost categories split by upstate and downstate residential HVAC service providers, which show a different trend than the top-down data (Table 16 and Figure 4). The data above, from the top-down estimate (i.e., asking contractors to provide the total cost and then to estimate the percentage of hard costs to the total cost) shows very similar costs between downstate and upstate contractors. However, when asked to provide bottom-up soft cost estimates (i.e., estimating hours and dollars for specific tasks), the estimates for downstate were higher than upstate by $2,229.

The largest differences on a dollar scale between the two regions are marketing and customer acquisition, installation, and transaction costs, which account for 96% of the total difference. Given the higher competition downstate and the fact that permitting (part of transaction costs) is directly related to local codes and ordinances, this difference is expected. Differences are not significant due to the small downstate sample for 2023, but directionally they fit trends observed in the 2019 and 2021 study.

When isolating permitting costs, the Market Evaluation Team found a persistent difference between upstate and downstate contractors. Permitting costs were $163 higher downstate, which is consistent with a more complex permitting landscape that downstate contractors must navigate.

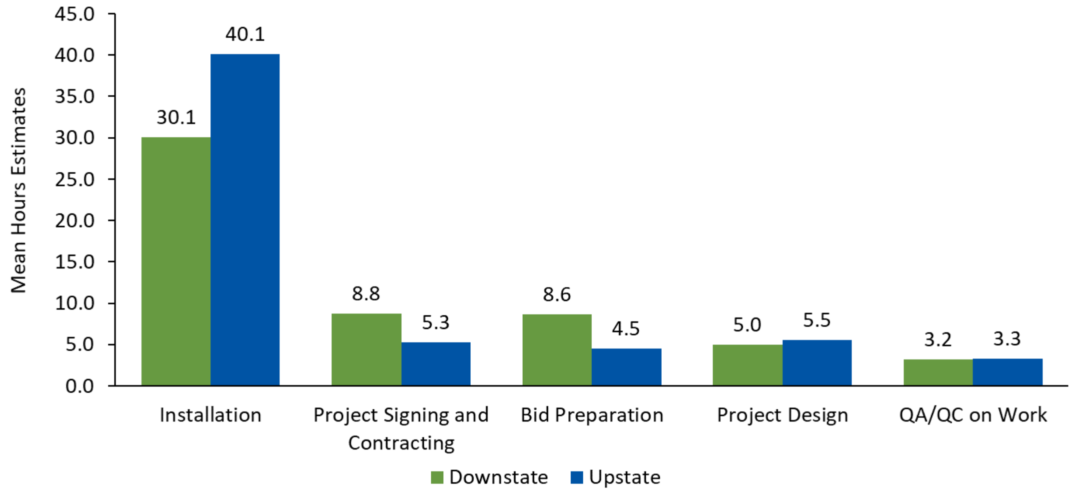
Figure 5. Soft Cost Category Mean Comparison: Upstate *vs.* Downstate



Note: Differences are not statistically significant and should be treated as directional.

When removing labor rate differences between upstate and downstate (the average labor rate is 51% higher downstate than upstate), the difference between the two regions closes. In this scenario, two key differences still exist—marketing and customer acquisition costs (+$595) and transaction costs (+$149)—representing the structural differences in these two regions. Interestingly, installation costs are now *lower* downstate (-$702), meaning that downstate contractors estimate a slightly shorter installation time than upstate contractors (the upstate average is 40 hours, and the downstate average is 30 hours, as shown in Figure 6). This may be because downstate contractors had more ASHP installs in the past year (62 downstate *versus* 40 upstate) or because of differences in experience (17 years downstate *versus* 15 years upstate).

Figure 6. Labor Hours Estimates for Select Soft Cost Components



Note: Differences are not statistically significant and should be treated as directional.

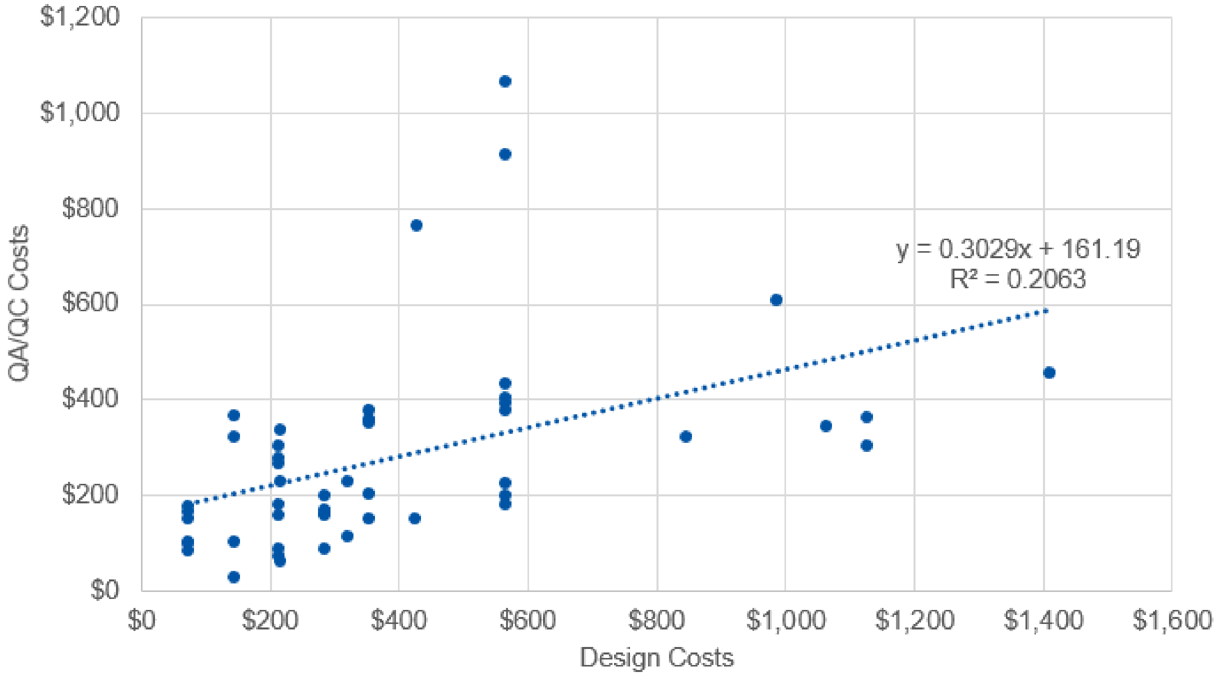
QA/QC and Design Costs

The Market Evaluation Team analyzed the relationship between a company's design spending and QA/QC spending. Two reasonable hypotheses emerged regarding this relationship:

- Companies that spend more on design costs may have more thoroughly planned projects and consequently spend *less* on QA/QC.
- Alternatively, companies that spend more time (and thus incur more labor cost) on design may be more thorough in general and ultimately spend *more* on QA/QC after installation.

Figure 7 characterizes this relationship for the HVAC replacement prototypical project. This relationship is positive, showing that companies spending more time on design are also spending more time on QA/QC. While the sample size is somewhat small, this may be partly attributed to ASHP installations being more comprehensive and demanding that contractors spend more time not only on design but also on QA/QC to ensure that the system is operating appropriately.

Figure 7. QA/QC Design Cost Correlations



Contractor Experience

The increase in market activity discussed in the *Fluctuations in Market and Economic Conditions* section likely encouraged more service providers to enter the market. This is supported by data collected from service providers across the three survey periods—the median years of experience installing HVAC systems was 15 years for the residential HVAC sample in 2019, 10 years in 2021, and 12 years in 2023. Some soft cost variations can be partially explained by a less experienced service provider market. Service providers with less experience tend to overestimate the time required for technical aspects of projects; this time is included in project design and development, installation, and transaction costs. The Market Evaluation Team found this trend in the service provider data; service providers with a level of experience below the median (12 years) estimated it would take more time to draft each bid (6.8 hours for less experienced *versus* 4.0 hours for more experienced providers, 70% higher) and for the heat pump installation (40.9 hours for less experienced *versus* 35.4 hours for more experienced providers, 16% higher). Thus, as the heat pump market matures, it is reasonable to assume that soft costs for certain categories will decrease.

Additional Topics

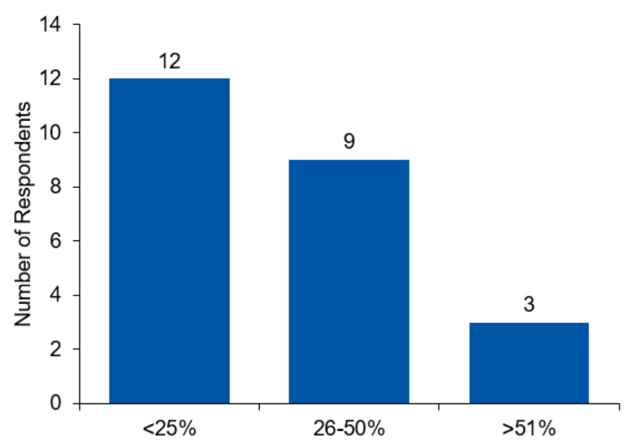
This section details some additional findings from HVAC service providers that are not directly tied to soft cost estimates.

Whole-Home *versus* Supplemental

The Market Evaluation Team asked service providers about their experience installing ductless heat pumps in both a whole-home and supplemental (i.e., not the primary heating system) capacity. Fortytwo percent of respondents said less time was spent on project initiation for ductless heat pumps in a supplemental capacity compared with whole-home capacity.

For those respondents that reported fewer hours needed for ductless heat pump project initiation in a supplemental capacity, the Market Evaluation Team asked by how much (as a percentage) project initiation costs (i.e., bid preparation, project design, etc.) were lower than those in a whole-home capacity. Figure 8 shows that half of respondents answered that project initiation time for projects completed in a supplemental capacity took up to 25% less time than those in a whole-home capacity. On average, the labor needed for project initiation was 36% less for projects completed in a supplemental capacity compared with a whole-home capacity.

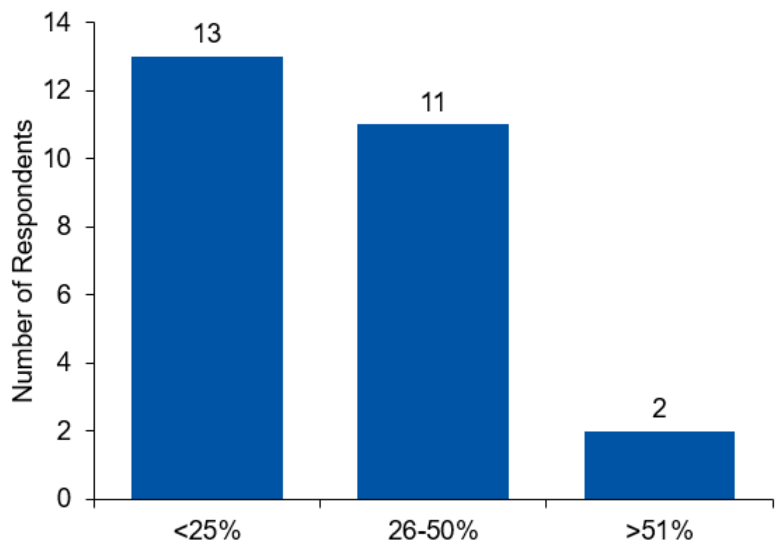
Figure 8. Percentage by Which Supplemental Heat Pump Project Initiation Hours are Less than Whole-Home Heat Pump Projects



Source: Residential HVAC Survey Q F2: “By what percent do you think these hours are lower? Please enter the percent as a whole number (i.e., 10%=10).” (n=24)

Similarly, 46% of service providers said that labor spent on project implementation (i.e., installation labor, QA/QC, etc.) was lower for ductless heat pumps in a supplemental capacity than in a whole-home capacity. As shown in Figure 9, half of respondents believed that project implementation took up to 25% less time for supplemental projects. On average, the labor needed for project implementation was 34% less for projects completed in a supplemental capacity compared with a whole-home capacity.

Figure 9. Percentage by which Supplemental Heat Pump Project Implementation is less than Whole-Home Heat Pump Project



Source: Residential HVAC Survey Q F4: "By what percent do you think these hours are lower? Please enter the percent as a whole number (i.e., 10%=10)." (n=26)

When asked how ductless heat pumps installed in a supplemental capacity differ from those installed in a whole-home capacity, contractors said supplemental projects are generally smaller and simpler installations and are therefore quicker to install and require fewer labor hours. Contractors also said less equipment such as fan coils is needed, which reduces material costs for these projects. One contractor said supplemental installations have less of an effect on load sizing and locations because homeowners specify where they would like equipment to be installed.

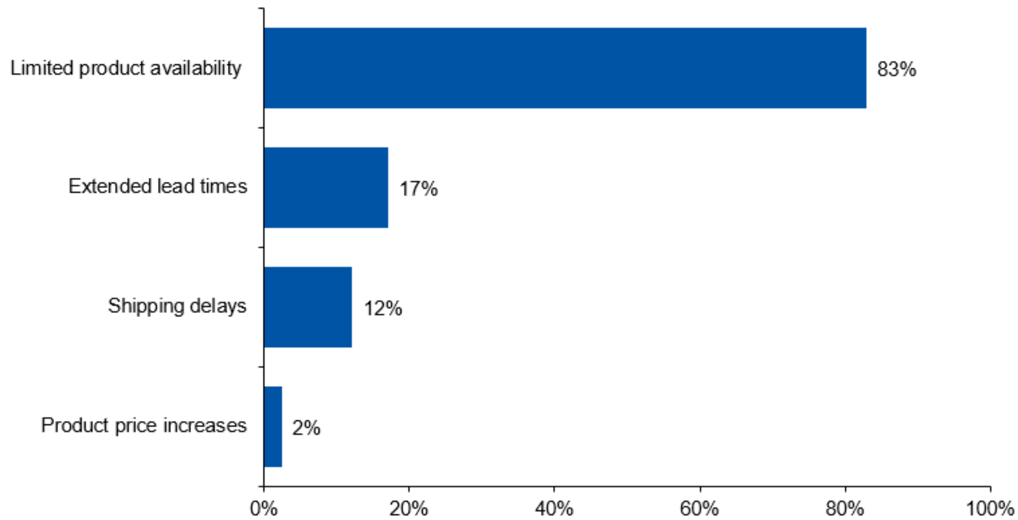
Equipment Stocking

The Market Evaluation Team asked service providers how they sourced equipment for residential HVAC replacement projects. All 58 service providers who responded to this question said that they sourced their equipment directly from the distributor. When asked about their experience acquiring equipment for ductless heat pump installations, 67% said they had encountered disruptive supply chain issues.

The Market Evaluation Team also asked service providers whether they rely on one source for their equipment or if they have identified multiple avenues to obtain necessary equipment in the event that one source cannot provide it. Twenty-one percent of service providers said that they source their ductless heat pump equipment from a single source, and 50% have a primary source but will buy from others.

To further understand the setbacks caused by supply chain disruptions, the Market Evaluation Team asked service providers to elaborate on the types of issues that arose while completing HVAC projects. Figure 10 shows that 83% of contractors faced limited product availability when trying to complete residential HVAC replacement projects, and extended lead times and shipping delays also contributed to project setbacks. While the majority of respondents experienced issues, two respondents said the supply chain has improved and they have experienced fewer issues than in previous years.

Figure 10. Issues Faced by HVAC Contractors

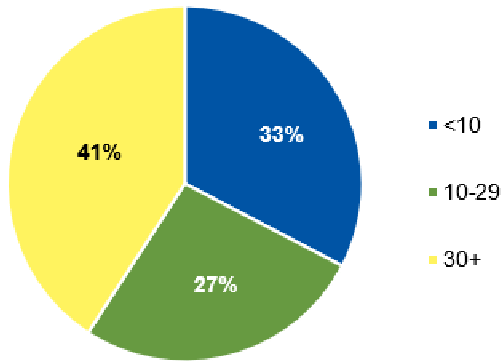


Source: Residential HVAC Survey Q G6: "In the past year, has your business encountered any issues with acquiring the needed equipment to install ductless heat pumps?" (n=41)

Commercial Sector - HVAC Retrofit: VRF

The Market Evaluation Team conducted surveys with a variety of commercial service providers to investigate soft costs associated with commercial HVAC replacement projects. The Market Evaluation Team gathered responses from 49 commercial service providers who completed a VRF project within the past 12 months. Of surveyed service providers, 28 (57%) primarily worked in upstate New York, and 21 (43%) worked downstate. Forty-one percent worked for a company with more than 30 employees as shown in Figure 11.

Figure 11. Number of Employees for Commercial Service Providers



Source: Commercial Contractor Survey Q F1: “Including yourself, approximately how many employees work for your company in New York state?” (n=49).

A summary of key findings from the commercial sector research is presented below. The full details are in the subsequent sub-sections within this section.

Key Findings: Commercial Sector
• Both soft and hard costs increased slightly for commercial HVAC retrofit projects from 2021 to 2023, with soft costs rising faster than hard costs.[a] Market forces since the baseline study have put pressure on commercial HVAC service providers, likely leading to increases in total project costs. • Installation cost experienced the largest change from 2021 (+25%); the remaining five categories experienced marginal decreases or were roughly equal.[a] • QA/QC and design costs were positively correlated. • Experienced contractors tended to have higher design costs,[a] which may signify that these contractors have a better understanding of the complex nature of VRF installations. • Top drivers of increased customer acquisition costs for commercial VRF projects include higher equipment costs and customer education costs. [a] These differences were not statistically significant and should be interpreted as directional.

Prototypical Project Cost Estimates

The Market Evaluation Team asked contractors to estimate soft costs for commercial HVAC retrofit VRF projects in the commercial sector, as shown in Table 17.

Table 17. HVAC Retrofit: VRF Prototypical Project Details (2023)

Attribute	Definition
Building Type	Commercial office building
Building Size	30,000 sq. ft.
Existing Conditions	**Fuel type**: Gas **Equipment**: Four (approximately 10-ton) packaged rooftop air-conditioning units with gas-fired heating, each controlling a single zone
Equipment to Be Installed	**Fuel type**: Electric **Equipment**: VRF system with 1 main outdoor unit and 10 indoor zones Assume significant updates to the electric service will not be required

Table 18 summarizes the high-level results using a top-down estimating approach. For an average installed project cost of $254,433, 43.7% of costs were hard (equipment-related) costs and 56.3% were soft costs.

Table 18. HVAC Retrofit: VRF Hard and Soft Cost Estimates (2023)

Component	Average Cost Per Project	Standard Deviation	First Quartile	Third Quartile	Sample Size
Average Total Installed Cost	$254,433	$1,000,000	$56,000	$350,000	28
Percentage Soft Costs	56.3%	96.0%	40.0%	70.0%	28
Value Soft Costs	$162,326	$960,000	$28,300	$167,500	28
Percentage Hard Costs	43.7%	75.0%	30.0%	60.0%	28
Value Hard Costs	$92,107	$405,000	$23,400	$112,500	28

Compared with 2021, average total project costs in 2023 increased by $10,713 per project, or 4%, which is relatively consistent with 2021. Most of the absolute change was in soft costs (83% of the total difference). The increases in hard and soft costs were likely related to continued shortages of HVAC equipment and raw materials, scarcity of labor, and supply chain disruptions brought about by the COVID-19 pandemic. See the *Fluctuations in Market and Economic Conditions* section for more details on these impacts.

Table 19. HVAC Retrofit: VRF Prototypical Project Cost Estimate 2019-2023 Comparison

Cost Category	2019 (n = 17-18)	2021 (n = 25)	2023 (n = 28)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Hard Costs	$86,269	$90,257	$92,107	+$1,850	+2.0%
Soft Costs	$144,008	$153,463	$162,326	+$8,863	+5.8%
Total Project Costs	$233,947	$243,720	$254,433	+$10,713	+4.2%

The Market Evaluation Team collected data to construct estimates for the six specific soft cost categories that contribute to the total soft cost estimate using a bottom-up estimating approach, as shown in Table 20. In 2023, installation costs were the highest, at $64,968 per HVAC retrofit: VRF project (76% of the estimated project soft costs). This is consistent with 2021, where installation costs comprised 66% of the total prototypical project soft costs. Marketing costs, including bid preparation, were the second highest, at $8,164 per project (10%). The technical nature of these projects, requiring specialized labor, is likely driving the high level of installation costs and bid preparation costs (part of the marketing cost category).

Table 20. HVAC Retrofit: VRF Soft Cost Component Estimates (2023)

Soft Cost Category	Soft Cost Component	Per Project Cost	Per Project (%)	Component Cost	Standard Deviation	First Quartile	Third Quartile	Sample Size
Marketing & Customer Acquisition	Marketing and/or customer education	$8,164	10%	$1,906	$7,035	$379	$2,216	28
	Bid preparation			$4,681	$26,846	$1,028	$5,369	34
	Project signing/ contracting			$1,577	$5,369	$671	$2,646	26
Project Design	Designing, scoping, and customizing the project	$2,727	3%	$2,727	$8,669	$1,035	$3,251	24
Installation	Installation labor	$64,968	76%	$64,968	$310,545	$9,428	$106,560	26
Transaction Costs	Obtaining permits	$5,739	7%	$3,802	$19,047	$1,103	$5,182	29
	Acquiring and maintaining training, certifications, and licenses			$1,937	$9,458	$427	$3,133	30
QA/QC	QA/QC activities	$3,506	4%	$2,312	$6,350	$1,197	$3,175	25
	Required callbacks to the customer to assist with equipment issues/ servicing			$1,195	$4,489	$169	$1,587	30
Recruiting & Hiring	Recruiting and hiring employees	$661	1%	$661	$3,844	$0	$591	29

Table 21 shows the breakdown of soft cost categories across study periods for the HVAC retrofit: VRF project. The share of soft costs across the different categories remained relatively consistent across years, with installation costs and marketing and customer acquisition costs remaining as the top two cost categories.

Table 21. HVAC Retrofit: VRF Soft Cost Category Shares, 2019-2023

Soft Cost Category	HVAC: VRF		
	2019 (n = 15-23)	2021 (n = 26-48)	2023 (n = 24-34)
Marketing and Customer Acquisition	12%	13%	10%
Project Design	6%	5%	3%
Installation	69%	65%	76%
Transaction Costs (Trainings, Certifications, Permits)	7%	10%	7%
Quality Assurance	5%	5%	4%
Recruiting and Hiring	0%	1%	1%

Total Soft Costs	$72,718	$79,622	$85,764

Table 22 shows the absolute value estimates for soft cost categories over the study periods. As noted earlier, the soft cost estimates for the commercial HVAC retrofit: VRF project grew slightly from 2021 to 2023, driven entirely by increased installation cost. The specialized nature of these installations can lead to increased costs during a tight labor market, as contractors compete for skilled labor.

Table 22. Soft Cost Category Absolute Value Estimates For HVAC: VRF Project 2019-2023

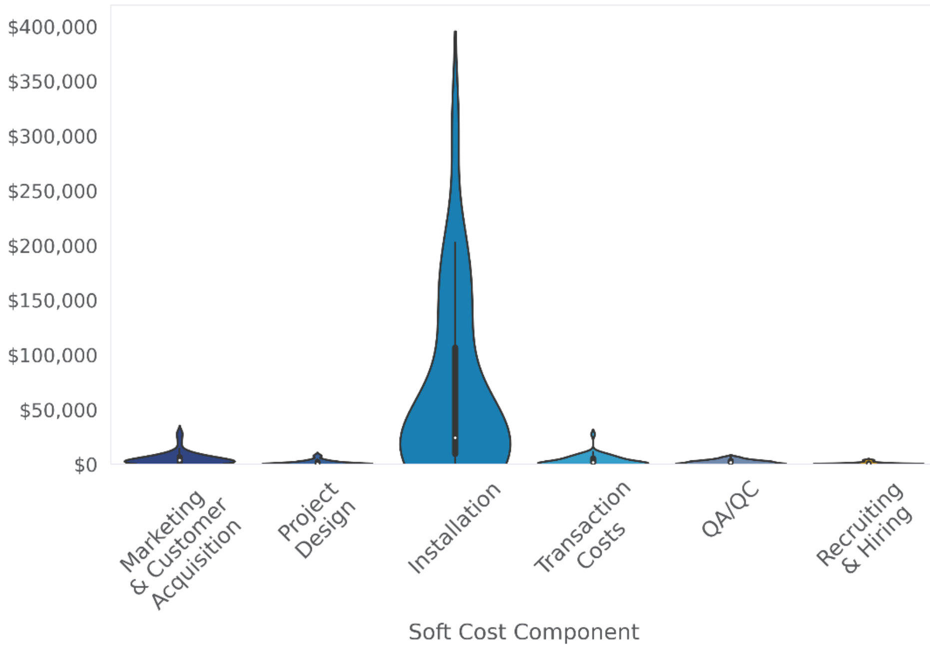
Soft Cost Category	2019 (n = 12-20)	2021 (n = 26-48)	2023 (n = 24-34)	Change from 2021-2023 ($)	Change from 2021-2023 (%)
Marketing and Customer Acquisition	$8,755	$10,440*	$8,164	-$2,277	-22%
Project Design and Development	$4,213	$4,112	$2,727	-$1,386	-34%
Installation	$50,471	$51,997	$64,968	$12,971	+25%
Transaction Costs	$5,437	$8,335	$5,739	-$2,597	-31%
Quality Assurance	$3,690	$3,945	$3,506	-$439	-11%
Recruiting and Hiring	$151	$792***	$661	-$132	-17%
Total Soft Costs [a]	**$72,718**	**$79,622**	**$85,764**	**$6,142**	**+8%**

The following notation denotes statistical significance at the different confidence levels compared to the prior period (i.e., notation in the 2021 column denotes significance compared to 2019): * $p < 0.20$, ** $p < 0.10$, *** $p < 0.05$

[a] Due to the calculation method for total soft costs (summing of individual cost buckets, with sample differences across the set), it is not possible to test statistical significance for total soft cost changes across study periods. Instead, Cadmus recommends looking for statistically significant differences at the soft cost category level. If several soft cost categories show statistically significant differences in the same direction in a given period, that is a good indication that the difference in total project soft costs is different as well.

Figure 12 shows the distribution of commercial HVAC retrofit: VRF soft costs by category. The violin plot represents the spread of cost estimates (i.e., more widely dispersed estimates are displayed by a long tail and/or a longer body shape). For example, project design QA/QC costs in the commercial sector center are close to zero, while installation, marketing and customer acquisition, and transaction costs disperse more widely. Installation costs have the widest spread, skewing the graph scale for the other categories. Soft costs with a larger spread (i.e., spanning a larger part of the x-axis) represent a reduction opportunity, as some contractors doing a similar job spend more than others.

Figure 12. Commercial Sector Soft Costs Violin Plot



Soft Cost Drivers

The Market Evaluation Team examined some drivers of soft costs for the commercial HVAC retrofit: VRF prototypical project. Because the sample size is smaller than for the residential sector, the Market Evaluation Team could only complete a limited analysis. In prior reports, the Market Evaluation Team conducted the drivers analysis at the sector level, providing a larger sample size and more robust drivers analysis.

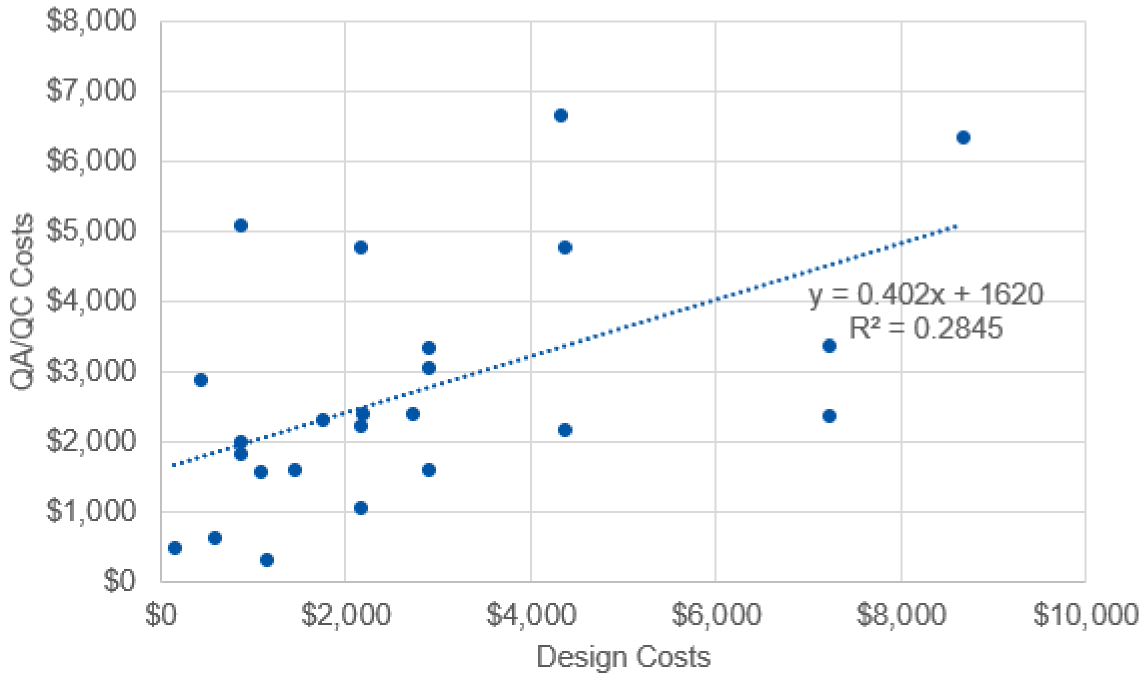
QA/QC and Design Costs

The Market Evaluation Team analyzed the relationship between a company's design spending and QA/QC spending. Two reasonable hypotheses emerged regarding this relationship:

- Companies that spend more on design costs may have more thoroughly planned projects and consequently spend *less* on QA/QC.
- Alternatively, companies that spend more time on design may be more thorough in general and ultimately spend *more* on QA/QC after installation.

Figure 13 characterizes this relationship for the commercial HVAC retrofit: VRF prototypical project. Like in the residential sector, this relationship is positive, showing that companies spending more time on design are also spending more time on QA/QC. While the sample size is small, this may be partly attributed to VRF installations being highly complex and demanding that contractors spend more time not only on design but also on QA/QC to ensure that the system is operating appropriately.

Figure 13. QA/QC Design Cost Correlations



The Market Evaluation Team examined design time compared to a contractor's level of experience – experienced contractors (greater than the mean of 16.8 years, n=8) estimated a design time of 49.4 hours, double what less experienced contractors estimated (21.7 hours; n=16). Given the complex nature of commercial VRF installations and the relative inexperience of the market with these technologies, it is reasonable to assume that contractors with more experience have a better understanding of the complex nature of VRF installations.

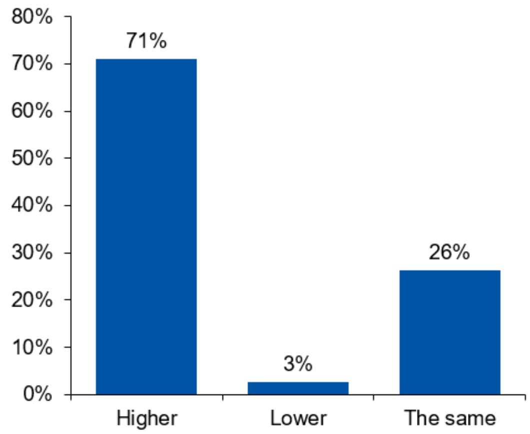
Additional Topics

This section details some additional findings from commercial service providers that are not directly tied to soft cost estimates.

ASHP Customer Acquisition Costs

HVAC: VRF providers were asked whether they thought costs associated with customer acquisition for commercial VRF systems were higher, lower, or the same as other commercial HVAC systems installed. 71% of respondents said these associated costs were higher for commercial VRF than for other HVAC technologies as shown in Figure 14.

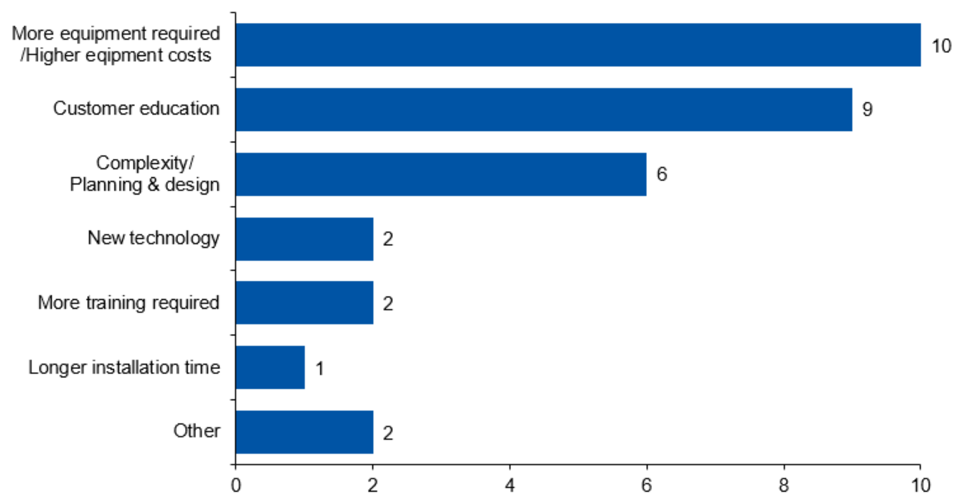
Figure 14. Commercial HVAC: VRF Customer Acquisition Costs



Source: Commercial HVAC VRF Survey Q I8: "Would you say the costs associated with customer acquisition for commercial VRF systems are higher, lower, or the same as other commercial HVAC systems you install? " (n=38)

The Market Evaluation Team asked why respondents believed customer acquisition costs are higher for commercial VRF systems than other HVAC technologies as shown in Figure 15. More equipment required/higher equipment costs and increased customer education efforts associated with commercial HVAC retrofit projects were cited as the top two reasons for higher costs. While higher equipment costs were an expected top driver, the higher customer education costs likely reflect the lack of institutional knowledge in many commercial management teams to operate and maintain complex VRF equipment.

Figure 15. Drivers of Higher Commercial HVAC Customer Acquisition Costs



Source: Commercial HVAC VRF Survey Q I9a: "Why do you say that the customer acquisition costs are higher for commercial VRF systems than other HVAC technologies?" (n=23)

Equipment Stocking

The Market Evaluation Team asked questions regarding equipment stocking practices. Three (10%, n=33) respondents said they kept equipment in stock to have it readily available for customers, and 18 respondents (55%) said they encountered issues in acquiring equipment. Contractors noted long lead times, manufacturer delays, and other supply chain issues as barriers to equipment acquisition. One respondent said they have had long lead times, but this has been "getting better as time goes on." Table 23 shows equipment stocking practices for each prototypical project type, and

Table 24 shows equipment stocking issues.

Table 23. Equipment Stocking Practices

	Count	Percentage
Yes	3	10%
No	30	90%
Total	**33**	**100%**

Source: Commercial Contractor Surveys Q L1 "Do you keep VRF equipment in stock to have it readily available for customers?" (n=33)

Table 24. Issues Acquiring Equipment

	Count	Percentage
Yes	18	55%
No	15	45%
Total	**33**	**100%**

Source: Commercial Contractor Surveys Q L4 "In the past year, has your business encountered any issues with acquiring the needed equipment to install VRF systems? " (n=33)

Conclusions and Recommendations

Like the 2021 baseline study, this report quantifies the soft costs associated with energy efficiency and electrification projects in New York, identifies the largest contributors to project soft costs, assesses the degree and drivers of variation within soft cost categories, and seeks to identify opportunities for soft cost reduction. This report also reviews changes in energy efficiency and electrification project costs from the 2021 study and identifies possible causes for observed changes.

Results from this year's study reveal a market in flux due to drastic impacts stemming from the COVID-19 pandemic, ongoing market recovery, and the general economic environment. As such, it is highly likely that the prototypical project cost quantifications were impacted by these factors, which were not present in the baseline study. In the 2021 study, a similar set of factors impacted the market, but the high level of inflation of the past two years had just begun, so that factor is unique to this study.

Research findings provide insights that NYSERDA (and other entities) can leverage to influence or assist market actors in reducing soft costs, though the direct impacts of interventions in the current environment remain uncertain. NYSERDA and New York State may also consider expanding existing regulatory options, such as building energy benchmarking, energy labeling, and stretch codes, to drive demand for energy efficiency and electrification and reduce costs.

In the following section, the Market Evaluation Team builds on conclusions and recommendations from NYSERDA's past research, the 2019 baseline report, and the 2021 report. Specifically, the conclusions and recommendations presented here explore how key findings from soft cost research identified in this study may inform the design and implementation of energy efficiency and electrification soft cost reduction strategies in New York. Some recommendations build on recommendations included in the 2021 study that remained relevant in this study.

Conclusion 1: Market forces likely caused total energy efficiency and electrification project costs to slightly increase.

In both residential and commercial prototypical projects, total project costs estimated using a top-down approach (i.e., asking for total cost and then the percentage for equipment) continued to increase from 2021. In 2023, soft costs made up the majority of the increase for both sectors but the opposite was true in 2021. For example, the average increase in total project costs in the residential sector was 20%, with soft costs increasing 24% and hard costs increasing 15% from 2021 to 2023. The difference was smaller (and not significant) in the commercial sector—total costs increased by 4.2%, soft costs by 5.8% and hard costs by 2.0%.

When estimated using a bottom-up approach (i.e., asking for hour and dollar estimates and calculating costs), residential and commercial sector soft cost estimates by category were not significantly different from 2021. The difference between these estimates and the top-down estimates indicates that the work required to complete HVAC replacement projects did not increase but what contractors charged did.

Factors stemming from the COVID-19 pandemic, ongoing market recovery, and the general economic environment impacted the 2021 results, and these impacts continued throughout the current study period. The cost of construction inputs continued to rise by between 13% and 14% for both the residential and nonresidential sectors. Inflation had a large impact on cost of living between 2021 and 2023, with a 10.1% increase in the CPI across the study period. Finally, a shortage of workers in the construction industry likely led to increases in project costs. (See *Fluctuations in Market* section for more details.)

Recommendation: Continue the market monitoring activities noted by NYSERDA in the 2021 study. This includes annual surveys with participating contractors, memberships with various trade organizations, and general market condition monitoring.

Recommendation: If not already completed, consider conducting qualitative research with engaged contractors to identify market factors having the largest impact on energy efficiency and electrification projects. Use this data to inform future program design decisions and market intervention opportunities.

Conclusion 2: Experience level can impact soft cost estimates in both sectors.

Residential and commercial HVAC contractors had opposite trends when splitting data by experience level. In the residential sector, less experienced contractors (those with less than 15.2 years of experience) estimated more time for installation (22% increase) and bid development (62% increase) than experienced contractors did. In the commercial sector, the opposite is true—experienced contractors estimated design costs over twice as high as did less experienced contractors.

The Market Evaluation Team hypothesizes that there are different “levels” of experience between these sectors—as residential ASHP installations have become more common over the years, a greater share of contractors have the skills to complete an installation. In contrast, VRF systems are less well-established and thus have a smaller set of eligible contractors capable of completing an installation. A contractor with deep residential ASHP experience but limited commercial VRF experience may underestimate the time needed for various aspects of the installation, relying on their experience with a technology that is similar on the surface but different in practice.

In the residential sector, contractors who have just entered the market and have less experience with ASHPs are likely less familiar with the technology overall (in either the residential or commercial sector) and may overestimate the effort required for specific tasks, building in time for them to learn the technology.

Recommendation: Expand promotion of the standardized bid packages of envelope improvements to a broader set of contractors beyond the pilot program group. As noted in the 2021 report, NYSERDA was working to add additional building typologies to the set of standardized bid packages. Should those be ready, NYSERDA should ensure they are updated on a regular basis to keep up with any changes in best practices or incentive program design. Additionally, NYSERDA might consider creating a version for a basic commercial HVAC retrofit if there is sufficient market demand.

Conclusion 3: Correlations between design and QA/QC costs signify the different approaches contractors take to heat pump installations.

In both the residential and commercial sectors, the Market Evaluation Team found a positive correlation between project design costs and QA/QC costs. That is, when a contractor spends more on project design, they also tend to spend more on QA/QC. While the sample size is somewhat small, this may be partly attributed to ASHP installations being more comprehensive and demanding that contractors spend more time not only on design but also on QA/QC to ensure that the system is operating appropriately. This trend is consistent with trends seen in 2019 and 2021 for other prototypical projects, demonstrating that this is likely a cross-sector trend. Given that proper heat pump system design and a well-working system are important to continue advancing electrification, contractors should ensure proper allocation of time to these tasks.

Recommendation: Review project installation best practice guidelines and ensure that appropriate system design and QA/QC are thoroughly covered. If these elements are not already included, it might be helpful to add checklists for contractors of items to cover during program design and complete during QA/QC.

Conclusion 4: Limited customer experience with commercial HVAC VRF systems adds to contractor costs.

When asked why respondents believed customer acquisition costs are higher for commercial VRF systems than other HVAC technologies, service providers cited more equipment required/higher equipment costs (10 responses) and increased customer education efforts (nine responses) associated with commercial HVAC retrofit projects. While higher equipment costs were an expected top driver, the higher customer education costs likely reflect the lack of institutional knowledge in many commercial management teams to operate and maintain complex VRF equipment.

Recommendation: Encourage service providers and manufacturers to provide resources to end-use commercial customers that educate them on appropriate system operation and maintenance, such as standardized hands-on training at the customer site upon installation of the new system.

CADMUS

Appendix C. NYSERDA Empire Building Challenge Case Studies Report

April 4, 2025

Prepared for:

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Table of Contents

Introduction

Since 2019, the New York State Energy Research and Development Authority (NYSERDA) has conducted a comprehensive study of energy efficiency soft costs in New York State, encompassing the residential, multifamily, and commercial sectors. NYSERDA completed three waves of the Energy Efficiency and Building Electrification Soft Costs (EESC) study – 2019, 2021, and 2024. While the EESC study provided a broad view of costs, it did not delve deeply into more advanced types of projects. As a result, NYSERDA contracted with Cadmus (the Market Evaluation team) to complete a supplemental study on the four Phase 1 Empire Building Challenge (EBC) projects completed in New York City (NYC). The Market Evaluation team conducted several interviews with project developers and analyzed available cost data, creating a case study for each EBC project. This deeper analysis of these comprehensive retrofit projects, along with a better understanding of the costs driving these projects, is critical to reaching the state's energy reduction goals.

This report describes the methods used to complete this work, a summary of synthesized key findings, and the four individual case studies. It is presented as an appendix to the 2024 EESC study.

Methods

Through this study, the Market Evaluation team sought to answer two research objectives:

- Understand the types of costs that impact energy efficiency projects and the underlying drivers
- Assess the scale of cost changes that can occur during project implementation

To complete this study, the Market Evaluation team conducted a series of interviews with the project developers from each Phase 1 EBC project. They completed either two or three interviews with each EBC project developer throughout the course of the project, with each interview building on the discussion and results from the prior. Table 1 summarizes the interview cadence and final status of each project at the time the case study was drafted. Please note that only one project was completed before the case study work was finished.

Table 1. Interview Sample and Project Status

Project Developer	EBC Project Name	First Interview	Second Interview	Third Interview	Final Project Status
Empire State Realty Trust (ESRT)	Empire State Building	5/1/2023	10/3/2023	-	Completed Q3 2024
L+M Development Partners	The Heritage	4/25/2023	10/11/2023	9/5/2024	In construction; targeted completion Q1-Q2 2025
Hines	345 Hudson	4/24/2023	10/30/2023	10/16/2024	In construction; targeted completion Q2 2026
Paths (formerly Omni)	Whitney Young Manor	5/4/2023	11/13/2023	10/21/2024	In construction; targeted completion Q4 2026

Additionally, the Market Evaluation team analyzed available project documentation and cost data for each EBC project. Specifically, this included items such as bid packages, invoices, contracts, spec sheets, and permits, among others. It is important to note that the cost data for the two projects that were completed by the time case studies were written allowed for more in-depth cost analysis compared to the other projects.

Synthesized Key Findings

This section presents synthesized key findings from across the case studies on four topics: design considerations, cost drivers, lessons learned, and soft cost learnings.

Design Considerations

Project developers across the four case studies cited similar challenges as they navigated through the planning, design, and execution of their projects. Notable shared design considerations included maintaining operations while working in occupied buildings, collaborating with the proper authorities to ensure compliance with New York City codes and regulations, and adequately planning logistics for new equipment.

Working in Occupied Buildings: All four buildings remained operational during the renovations to save on cost, retain cash flow, and avoid disrupting or displacing tenants. Each project developer had a unique approach to managing occupied renovations. For example, the Paths redevelopment emphasized open and transparent communication with tenants, including presentations to gain their buy-in. On the other hand, the Hines redevelopment scheduled retrofits to coincide with the expiration of tenant leases whenever possible. In short, the project developers underscored the importance of making sure tenants remained updated and informed about construction scheduling and the benefits (both the energy and non-energy) of the building upgrades. Finally, project developers noted the importance of keeping everyone healthy and safe by mitigating risks such as exposure to hazardous materials (e.g., asbestos).

- *Soft Cost Impacts:* By keeping tenants in place during the retrofit work, the projects incurred additional costs related to project design (i.e., tenant mitigation plans), installation labor (i.e., additional work needed to accommodate tenants), and transaction costs (i.e., reviewing mitigation plans with additional city agencies) compared to a standard retrofit project.

Collaborating with City Agencies: The projects also required additional design considerations to meet the needed regulations. New York City can be a particularly challenging place to operate due to the myriad governing agencies that influence project permissions and timelines. This is especially true for developers working on highly complex projects like the EBC projects. While some standards were straightforward, such as ensuring that heating and cooling were available to the tenants, others were much more complex. For example, the Hines project had to comply with new restrictions for phasing out hydrofluorocarbons (HFCs) like R-401A, which is considered a high global warming potential (GWP) refrigerant. This Environmental Protection Agency regulation, effective January 1, 2025, required Hines to use equipment that was new to them to meet these standards. To avoid obstacles, project developers emphasized the importance of extensive planning and pre-construction meetings with agencies such as the NYC Department of Buildings (DOB), stressing the importance of being over-prepared to minimize delays. Lastly, project developers highlighted the rich culture of these historic NYC buildings and the importance of making every effort to preserve the artistic integrity of NYC's cultural and social history.

- *Soft Cost Impacts:* To meet these requirements, the projects incurred additional costs for project design (i.e., meeting with agencies to review plans) and transaction costs (i.e., additional permitting requirements) compared to a standard retrofit project.

Adequately Planning Logistics. Much of the equipment installed as part of this project was highly advanced and new to the team, which presented challenges for a workforce with less experience installing or operating these types of equipment. Project developers had to ensure that they hired staff and contractors with relevant experience or a willingness and eagerness to learn. Additionally, as some equipment had to be ordered and delivered from overseas manufacturers, project developers had to account for engineering specifications and the additional timing required to receive the materials. In one instance, a project developer sent a team of engineers to Europe to observe the installation of equipment so that they would be better prepared for their own project. Project developers also had to consider space clearances and substantial differences in sizing between the old and new equipment to ensure that the new equipment would fit properly. Additionally, project developers emphasized the importance of being prepared for potential issues with the new equipment and having backup plans in place while troubleshooting any problems.

- *Soft Cost Impacts:* Compared to projects with familiar equipment, the EBC projects incurred more substantial project design and transaction costs to train contractors on the installation processes.

Project Cost Drivers

As expected with any project of this magnitude, numerous factors, both prior to and during construction, can influence the cost of these projects. Each of the four projects investigated as part of this study had its own unique cost drivers, but several commonalities emerged.

Assembling an Experienced and Knowledgeable Workforce: The primary cost driver across all four sites was the project team. By participating in the EBC, these properties developed projects far more complex than standard energy efficiency retrofit projects. This complexity made partnering with the right contractors crucial to managing costs throughout the project. Due to the uniqueness of these projects and the inclusion of systems sometimes unfamiliar to the DOB, significantly more time was required by project staff to prepare engineering and permitting documentation than a standard retrofit project. Projects developers had to put in additional time to train contractors and employees on equipment installation and operation procedures – in one instance, the project developer sent staff overseas to observe the installation of the chosen equipment to improve their knowledge of the appropriate processes. Additionally, project developers felt that some of the installations took longer than a standard retrofit project due to the unfamiliarity with the types of energy conservation measures (ECMs) installed.

- *Soft Cost Impacts:* Compared to projects with familiar equipment, the EBC projects incurred more substantial costs for recruiting and hiring (bringing in new employees), transaction costs (employee training), and installation labor (less experienced contractors drive up labor costs)

Building Envelope Upgrades: One common and costly efficiency measure was upgrading the building envelope, which in some cases accounted for a large majority of the project cost. This expense was typically substantial due to the size of these buildings, and in some cases, multiple buildings, as well as the complexity that goes into removing and reinstalling a building's exterior walls. The project developers noted that a quality building envelope will reduce the HVAC load and improve tenants' comfort/quality of life, key value-adds to the project scope. Because of the extent of these envelope upgrades and the work being completed in occupied buildings, envelope upgrades were more costly than if performed in an empty building where power could be disconnected during certain parts of the upgrade.

Permitting and Testing Requirements: As mentioned above, choosing the right team members is crucial for maintaining project timelines and making adjustments during construction. This benefit is even more apparent when considering the complexities of testing and permitting the equipment for these projects. In some cases, sites received stop work orders so the DOB could re-review the documentation, resulting in additional costs and delays. Although these delays did not result in fines, they added significant costs due to construction delays and extended timelines. While some of the DOB issues may not have been related to the detail provided by the engineers, having clear and thorough documentation helped streamline the permitting process.

The permitting process could significantly impact project timelines, especially for projects using equipment manufactured overseas and not commonly seen by the DOB. In some cases, teams held multiple meetings to discuss and review submitted documentation with the DOB. Even with careful planning and detailed paperwork, additional adjustments were necessary when it came to testing and commissioning these projects. For instance, some sites had to build special pieces of equipment to simulate building load to properly test and verify system functionality, which proved to be both timely and costly. In other cases, equipment had to be relocated or downsized to ensure proper functionality while adhering to all code requirements.

- *Soft Cost Impacts:* Compared to more traditional retrofit projects, the EBC projects incurred additional soft costs for QA/QC (system testing) and transaction costs (permitting requirements).

Lessons Learned

Across the four projects in the EBC, there were several valuable lessons learned that project developers believe can be applied to similar future projects to maximize the potential for successful outcomes. Although each project faced its own unique challenges, several themes emerged that were common across multiple or all cases. These common themes included the importance of rigorous planning and attention to detail, open communication, and being open to new experiences and opportunities to learn:

Rigorous Planning and Attention to Detail. All four project developers noted the importance of meticulous planning and having the foresight to anticipate unexpected issues. Managing projects of this size and scope requires operating with a multidimensional focus. The ambitious goals of increasing energy efficiency by installing new products could only be achieved by successfully navigating through the complexities of interconnected technologies. These retrofits incorporated multiple novel technologies, such as window and façade upgrades in conjunction with HVAC upgrades, requiring developers to account for various aspects of construction planning. Furthermore, modifications to the buildings' energy output would affect not only the occupants but also the neighbors who relied on energy from the same source. Ultimately, achieving EBC goals and installing new products could not negatively impact those in adjacent settings. As such, key strategies to achieve the proper levels of planning included the following:

- *Acquire thorough knowledge* of existing and new equipment involved in the project
- *Ensure the workforce is adequately staffed* and equipped with the right resources to succeed
- *Understand that issues will inevitably arise* and be prepared to pivot with a contingency plan

Pre-construction meetings with relevant stakeholders were crucial to ensuring that all parties understood the scope of the project and could help mitigate delays. These meetings facilitated a thorough knowledge of new equipment and helped to ensure an adequate workforce by identifying a range of project needs and possible outcomes early, ultimately limiting unforeseen issues.

- *Soft Cost Impacts:* Project developers believed the increased time spent during the project design paid dividends, leading to more successful project execution.

Open Communication. Another valuable lesson learned was the importance of transparent, clear, and open communication. All four project developers mentioned, in some form or another, that open dialogue helped facilitate coordination among the workforce and between the team and the tenants affected by construction. Consistent dialogue among the team ensured that all members shared an understanding of the project goals and helped identify any knowledge gaps and potential solutions early in the process. When working with new equipment or innovative approaches, it was essential that workers were well informed and given proper guidance on matters pertaining to the installation practices and the specifications of technologies, particularly with the high standards and limited market knowledge. Coordination and understanding between the project developer and manufacturers helped to prevent unexpected overpricing, which could arise when dealing with technology that was unfamiliar to the developer. Equally important to team cohesion was having tenants' buy-in and making them feel heard and valued. Tenants were more likely to cooperate when included in the process and kept well informed. Since the tenants were the ones whose lives were disrupted, it was paramount to minimize their discomfort and take every precaution to ensure their safety from any potential hazards or dangers inherent in projects of this magnitude.

- *Soft Cost Impacts:* Project developers believed that the additional time interfacing with tenants and other stakeholders on the project to generate buy-in (which increased marketing and customer acquisition costs) was critical to project success.

Remaining Open to New Experiences and Opportunities to Learn. Project developers, specifically those on the Hines and ESRT projects, noted that a willingness to learn from experts on matters that are novel is likely to benefit current and future projects. Each project is a chance to learn from mistakes and to ensure that best practices are applied to future endeavors. For instance, the Hines project required coordination with foreign manufacturers, so team members were sent to Sweden to observe installation techniques of new heating technology. This experience provided the team members with training and hands-on experience with new methods and helped improve planning and execution. The ESRT project developer believed that initial projects could serve as a template for implementing upgrades at historic landmarks and buildings. Ultimately, embracing new challenges in different contexts facilitated growth and the capacities of all members of the workforce, including the project developer.

- *Soft Cost Impacts:* The increase in experience was generally relevant across all types of project soft costs, as it could lead to process efficiencies for similar work in the future.

Soft Cost Learnings

Through the case studies, the Market Evaluation team identified several tie-ins to the broader EESC market study. While the tie-ins could not be independently tested through the case studies, key themes emerged through the interviews that mirror trends seen in the broader EESC work:

Influence of Complexity on Design Costs and Installation Labor. The EESC study found that projects with more complex scope have a higher share of soft costs for project design and installation labor. This trend was observed for all four EBC projects, which had highly complex scopes that led to design and installation costs exceeding those for other types of retrofit projects. While the data available did not allow for a detailed view of project soft costs, the interviews with project developers indicated that they spent a significant amount of time on these types of costs.

Importance of Buy-In from Multiple Parties on Project Signing. All four EBC projects were very large retrofit projects, which required buy-in from multiple parties, both internal (building owner, senior executives, etc.) and external (city offices, permitting departments, etc.). This level of buy-in required the project developer to do extensive work upfront to present the scope of work and various mitigation plans for any impacts to tenants. While project signing can be a relatively minor cost for many other types of projects, the size and the advanced technologies used in EBC projects made the process costly.

Importance of Training for Both Subcontractors and Building Managers. Given the advanced nature of the ECMs included in the EBC project scopes, there is a smaller pool of subcontractors capable of installing these types of ECMs, as well as building managers and maintenance staff able to operate and maintain them. This required additional types of training that may not have been needed in other cases, leading to higher project soft costs. A similar trend was observed in the EESC study, where more advanced project types (i.e., commercial HVAC, multifamily air source heat pump retrofit, commercial building controls) had higher training needs.

Financing as a Driver of Project Timeline and Overhead. As noted in the *Project Cost* Drivers section, project financing can significantly impact project timelines and can increase the overhead for a project due to contractors waiting for work to begin. While this was not quantified in the EESC study, contractors surveyed in the EESC study noted that this was an important factor for commercial projects.

Case Study: Empire State Building

This section presents a case study on the ESRT project that is part of NYSERDA's EBC, a public-private partnership between NYSERDA and leading commercial and multifamily real estate owners that is elevating new design approaches for low-carbon retrofits in New York's tallest buildings. ESRT focuses on energy reduction and resiliency through data-based engineering using technologies that generate an economic return. ESRT invests in more efficient and effective equipment replacement at the end of useful life and in reuse and retrocommissioning for existing equipment.

This case study, along with the other three phase 1 Empire Building Challenge projects, is intended to expand upon the Energy Efficiency and Electrification Soft Costs market evaluations completed by NYSERDA in 2019, 2021, and 2024. These case studies take a deeper dive into the costs behind comprehensive retrofit projects–projects that are critical to reaching the state's energy reduction goals.

Project Background and Scope

In 2020, ESRT began working closely with NYSERDA to scope this project and create a technical, economic case for advanced energy efficiency upgrades in large buildings. Through this process, the project developer learned that **an educated workforce (particularly engineers) is key to successfully developing advanced energy efficiency projects**. Most importantly, **the completion of this work inside a historic building led to unique challenges and lessons that needed to be addressed for successful project completion**. These findings have not only benefited ESRT but are common discoveries when considering projects of this magnitude and their soft costs.

The ESRT project is a collection of pilot projects focusing on three aspects: (1) retrofitting building floors as tenants turnover, (2) electrification of certain space conditioning loads, and (3) waste heat recovery. Most importantly, the EBC helped to fund the development of a building-wide thermal network, which ESRT described as a "piece of the program to get the building to net-zero [emissions]… of which we need interventions on many levels to make it possible." This case study primarily focuses on the building management system (BMS) control upgrades, specifically to meet the ASHRAE guideline 36 BMS standard, a best-in-class HVAC controls system standard. In addition to these measures, this case study also offers insight into energy recovery and building electrification. Though this scope is unique to ESRT, these are measures that can and have benefited a number of buildings and businesses across the state. Interestingly, the project developer called these upgrades "[an] enhanced version of a standard [Building Management System - BMS] offering… which would not typically qualify for funding [from a utility and/or NYSERDA program]." ESRT said that without the EBC funding, the developer would have defaulted to a more standard BMS installation.

In an effort to upgrade and reduce the carbon emissions of one of the most famous buildings in Manhattan, ESRT has implemented a number of ECMs at the Empire State Building, as shown in Table 2.

Table 2. Energy Conservation Measures Installed

Related System	ECM	Work Package
Heat Recovery	First Floor Lobby System Optimization	2
Cooling	Central Cooling Plant Optimization	1
Heating and Cooling	Retail Loop Upgrades and Controls	1
Heating	Steam system Startup Optimization and Upgrades	3
Ventilation	Pilot Energy Recovery Ventilators and Damper Upgrades	4
Heating	Steam System Phase-Out and Electrification	4

ESRT focused on upgrading the heating and cooling systems since they use the most energy in the building. One of this project's first upgrades was to replace steam heating coils in the Air Handling Units (AHUs) with hydronic heating coils. These new coils are supplied by a combination of air source heat pumps and water source heat pumps that recover waste heat from both the condenser water and the steam condensate lines in the building. Modulating valves were installed on a number of components in the central cooling plant in order to modulate system flow and increase pump efficiency. As these valves are installed, the central cooling plant is also being reconfigured to increase the efficiency of the site's chillers. This reconfiguration includes the installation of a new 250-ton heat exchanger, which significantly reduces the energy required to meet the building load through the cooling season.

The site also has retail spaces that have benefited from these upgrades. Before this project, retail spaces had no space heating equipment. As a result, there was a significant heating load from tenants installing and using electric resistance heaters. The installation of a three-way valve allows the site to independently control the retail space condenser water temperatures, allowing it to operate at a higher temperature than the rest of the condenser water loop and enabling the tenant heat pumps to operate in heating mode. The project developer also installed modulating valves on the steam system and shifted from a medium- to low-pressure system to increase efficiency. These, along with the automated startup procedure. will greatly benefit the heating system.

The final component of this efficiency upgrade project involves heat recovery, leakage reduction, and electrification of the steam system. Replacing the outdoor fans and the leaking dampers will reduce the amount of waste heat that is lost to the environment. The new heat recovery unit, exhaust fans, and exhaust air louver will allow the site to capture more waste heat and utilize it for preheating, further reducing energy consumption.

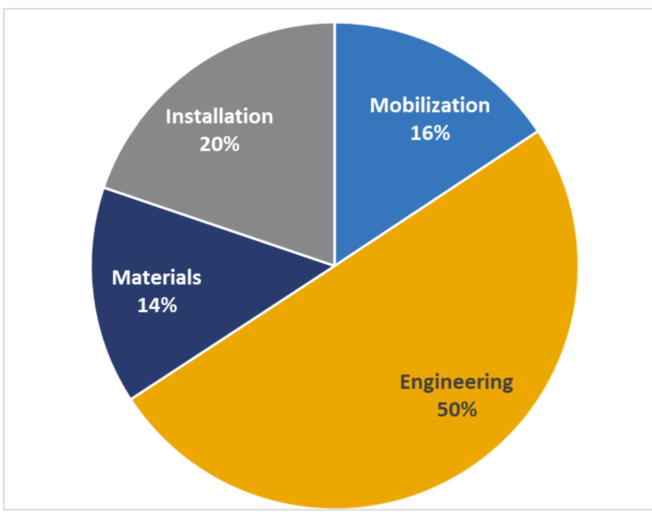
Design Considerations

The project developer needed to overcome some unique challenges to get these upgrades implemented in the Empire State Building. Since it is one of the most recognizable and historic buildings in New York State, ESRT needed to ensure that these upgrades aligned with the rules of the New York City Landmarks Preservation Commission. Specifically, ESRT needed to follow the Landmarks Law, which allows the Commission to act as a stakeholder in the work on any historically significant buildings in New York City that represent the city's cultural, social, economic, political, and architectural history. This was mainly a point of influence in the design of the First Floor Lobby Optimization ECM, where the project developer needed to preserve the artistic history of the building throughout the upgrades. While this required including additional stakeholders and reviews in the planning process, the project developer felt that it did not hinder the project costs or timeline because of the inclusion of these stakeholders early in the process.

Project Cost Drivers

To conduct a deeper analysis of select project costs, Cadmus analyzed invoices for completion of the ”Package 4” components (see Table 2 for specifics), so details from other Packages are not included in the cost analysis. The total for the work covered in these invoices was approximately $4,148,000 – this may not represent the full installed cost but is the sum of what was provided to Cadmus. These costs fall into four general categories: (1) mobilization (i.e., planning, general conditioning, overhead, and profit), 2) engineering (i.e., structural, architectural, mechanical, and electrical engineering designs and drawing), 3) materials, and 4) installation, as shown in Figure 1. Cadmus used the cost buckets defined in these invoices to group like costs together. While these cost categories do not exactly match the cost categories used in NYSERDA’s overarching EESC studies, bucket 1 matches most closely to Marketing & Customer Acquisition and Recruiting & Hiring, bucket 2 matches most closely to Project Design and Development and QA/QC, and bucket 4 matches to Installation. Bucket 3 (materials) was not counted as a soft cost in the EESC studies but rather as a hard cost.

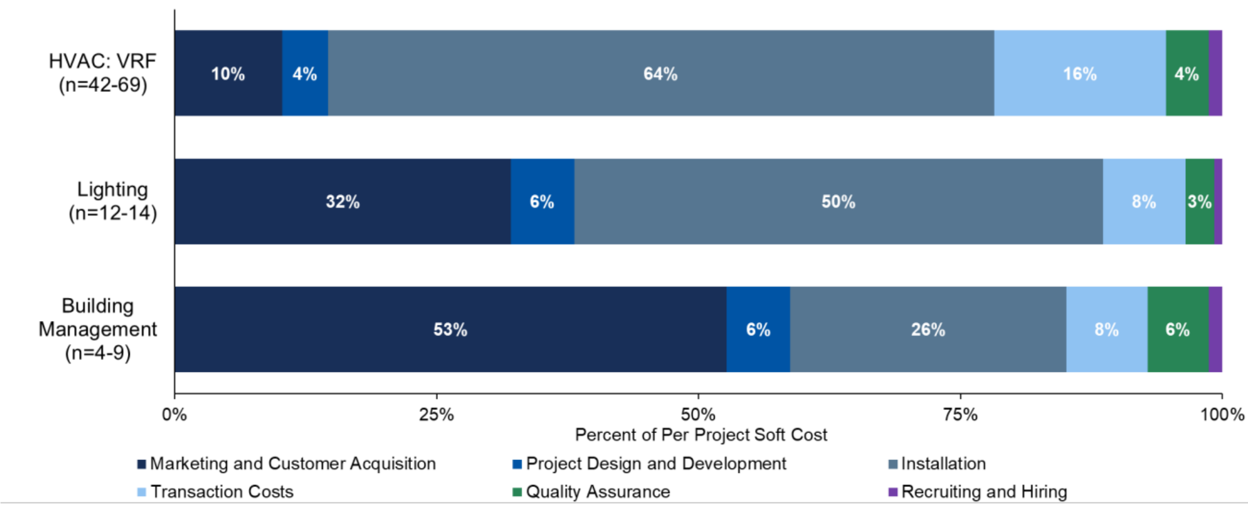
Figure 1. Invoice Cost Decomposition



The project’s engineering design work was roughly half of the total project cost and the costliest of these categories. This is expected given the highly advanced and technical nature of the work completed through the EBC, as well as the additional care and design detail needed for a historic building like the Empire State Building. Project installation was the next most significant cost. Installation included construction, labor, and cleanup of the site and made up about 20% of the project cost. The remaining 30% of the project cost was roughly an even distribution between mobilization and materials. Mobilization, which includes planning, general conditioning, overhead, and profit, accounted for roughly 16% of the cost of the project. The materials themselves, including HVAC equipment, scaffolding for construction, and tax, are about 14% of the total project cost.

While not able to be mapped exactly to the same categories, these percentage results differed somewhat from results found in the 2024 EESC study for the Commercial sector (results shown in Figure 2). The ESRT project is most closely related to building management and HVAC: Variable Refrigerant Flow (VRF) projects, although quite different in size and scope. In the 2024 EESC study, installation costs were generally the largest share of Commercial sector costs, followed by Marketing & Customer Acquisition and then Transaction costs. This contrasts with the ESRT project, where Project Design & Development had the largest share of costs, with installation labor at only approximately 20%. Several factors likely contributed to this difference, including the highly complex nature of the ESRT project (both the HVAC work and controls system), the limiting factors of working in a historic building, and the hypothetical nature of the projects measure in the EESC study (compared to the real data from the ESRT project).

Figure 2. Soft Cost Estimate Breakdown for Commercial Prototypical Projects



Note: Numbers may not add to 100% due to rounding.

According to the ESRT project developer, several factors drove the costs for the EBC-funded projects at the Empire State Building. One of the core drivers of the cost was the fact that the scope of the project was highly advanced, resulting in limited contractor experience. Thus, not knowing how to effectively install and program the BMS to meet ASHRAE guideline 36 standards resulted in several challenges:

- **Internal staff**: Prior to going out to bid, ESRT spent additional time to "get our staff up to speed on this type of work" due to the novel nature of the installed system. This had minor impacts on project installation and commissioning, with additional back-and-forth between the engineers and contractors to get the system up and running.
- **Contractors**: It was difficult to find contractors with the needed experience for this project. As the project developer said, "Not a lot of contractors have worked with [the ASHRAE guideline 36 standards]. The control sequences are critical to making it work, and this has been the hardest piece of the puzzle." The project developer noted that additional work was needed to correct

installations that were not done properly, adding cost to the project. Without a pool of skilled labor, the project developer found it challenging to find the right partner to support this work and ultimately ended up selecting "a better engineering firm" that could handle "more complex, more innovative work." While this engineering firm was more expensive than others in the market, ESRT felt it was necessary for this specific project to succeed.

Another key factor influencing cost and all aspects of the project design was the fact that the building was still occupied during the work. The project developer said working in an occupied building "is always challenging [because you have to] mitigate risks differently than if it was unoccupied [or new construction]." For example, noise levels must be kept to a certain level due to other tenants in the building, meaning that some work must occur outside the typical workday, leading to increased labor costs from overtime.

Finally, the project developer noted that the specialized components needed for this project were not as readily available as more commonly used products were, leading to increased ordering lead times. This slowed down the project installation and resulted in increased downtime compared to a project with less specialized equipment. All of the above factors contributed to the project cost allocation being heavily weighted towards engineering costs, whereas simpler projects will be weighted more towards installation costs.

Lessons Learned

Through their experience in the EBC, the project developer noted several items that could help to improve future projects of similar scope:

- When approving projects that introduce new or rare measures to the market, ensure there are **adequate workforce development resources for the market**, including for both client- and contractor-side stakeholders. Specifically, this was needed with the building management system since it was a highly advanced standard with little existing market knowledge. This will help to reduce delays across all project phases and decrease the likelihood of contractors overpricing due to a lack of knowledge with the project type. Coordination among the project developer, the NYSERDA Workforce Development team, and the manufacturers for technologies included in a given project early in the project development phase will help identify market knowledge gaps and potential solutions.
- ESRT believed that this project could **serve as a precedent for the upgrades that can be implemented at historic landmarks**. The project not only demonstrated what measures can be most beneficial and how to effectively install them in historic buildings, but it also provided valuable experience to the market for this type of work.
- Finally, the building operators discovered that the **upgrades enabled them to quickly lower the building's overall power demand** from the grid. This was not something quantified during project planning and design, but upon implementation, the site was able to realize the improvement. That could reveal additional cost savings for owners and tenants in similar buildings and should be considered earlier in the project planning to fully grasp the benefits.

Case Study: The Heritage

This section presents a case study on the L+M Development Partners project ("The Heritage") that is part of NYSERDA's Empire Building Challenge. This case study, along with the other three phase 1 Empire Building Challenge projects, is intended to expand upon the Energy Efficiency and Electrification Soft Costs market evaluations completed by NYSERDA in 2019, 2021, and 2024. These case studies take a deeper dive into the costs behind comprehensive retrofit projects–projects, which are critical to reaching the state's energy reduction goals.

Project Background and Scope

L+M Development partners (the project developer) have worked with NYSERDA since 2022 to scope a project to help The Heritage achieve carbon neutrality. The Heritage is a three-building mixed-use development with both residential units and commercial spaces. It comprises two 34-story high-rise buildings at 1285 and 1309 Fifth Avenue, New York, and one 11-story building at 1660 Madison Avenue that includes 600 mixed-income residential units with four stories of community facilities and commercial spaces. The buildings, built in 1975, were prime candidates for a carbon-neutral deep retrofit. The buildings had poor insulation, costly and inefficient baseboard electric resistance heat, and central natural gas-fired domestic hot water plants. The project developer and NYSERDA scoped this project to reduce these buildings' loads through major envelope upgrades, as well as decentralized high-efficiency heat pump systems with centralized controls able to modify building energy usage to respond to grid conditions.

As these were occupied buildings, the project developer took an innovative approach to limit the impact of the façade construction on residents – putting up temporary walls in units when façade replacement work was happening. This allowed residents to stay in their units during construction, removing the need to move to a temporary unit and easing the impacts of living in a building under construction. While there were some minor complaints from tenants, the overall process was a success.

Table 3 shows the energy conservation measures the project developer incorporated to achieve the desired load reduction.

Table 3. Energy Conservation Measures Installed

Related System	Energy Conservation Measure	Property Performed
Envelope	Exterior Insulation & High-Performance Windows Installation	All three buildings
Heating & Cooling	Packaged Terminal Heat Pump Installation	1660 Madison Ave
Heating	Domestic Hot Water Electrification	1660 Madison Ave
Heating & Cooling	Centralized Controls Upgrade	1660 Madison Ave
Heating & Cooling	Variable Refrigerant Flow (VRF) System Installation (lobbies and community spaces only)	1285 & 1309 Fifth Ave
Heating	Laundry Dryer Electrification	1660 Madison Ave
Ventilation	Central Ventilation Upgrade	1660 Madison Ave

Building Envelope. The largest and most notable factor the project developer considered was the outdated and ineffective insulation for all three buildings, which allowed large amounts of heating and cooling to be lost to the environment. The envelope upgrades not only allowed the buildings to significantly improve the thermal barrier, but it also allowed them to undertake additional measures to their full potential and no longer exhaust conditioned air into the environment. Since the existing windows were recently upgraded at the Fifth Avenue buildings, the project developer installed three to five inches of insulation for over-cladding, an exterior insulation and finish system on floors two through 35, and an insulated metal panel system on the ground floor. The third building on Madison Avenue received double-pane insulated glass for the commercial spaces on floors one through four, and the rest of the building received Dextall's panelized units, which integrated the new windows into the façade. These Dextall panels not only increased the insulation for the building walls and windows but also provided openings for the packaged terminal heat pumps, created pathways to run electrical service throughout the building, and set up drainage for the installed heat pumps. Upgrades also included replacing the building roof and upgrading the insulation to R-30.

Electrification of Gas Systems. The Madison Avenue building not only received efficiency measures but also electrified two systems to reduce the site's natural gas consumption, including natural gas-fired domestic hot water heaters and laundry dryers. In 2025, the project developer will replace the gas-fired water heaters with centralized air-to-water heat pumps, which extract heat from the outside air and transfer it to water to efficiently heat or cool the building using significantly less energy consumption and without fossil fuels. The building also had a common laundry room that used gas-fired dryers, which the project developer replaced with individual, in-unit electric washer and dryer sets for each residential unit. Electric dryers also typically need less maintenance and also eliminate the risk of gas leaks. Removing the gas-fired dryers also allowed the building to repurpose the old, centralized laundry room.

Efficiency and Controls Upgrade. The Madison Avenue building also received a number of measures focused on efficiency and controls. The original electric baseboard for heating consumed a large amount of electricity. The project developer replaced it with a much more efficient heat pump system, including a cold climate perimeter terminal heat pump in each of the bedrooms and living rooms of four- and five-bedroom residential units. The upgrades included sizing the systems to meet the needs of the room type and size and incorporating local and global controls, which were integrated into the building's new central management system. A significant upgrade, the central management system allows building managers to program global setback schedules for unoccupied periods, view and set temperatures for the different spaces, and track data to help find additional ways to reduce load. The building also upgraded the central ventilation system by cleaning the ducts and sealing ventilation shafts and will install energy recovery units and airflow regulator dampers where feasible (projected for 2025). This will not only reduce energy consumption, but it will improve the air quality and quality of life for the tenants.

VRF Systems. The project developer installed VRF systems at both Fifth Avenue buildings to serve the lobbies and community spaces, which provided several benefits to the building. Not only will the systems increase efficiency compared to the air-cooled split system, but they will require less maintenance. Removing the old systems also allowed the buildings to reclaim space that was otherwise occupied with equipment.

Design Considerations

The project developer had to take into account a number of factors when planning this project to ensure successful implementation.

Working in Occupied Buildings. One of the key challenges the project developer had to address was how to efficiently complete this work in an occupied building. Since this project was a retrofit, the construction had to be done in phases so as not to significantly displace their tenants. A unique measure that was used during the façade work was the installation of a temporary wall in each tenant's unit when work was being completed outside. The project developer noted that this was a novel approach to conducting work in occupied units and felt it was mostly successful. Some minor complaints did arise from tenants, specifically during the summer when the temporary walls somewhat restricted air conditioning circulation to these units. However, this approach allowed tenants to stay in their own unit when work was completed rather than moving to a temporary apartment. Clear communication with tenants was crucial to the success of this project.

Working in Affordable Housing Buildings. A secondary but related challenge is that some of the units in these buildings are not at market rate. Given that the project developer is focused on positive social impact, they sought to "improve the quality of life for building residents" after work is completed. While this should be a factor in any efficiency upgrades, it meant that the project developer had to more clearly articulate the energy and non-energy benefits of the project than if the buildings were market rate.

Working in New York City. Projects completed in New York City face additional obstacles compared to projects in other jurisdictions. This includes working with various city agencies that serve as stakeholders that must be brought into the process to receive the needed approvals. The most impactful agency for this project was the DOB, which has the ability to shut down work to assess project impacts and ensure there are sufficient tenant protections. Due to a tenant complaint arising from the project work, the DOB shut down work for six weeks for an investigation. Given the novel nature of this project, the DOB was not sufficiently familiar with the retrofit approach and needed several meetings and deliveries of project documentation to get the issue resolved. This did not result in any scope changes or project cost increases due to the thorough documentation and planning by the project development team. For example, the project developer's agreements with key contractors stipulated that these types of work shutdowns would not create additional expenses – the work stoppage just resulted in a timeline delay. The project developer was able to do this because of strong and longstanding relationships with these contractors. Overall, the project developer felt that additional pre-work with the DOB to help them better understand the project could have helped to reduce some of the work stoppage.

Equipment Sourcing. The project developer sourced some custom-made equipment from overseas, which required highly precise measurements to avoid delays and cost increases due to misfitting components. The component most impacted by this was the façade upgrade, which required a custom-measured segment for each unit. The project developer had a rigorous measurement plan in place that resulted in only minor, on-site adjustments needed for the façade components.

Project Cost Drivers

Given the scope of work involved with these upgrades, this project required several specialized contractors to ensure that it was completed to the highest quality. As stated in the project plan, the expected cost to complete these measures was just over $18.4M, and an analysis of the invoices confirmed contractors charged just under $15.8M, or approximately 85% of the planned cost. The invoiced amounts do not sum to the expected cost due to natural variations in scope and because some work is still in progress with a scheduled completion date in 2025. Table 4 shows the costs for all ECMs evaluated as part of this case study, including the expected cost, the actual cost, and the amount of any change orders.

Table 4. Energy Cconservation Measure Costs Analyzed

Energy Conservation Measure	Expected Cost	Invoiced Amount	Cost of Change Orders (% of Invoiced)
Exterior Insulation & High-Performance Windows Installation	$13,732,034	$11,570,672	$220,172 (2%)
Packaged Terminal Heat Pump Installation	$1,896,734	$1,733,250	$0
Domestic Hot Water Electrification[a]	$1,523,750	$900,000	$0
Centralized Controls Upgrade[a]	$667,920	$400,000	$90,000 (23%)
Variable Refrigerant Flow (VRF) System Installation	$201,250	Not invoiced separately	-
Laundry Dryer Electrification	$171,000	Not invoiced separately – done upon unit turnover	-
Central Ventilation Upgrade	$232,300	Work pending as of Feb 2025	-
Miscellaneous[c]	$710,847[d]	$1,103,707	$392,860 (36%)
Total	**$18,424,988**	**$15,707,629**	**$703,032 (5%)**

[a] These measures are scheduled for completion in 2025.
[b] The invoices reviewed by Cadmus did not have any costs for these ECMs.
[c] This includes costs such as garage waterproofing and repairs, painting, cleaning, and other costs listed as miscellaneous.
[d] This cost was not specifically outlined in the "Expected Costs" breakdown, so Cadmus made this assumption based on the invoices.

Exterior Insulation and High-Performance Window Installation. The largest and most planning-intensive measure in this project was the envelope upgrades. This was the only measure involved that covered all three of the buildings at this site. The project developer originally scoped this ECM at just under $13.7M, and direct costs for paid invoices came in at just under $11.6M, approximately 85% of the planned cost. There was approximately $220k (2% of the invoiced cost for this ECM) in change orders associated with this work, including the removal and replacement of broken items, testing equipment, miscellaneous changes to scope, and other smaller items that arose throughout the installation phase.

Packaged Terminal Heat Pump Installation (PTHP). After the envelope upgrades discussed previously, this measure was the next most costly, both in terms of preparation and financial cost. The site was expecting to pay roughly $1.9M for this upgrade, and through contractor invoices, it was determined that the total cost came to just over $1.7M. Thanks to careful planning and preparation, there were no Change Orders that were found to be a result of the PTHP upgrade. Being the second most costly measure, this work accounted for about 10% of the total expected project cost.

Domestic Hot Water Electrification. This measure is one of the two electrification measures involved in these upgrades. Accounting for about 5% of the total expected project cost, this upgrade will allow the site to reduce its dependance on Natural Gas and heat water much more efficiently using electricity. There was an additional charge by this contractor that was not included in the cost of the measure installation. This included a 2-year preventative maintenance plan, and this additional $30,000 makes this measure go from just under 5%, to just over 5% of the total project cost. The measure installation is planned for completion in 2025, after which the remainder of the measure cost will be billed.

Central Controls Upgrade. Although this measure does not come at a significant cost for the entire project, these control upgrades are an integral part of bringing the site to the target efficiency level of this project. This measure, accounting for just over 1.5% of the total expected project cost, allows the site to monitor and control the spaces with much greater granularity. During the installation and interconnection of this system, it was determined that controls would be incorporated into the system. This $90,000 change order brought the total for this measure up to just over 2% of the total project cost.

Variable Refrigerant Flow Installation. After examination of the provided invoices, it appears that this measure was completed by the project developer’s internal team, though some of the work completed by contractors may have prepared the site or assisted the internal team with completing this installation. Though these costs were not clearly stated on invoices, it is expected that the roughly $200,000, or 1% of the total expected project cost, that was planned for these upgrades was covered by the internal team and partially accounted for on contractor invoices.

Laundry Dryer Electrification. The second of the two electrification measures is the electrification and reclamation of the laundry room (i.e., the prior communal laundry room can now be repurposed or another use because of the shift to in-unit machines) at 1660 Madison Ave. Though this was another measure that Cadmus was not able to tie directly to the invoices provided by the contractors, the expected cost of this upgrade was heavily influenced by the time and effort it takes to plan and install this equipment into each room. The total cost accounting for just less than 1% of the total expected cost, this measure provided a significant quality of life upgrade to the tenants.

Central Ventilation Upgrades. The final measure to be discussed accounted for just over 1% of the total project cost. This measure was also not explicitly stated on any of the provided invoices; however, it is anticipated that this upgrade allows some of these other measures to operate with the highest efficiency and quality.

Miscellaneous. There were some additional costs discovered during the invoice review that were not tied directly to any of the measures mentioned above, such as garage waterproofing and repairs, painting, and cleaning, among others. These costs totaled just over $1M and accounted for around 7% of the total invoiced amount. The most significant charge in this category was focused on garage repairs. As this did not seem to tie directly to any of these measures, this work included on this invoice was categorized as miscellaneous.

Connections to Soft Cost Study. The invoices provided for The Heritage project did not have the level of detail needed to group costs into categories (i.e., project design, project installation, materials, etc.). Instead, the invoices costs were grouped mainly by equipment type, which included both soft and hard costs. However, there are two clear qualitative connections between this project and the 2024 EESC study results for the Multifamily and Commercial sectors.

First, the project developer noted the increased burden of completing projects in New York City compared to other areas due to the additional stakeholders that need to be engaged. This is similar to the findings for the Commercial sector, where contractors working downstate (New York City and surrounding counties) had higher permitting costs than contractors working upstate. While there is no way for the project developer to avoid these costs, they noted the importance of relationships with government officials and early communication to reduce delays from these extra steps.

Second, the costs associated with installing the new systems and training employees proved to be a significant cost for this project, as noted through the project developer interviews. This aligns with findings from the more advanced prototypical projects from the 2024 EESC study, such as the Commercial HVAC: VRF project, where installation and transaction (including training) costs represented 64% and 16%, respectively, of total project soft costs.

Lessons Learned

Throughout the course of this project, the project developer noted multiple ways in which meticulous planning led to effective project execution, as discussed below. Given the innovative way the developer limited the impact of the façade retrofit work on tenants (i.e., setting up a temporary wall to keep tenants in their apartments during construction), these lessons were critical to success:

- Engineering and planning were the biggest factors affecting project costs and timelines. With some of the components being manufactured overseas, measuring and planning were crucial to making sure there were no major complications during the installation. Having a rigorous planning process in place ensured that the parts did not need to be reordered, avoiding both material cost increases and timeline delays. Additionally, avoiding these costs and delays likely resulted in a more efficient project – fewer scope revisions and less lost staff time.
- Community relations were also key to project success. The project developer noted that the "community relations team have been instrumental to getting the residents' cooperation." With this work being done in occupied buildings, it was important that all tenant spaces remained safe and dry throughout the construction. This type of work is very intrusive to the tenant's space, but the project team maintained clear and consistent communication with the tenants. Thanks to these beneficial community relations, tenants were cooperative, and all work was completed safely and securely.

- While it did not impact cost, the six-week DOB Stop Work Order to assess project scope and impacts on residents led to a timeline delay. As noted above, the investigation did not result in any violations and the project developer was allowed to continue with the project as scoped. By thoroughly planning for and documenting the impact of the project on residents and the mitigation steps early in the project, the project developer was able to avoid any issues with the DOB investigation. In future projects, the project developer noted that “holding a pre-construction meeting with the DOB to ensure they have a thorough understanding of the scope and get their input upfront” could help to reduce these types of delays.

Case Study: 345 Hudson Street

This section presents a case study on the Hines and Hudson Square Properties project (345 Hudson Street) that is part of NYSERDA's Empire Building Challenge. This case study, along with the other three Phase 1 Empire Building Challenge projects, expands upon the Energy Efficiency and Electrification Soft Costs market evaluations completed by NYSERDA in 2019, 2021, and 2024. The Empire Building Challenge case studies provide in-depth analyses of the factors influencing hard and soft costs for comprehensive retrofit projects, which are critical to reaching the state's energy reduction goals.

Since the 345 Hudson Street project was under construction during the drafting of this case study, final cost data was not available. This section highlights findings from the interviews with the project developer.

Project Background and Scope

As part of the NYSERDA Empire Building Challenge, Hines and Hudson Square Properties have implemented their carbon neutrality roadmap for their 856,000-square-foot property at 345 Hudson Street. This project has transitioned the building's primary heating and hot water fuel source from fossil fuels to electricity, while also reducing energy use by improving the air handling and heat rejection systems. The project incorporated a number of ECMs, including the following:

- **Floor-by-floor implementation of Water Source Heat Pumps (WSHPs):** These WSHPs, along with rooftop air-source heat pumps (ASHPs) and adiabatic fluid coolers, serve as the new heating and cooling system for the building. They replaced the existing gas-fired boilers and steam radiators that ran along the building perimeter.
- **Interconnection for Thermal Energy Network:** 345 Hudson's heating system was connected to the adjacent property at 555 Greenwich Street (which uses a ground-source heat pump system), allowing heat to be shared between the buildings via a glycol-water loop (a typical fluid type used for these systems).
- **Installation of a Central Adiabatic Fluid Cooler and Air Source Heat Pumps to Control Ambient Loop Temperature:** This involved converting the existing closed loop condenser water system into an adiabatic loop feeding the floor by floor water source heat pumps.
- **Replacement of the Outdoor Air system with a new, Direct Outside Air Handling Unit (DOAHU):** This unit improves indoor air quality by providing 100% outdoor air to occupants rather than recycling conditioned air. It also reduces energy use with an energy recovery ventilator (ERV), so exhaust air tempers the incoming air in heating and cooling seasons.

Design Considerations

The project developer considered many factors in planning this project to ensure successful implementation. The building needed to incorporate leading edge energy systems cost-effectively. While adding newer systems can add many types of soft costs to the project, including design, installation, and training costs, the project developer felt these were worth the added costs for the end benefits. This would translate to improved tenant comfort and profitability for landlords. But these new approaches also improved tenant health and well-being while keeping construction disruption to a minimum.

One of the project developers' primary considerations for work was that the tenants could remain in place and the building stayed operational throughout the construction. Scheduling retrofits to coincide with the expiration of tenants' leases helped to minimize disruption to tenants and building operations. To achieve this, the project developer had to determine the best control scheme for the new heat recovery unit without shutting the building down. The project developer said that if the work had not been able to be completed when tenant leases expired (i.e., needing to relocate tenants temporarily), it would have been a much more complex project.

Another design factor came from changes to EPA and NYS regulations on permissible refrigerants. Due to New York phasing out the use of HFCs, common refrigerant types, like R-410A, are no longer allowable due to their high GWP.[1] New restrictions started on January 1st, 2025, so the market will need to adjust to an alternative lower GWP refrigerants, many of which are A2Ls. While the WSHP installed in this project still used R-410A refrigerant because it was ordered before the phase-out period, the project team utilized R-454B in the rooftop air source heat pumps which is a lower GWP A2L. This required the team to stay on the forefront of ongoing changes to local, state and federal regulations and strategize equipment purchases accordingly to ensure the design would meet local regulations and requirements. The inclusion of this technology (a first for this project developer) impacted the project costs, adding more time to the planning/design phase.

Additionally, the available space was another major consideration. The team needed to ensure that all equipment spatial clearances were met. The property needed adequate space not only for the current equipment but also for future expansion to accommodate new clients and upgrades. While this approach is common for these types of projects, it depends on the specific type of equipment used, which can be complicated when working with new, innovative equipment. When working with known

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[1] The U.S. EPA has mandated the phasedown of HFCs through The American Innovation and Manufacturing Act of 2020 (https://www.epa.gov/climate-hfcs-reduction/frequent-questions-phasedown-hydrofluorocarbons#overview). Starting as soon as January 1, 2025, restrictions in Title 40 CFR Section 84.54 (c)(3) (https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-84/subpart-B/section-84.54) will take effect on the use of higher-GWP HFCs in new 1) aerosols, 2) foams, and 3) refrigeration, air conditioning, and heat pump equipment. New York State also began prohibitions on HFCs in 2025 under the Department of Environmental Conservation's (NYS DEC) Part 494 (https://dec.ny.gov/sites/default/files/2025-02/part%20494factsheet.pdf).

and commonly used equipment, certain maintenance routines or issues are expected. However, it can be difficult to predict what maintenance, or issues, will need to be managed when using new equipment, as well as how those adjustments or corrections will be made when they do arise.

Since the project developer chose to incorporate a new, highly efficient technology from an overseas manufacturer, the design and engineering of the installation became a major consideration. This equipment required meticulous attention to detail to ensure smooth assembly and installation, as it was shipped in components and assembled on site. To prepare, the project developer sent a few contractors to Sweden, where the equipment was manufactured, to meet the manufacturer and observe a system installation. This preparation helped to reduce, but not eliminate, the impact of including a new technology on project soft costs, primarily system design and installation.

Project Cost Drivers

The project developer said it took a couple of years to align all the stakeholders for a project of this magnitude, especially given the newness of the technology. However, once all stakeholders approved and were aware of the project plans, unexpected costs, such as additional design and installation costs, were within planned allowances and contingencies.[2] During this project, the project developer made three impactful decisions related to the complexities of working in an occupied building and contractor selection.

When completing projects of this size in older, occupied buildings there are a number of adjustments that must be made by the project developer during project planning that can impact project soft costs. In this project, the building was not designed for the modern systems being installed, so the team had to find an innovative solution so that the existing risers and ductwork would provide satisfactory conditions for the new system to properly operate. During construction, the project developer opted to upsize the piping for maximum flexibility for future tenants. Additionally, the work had to be completed in phases due to the building remaining occupied throughout construction, as noted above.

Another influential factor to the project’s cost and timeline came with the bidding and contractor selection process. For the project developer to be confident in their chosen contractor, they requested a few unique items in the contractor bids, including a trip overseas to Sweden to observe the new equipment being assembled and installed. Though it was included in the contractor bids, this was a costly and timely component of the work. Another unique request was to have the contractors come in early and scope the project in person. The project developer was aware of the level of detail that would be required for these upgrades and found it beneficial for the contractor to spend additional time familiarizing themselves with the site and equipment in order to minimize adjustments that would need to be made during construction.

[2] As of the delivery of this memo, the project was still in construction, so changes in cost may still occur.

Lessons Learned

As with any new technology or complex project, clear communication and planning were important for effective project execution. The project developer noted several lessons that were critical to success:

- **Attention to Detail and Planning**. The importance of meticulous planning and engineering was evident throughout this project. Thorough knowledge of the existing and new equipment functionality was vital when the team had to make on-the-fly decisions during construction. This is made more challenging when incorporating newer technologies without a large base of existing knowledge within the market.
- **Team Cohesion and Communication.** Having the right team members and a shared understanding of the project's goals was extremely beneficial. Anticipating complications and ensuring everyone followed the same plan were critical. Clear communication was critical not only for the installation but also for understanding the equipment and planning for future work.
- **Clear Designs and Paperwork for Permits.** Ensuring designs and paperwork were clear and understandable minimized the time spent on the permitting process. Many of the engineers lacked experience sizing a system like this, which led to more time spent on confirmations than a normal design, increasing the labor costs for design compared to a more traditional system. Though time-consuming, paying close attention to detail and putting together a clear and concise design can avoid corrections and unexpected delays with permitting, as this was also a new type of project for the Department of Buildings.
- **Gaining Experience.** Installing this equipment taught the team how to work more efficiently moving forward. The project developer is confident that the next phase of floor upgrades will be completed more cost-effectively than the initial phase given the experience and learnings from this project. Now that they are familiar with the equipment, the work is more like the types of projects they are accustomed to.
- **Creativity and Flexibility.** Given the new system piping design, the project developer had not finalized all aspects of how to complete final commissioning prior to construction. The project developer devised a creative solution to commission both hot water and chilled water service from the WSHP, even without chilled water infrastructure installed. Being creative and flexible with the ability to pivot and problem solve in real time is paramount to successful implementation.
- **Learning from Others.** Additionally, sending team members to Sweden to observe the installation of the new heat sharing technology provided valuable context for this project's construction. This training, combined with their hands-on experience, deepened their understanding of the equipment and will enable better planning and reducing on-the-fly decisions on future projects.

While many lessons have already been learned, this project is ongoing, with more insights expected. As of January 2025, the team has completed the on-floor work for the vacant floors. They are currently working on the central plant retrofit and expect to reach 50% completion of the rooftop plant in the second quarter of 2025. The full project is projected to close Q2 2026.

Case Study: Whitney Young Manor

This section presents a case study on the Paths Development (formerly Omni New York LLC) project that is part of the NYSERDA's Empire Building Challenge. The case study, along with the other three Phase 1 Empire Building Challenge projects, expands upon the energy efficiency and electrification soft costs market evaluations NYSERDA completed in 2019, 2021, and 2024. These case studies take a deeper dive into the hard and soft costs of these comprehensive retrofit projects, which are critical to reaching the state's energy reduction goals.

Since the Whitney Young Manor project was under construction during the drafting of this case study, final cost data was not available. This section highlights findings from the interviews with the project developer.

Project Background and Scope

NYSERDA launched the EBC to accelerate carbon-neutral retrofits across the state. As a leader in sustainability and energy efficiency, Paths Development (the project developer, which is inclusive of a broader team working on this project) developed a carbon neutrality roadmap for Whitney Young Manor, a two-building, twelve-story residential property in Yonkers, New York. Built in 1974, the Whitney Young Manor consists of 195 affordable housing units. As part of a significant property revitalization, Whitney Young Manor is undergoing a major $22 million renovation, with nearly $11 million allocated to the project's decarbonization effort to meet carbon neutrality by 2035. The project developer and NYSERDA began to scope this project in 2022 to have a holistic approach and phasing to make decarbonization technically and economically feasible.

This project incorporated several ECMs, including the electrification of space heating. Three ECMs were accepted for funding through the EBC to make progress toward carbon neutrality. Table 5 summarizes the installed ECMs and their associated costs, and the sections below describe the ECMs in greater detail. Given that this project was not complete when drafting this case study, cost data is from the original scope and could not be disaggregated into different cost categories. However, when possible, Cadmus noted how certain factors could contribute to project soft costs.

Table 5. ECMs in Whitney Young Manor Project and Original Projected Costs

ECM	Description	Projected Cost
1	**Envelope Upgrades**: 4-inch expanded polystyrene (EPS) exterior insulating finishing system (EIFS) except at balconies, reinforced at ground floor, new windows, new roof	$5,066,250
2	**Centralized ASHP System Installation,** including the wastewater heat recovery (WWHR) system	$5,498,750
3	**Property Ventilation System Overhaul:** Exhaust overhaul, ASHP, energy recovery unit (ERV), and dedicated outdoor air system (DOAS)	$416,750
Total ECM Renovation Costs		$10,981,750
Additional Rehabilitation Costs Beyond EBC Scope		$10,590,435
Total Rehabilitation Cost		**$21,572,185**

Envelope Upgrades: The project developer planned to revitalize and upgrade the building envelope to ensure that Whitney Young Manor is energy efficient and keeps occupants comfortable. This included installing four-inch EPS insulation and replacing windows, which will significantly improve the buildings' thermal performance and thus reduce heating and cooling requirements. According to the project developer, the window replacements are the most expensive part of the envelope upgrade due to the cost of the windows and the amount of area they cover on the façade. This upgrade also includes a roof rehabilitation that will support added insulation and the installation of new HVAC equipment.

Centralized Heat Pump System: Whitney Young Manor's existing heating and cooling system (electric resistance baseboard heating and window air conditioner sleeve units) was outdated and inefficient, so the project developer designed a centralized heat pump system to ensure that the system would be resilient and robust. The project developer notes that this distribution system brings heating and cooling into the units and is relatively simple and straightforward compared to other options they were considering. The central ASHP will be on the roof and connect to a hydronic system that will provide most of the hot water and assist in regulating the temperature of the building.

A SHARC wastewater energy recovery system[3] will extract heat from outgoing wastewater and transfer the heat to the hydronic loop. During this process, a separate below-grade heat pump will enhance this heat transfer while keeping the wastewater completely contained and isolated from other water loops. This heat recovery system will augment the central rooftop ASHP system, which will keep the temperature of the water in the hydronic loop between 70°F and 80°F.

Updating Property Ventilation System: The project developer plans to install ERVs and a DOAS to update Whitney Young Manor's ventilation system. The ERVs will capture and recover energy from exhaust air from kitchens and bathrooms, reducing overall energy consumption while helping regulate indoor temperatures more efficiently. The ERVs will create a stable and comfortable indoor environment by transferring heat and moisture between incoming and outgoing air streams. In addition, a DOAS will be installed to improve indoor air quality by supplying fresh, conditioned air independent from the building's heating and cooling system. This system ensures consistent intake of fresh outdoor air, reducing indoor pollutants and enhancing overall ventilation.

Additional Miscellaneous Building Improvements: During the implementation of ECMs, the project developer conducted general in-unit renovations outside the EBC's scope, such as kitchen renovations, renovating shared spaces, and a lobby expansion. The project developer also plans to support several electrical upgrades, including rewiring but does not expect these upgrades to necessitate new switchgear or transformers.

Design Considerations

The project developer had to consider several factors when planning this project to ensure its successful implementation.

[3] https://www.sharcenergy.com/

System Resiliency and Reliability: The project developer needed to ensure that residents would have heat, especially on the coldest of days. To do this, the project developer included components in the system that were robust (not likely to fail) and would not cause the system to completely shut down if they did malfunction. By minimizing failure points, the project developer safeguarded residents' access to heat and ensured that heating and cooling would be consistently delivered to the units. Failure points that the project developer could not guarantee avoiding needed to be easy to repair. For example, condensers often need specialized technicians, whereas a standard plumber can easily replace a hydronic line. By choosing equipment that can be repaired by a broader set of contractors and maintenance technicians, the project developer reduced the need for specialized training on new systems and ensured that future repair and maintenance would be easier. Reliable backups that can work at the lowest temperatures were also essential. To ensure redundancy, the project developer kept backup boilers that would coordinate with the other heating systems.

Working in Occupied Buildings: The two buildings that make up Whitney Young Manor were occupied during the property redevelopment. Given the building was occupied, the project developer had to be cognizant of hazardous materials, especially asbestos, to ensure tenant safety. This increased the cost of planning compared to working in a vacant building, as the project developer needed to draft plans for tenant impact mitigation and get these plans approved by the required agencies. Maintaining open and transparent communication with residents was crucial to fostering trust and minimizing disruptions to their daily lives. Because the renovation process inevitably affected tenants, securing their buy-in and conveying the benefits of these improvements was essential to the project.

Favoring Centralization Over Decentralization: The original plan for Whitney Young Manor was to install a decentralized system. However, this was revised during project design to a centralized system to minimize the failure points of individual equipment (i.e., having more technical equipment in a centralized location) and being able to incorporate other centralized elements, such as a WWHR system. Further, the project developer felt that they could get more cost-effective performance from a centralized system.

Project Cost Drivers

During the project, several complications arose that affected the project’s timeline and costs, including soft costs.

Financing and Interest Rates: One significant issue that the project developer faced was securing financing for the project. Although the approval process went relatively smoothly, due to changes in interest rates, the project's financing was delayed, ultimately causing a six-month delay and adding some soft costs to the project via the need to revise plans and schedules. As a result of this delay in funding, the construction team slated to renovate the project had a slow ramp-up. Despite these delays, the project developer and its contractors were able to work on the design documents and procurement phase and did not make any design changes due to financing.

Permitting: During the course of the project, the developer noted that navigating the permitting process involved some complexities, as expected. As with many permitting procedures, the project developer said that they had to address some unique requirements for specific permits. The permitting approval process for some project components, such as outrigger scaffolding, was prolonged, which caused some delays in project work. Additionally, the permitting for various project components was separate rather than part of the same process, adding complexity and duplication of some efforts. These delays did not cause significant cost increases, though they did extend the timeline for the project, which could have impacts on other project soft costs.

Space Constraints: The project at Whitney Young Manor has faced multiple space challenges, particularly with installing the wastewater heat recovery system. Initially, most equipment was planned to be installed on the roof. However, during the final design, the project developer found that the space could not accommodate all the necessary equipment. This resulted in moving some equipment to the basement, requiring an additional express hydronic riser that cost approximately $100,000, adding to the project equipment costs. Additionally, the project developer needed to rework some of the designs, adding soft costs to the project that were not initially anticipated. Once the equipment was installed in the basement, the project developer also needed to ensure plenty of clearance for maintenance. This also allowed for the incorporation of the WWHR system, which would not have been possible on the roof.

Wastewater Heat Recovery System: When the WWHR system was initially laid out, the engineers did not plan for the required piping, with space constraints limiting what was feasible. This limited the areas where the system could be installed, and the project developer was ultimately forced to use a smaller system with a 7,000-gallon tank rather than the originally scoped 18,000-gallon tank. This 62% reduction in tank size impacts the system's efficiency, as larger tanks lead to more consistent temperatures and better heat transfer. However, if the project had included the 18,000-gallon tank, the developer would have had to take numerous costly steps that could have threatened the existing building structure, such as removing structural beams and significantly retrofitting the basement. By using the 7,000-gallon tank, the system could be placed in the ideal location, which reduced the need for additional piping that would create inefficiencies in the sanitary lines. The project developer noted that the upgrades required to install the larger tank and modify the building structure could have cost five times more than originally expected due to the unforeseen additional piping and building modification work that would be required. The redesign to accommodate a smaller tank incurred some additional soft costs for the project, but these were substantially lower than what would have been required with the original design.

Utilization of New Technologies: The project developer used many innovative technologies, which the building operations team expressed skepticism about. In the case of the WWHR system, the operations team believed that because of heat loss, domestic hot water (DHW) storage tanks were less efficient than using instantaneous hot water in the units and thus costlier. However, the DHW storage tanks were necessary for this system to produce water at 140°F, a safety requirement for hot water storage. Additionally, the coordination between the WWHR and DHW systems has been more complicated for the developer than initially planned.

Continuing to utilize backup boilers in the project added another level of complexity. These boilers required additional controls that cost roughly $40,000 to procure and install. These controls assist in coordinating systems required to heat and cool the building as needed. The project developer was able to source sensors that are situated inside the individual supply lines and the fan coils. These sensors will automatically sense if the building is being cooled or heated by the temperature of the water coming through the supply lines and will communicate with the thermostat accordingly to flip between heating and cooling.

Lessons Learned

Throughout the project, the project developer noted multiple ways in which improved planning could have led to more effective project execution and reductions in some unexpected costs. These lessons can be applied to similar projects implementing newer ECMs in occupied buildings. In particular, the lessons learned from this project can be applied to other residential buildings that are transitioning from electric resistance heating to a centralized heating system.

- **Additional planning is beneficial.** The project developer noted that many issues could have been addressed with more thorough planning. This includes better estimates of when permits would be issued by local authorities, ensuring that equipment could fit in proposed locations, and accommodating the required infrastructure—such as piping, ventilation, and electrical systems—in the proposed areas. Unexpected changes and issues that could have been mitigated with additional planning led to complications with this project that impacted both the cost (hard and soft) and timeline. While additional planning can add costs to the planning and permitting phases of a project, the project developer felt it would have reduced some of the cost impacts felt during the installation phase.

Outreach to tenants is key to getting buy-in. Given that these renovations are occurring in occupied buildings, it is critical to have the ongoing support of building tenants. The project developer has done several presentations to educate tenants about what is happening in the building. and plans to use the expanded lobby and improved shared space in Whitney Young Manor to share what has been redeveloped on the property. This adds soft costs to the project compared to working in a vacant building but is often unavoidable and can be more cost effective than relocating tenants temporarily. By communicating with tenants throughout the project, the developer can address any tenant concerns early and make sure they are comfortable throughout the renovation.

While many lessons have already been learned, this project is ongoing, with more insights expected. As of January 2025, the full project is projected to close Q4 2026.