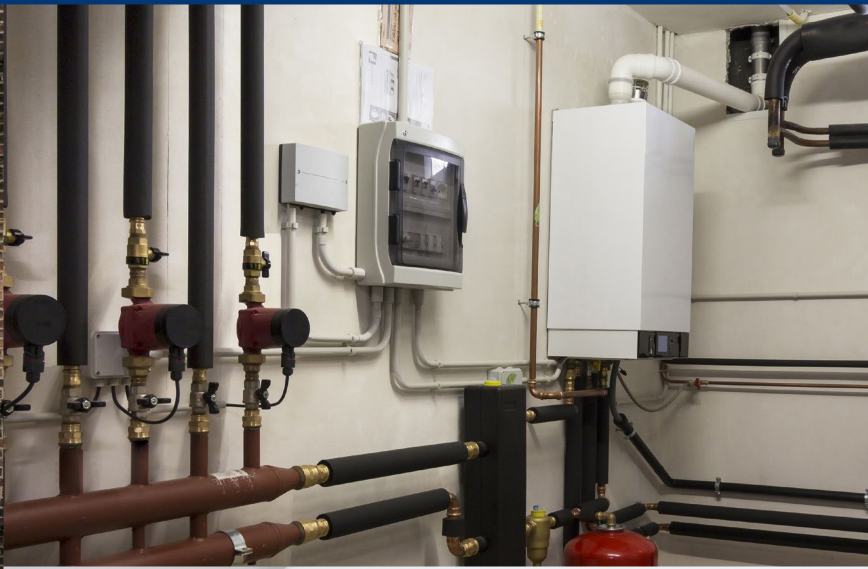
2019 ENERGY EFFICIENCY SOFT COSTS IN NEW YORK

BASELINE STUDY



July 10, 2020

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2019 ENERGY EFFICIENCY SOFT COSTS IN NEW YORK
BASELINE STUDY

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ACRONYMS AND ABBREVIATIONS

ASHP	Air-source heat pump
ESCO	Energy servicing company
Hard Costs	Materials and equipment costs, excluding any contractor mark-ups
HVAC	Heating, ventilation, and air conditioning
IQR	Inter-quartile range
QA/QC	Quality assurance and quality control
RTU	Rooftop unit (type of HVAC system)
SAC	Strategic Advisory Committee
Soft Costs	All other project-related costs including: marketing and acquisition costs, 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 Department of Public Service (DPS) and the New York State Energy Research and Development Authority (NYSERDA) published the *New Efficiency: New York* report,[1] outlining plans to accelerate the state's energy efficiency goal by 40%. The report calls for 185 trillion British thermal units (BTUs) of cumulative, annual, site-energy savings—relative to forecasted 2025 consumption—representing savings equivalent to fueling and powering over 1.8 million New York homes by 2025. The new energy efficiency target requires savings in buildings and the industrial sector across all fuel sources (electricity, natural gas, heating oil and propane).

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 project development. Soft costs encompass all project-, marketing-, or staff development-related costs—including marketing and customer acquisition, project design, project installation, transaction costs (trainings, certifications, permits), quality assurance, and recruiting/hiring costs.[2] For this study, NYSERDA contracted with Cadmus to conduct research to quantify soft costs across nine energy efficiency "prototypical projects,"[3] specifically surveying contractors across the residential, commercial, and multifamily sectors.

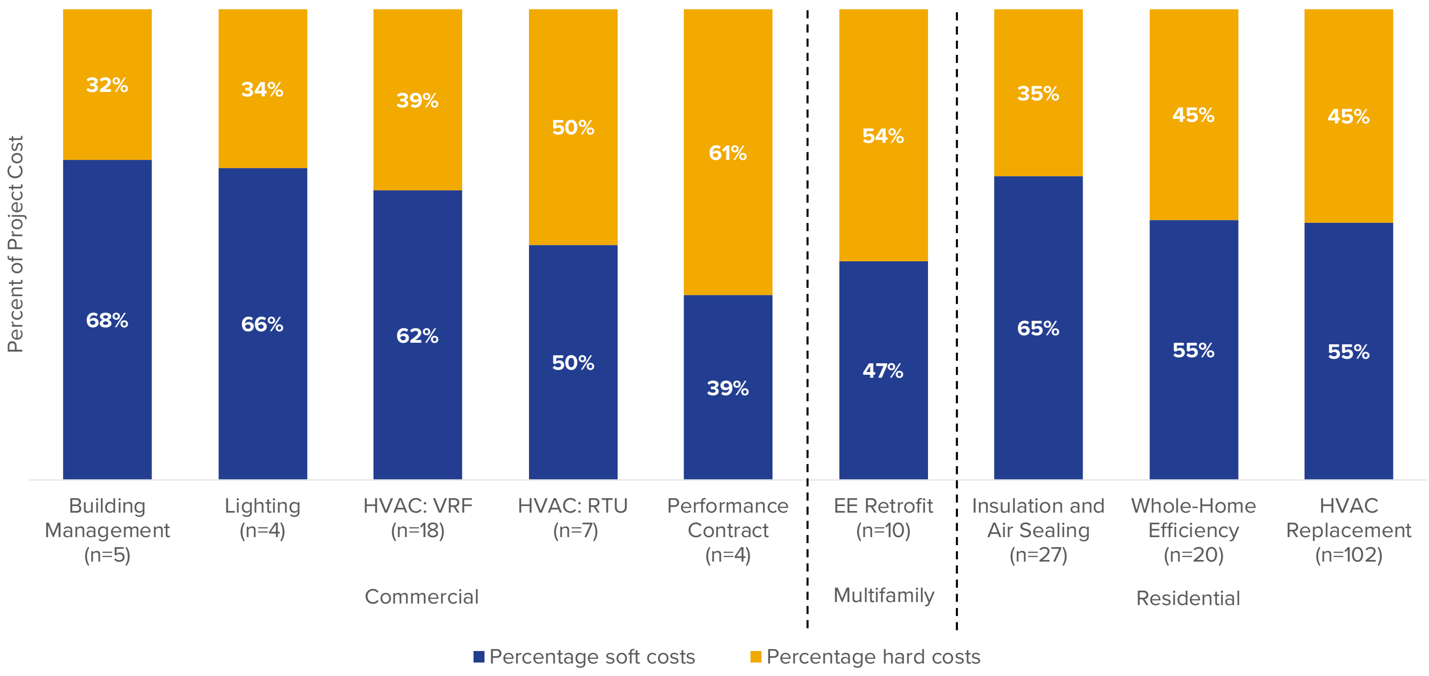
Cadmus found significant variability in the distribution of soft costs across prototypical projects. Soft costs ranged from a low of 39% to a high of 68%, with the majority above 50% of total project costs. As shown in Figure 1, the residential sector remains relatively consistent, with HVAC replacement and whole-home efficiency projects consisting of roughly 55% soft costs, while the insulation and air sealing project consists of roughly 65% soft costs.

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

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

3 Prototypical projects assessed in this study encompassed the residential, commercial and multifamily sectors. For the residential sector, they included ASHP installations, insulation and air sealing improvements, and whole-home weatherization work. For the commercial sector they included HVAC retrofits (both electrification and high-efficiency natural gas), lighting retrofits, building controls optimization, and performance contracts. And for the multifamily sector, they included a building retrofit project encompassing ASHPs, lighting, and weatherization.

FIGURE 1. HARD VS. SOFT COST ESTIMATED BREAKDOWN PER PROTOTYPICAL PROJECT



A few trends emerge when looking at soft costs at the residential, commercial and multifamily sector level (as shown in Table 1). First, installation labor composes approximately one-half of project soft costs across sectors, which is the largest single category of soft costs. Marketing and customer acquisition represent the next-largest soft cost category, accounting for about one-fourth of soft costs in the residential and commercial sectors. Marketing and customer acquisition costs are, however, a lower proportion of the soft cost stack in the multifamily sector, making up only 14% of total soft costs. (Transaction costs are the second highest soft cost category for the multifamily sector.)

The spread of soft costs is substantially greater in the commercial and multifamily sectors (compared to the residential sector). For example, three commercial soft cost categories (marketing and customer acquisition, installation, transaction costs) have estimate spreads at or above 20 percentage points. The increased variability of soft cost estimates in the commercial and multifamily sectors reflects the diverse and complex nature of projects in those sectors. The tighter spread of soft cost estimates for the residential sector[4] suggests that projects in the residential sector are more homogenous.

[4] The sample size of residential contractors was largest and thus allowed for a more robust analysis.

TABLE 1. SOFT COST CATEGORY AVERAGES AND SPREAD BY SECTOR

SOFT COST CATEGORY	RESIDENTIAL (N=129-145)	COMMERCIAL (N=129-145)	MULTIFAMILY (N=129-145)
Marketing and Customer Acquisition	27% (26%-28%)	21% (12%-38%)	14%
Project Design	5% (4%-6%)	7% (6%-10%)	8%
Installation	51% (50%-54%)	53% (24%-69%)	48%
Transaction Costs (Training, Certifications, Permits)	11% (9%-12%)	13% (5%-25%)	20%
Quality Assurance	5% (3%-5%)	6% (3%-9%)	10%
Recruiting and Hiring	1% (0%-1%)	0% (0%-1%)	1%

Several other notable trends emerged over the course of research:

First, **differences between upstate and downstate contractors' estimates for the total cost of a residential HVAC installation was driven almost entirely by soft costs.** As shown in Figure 2, contractors' soft costs were $1,640 higher downstate compared to upstate while hard costs were only higher by $524. Higher soft costs in the downstate region are driven by multiple factors, including a more expensive labor rate, higher marketing costs, and higher permitting costs. One market expert Cadmus interviewed hypothesized that commute times and a higher cost of living downstate contribute to differences in soft costs. In addition, it is worth noting that there is a higher spread of costs among downstate contractors, suggesting a more complex market to navigate.

This differences in **regional soft costs differences is especially clear when examining permitting costs.** As shown in Figure 3, downstate residential contractors spend an average of $224 more per project on permitting—and have a wider spread of permitting costs than their upstate counterparts—providing further evidence of the complexity of the downstate energy efficiency market. The same is true for the commercial sector, as shown in Figure 4, but the mean for downstate contractors is nearly $3,000 higher.

FIGURE 2. RESIDENTIAL HVAC REPLACEMENT COST ESTIMATES BY REGION

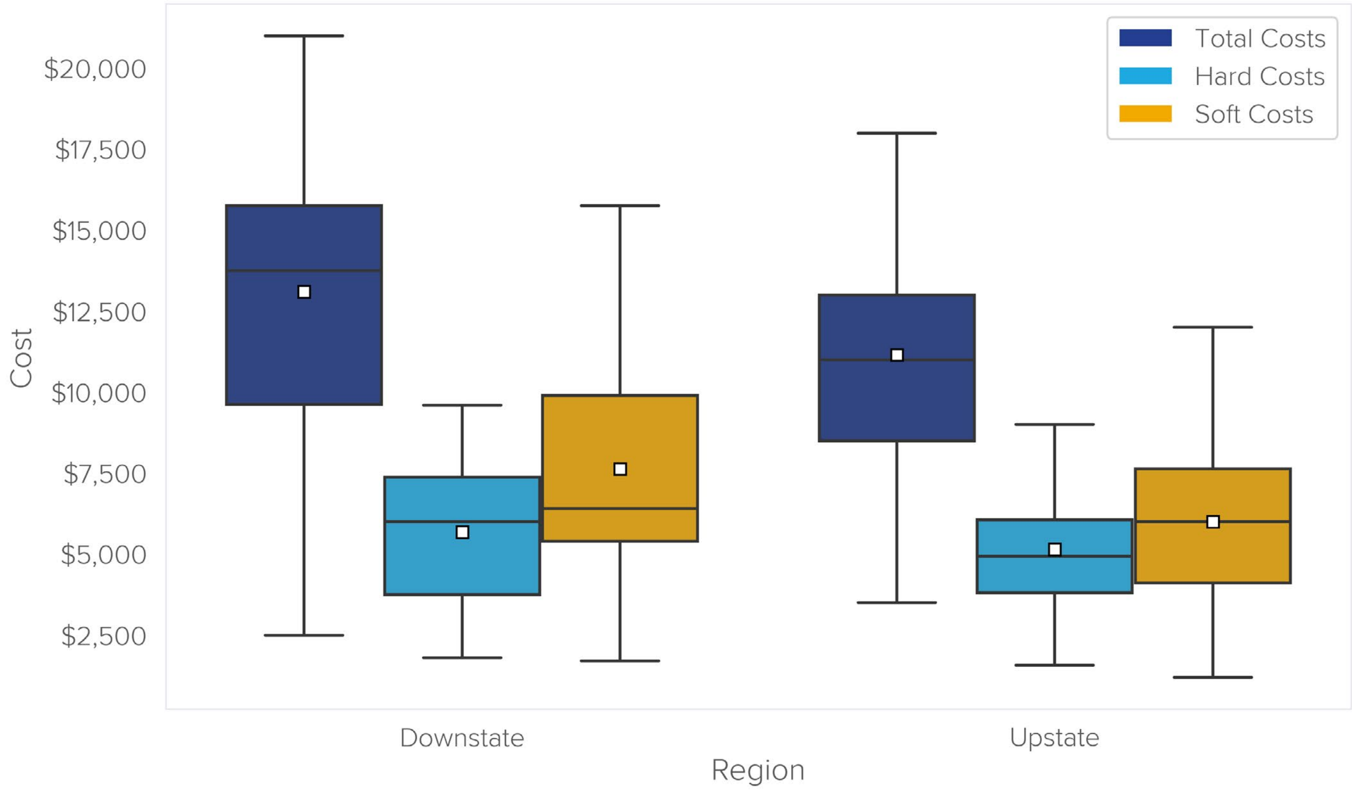


FIGURE 3. RESIDENTIAL SECTOR PERMITTING COSTS BY REGION

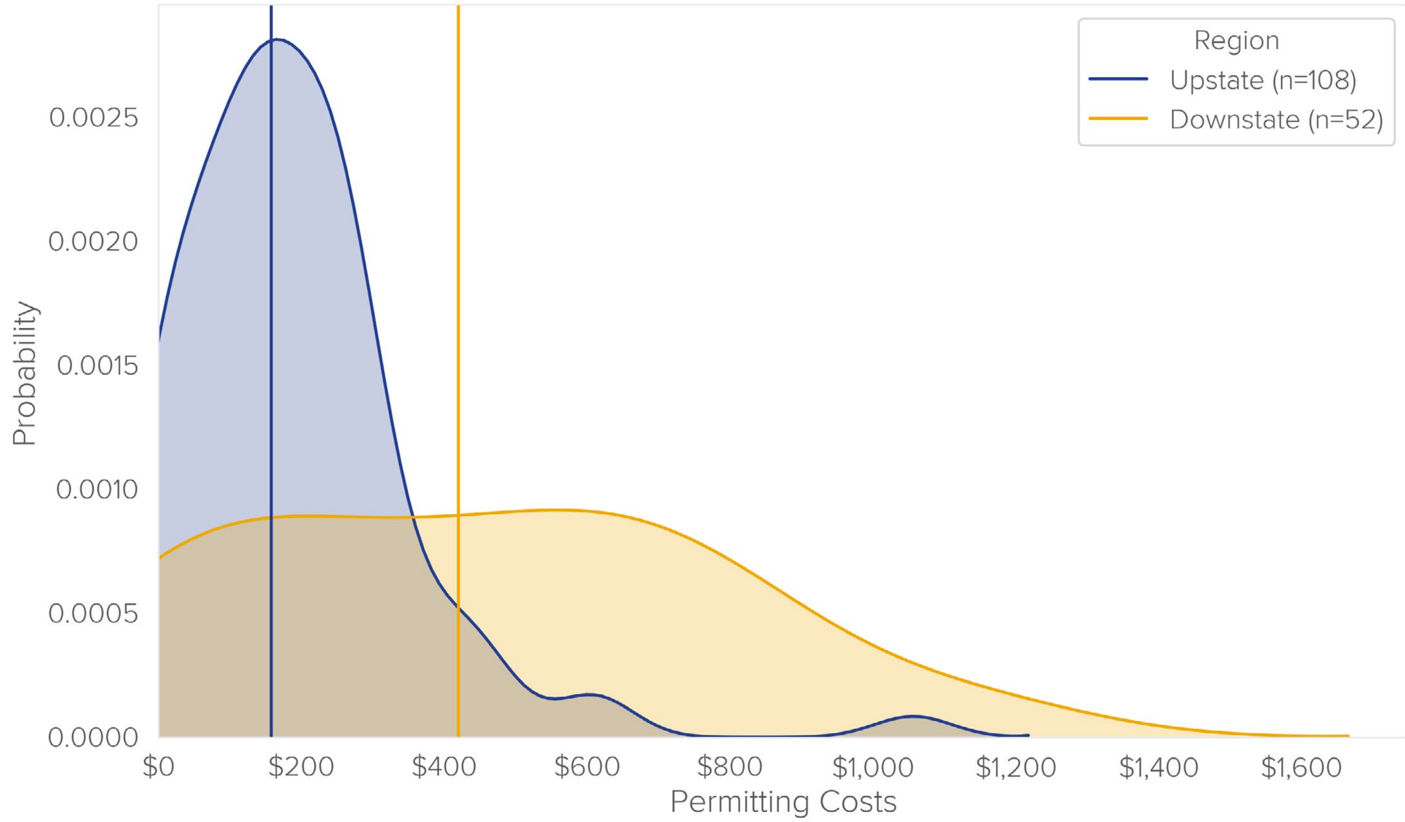
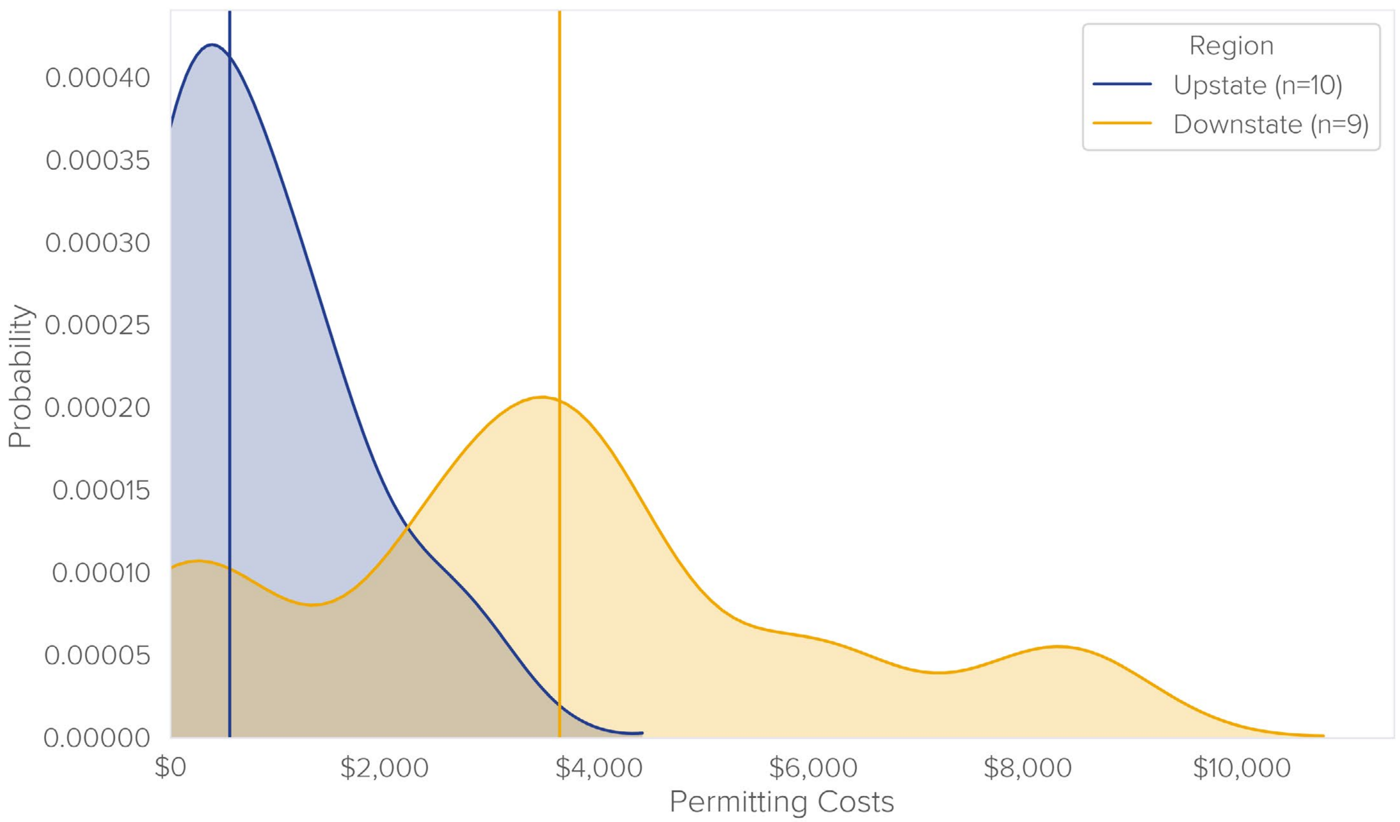


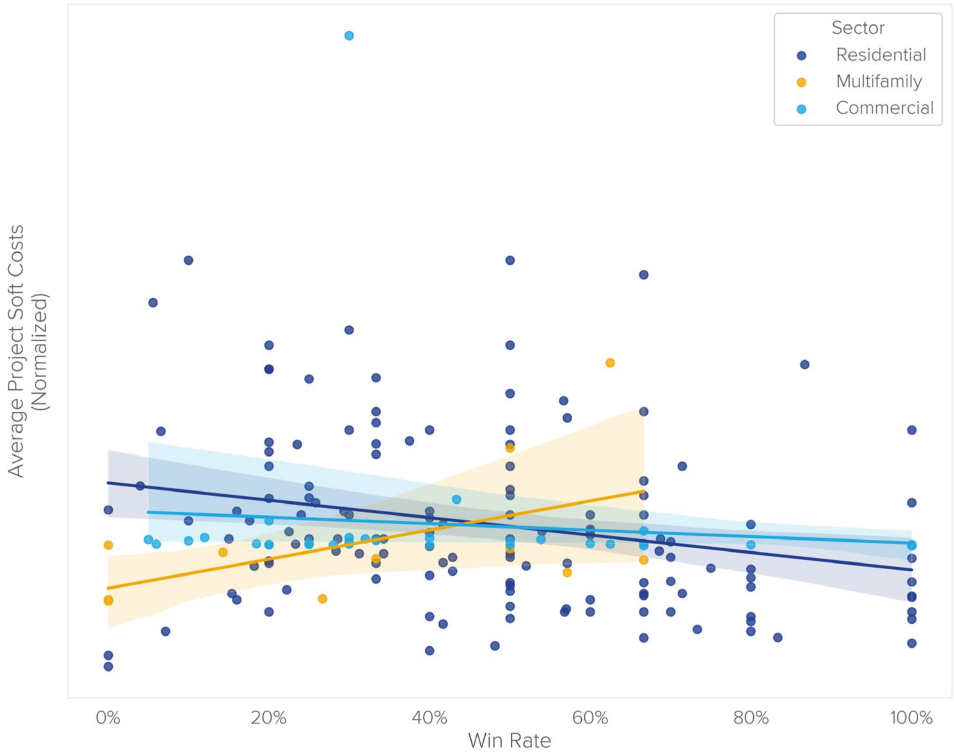
FIGURE 4. COMMERCIAL SECTOR PERMITTING COSTS BY REGION



Next, **contractors with higher win rates—or the percentage of bids a contractor reports winning—have lower overall soft costs** (Figure 5). For example, residential contractors (blue line and points) at the 75th percentile of win rates (i.e., with a win rate of 67%) report soft costs $1,250 lower than contractors at the 25th percentile of win rates (i.e., with a win rate of 28%). It is reasonable to infer that by reducing time spent on losing bids, contractors can significantly reduce soft costs. The multifamily sample size was too low for a win rate trend to emerge.

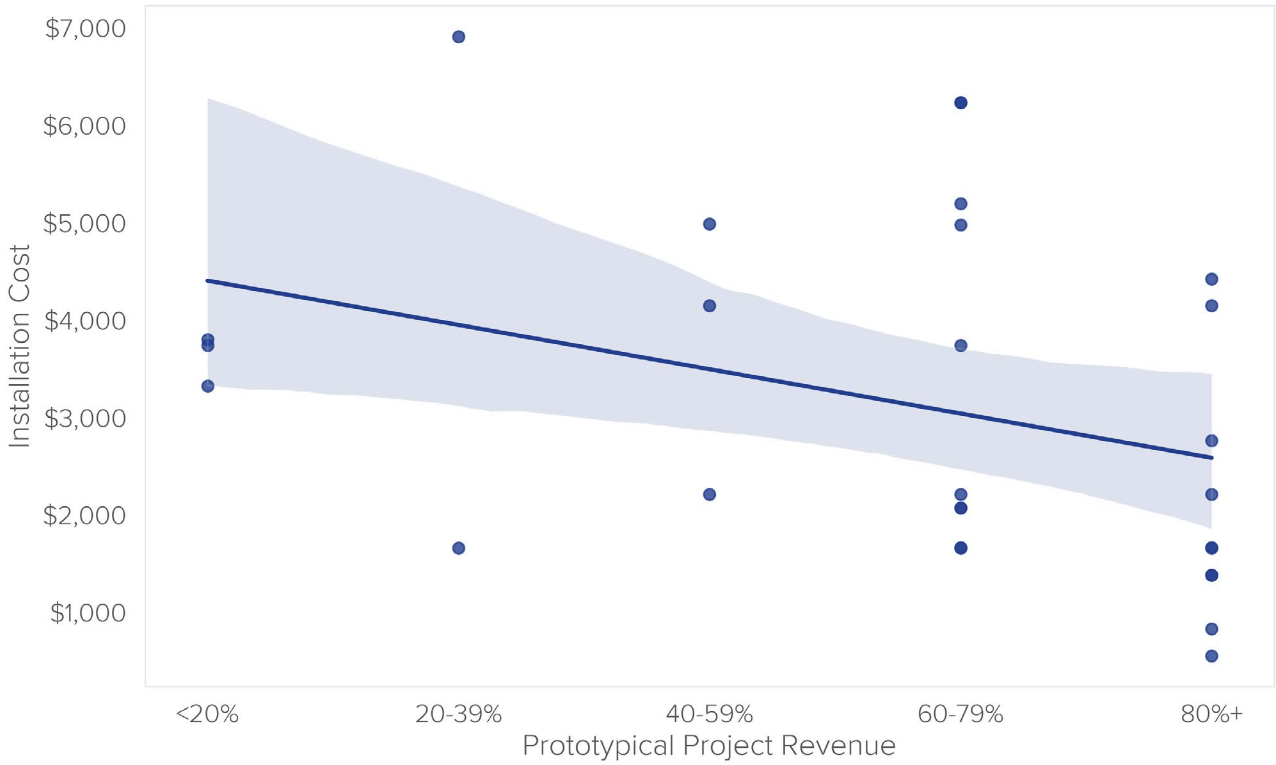
Finally, for some prototypical projects, a **"specialization effect"** exists, where contractors that have a larger percentage of their revenue from one source (e.g., contractors that conduct a majority of their work—or specialize—in one type of work) tend to have lower installation costs. This trend was observed among residential insulation and whole-home weatherization contractors but, interestingly, not among residential HVAC contractors. This trend suggests that contractors who specialize in one type of energy efficiency project can gain installation efficiencies compared to contractors who work across a variety of project types. Figure 6 shows an example of this trend among residential insulation contractors.

FIGURE 5. ALL SECTOR AVERAGE PROJECT SOFT COSTS VS. WIN RATE



Note: Average project soft costs and win rate have been centered to a mean of 0 to make sectors directly comparable. Consequently, tick labels on the corresponding axes should be interpreted as deviations from the mean value for each prototypical project type.

FIGURE 6. INSTALLATION COSTS VS. PERCENT REVENUE FROM INSULATION AND AIR SEALING



Notably, Cadmus **did not find evidence of economies of scale in the residential sector**,[5] i.e., an increase in a company's size (based on number of employees or total installation count) did not lead to lower soft costs on a project level. This trend (or lack thereof) was most prevalent when reviewing data associated with bid preparation and marketing costs, which suggests that the additional overhead larger companies take on (i.e., dedicated marketing staff) does not translate into savings for customers.[6]

Research to date has not identified a "silver bullet" for achieving soft cost reductions in New York's energy efficiency market. Instead, research shows that the New York energy efficiency market is complex, regionalized, fragmented, and diverse—and all of these factors influence the soft costs associated with any given energy efficiency installation.

Research findings do provide insights that NYSERDA (or other entities) can leverage to influence or assist market actors in reducing soft costs, as summarized below:

Continue to develop resources and leverage existing relationships to assist contractors with customer acquisition.

Research shows that customer acquisition for contractors—comprising time spent finding potential customers, drafting bids, and conducting initial site assessments—requires a significant investment of time and energy, typically around one-quarter of a project's total soft costs. NYSERDA should build on work already started under previous engagements, such as the *Renewable Heating and Cooling* Policy Framework and the state's Solarize campaigns, to reduce barriers to generating new business. Specifically, market interventions may include maps that identify potential customers based on building characteristics and educational materials to utilize these resources. In existing outreach channels, NYSERDA may build on past successes to utilize relationships with communities that could be prime targets for energy efficiency work. Additionally, identifying opportunities for customer aggregation, such as targeting large portfolio owners, could lead to reductions in customer acquisition costs.

Provide technical and engineering assistance and project development support.

The inclusion of newer energy efficiency technologies in a project (e.g., VRF installations in the commercial sector)—or the requirement of extensive pre-installation procedures/assessments (e.g., performance contracting projects)—can lead to substantially increased customer acquisition, design, and installation costs. This trend was clearest in the commercial VRF project, where installation cost estimates made up 69% of the total project soft costs. Similarly, performance contracts cover a large array of measures across a long time-horizon (typically 10 years) and require detailed energy savings calculations, which leads to a significant investment in initial work at potential customer sites. Thus, NYSERDA may consider creating or expanding initiatives that provide greater technical and engineering assistance and project development support for large, critical, multi-technology, or otherwise complex projects in key market segments. Support could include initial assessments, feasibility studies, design support, or measurement and verification assistance. Additionally, NYSERDA could consider developing tools that assist contractors with streamlining components of the project development process, such as remote audits or standardized technical analyses.

Create and educate contractors on standardized project design and installation procedures.

Total soft costs are highly impacted by the cost associated with project design and installation work, which accounts for nearly 60% of total project soft costs across all sectors. Additionally, these costs are relatively dispersed, showing the potential for process efficiencies. Some evidence exists of a specialization effect among specific types of contractors, in which contractors that have a higher percentage of their revenue coming from one specific prototypical project tend to have lower installation costs. To reduce costs, NYSERDA may consider creating or expanding facilitation of standardized installation, design, and quality control approaches by encouraging industry best practice and/or through requirements in incentive programs. Through this process, it will be critical to work with key manufacturer partners to standardize approaches and offer contractor training programs. Finally, NYSERDA may consider creating or expanding programs that recruit contractors to specialize in new or high growth business areas (like ASHPs) to increase the level of experience within the market.

Encourage the development of a unified and streamlined permitting process.

Permitting can be a driver of variability in project costs, with substantial differences observed across sectors and geographic regions. In addition, there is substantial difference by region, with downstate contractors' permitting costs higher and more dispersed than their upstate counterparts. NYSERDA may consider developing a unified, streamlined permitting process for key technologies and encourage adoption across NYS municipalities, which would entail the creation and dissemination of model codes for various technologies. Additionally, NYSERDA may consider creating or expanding training and education programs for building inspectors, specifically once model permitting codes are developed. It will be important for New York State to establish an incentive for municipalities that adopt the model codes.

Recommendations in this report have focused on technical assistance programs that NYSERDA can implement to stimulate soft cost reductions. 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 reduce costs.

The following sections of this report quantifies the soft costs associated with energy efficiency 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. Ultimately, the research described here contributes to New York's broader policy goals to transform its building stock and achieve energy, economic, and climate priorities. While additional work exists to -evaluate—and reduce—the cost stack associated with energy efficiency installations in New York, this research helps to deepen New York's understanding of soft costs, identifies potential areas for soft cost reduction, and establishes a baseline to measure the impact of future initiatives in reducing the cost of energy efficiency installations.

[5] Cadmus did not have enough data in the commercial or multifamily sectors to make a determination.

[6] Cadmus did not ask contractors if they have dedicated marketing staff in the survey, but rather is making an inference based on market knowledge.

INTRODUCTION AND BACKGROUND

On April 26, 2018, DPS and NYSERDA published the *New Efficiency: New York* report,[7] outlining plans to accelerate the state's energy efficiency goal by 40%. The report calls for 185 trillion British thermal units of cumulative, annual, site-energy savings, relative to forecasted 2025 consumption. The new target is based on savings in buildings and the industrial sector across all fuel sources (electricity, natural gas, heating oil and propane). In NYSERDA's support for more energy-efficient buildings, a need exists to investigate cross-cutting barriers and opportunities not specific to one market sector.

Preliminary research conducted by Cadmus prior to this work, in collaboration with NYSERDA, suggests that energy efficiency projects can pose significant soft costs. For example, recent qualitative research with New York energy efficiency vendors indicates that soft costs can account for over one-half of total project costs,[8] a finding consistent with the findings of this study.[9]

Similarly, in the solar market, the U.S. Department of Energy reports that soft costs can amount to as much as 64% of overall project costs. Hence, addressing soft cost barriers remains critical to reducing energy efficiency's overall price, maintaining market growth, and meeting the State's ambitious energy efficiency goals. The first step in this process is to identify and quantify soft costs that affect energy efficiency projects and to identify potential cost-reduction opportunities.

For this study, Cadmus and NYSERDA narrowed the definition of soft costs: 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. In contrast, hard costs are defined as the cost for equipment (i.e., air-source heat pump [ASHP], light fixtures) and materials (i.e., insulation, other raw material inputs) needed to complete an energy efficiency project. This study provides a baseline assessment, with updates to track soft cost changes planned for 2021 and 2023.

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

8 Cadmus. *Energy Efficiency Soft Cost Challenge: VOC Report and Recommendations.* Prepared for New York State Energy Research and Development Agency (NYSERDA). February 2018.

9 See Figure 1 for prototypical project-level breakdown of hard and soft cost estimates.

THE FOLLOWING RESEARCH OBJECTIVES 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 energy efficiency projects in New York by sector? (For follow-up assessments in 2021/2023: How do soft costs change over time?)

What percent of total project costs is represented by soft costs? (For follow-up assessments in 2021/2023: What is the trend of this soft cost percentage?)

What degree of variation exists for each major soft cost category for prototypical energy efficiency projects in each sector?

To what extent do soft costs differ across geographical areas in New York state? How does this compare to other states or regions?

Are there opportunities to reduce soft costs and, if so, what are they.

The report begins by outlining the methodology employed, including the research design, data collection methods, sample composition, and data analysis approach. Next, the bulk of the report covers the detailed findings from assessing findings, trends, and drivers across sectors, at the sector level, and for prototypical projects when the sample size allows. Finally, the report closes with the conclusions and recommendations section, which synthesizes conclusions drawn from the findings and provides Cadmus' recommendations for NYSERDA's path forward.

METHODOLOGY

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

RESEARCH DESIGN

During the project's first phase, Cadmus worked directly with NYSERDA and market experts to refine the research design, determining which prototypical projects to test and which soft costs to include. Throughout this process, Cadmus and NYSERDA balanced multiple factors to come up with the final research design, such as:

1. Focus on soft costs for technologies currently in the market (e.g., gas furnaces) or decarbonization technologies entering the market (e.g., VRF systems)

2. Selecting example buildings for prototypical projects that are representative of how the work was typically completed but can be found throughout the entire state (e.g., multifamily building sizing – we selected a 24-unit pre-war walk-up)

3. Identifying the proper level of detail to include in surveys to ensure contractors are thinking about the same scope of work while not overwhelming them with details

These trade-offs were necessary to ensure the baseline study is realistic while also being applicable in future iterations. As discussed in the *Sample Composition and Interpretation* section, the choices made restricted the pool of available contractors able to complete the survey, given their level of familiarity with the technology.

PROTOTYPICAL PROJECTS

Through this research, Cadmus explored nine distinct, prototypical projects across three sectors. Listed in Table 2, these prototypical projects received rigorous testing with a variety of stakeholders, from NYSERDA, Cadmus, and experts within New York State.

TABLE 2. 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	Standard efficiency, gas-powered condensing boiler for heating; window AC units for cooling
	Equipment Installed	Ductless heat pump with 1 outdoor unit and 3 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.
Insulation and Air Sealing	**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; R19 insulation
	Existing Conditions	R19 insulation in ceiling; crawl space/basement uninsulated; typical attic leakage in bypasses
	Equipment Installed	R49 insulation (blown-in) for ceiling and R30 insulation (fiberglass) for crawl space/ basement; air sealing for whole house, attic and basement bypasses
Comprehensive Whole-Home Efficiency Projects Addressing HVAC Plus Insulation and Air Sealing	**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; R19 insulation
	Existing Conditions	**HVAC:** Gas-powered condensing boiler; standard thermostat **Insulation:** R19 insulation in ceiling; crawl space/basement uninsulated; typical attic leakage in bypasses; typical metal ductwork
	Equipment Installed	**HVAC:** ASHP minisplit (ductless); WiFi-connected thermostat **Insulation:** R49 insulation (blown-in) for ceiling and R30 insulation (fiberglass) crawl space/basement; air sealing for whole house, attic & basement bypasses
COMMERCIAL SECTOR		
Lighting Retrofit	**Building Type**	Retail store (one floor)
	Building Size	10,000 sq. ft
	Existing Conditions	**Indoor:** Linear fluorescent **Outdoor:** HID Assume no controls currently installed
	Equipment Installed	**Indoor:** 1:1 LED retrofit using LED retrofit kits (not changing fixtures) **Outdoor:** 100% fixture replacement with LED Install lighting controls in a networked system, including features such as daylighting and auto-dimming
HVAC Retrofit: Variable Refrigerant Flow (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

HVAC Retrofit: Efficient Rooftop Unit (RTU)	**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:** Gas **Equipment:** High-efficiency rooftop unit. Assume the rooftop units have a variable frequency drive (VFD) on the supply fan and an economizer with integrated demand-control ventilation. The new HVAC systems control zones in the same way, and key data points will be integrated into the existing building management system (e.g., economizer status and temperatures, space temp, fan speed, heating/cooling/occupancy status, CO_2 level).
Energy Efficiency Retrofit via Performance Contract	**Building Type**	Campus (College)
	Building Size	Single central plant serving 1.5M sq. ft campus
	Existing Conditions	**Lighting:** Indoor/outdoor uses fluorescent/HID **HVAC (central plant):** Older chiller and boiler, constant volume distribution system **HVAC (buildings):** Constant volume air-handler system **Controls:** Older lighting and HVAC controls **Envelope:** Low insulation and poor air sealing
	Equipment Installed	**Lighting (indoor):** 1:1 LED retrofit, not changing fixtures, assume 100% ballast replacement **Lighting (outdoor):** 100% fixture replacement with LED **HVAC (central plant):** High-efficiency chiller and boiler, variable flow distribution system **HVAC (buildings):** Air-handler upgrades (conversion to Variable Air Volume) **Controls:** Upgrade controls for lighting and HVAC to newer direct digital control systems **Envelope:** Increased insulation, increased air sealing, adding window glazing
Building Management Project Involving System/ Operational Optimization for Energy Efficiency	**Building Type**	Commercial office building
	Building Size	100,000 sq. ft
	Existing Conditions	**HVAC:** System has older controls and requires hardware and software updates **Lighting:** Newer control system does not require a hardware update (only software)
	Equipment Installed	**HVAC:** Upgrade controls system for air handling unit; assume 25% of sensors need replacement (but no additional sensors); conduct static pressure reset and economizer optimization **Lighting:** Assume no system/hardware upgrades, only reprogramming (daylighting and auto-dimming); integrate with HVAC controls system
MULTIFAMILY SECTOR		
Buildings Undergoing Energy Efficiency Retrofit	**Building Type**	Pre-war walk-up apartment building (market-rate)
	Building Size	24 units (4 stories)
	Existing Conditions	**HVAC:** Gas-fired, one-pipe steam system **Insulation:** Low ceiling/attic insulation level **Lighting (indoor—in-unit and common areas):** CFL (in-unit) and linear fluorescent (common areas) **Lighting (outdoor):** HID
	Equipment Installed	**HVAC:** ASHP minisplits **Insulation:** add blown-in insulation to ceiling/attic **Lighting (indoor - in-unit and common areas):** LED; no fixture replacement **Lighting (outdoor):** LED; no fixture replacement

TABLE 3. 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 the work compliant to local, state, and federal regulations
	Obtaining licenses necessary to execute [PROTOTYPICAL PROJECT] installations
	Acquiring and maintaining trainings and certifications necessary to execute [PROTOTYPICAL PROJECT] installations
QA/QC	**Quality assurance** and quality control activities to ensure 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 necessary to execute [PROTOTYPICAL PROJECT] installations

SOFT COST CATEGORIES

Throughout the study, Cadmus refers to two categories of costs: hard costs and soft costs. Hard costs are defined as materials and equipment costs, excluding any mark-ups contractors add when selling to customers. Table 3 presents the final soft cost categories and components used in the study. As detailed below, Cadmus revised soft cost category definitions through rigorous testing with our own subject-matter experts, external advisors (Table 6), and NYSERDA experts and program managers. *Appendix C. Expert Interview Feedback* details expert feedback that led to the final soft cost categories and components.

In addition to the soft cost categories listed in Table 3, Cadmus asked service providers about supply chain/stocking costs and project financing/cash flow. Experts recommended not quantifying these soft costs due to the fact that these costs are often determined by non-project-specific factors (such as a company's financial health or a facility's size). Rather, Cadmus 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.

Cadmus also assessed a set of soft costs for decision-makers, as shown in Table 4. While these were not used in the final soft cost quantifications (as the majority of soft costs are borne by the contractors), these results provide insight into interventions that can be made from an end-user perspective. Some soft costs, such as transaction costs and supply chain/stocking, are not applicable to decision-makers, as these costs are primarily borne by service providers.

TABLE 4. SOFT COST CATEGORIES (DECISION-MAKERS)

CATEGORY	COMPONENT
Marketing and customer acquisition	**Finding a contractor to complete the project,** including preparing a bid package, price negotiations, and signing the contract
Project/system design and development	**Revising project scope** based on discussions with key stakeholders and the vendor
Installation labor	**Project management** to ensure the work is going as planned, including meeting with service providers, inspecting the job site, and managing service provider invoicing
Transaction costs	**Time needed to acquire funding** to complete [PROTOTYPICAL PROJECT], such as preparing information on the project for internal stakeholders, and applying for loans/grants
Recruiting and hiring	**Time and money spent on maintaining the new system**, including training staff, repairs completed internally and repairs completed via a hired contractor

RESEARCH METHODS

To complete the Energy Efficiency Soft Costs baseline study, Cadmus used a suite of research methods to gather the necessary data. These included secondary research, expert interviews, surveys, cognitive interviews, and reviews with an advisory committee of experts. This section describes our approach to each method.

SECONDARY RESEARCH

At the project's beginning, Cadmus reviewed all relevant research on soft costs to set a baseline knowledge level of soft cost categories, building sectors, and quantification methodologies. Cadmus reviewed the documents listed in Table 5. To Cadmus' and NYSERDA's knowledge, there are no known reports that have sought to quantify soft costs of energy efficiency projects. As a result, Cadmus relied heavily on soft cost studies from other sectors, such as solar and energy storage, as well as interviews with experts (detailed in the next section).

EXPERT INTERVIEWS

To inform the research design, Cadmus interviewed 13 experts with energy efficiency project experience across the residential, commercial, and multifamily sectors in New York state. Through these interviews, Cadmus addressed the following research objectives:

- Refine the working definitions of soft cost categories, ensuring that soft costs are discussed using the correct terminology
- Refine the working definitions of prototypical projects
- Develop soft and hard cost estimate for prototypical projects
- Identify the largest soft cost categories within prototypical energy efficiency projects and sectors
- Discuss regional or other drivers of soft cost estimate variations
- Explore drivers behind high soft costs, and discuss high-potential opportunities for achieving soft cost reductions across defined cost categories
- Gather suggested refinements to sampling plan and data collection methodologies

During the kickoff meeting, Cadmus conducted a stakeholder mapping exercise with NYSERDA to identify the right set of experts to interview. Table 6 lists the final sample of experts with names and companies redacted. Feedback from the expert interviews is in Appendix C. Expert Interview Feedback.

TABLE 5. DOCUMENTS REVIEWED FOR LITERATURE REVIEW

DOCUMENT TITLE	AUTHOR	DATE
U.S. Department of Energy Technologies Office Sunshot Prize Competition	U.S. Department of Energy Solar Energy Technologies Office	2017
Solar Balance-of-System Costs Baseline Cost Study	Industrial Economics, Inc.	2017
Baseline Market Evaluation Metrics for Energy Storage	Research Into Action, Inc.	2017
Large-Scale Wind Soft Cost Study Evaluation Plan	DNV GL	2018
Residential Statewide Baseline Study of New York State	NYSERDA	2015
Energy Efficiency Soft Cost Challenge: VOC Report and Recommendations	The Cadmus Group	2018
Energy Efficiency Program Cost Forecasting	Industrial Economics, Inc.	2018
Waking the Sleeping Giant: Next Generation Policy Instruments for Renewable Heating and Cooling in Commercial Buildings (RES-H-NEXT)	Cadmus (formerly Meister Consultants Group)	2015
New York City Air-Source Heat Pump Contractor Supply Chain Research	The Cadmus Group	2018
Benchmarking Non-Hardware Balance-of-System (Soft) Costs for U.S. Photovoltaic Systems Using a Bottom-Up Approach and Installer Survey	NREL and LBNL	2012

SURVEYS

Cadmus developed prototypical, project-specific surveys for energy-service providers and decision-makers operating in New York State to clarify soft and hard costs as well as the timelines associated with completing the selected, prototypical, energy efficiency projects. These surveys were suited to the commercial, multifamily, and residential sectors, prototypical energy projects, and respondent types.

SERVICE PROVIDERS

Cadmus conducted quantitative surveys 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 that work within the residential, commercial, or multifamily sectors to provide energy efficiency 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 energy-service companies (ESCOs).

To collect the data necessary to quantify soft costs for energy efficiency project development, Cadmus conducted online and telephone surveys with New York state service providers across the residential, commercial, and multifamily sectors. Cadmus invited contacts with valid email addresses to complete the survey online, and then followed up with a reminder email to nonrespondents. Cadmus then contacted potential respondents (those without a valid email address or those not responding to the initial survey invitation) by phone to complete the survey.

TABLE 6. EXPERT INTERVIEW SAMPLE

TYPE OF COMPANY[1]	SECTOR	TECHNOLOGY/EXPERTISE
Small-sized contractor	Residential	Insulation
Large manufacturer	Commercial	Building automation, performance contracts, energy efficiency retrofits
Large-sized contractor	All	HVAC and energy efficiency retrofits
National real estate investment trust	Multifamily	Property management and development
Medium-sized contractor	Residential	Whole-home efficiency
Medium-sized contractor	Multifamily	Energy efficiency retrofit
Medium-sized contractor	Residential	Insulation
Medium-sized contractor	Residential	HVAC
Large HVAC manufacturer	Commercial	HVAC (VRF)
Large HVAC manufacturer	All	HVAC (ASHP)
National real estate investment trust	Multifamily	Property management and development
Engineering firm	Commercial	Lighting and energy efficiency retrofits
NY-focused trade group	All	Trade group

[1]Names of interviewees and companies redacted to keep anonymity of respondents.

Cadmus used InfoGroup data as the primary source for developing the energy-service providers' sample frame, supplemented with contacts from additional sources:

- Exact Data (direct-marketing service provider)
- NYSERDA's contractor lists: Multifamily Building Solutions Network, HPwES Contractors, and RTEM Qualified Vendors
- Manufacturer qualified contractor lists: Mitsubishi, Daikin Comfort, LG, KMC Controls, Automated Logic, Computrols, Alterton
- Relevant trade associations: NY Plumbing-Heating-Cooling Contractors Association

In addition to interviewers, Cadmus subcontracted phone surveys with a NYSERDA-qualified contractor—Abt Associates—providing Abt with programmed versions of the surveys and all contact lists from which to sample. Abt made up to three attempts per record, leaving a message when unable to reach contacts.

Table 7, in the Sample Composition and Interpretation section, shows the targeted number of completions versus the achieved number of completed service-provider surveys.

DECISION-MAKERS

In addition to service provider surveys, Cadmus conducted quantitative surveys with residential decision-makers and qualitative interviews with commercial and multifamily decision-makers to gather insights on soft costs' impacts on project decision-making and associated points of friction. Using an online panel (purchased from Qualtrics), Cadmus surveyed residential-sector homeowners and landlords (in the single-family market). Decision-makers in the commercial and multifamily sectors included property owners and managers who recently completed one of the prototypical commercial or multifamily projects. Drawing upon InfoGroup data, Cadmus developed a sample frame for the commercial and multifamily sectors, supplementing this with contacts from property management company websites (such as Colliers, AJ Clarke, ABS Real Estate, and Pemco Group) and relevant trade associations (such as NY Building Managers Association, NY Capital Region Apartment Association, and International Facility Management Association).

To collect the necessary data among decision-makers, Cadmus invited contacts with a valid email address to complete the survey online and followed up with a reminder email to nonrespondents. Table 7, in the *Sample Composition and Interpretation* section, shows the targeted number of completions versus the achieved number of completed decision-maker surveys.

COGNITIVE INTERVIEWS

Prior to conducting a full launch of the surveys, Cadmus held a series of cognitive interviews with market experts. Cognitive interviews are in-depth interviews using a survey instrument as the interview guide. The interviewer (Cadmus) asked each survey question to the interviewee (market expert). The market expert answered the question and provided feedback on aspects of the question that proved confusing or inaccurate, thereby assisting Cadmus in vetting and refining the survey instrument before engaging a larger sample of respondents.

Ultimately, Cadmus used cognitive interviews to test the survey instruments for design, clarity, and length. Several revisions were made to the survey instruments, most of which focused on wording changes, so questions were clearer to respondents. Cadmus conducted cognitive interviews for the following prototypical projects: commercial HVAC (VRF); commercial performance contract; residential insulation and air sealing; and residential whole-home efficiency. Typically, these interviews lasted 30 minutes (approximately double the average survey time).

FOLLOW-UP INTERVIEWS

Cadmus conducted a series of follow-up interviews with a select group of contractors not surveyed during the project. Specifically, Cadmus conducted interviews with large players in the building controls, performance contract, and multifamily spaces in New York. In these interviews, Cadmus gathered additional market insights that were not possible to cover in the surveys, which provided context to the current set of findings.

STRATEGIC ADVISORY COMMITTEE

Cadmus engaged a group of three market experts (referred to as the Strategic Advisory Committee [SAC]) to provide additional direction and input to the project. This group had an expanded role as compared to the expert interviews, with Cadmus gathering their input at key points throughout the project. Initially, Cadmus planned to meet with the SAC at a project midpoint, before much of the data collection was completed. However, given the phased fielding approach (sector by sector, beginning with residential) and a lower than anticipated response rate among commercial and multifamily service provides, Cadmus engaged the SAC after the residential projects completed fielding and reviewed these early results along with the soft cost quantification plan to make any needed changes before conducting the full analysis. Additionally, the SAC reviewed the completed draft report to ensure the findings, conclusions, and recommendations are realistic and applicable to the general market.

SAMPLE COMPOSITION AND INTERPRETATION

Cadmus collected survey data from a total of 472 respondents, 252 service providers and 220 decision-makers. Table 7 shows the distribution of the sample by sector and prototypical project. While Cadmus achieved the majority of its sample-size targets in the residential sector, this did not occur in the multifamily and commercial sectors, where we believe the following challenges were present:

- Commercial and multifamily prototypical projects were highly complex and specialized, making them hard to reach because the size of those populations (contractors qualified to respond to the survey) were small in comparison to the larger population of contractors.
- Some projects in the multifamily and commercial sector were more forward-looking than those commonly found in the market today, again reducing the population of contractors qualified to respond to the survey. Specific examples of such projects include HVAC: VRF and multifamily (including ASHPs in every unit).
- Multifamily and commercial projects were typically completed by larger firms, posing challenges in finding the "right" contact, as employees in larger firms tended to have a more specialized role than in a larger firm (i.e., there is a dedicated marketing team, recruiting team, etc.).

As noted in the *Surveys* section, Cadmus used multiple sources to sample from. Some of these sources, such as manufacturer or NYSERDA qualified contractor lists, introduce an element of bias into the sample. For example, contractors who are on one of NYSERDA's qualified contractor lists are likely to have lower customer acquisition costs due to the free advertising they receive through their presence on the list. Cadmus and NYSERDA discussed the benefits and drawbacks of using each sample source and ultimately decided to use the sample sources listed even though it was not a true random sample.

Residential sampling resulted in a strong number of completed surveys which we used to conduct robust statistical analyses that identified drivers of soft costs within each type of prototypical project. These results will serve as a baseline to make statistical comparisons with future study iterations, to determine how the market changes over time. The sample sizes were small in the commercial and multifamily sectors and some of the largest contractors serving these sectors are not represented in the surveys. Therefore, we did not attempt to generalize the results to the broader population but focused on presenting the information with practical significance (rather than statistical significance) and focusing on the subpopulation of such contractors that are represented by the surveys, namely smaller commercial and multifamily sector contractors. As a result, Cadmus recommends tracking changes in the inter-quartile range (IQR)[10] to uncover soft cost changes for the commercial and multifamily sectors over time (i.e., comparing baseline to future iterations). Tracking the IQR helps account for some of the variability that is typically present among smaller sample sizes, as it does not rely on a single point estimate (such as a mean or median).

[10] The inter-quartile range (IQR) is the middle 50% of the statistical dispersion of a dataset. It is equal to the difference between the 3rd quartile (i.e., 75th percentile) and 1st quartile (i.e., 25th percentile).

TABLE 7. FINAL SAMPLE COMPOSITION

PROTOTYPICAL PROJECT	SERVICE PROVIDERS		DECISION-MAKERS	
	COMPLETIONS (+ PARTIAL)	GOAL	COMPLETIONS (+ PARTIAL)	GOAL
Commercial	**38 (+14)**	**234**	**4**	**15**
HVAC: VRF	17 (+4)	68	1	5
HVAC: RTU	7 (+1)	68		
Lighting	7 (+2)	68	3	7
Performance Contract	4 (+4)	15	-	-
Building Management Systems	3 (+3)	15	-	3
Multifamily	**8 (+7)**	**88**	**8 (+1)**	**10**
EE Retrofit	8 (+7)	88	8 (+1)	10
Residential	**159 (+26)**	**166**	**207**	**204**
HVAC: ASHP	106 (+8)	68	68	68
Insulation	32 (+7)	68	71	68
Whole-Home Efficiency	21 (+11)	30	68	68

ANALYSIS METHODOLOGY

Cadmus used several methods to analyze the drivers of soft costs, including statistical comparisons of group means, standard deviations, and IQRs, as well as correlation analyses.

APPROACH TO QUANTIFYING SOFT COSTS

Cadmus used survey data as the primary source to generate the soft cost estimates presented in this study, designing the survey to ask about specific soft cost components in a manner easy for contractors to quantify. As detailed in *Appendix A. Soft Cost Category and Component Calculations*, Cadmus asked questions about each soft cost component using 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). Cadmus gathered data from market expert interviews, Cadmus' internal subject-matter experts, and NYSERDA. Cadmus 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), Cadmus transformed labor hours into dollars. As detailed in *Appendix A. Blended Labor Rates Calculation*, Cadmus 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 asked about. This led to a set of blended labor rates that Cadmus used in the calculations, presented in Table 8. Cadmus reviewed this blended labor rates methodology with the SAC, internal Cadmus subject-matter experts, and NYSERDA.

After completing data collection, Cadmus cleaned the data using a two-step process: first removing errors and then "far-out" outliers. The process began by removing any data points that were clearly errors or unrealistic for the given question (i.e., entering either zero or 50,000 hours for residential HVAC installation labor). Removing these data points allowed Cadmus to calculate more accurate summary statistics, such as the mean and IQR.

During this step, Cadmus acted as conservatively as possible, only removing data points clearly entered in error. Cadmus then used John Tukey's (1977) method for removing outliers known as "Tukey fences": 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.

TABLE 8. FINAL BLENDED LABOR RATES USED FOR QUANTIFICATION

SOFT COST CATEGORY	COMMERCIAL					MULTI-FAMILY	RESIDENTIAL		
	LIGHTING	HVAC: VRF	HVAC: RTU	PERF. CONT.	BLDG. MGMT.		HVAC	INSULATION	WHOLE-HOME
Upstate									
Marketing and Customer Acquisition	$63.70	$61.89	$59.64	$58.84	$63.70	$60.93	$59.64	$63.51	$59.55
System Design	$69.31	$67.50	$65.25	$64.45	$69.31	$66.54	$65.25	$69.12	$65.16
Installation Labor	$69.31	$67.50	$65.25	$64.45	$69.31	$66.54	$65.25	$69.12	$65.16
Transaction Costs	$56.48	$55.40	$54.04	$53.56	$56.48	$54.82	$54.04	$56.36	$53.99
Training and Certifications	$70.91	$68.39	$65.24	$64.11	$70.91	$67.04	$65.24	$70.65	$65.10
QA/QC	$76.77	$73.88	$70.28	$68.99	$76.77	$72.34	$70.28	$76.46	$70.13
Downstate									
Marketing and Customer Acquisition	$95.73	$93.02	$89.64	$88.43	$95.73	$91.58	$89.64	$95.45	$89.50
System Design	$104.17	$101.46	$98.07	$96.86	$104.17	$100.01	$98.07	$103.88	$97.93
Installation Labor	$104.17	$101.46	$98.07	$96.86	$104.17	$100.01	$98.07	$103.88	$97.93
Transaction Costs	$84.89	$83.26	$81.23	$80.50	$84.89	$82.39	$81.23	$84.72	$81.14
Training and Certifications	$106.58	$102.79	$98.05	$96.36	$106.58	$100.76	$98.05	$106.18	$97.85
QA/QC	$115.38	$111.04	$105.63	$103.69	$115.38	$108.73	$105.63	$114.92	$105.40

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 "far out"

Cadmus 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, Cadmus only used the initial process of removing responses that were clearly errors or not realistic.

Appendix A. Soft Cost Quantification Methodology provides a full description of the soft cost quantification methodology.

MULTIPLE LINEAR REGRESSION

Cadmus 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, Cadmus regressed each soft cost category (y/dependent variable) against a set of explanatory variables (x/independent variables). In these models, Cadmus used the x variables listed in Table 9.

TABLE 9. LINEAR REGRESSION VARIABLE DEFINITIONS AND SCALES

VARIABLE	DEFINITION	COEFFICIENT INTERPRETATION*
Intercept	Baseline soft costs of operation when all independent variables in regression set to 0	Not used for interpretation – only exists 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 NY 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
Percent 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 rate11	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	
n	Sample size	
R2	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)	

*Note: "All else equal" implied for all coefficient interpretations.

[11] 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 we omitted win rate from a regression due to its interaction with the dependent variable by nature of the way win rate is calculated.

Detailed Findings

THIS SECTION DESCRIBES FINDINGS FROM THE RESEARCH ACTIVITIES DESCRIBED ABOVE AND IS ORGANIZED AS FOLLOWS:

CROSS-SECTOR TRENDS:

view of soft cost results across sectors, focusing on market-level trends

RESIDENTIAL SECTOR:

deep dive into the residential sector and its three prototypical projects: HVAC replacement, insulation and air sealing, and whole-home efficiency

COMMERCIAL SECTOR:

results at the commercial sector level, with differences by prototypical project when sample size allowed

MULTIFAMILY SECTOR:

results at the multifamily sector level

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

CROSS-SECTOR TRENDS

This section details overarching soft cost trends across the three sectors: residential, commercial, and multifamily. Specifically, the section contains high-level findings related to the breakdown of hard vs. soft costs, the largest sources of soft costs, and variability in soft costs. More detailed information is reserved for each sector's specific section.

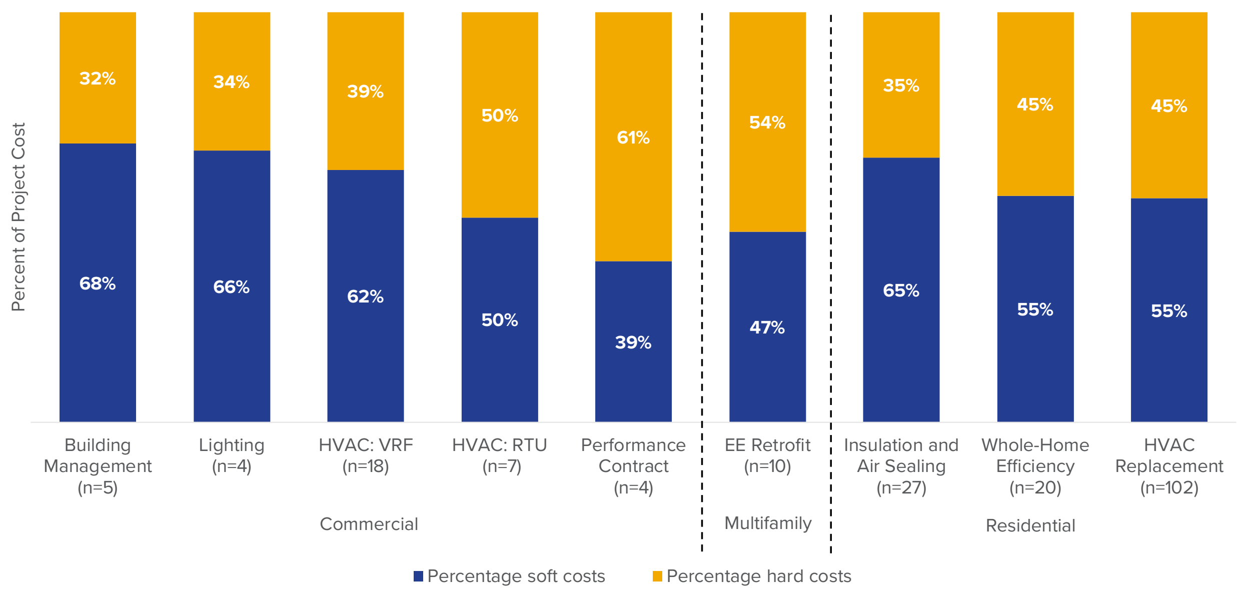
HARD VS. SOFT COSTS

Across sectors, service provider estimates for the percentage of total project costs composed soft costs that ranged from a low of 39% to a high of 68%, with the majority above 50%. As shown in Figure 7, the residential sector remains relatively consistent, with HVAC replacement and whole-home efficiency projects consisting of roughly 55% soft costs, while the insulation and air sealing project consists of roughly 65% soft costs. Cadmus hypothesizes that this results from lower equipment/materials costs for an insulation and air sealing project, given both HVAC replacement and whole-home efficiency projects contain an ASHP.

In the commercial sector, soft cost estimates as a percentage of total project costs prove more variable, likely due to two factors:

1. The projects themselves contain greater variability in terms of scope, timeline, and measures
2. These estimates' sample sizes are lower than those in the residential sector, which increases the probability of having a non-representative sample

FIGURE 7. HARD VS. SOFT COST ESTIMATED BREAKDOWN PER PROTOTYPICAL PROJECT



Note: Percentages presented in this chart are relative to total project cost estimates for a specific prototypical project. That is, a soft cost percentage being higher, for example with Insulation and Air Sealing compared to Whole-Home Efficiency, does **not** indicate that the Insulation and Air Sealing prototypical project has higher absolute soft costs. Numbers may not add to 100% due to rounding.

Cadmus discussed the proportional hard and soft cost estimates shown in Figure 7 with market experts. With few exceptions, market experts stated that the relative estimates are approximately consistent with their experiences in the market. However, one market expert noted that they expected the share of hard costs to be greater for performance contract projects, as these projects tend to be highly customized and therefore soft cost intensive. Another contractor corroborated this statement, noting that ESCOs' material costs (hard costs) tend to be low relative to other project costs.

SOURCES OF SOFT COSTS

A few trends emerge when looking at soft costs on only a sector level, as shown in Table 10. First, installation labor composes approximately one-half of project soft costs across sectors and poses the largest contributor to soft costs. Marketing and customer acquisition represent the next-largest soft cost category, accounting for about one-fourth of soft costs in the residential and commercial sectors. One market expert explained that they expected marketing and customer acquisition costs to be the largest soft cost category, noting that in some cases, marketing and customer acquisition costs might be even greater than installation labor. Notably, marketing and customer acquisition costs are lowest in the multifamily sector, with only 14% of prototypical project soft costs consisting of marketing and acquisition. Cadmus suspects this may be affected by sample sources used for the project, as discussed in the *Methodology* section.

Additionally, Cadmus found very small recruiting and hiring costs across sectors, composing only 0%–1% of total project soft costs. This may result from numerous factors:

- The final sample had a large number of firms below 10 employees (77% across all sectors), which may not be looking to grow
- Recruiting and hiring work may be completed by others in the firm, so respondents may not know the true cost
- Respondents may include recruiting and hiring costs in a broader "workforce development" category, thus mentally accounting for these costs in the "Transaction Costs" category.

As is clear in Table 10, there is a higher spread of soft cost category estimates in the commercial sector as compared to the residential sector. While in the residential sector there is no more than a four percentage point difference in the soft cost percent breakdown by prototypical project, the commercial sector has three soft cost categories with estimate spreads above 20 percentage points: installation labor (45 percentage points), marketing and customer acquisition (26 percentage points), and transaction costs (20 percentage points). As discussed in the *Hard vs. Soft Costs* section, the variability in prototypical project scope and comparatively lower sample sizes (relative to residential) likely contributed to the increased spread.

KEY FINDINGS

The breakdown in hard vs. soft costs and by soft cost category was relatively consistent in the residential sector, with variation below 5 percentage points, while greater variability existed in the commercial sector.

Installation labor was consistently the largest contributor to sector-level soft costs, accounting for nearly half of soft cost estimates. Following this was marketing and customer acquisition costs for the residential and commercial sectors, while transaction costs played a bigger role in the multifamily sector.

TABLE 10. SOFT COST CATEGORY AVERAGES AND SPREAD BY SECTOR

SOFT COST CATEGORY	RESIDENTIAL (N=129-145)	COMMERCIAL (N-33-42)	MULTIFAMILY (N=8-11)
Marketing and Customer Acquisition	27% (26%-28%)	21% (12%-38%)	14%
Project Design	5% (4%-6%)	7% (6%-10%)	8%
Installation	51% (50%-54%)	53% (24%-69%)	48%
Transaction Costs (Trainings, Certifications, Permits)	11% (9%-12%)	13% (5%-25%)	20%
Quality Assurance	5% (3%-5%)	6% (3%-9%)	10%
Recruiting and Hiring	1% (0%-1%)	0% (0%-1%)	1%

Note: Columns may not add to 100% due to rounding. Differences across sectors within a soft cost category are solely directional and not statistically significant at the 80% confidence interval.

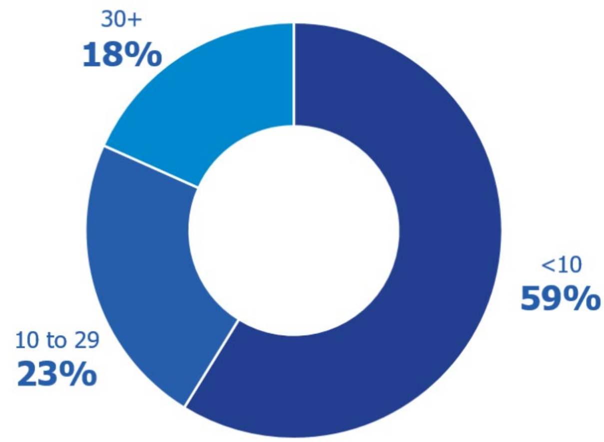
RESIDENTIAL SECTOR

This section details soft cost results for the residential sector. The section begins with a sector-level view of soft costs, then moves into the three prototypical projects: HVAC replacement, insulation and air sealing, and whole-home efficiency. Each section contains the following types of information:

- Soft cost estimates for prototypical projects
- Drivers of soft costs variation (i.e., win rate, contractor region, etc.)
- Additional soft cost-related topics (i.e., supply chain/stocking, project financing, etc.)

Additionally, the sector-level section contains results from decision-maker surveys.

FIGURE 8. NUMBER OF EMPLOYEES



Source: Residential Contractor Survey Q F1 “Including yourself, approximately how many employees work for your company in New York state?” (n=153).

SECTOR-LEVEL

This section details soft costs at the residential sector level. Cadmus gathered responses from 185 residential contractors, 114 of whom completed a HVAC project, 39 completed an insulation project, and 32 completed a whole-home efficiency project within the past 12 months. Of surveyed contractors, 73% primarily worked in upstate New York and 27% worked downstate. Most respondents (59%) worked in a company employing fewer than 10 employees, as shown in Figure 8.

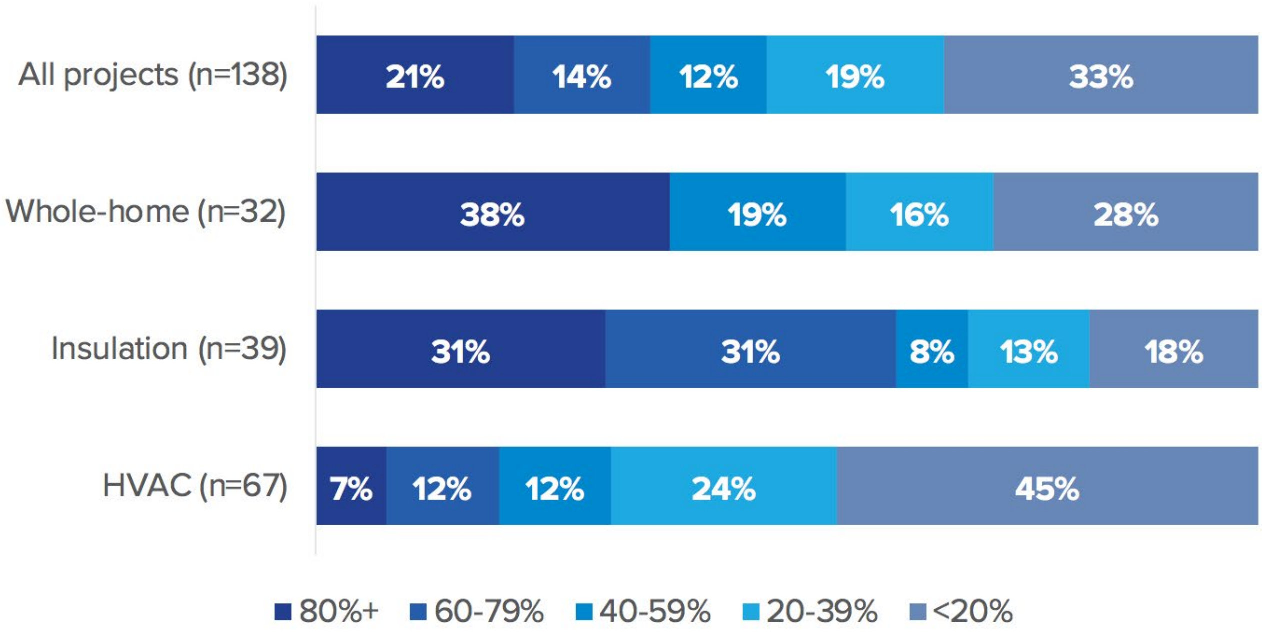
One-third of respondents (33%) said less than 20% of their company’s revenue came from the selected projects (i.e., HVAC replacement, insulation and air sealing, or whole-home efficiency project) in a residential building. Figure 9 shows these results by project type.

As shown in Table 11, soft costs remain relatively consistent across the three residential-sector prototypical projects. Some small differences do occur, directionally suggesting that transaction costs (permitting, training and certifications, and licensing) make up a smaller portion of soft costs for insulation contractors when compared to HVAC or whole-home efficiency contractors. Given the greater complexity involved with HVAC replacements and whole-home efficiency projects (both involving ASHP installations), this finding proved consistent with Cadmus’ expectations.

As shown in Table 12, examining soft costs by absolute values tells a similar story regarding the percentage breakdowns. In three categories (marketing and customer acquisition, installation labor, and transaction costs) values for HVAC replacement, insulation, and air sealing roughly sum to values for whole-home efficiency. Though expected for installation and transaction costs, due to the prototypical project design (the whole-home efficiency project specifications combines measures from the HVAC replacement and insulation and air sealing projects), this seems somewhat counter-intuitive for marketing and customer acquisition, as one would expect some economies of scale[12] from a customer-acquisition perspective.

[12] Economies of scale in the principle that as a company grows larger, it can use resources more efficiently and thus lower the cost per project.

FIGURE 9. PROJECT REVENUE



Source: Residential Survey Q A3 “In the past 12 months, approximately what percent of your company's revenue came from [PROJECT] in [SECTOR] buildings?”

Note: the “All Projects” value is a combination of all residential contractors. The 21% value for 80%+ means that 21% of residential contractors said that 80% or more of their revenue came from work involving the specific prototypical project technology they were asked about in the survey.

A possible explanation may be the relatively challenging sales pitch typically needed to sell whole-home efficiency projects to customers, as measures included in the whole-home efficiency project (e.g., ASHP, adding insulation, air sealing home) constitute a considerably larger investment and are not often completed in tandem.

Based on the prototypical project specifications (building size and type), Cadmus estimates that a 3.5-ton system would be the proper size for the HVAC Replacement project and a 3-ton system for the Whole-Home Efficiency project.[13] This equates to soft costs per thermal ton of $1,343 for HVAC Replacement and $3,329 for Whole-Home Efficiency.

Figure 10 shows the distribution of aggregated residential soft costs by category. The violin plot represents the spread of cost estimates (i.e., estimates are more widely dispersed for a long tail and/or a longer body shape). For example, project design costs in the residential sector center closer to zero, while marketing and customer acquisition, installation, and QA/QC costs disperse more widely. Soft costs with a larger spread (i.e., wider across a larger part of the x-axis) represent a reduction opportunity, as some contractors doing a similar job spend more than others. The prototypical project-specific subsections that follow explore soft costs with a high spread.

[13] The HVAC Replacement system sizing assumes the home has standard insulation and air sealing. In contrast, the Whole-Home Efficiency prototypical project sizing assumes the home received comprehensive air sealing and insulation improvements at the time of heat pump installation Cadmus has found that air sealing and insulation improvements might typically reduce the heating load by 10-20%. Thus, Cadmus assumed a reduction in heating load by 15% for the Whole-Home Efficiency project as compared to the Residential HVAC Replacement project.

TABLE 11. RESIDENTIAL SECTOR SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	SOFT COST COMPONENT	HVAC REPLACEMENT (N =69-98)	INSULATION AND AIR SEALING (N=22-30)	WHOLE-HOME EFFICIENCY (N=18-30)	AVERAGE
Marketing & Customer Acquisition	• Marketing and/or customer education • Bid preparation • Project signing/ contracting	26%	27%	28%	27%
Project Design	• Designing, scoping, and customizing the project	5%	6%	4%	5%
Installation	• Installation labor	50%	54%	53%	51%
Transaction Costs	• Obtaining permits • Acquiring and maintaining trainings, certifications, and licenses	12%	9%	11%	11%
QA/QC	• QA/QC activities • Required callbacks to the customer to assist with equipment issues/ servicing	5%	4%	3%	5%

TABLE 12. RESIDENTIAL SOFT COST CATEGORY ABSOLUTE VALUES

SOFT COST CATEGORY	HVAC REPLACEMENT (N =69-98)	INSULATION AND AIR SEALING (N=22-30)	WHOLE-HOME EFFICIENCY (N=18-30)
Marketing and Customer Acquisition	$1,215	$1,565	$2,834
Project Design	$248	$357	$416
Installation	$2,337	$3,138	$5,259
Transaction Costs (Trainings, Certifications, Permits)	$582	$523	$1,105
Quality Assurance	$251	$229	$328
Recruiting and Hiring	$68	$35	$46
Total Soft Costs	**$4,702**	**$5,846**	**$9,988**

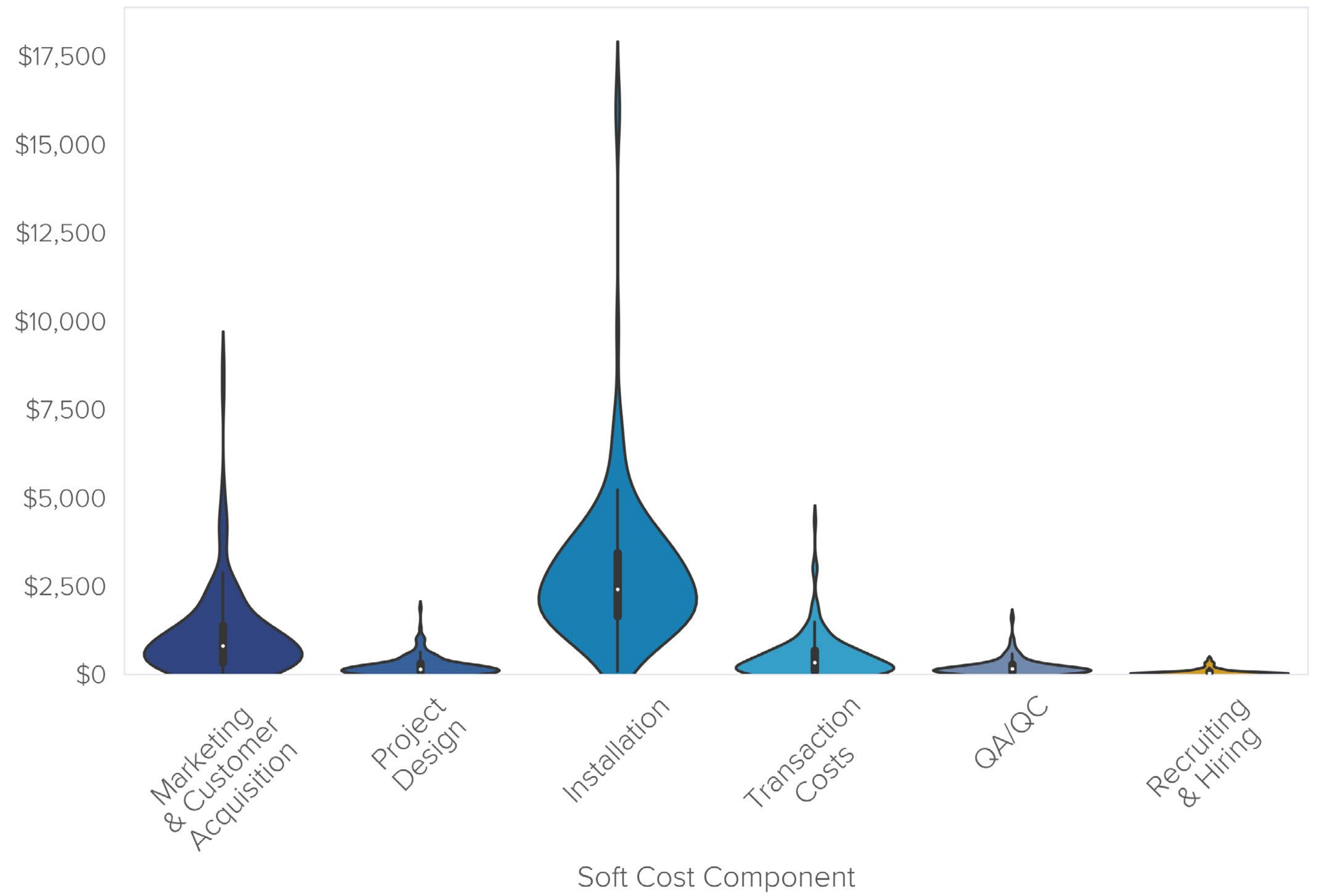
Figure 10 shows the distribution of aggregated residential soft costs by category. The violin plot represents the spread of cost estimates (i.e., estimates are more widely dispersed for a long tail and/or a longer body shape). For example, project design costs in the residential sector center closer to zero, while marketing and customer acquisition, installation, and QA/QC costs disperse more widely. Soft costs with a larger spread (i.e., wider across a larger part of the x-axis) represent a reduction opportunity, as some contractors doing a similar job spend more than others. The prototypical project-specific subsections that follow explore soft costs with a high spread.

DRIVERS OF SOFT COSTS

This section describes soft cost drivers at the sector-level. In most cases, residential sector-level findings are highly consistent with individual, prototypical, project-level findings, as the residential sector-level data are comprised of concatenated data from each of the three prototypical projects. Subsequent sections provide a more detailed analysis for each residential prototypical project.

As shown in Figure 11, firm-by-firm analysis shows that hard and soft costs positively correlate (r=0.46). That is, companies with higher hard costs also tend to have higher soft costs. Additionally, the marker colors of the Figure 11 scatterplot capture the differences in hard and soft costs between prototypical program types as well as the sample size for each prototypical program type. Insulation costs, for example, have hard and soft costs clustered at lower values, while whole-home costs show generally larger hard and soft cost values and little evidence of clustering.

FIGURE 10. RESIDENTIAL SECTOR SOFT COSTS VIOLIN PLOT



Cadmus utilized linear regression models to assess the degree to which residential sector soft costs can be explained by the firmographic variables collected. Residential sector-level regression results remain highly consistent with those of individual program components.

Table 13 shows regression estimates for residential sector project soft costs, regressed on firmographic variables. Except for the win rate (percent of bids prepared that a respondent reports turned into a contract), firmographic variables included in the regression model had little explanatory power over total soft costs in the residential sector). The estimated win rate coefficient suggests that, for every 1% increase in the win rate, residential contractors spend an average of $32.62 less per project, all else equal.

This effect size can be best characterized by relating the estimated coefficient to the interquartile range of residential win rates. On average, residential contractors at the 75th percentile of win rates (67% win rate) have $1,272 lower average soft costs than contractors at the 25th percentile of win rates (28% win rate), all else equal. This suggest that improving a contractor's win rate is associated with a drastic reduction in soft costs. Figure 12 shows this trend graphically, excluding controls included in the regression model.

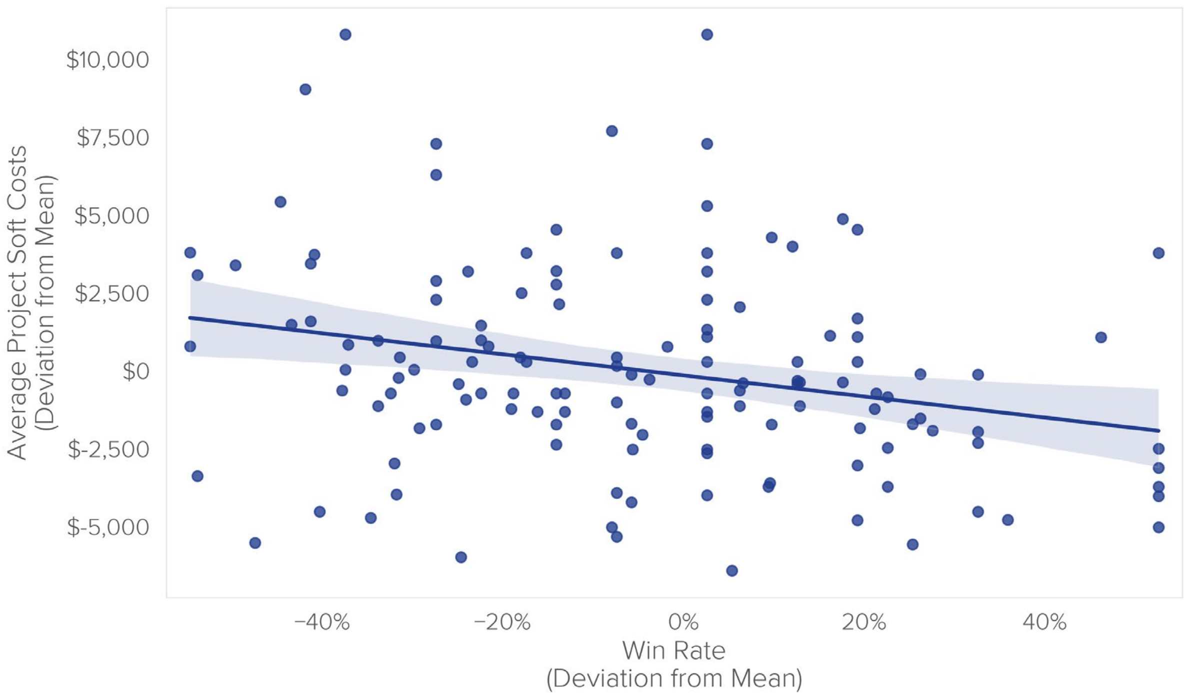
FIGURE 11. RESIDENTIAL SECTOR HARD COSTS VS. SOFT COSTS

TABLE 13. RESIDENTIAL TOTAL SOFT COSTS REGRESSION ESTIMATES

DEPENDENT VARIABLE: TOTAL SOFT COSTS			
INDEPENDENT VARIABLE	COEFFICIENT	STANDARD ERROR	P-VALUE
Intercept	5827.43	1031.39	0.00***
Region (=Upstate)	-375.66	723.85	0.61
Employees	24.25	16.42	0.14*
Installations	-0.76	1.49	0.61
Percent revenue bin (1-5)	93.38	257.22	0.72
Win Rate	-32.62	13.01	0.01***
HVAC Replacement Fixed Effects	1365.64	394.93	0.00***
Insulation and Air Sealing Fixed Effects	-380.19	741.06	0.61
Whole-Home Efficiency Fixed Effect	4841.97	739.25	0.00***
n	97		
R^2	0.319		
Adjusted R^2	0.266		

Note: Standard errors in parentheses. * p < 0.20, ** p < 0.10, *** p < 0.05. Prototypical project fixed effects included to control for differences in means soft cost values among prototypical projects.

FIGURE 12. RESIDENTIAL AVERAGE PROJECT SOFT COSTS VS. WIN RATE

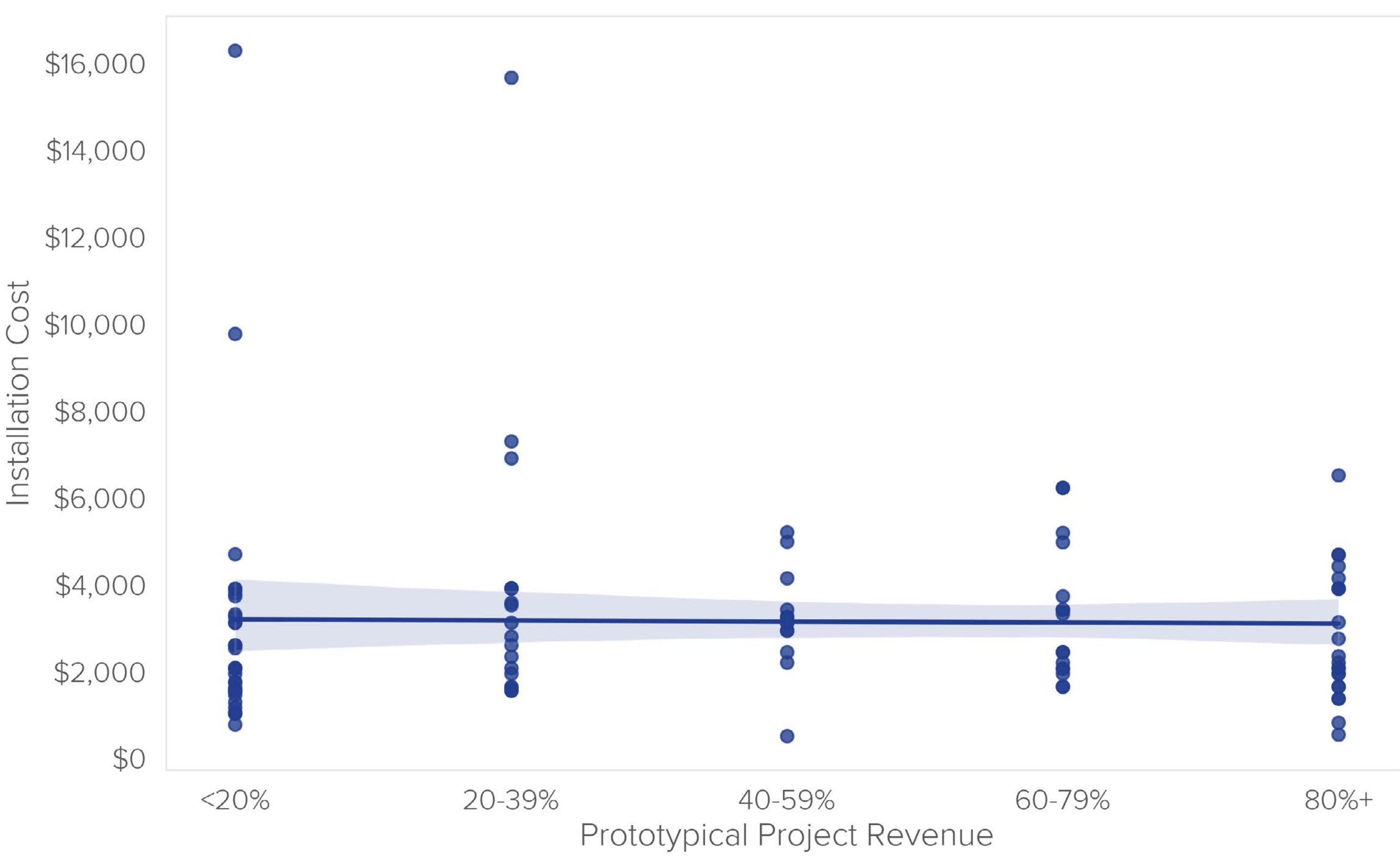


Note: Average project soft costs and win rate have been centered to a mean of 0 to make programs directly comparable. Consequently, tick labels on the corresponding axes should be interpreted as deviations from the mean value for each prototypical project type.

INSTALLATION LABOR

Cadmus also examined the relationship between installation costs for the residential prototypical project type and the percent share of revenue each company attributed to the prototypical project type. As discussed in subsequent sections, insulation and air sealing as well as whole-home efficiency projects exhibited strong negative relationships between these two variables, suggesting that companies with more revenue attributed to these prototypical project types exhibit “expertise” efficiencies that non-specialist firms do not. The strength of this relationship does not prevail when considering all residential prototypical project types jointly. The trend’s weakness is attributed to the large sample size for HVAC replacement (for which no trend was observed) suppressing the trend of insulation and air sealing and whole-home efficiency, which have smaller sample sizes.

FIGURE 13. INSTALLATION COSTS VS. PERCENT REVENUE FROM RESIDENTIAL PROTOTYPICAL PROJECT TYPE



PERMITTING

Lastly, Cadmus explored the relationship between the contractor's region and permitting costs, as prototypical project-level findings show differences in the distributions of permitting costs for upstate and downstate contractors. Regression results shown in Table 14 show estimated coefficients for a regression of residential-sector permitting costs on firmographic variables, including the region.

The estimated coefficient for the region indicator variable suggests that residential contractors in upstate New York spend an average of $224 less on permitting costs than do residential contractors in downstate New York, all else equal. Figure 14 illustrates this relationship graphically, excluding the controls included in the regression model. Subsequent sections show this relationship varies, depending on the prototypical project type.

The regression model estimates reported in Table 14 present a second, noteworthy finding: the HVAC Replacement fixed-effects coefficient, which captures the average difference in permitting costs for residential HVAC contractors relative to other residential sector contractors. This coefficient indicates that HVAC replacement contractors spend an average of $202 more on permitting costs than do other residential sector contractors, with all else equal. Figure 14 plots the distribution of residential permitting costs for upstate and downstate contractors, with the vertical lines indicating median values for each group. The differential between median permitting costs for downstate and upstate New York contractors, as indicated by the respective vertical lines, show that downstate New York contractors spend more on average than do upstate New York contractors

TABLE 14. RESIDENTIAL PERMITTING COSTS REGRESSION ESTIMATES

DEPENDENT VARIABLE: PERMITTING COSTS			
INDEPENDENT VARIABLE	COEFFICIENT	STANDARD ERROR	P-VALUE
Intercept	193.53	84.9	0.03***
Region (=Upstate)	-223.55	57.44	0.00***
Employees	-1.66	1.45	0.26
Installations	-0.085	0.12	0.481
Percent revenue bin (1-5)	40.46	21.5	0.06***
Win rate	1.2	1.04	0.25
HVAC Replacement Fixed Effects	201.99	33.14	0.00***
Insulation and Air Sealing Fixed Effects	-22.01	58.26	0.71
Whole-Home Efficiency Fixed Effect	13.55	60.52	0.82
n	89		
R^2	0.336		
Adjusted R^2	0.279		

QA/QC AND DESIGN COSTS

Cadmus analyzed the extent to which a company's design spending relates to the company's QA/QC spending. Two reasonable hypotheses emerged regarding the character of 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 nature and ultimately spend more on QA/QC after installation.

Figure 15 characterizes this relationship for each of the three residential project categories. While the relationship remains positive for each of these, the best-fit relationship (red line) is most prominent for whole-home efficiency. While the strength of this relationship may be attributed to random chance induced by the small sample size of the data (as illustrated by the wide 95% confidence interval shaded in orange), it may also be partly attributed to more comprehensive nature of whole-home efficiency improvements, which demand that contractors not only spend more time on design, but also spend more time on QA/QC for the numerous measures installed.

FIGURE 14. RESIDENTIAL PERMITTING COSTS DISTRIBUTION AND MEAN BY REGION

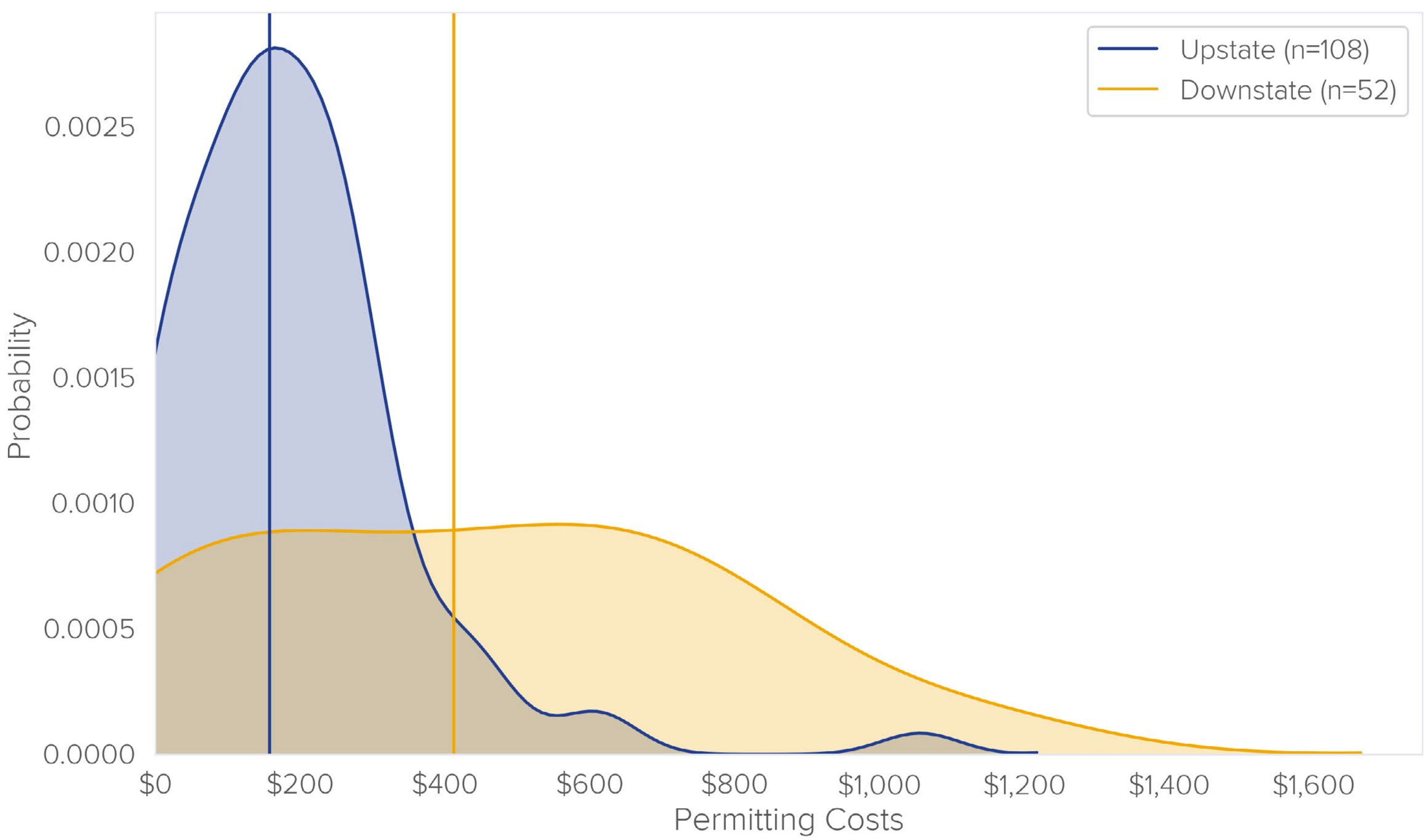
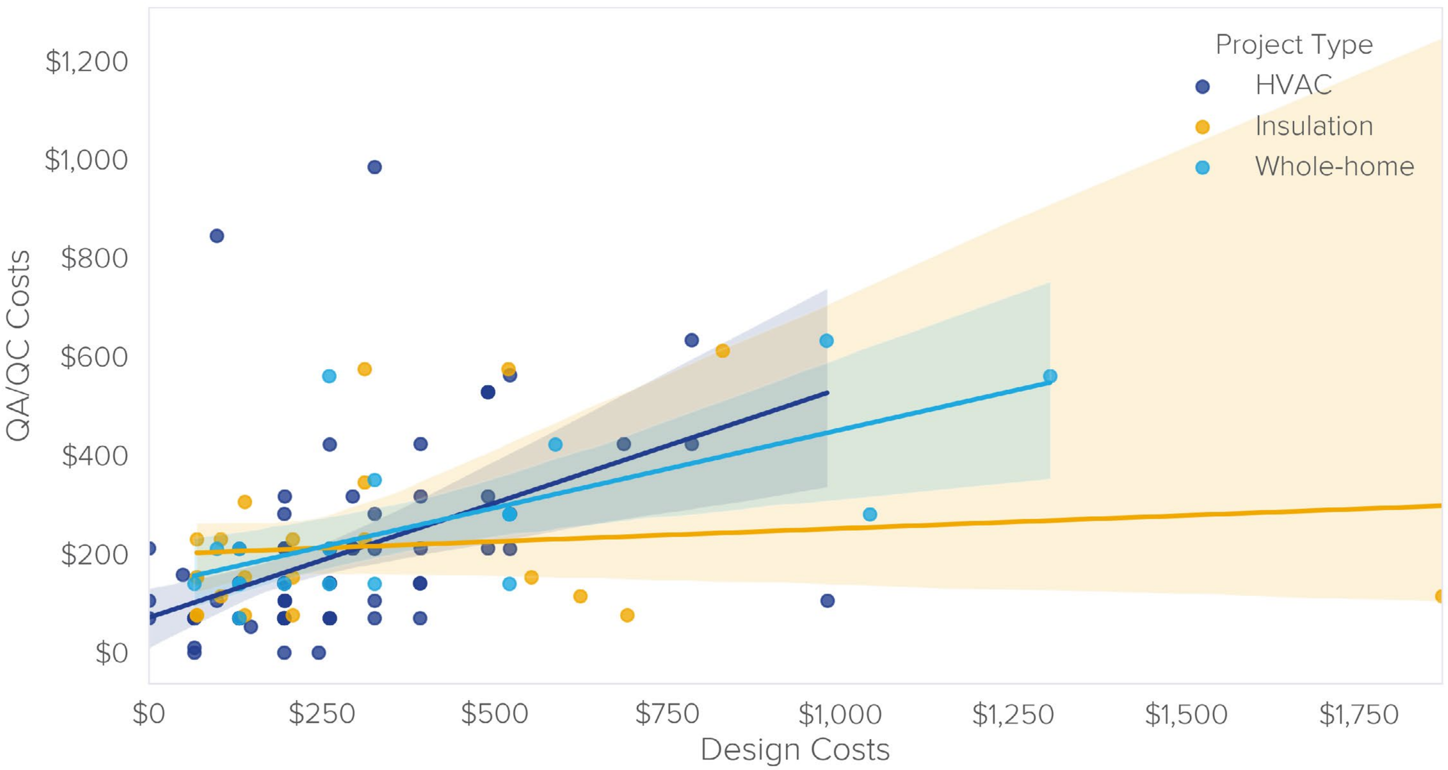


FIGURE 15. QA/QC DESIGN COST CORRELATIONS



ADDITIONAL TOPICS

In addition to soft cost-related questions (comprising the bulk of the survey), Cadmus asked contractors another set of questions to provide context around their soft cost responses and to explore topics of interest identified by NYSERDA that could not be incorporated into the soft cost quantification.

EQUIPMENT-STOCKING PRACTICES

Cadmus asked questions regarding equipment-stocking practices. Contractors reported a variety of equipment stocking practices: more than one-third of respondents (42%; n=96) said they kept equipment in stock to have it readily available for customers, and almost one quarter of respondents (23%; n=95) said they encountered issues acquiring equipment. The two most common issues respondents encountered related to stocking issues on the supplier's end and delivery delays. Other stocking issues included long lead times, increasing material costs, and increased demand for certain items during the year.

FINANCING

Cadmus asked contractors if they encountered clients who had difficulty securing financing to complete their projects. More than one-quarter of respondents (28%; n=95) said they encountered clients that experienced difficulty securing financing Contractors reported their clients primarily experienced two financing issues: low credit scores/ inability to qualify for financing (78%), and a lack of incentives or complexity of current incentives (11%; n=27). Upstate contractors encountered clients with financing issues at a slightly higher rate than downstate contractors (23% and 16%, respectively).

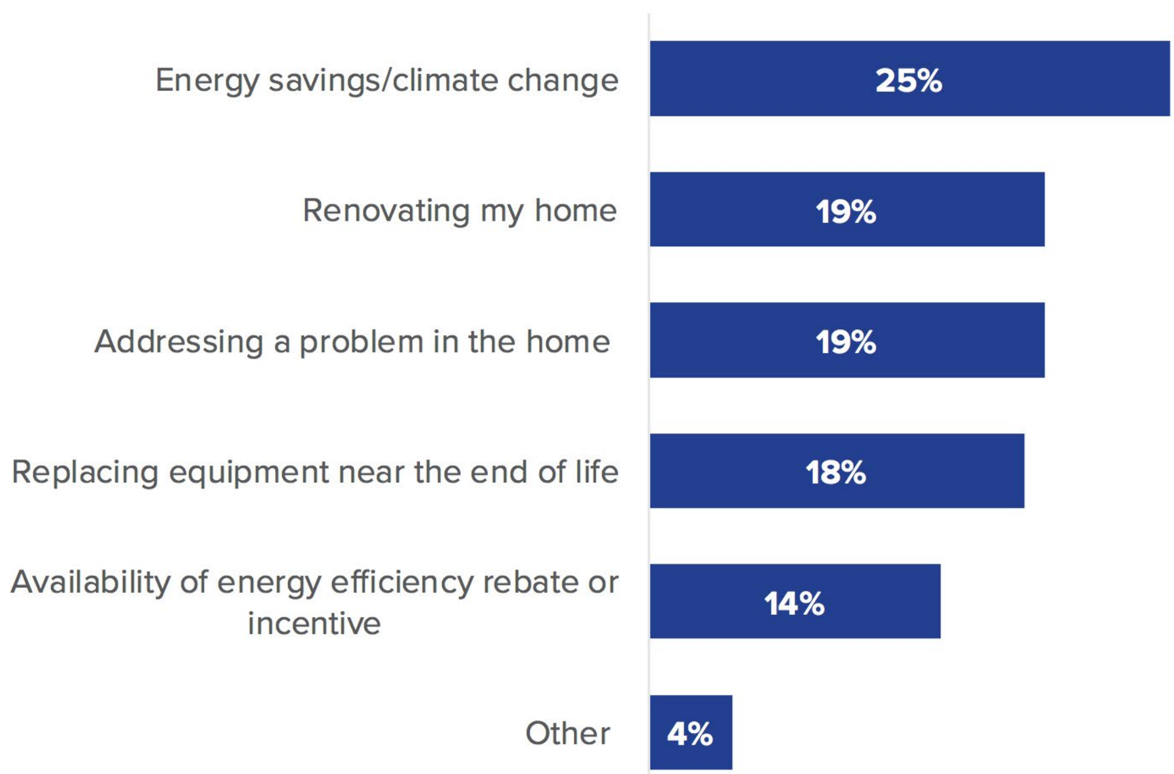
DECISION-MAKERS

Cadmus gathered survey responses from 207 residential decision-makers, with 46% completing a home energy audit before finishing their energy efficiency project. Whole-home decision-makers were twice as likely to have an energy audit completed before the project (66%; n=24), compared to insulation (38%; n=30) and HVAC (35%; n=68).

Cadmus asked residential decision-makers about their primary motivations to complete an energy efficiency project. One-quarter of respondents cited energy savings and home renovations as the top two factors, as shown in Figure 16. More than one-half of respondents (53%; n=96) received financial assistance that covered the project's entire cost.

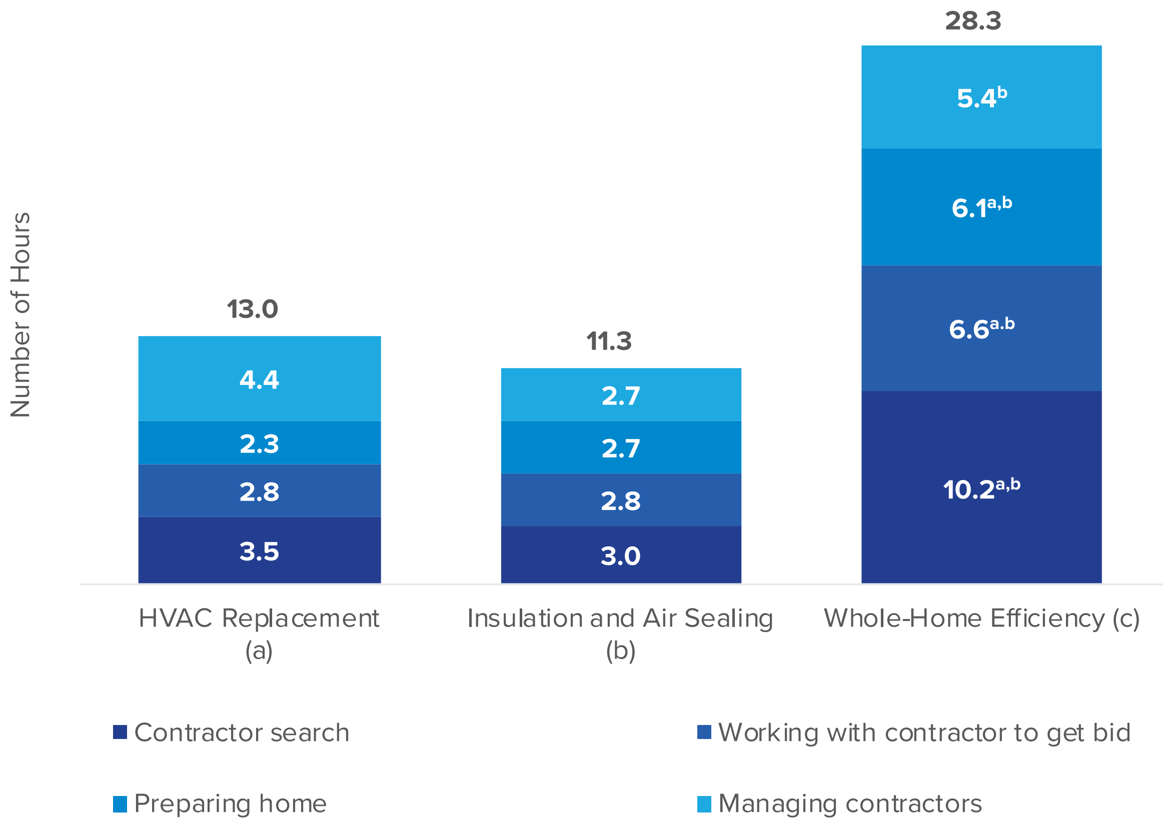
A small percentage of respondents reported issues with acquiring financing to complete their projects (10%; n=203). In contrast to contractor responses, none of the decision-maker respondents identified low credit scores or an inability to qualify for a loan as barriers to project financing.

FIGURE 16. PRIMARY MOTIVATORS FOR DECISION-MAKERS



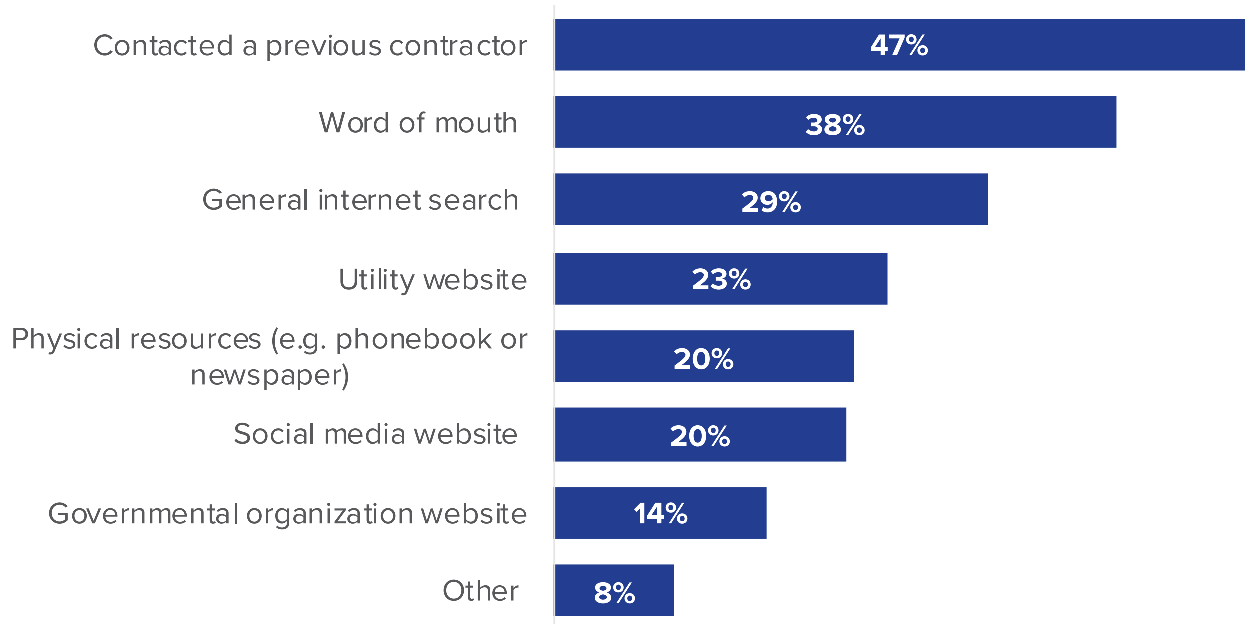
Source: Residential Decision-maker Survey Q B2 "What was your primary motivation for completing this [Field-PROJECT_TYPE] project?" (n=99)

FIGURE 17. TIME SPENT ON PROJECT DESIGN



Note: Differences are denoted by letters and are significant at the 90% confidence interval.

FIGURE 18. CONTRACTOR SEARCH METHODS USED



Source: Decision-Maker Survey Q C1 "What sources did you use to search for a contractor to complete the [PROJECT_TYPE] project?". Multiple responses allowed. (n=207)

As shown in Figure 17, decision-makers completing a whole-home project spent significantly more time across nearly all project preparation and design aspects, including time spent searching for a contractor, working with contractors to procure bids, preparing their house for the work, and managing contractors while the project was in progress.

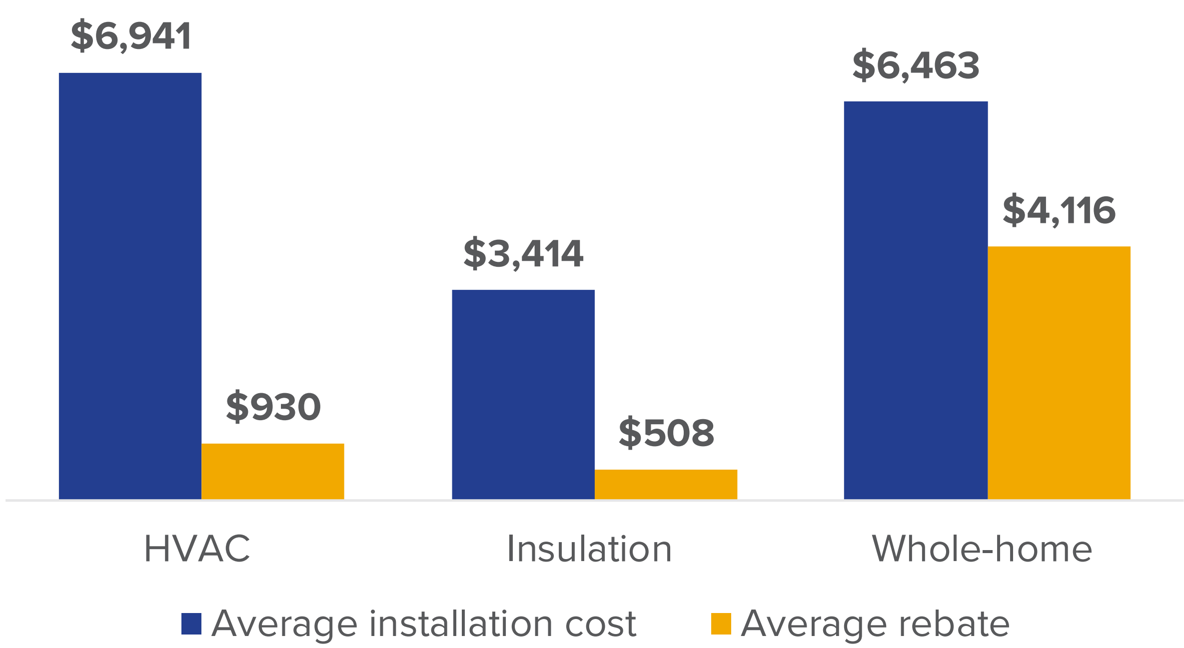
As shown in Figure 18, respondents most commonly used a contractor they had previously worked with (47%) or found a contractor through word-of-mouth (38%) to complete their home efficiency projects.

For decision-makers in the residential sector, HVAC and whole-home efficiency projects cost significantly more than insulation projects, as expected due to the installation of an ASHP (Figure 19). Respondents completing a whole-home project (n=34) required an additional 22 hours, on average, to acquire financing necessary to undertake the project.[14] Time spent on HVAC (n=21) and insulation (n=8) projects required approximately four hours to acquire financing.

Cadmus asked respondents about quality assurance and quality control costs required after completing projects. Of 201 respondents, 18% had to call their contractor back for repair and maintenance issues. Time spent contacting, scheduling, and managing contractors for repairs averaged 4.1 hours for HVAC replacement (n=15), 2.3 for insulation and air sealing (n=3), and 3.9 for whole-home efficiency (n=19). As shown in Figure 20, whole-home projects had, on average, the most expensive labor and material costs for repairs.

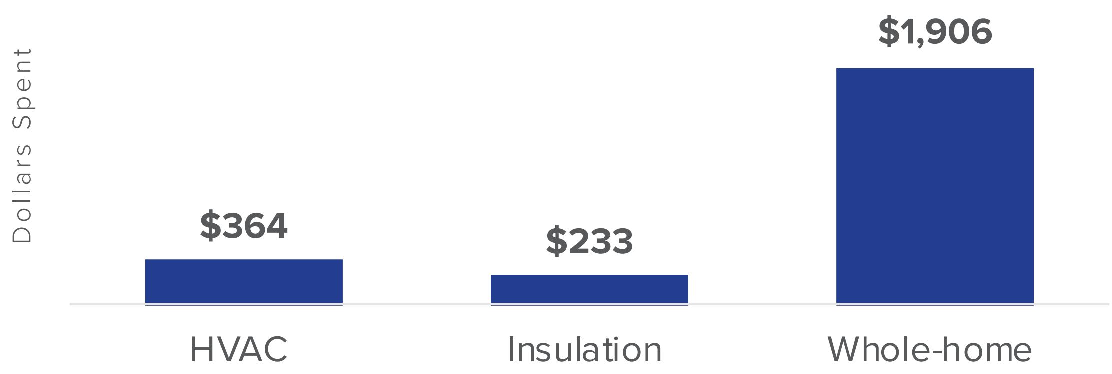
[14] While the question specifically asked about financing, Cadmus anticipates that some respondents may be including time needed to complete a rebate application.

FIGURE 19. AVERAGE INSTALLATION COSTS AND REBATE



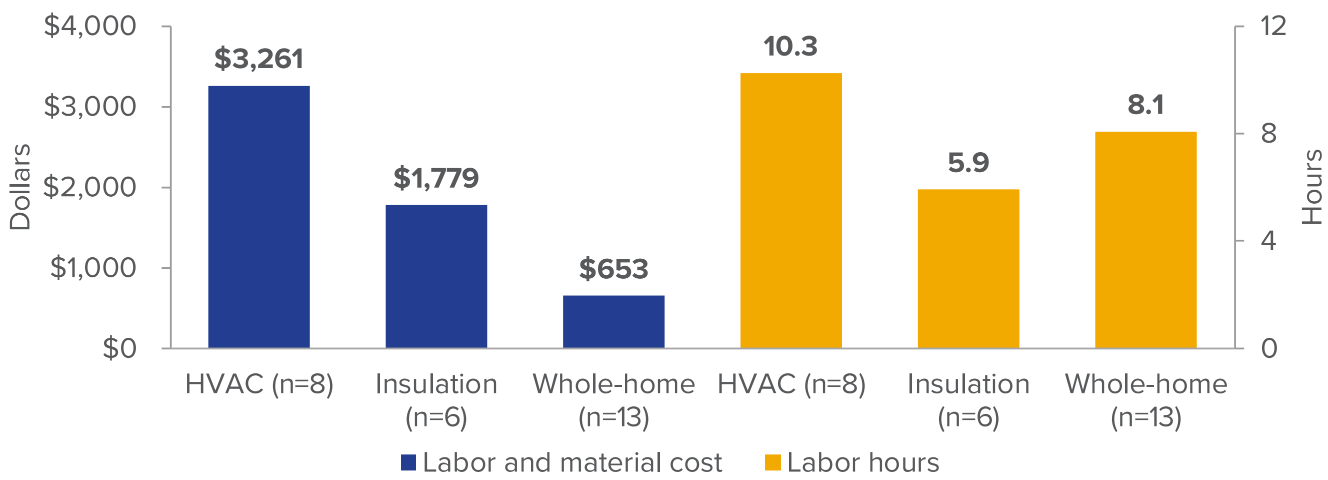
Source: Residential Decision-Maker Survey Q E1 “What was the total installed cost for the [PROJECT_TYPE] project? Please include everything you paid, including contractor labor to install the equipment and the materials themselves.” Note: Differences are denoted by letters and are significant at the 95% confidence interval. Installation cost: HVAC n=68; Insulation n=70; and Whole-home n=68. Average rebate: HVAC n=13; Insulation n=6; Whole-home n=18.

FIGURE 20. LABOR AND REPAIR COSTS



Source: Residential Decision-Maker Survey Q F1 "About how much (in dollars) did you spend on the contractor(s) you hired to fix the issue(s)? Please include the total cost you paid, both labor and materials." HVAC n=15; Insulation n=3; and Whole-home n=19.

FIGURE 21. DIY LABOR AND MATERIAL COSTS



Source: Residential Decision-Maker Survey Q F8 "About how much (in dollars) did you spend on materials for the repairs needed to fix the issue(s)?" HVAC replacement labor and material costs ranged from $4 to $25,000. Labor and material costs averaged $155 if excluding the outlier response of $25,000.

Less than one-quarter (13%; n=202) of respondents completed repairs on their own after completing their projects. These DIY repairs took an average of 10.3 hours for HVAC replacement (n=8), 5.9 for insulation and air sealing (n=6), and 8.1 for whole-home efficiency (n=13). The DIY group's labor and material costs for repairs were the most expensive for HVAC replacement projects, as shown in Figure 21.

KEY FINDINGS: RESIDENTIAL

Win rate is a key explanatory variable on sector-level soft costs, with residential contractors at the 75th percentile of win rates (67% win rate) reporting soft costs $1,250 lower than contractors at the 25th percentile of win rates (28% win rate).

A positive relationship exists between QA/QC and project design costs, most prominently for the whole-home efficiency prototypical project and least for the insulation prototypical project.

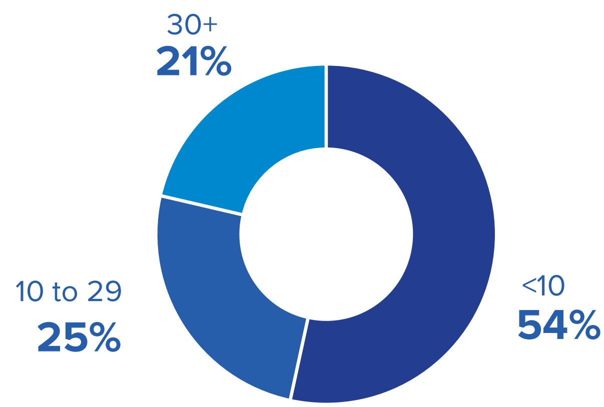
The spread of permitting costs is wider for downstate contractors than for those upstate, suggesting a more complex permitting landscape that downstate need to navigate.

Decision-makers completing a whole-home efficiency project report spending nearly twice as much time finding and managing contractors as decision-makers completing an HVAC replacement or insulation and air sealing project.

HVAC REPLACEMENT

This section details soft costs for the residential HVAC replacement project, specifically reviewing the prototypical project soft cost estimates, soft cost drivers, and additional related topics. Cadmus gathered responses from 114 residential contractors who completed an HVAC replacement project within the previous 12 months; 72 contractors were located upstate; and 39 were located downstate.[15] Over one-half of respondents (53%) worked for a company that employed fewer than 10 employees, as shown in Figure 22.

FIGURE 22. HVAC CONTRACTORS' NUMBER OF EMPLOYEES



Source: HVAC Contractor Survey "Including yourself, approximately how many employees work for your company in New York state?" (n=103)

[15] Of those contractors, almost one-half (45%, n=67) said less than 20% of their company's revenue came from installing ductless mini-split ASHPs in existing single-family homes.

TABLE 15. HVAC REPLACEMENT PROTOTYPICAL PROJECT DETAILS

ATTRIBUTE	DEFINITION
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	Standard efficiency, gas-powered condensing boiler for heating; window AC units for cooling
Equipment to be Installed	Ductless heat pump with 1 outdoor unit and 3 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 16. HVAC REPLACEMENT HARD AND SOFT COST ESTIMATES

METRIC	MEAN	STANDARD DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Total Installed Cost	**$12,201**	**$4,449**	**$9,050**	**$15,000**	**102**
% Soft Costs	**55%**	**14%**	**46%**	**65%**	**102**
Value Soft Costs	**$6,722**	**$3,367**	**$4,675**	**$8,177**	**97**
% Hard Costs	**45%**	**14%**	**35%**	**54%**	**102**
Value Hard Costs	**$5,387**	**$2,094**	**$3,763**	**$7,000**	**98**

PROTOTYPICAL PROJECT COST ESTIMATES

Cadmus asked contractors to provide information on their hard and soft cost expenditures within the last 12 months as well as estimates regarding the residential HVAC replacement prototypical project, outlined in Table 15.

Table 16 summarizes the high-level results. For an average installed project cost of $12,201, 45% of costs were hard (equipment-related) and 55% of costs were soft.

Figure 23 graphs contractors' responses, arranged from the lowest to highest total project cost. This produces a smooth "S"-shaped curve—a typical normal distribution when responses are shown in this manner. Results and insights obtained from this sample set should highly reflect the sampled population.

Figure 23 graphs contractors' responses, arranged from the lowest to highest total project cost. This produces a smooth "S"-shaped curve—a typical normal distribution when responses are shown in this manner. Results and insights obtained from this sample set should highly reflect the sampled population.

From the survey responses, Cadmus concluded with high confidence that downstate project costs were higher than upstate project costs, with an average total project cost of $13,650 downstate and an average total project cost of $11,134 upstate. Soft costs were $1,640 higher downstate compared to upstate while hard costs were only higher by $524. Cadmus also found a higher spread of costs from survey respondents for downstate contractors, which could be due to the complexity of the downstate market compared to upstate. The box-and-whisker plot shown in Figure 24 visually represents the range of reported hard and soft costs by region. The 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.

FIGURE 23. HVAC REPLACEMENT: TOTAL PROJECT COSTS FOR EACH RESPONDENT (N=84)

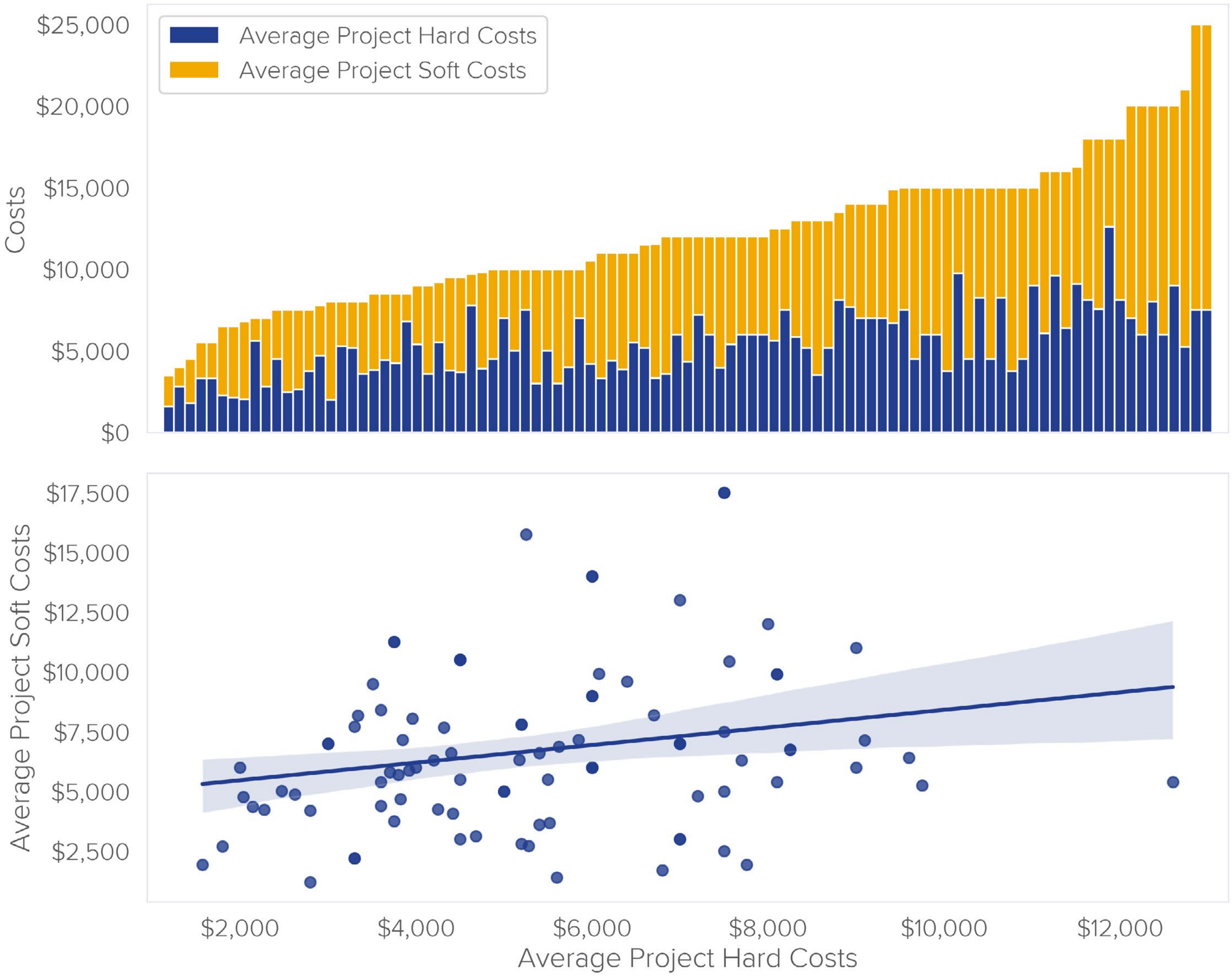


FIGURE 24. HVAC REPLACEMENT PROTOTYPICAL PROJECT COST ESTIMATES: BOX AND WHISKER PLOT BY REGION

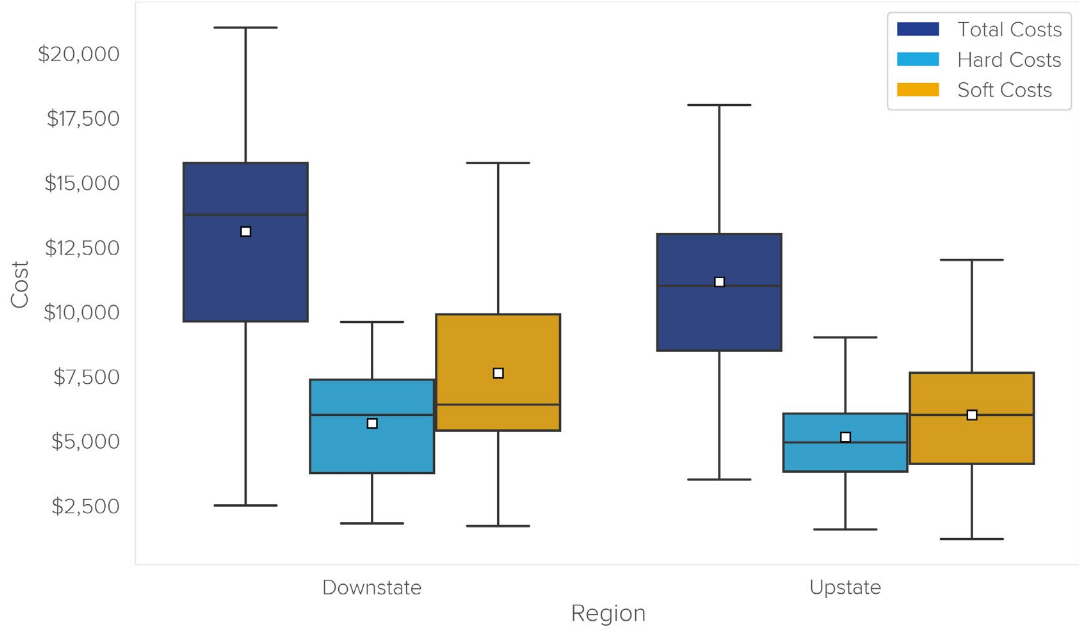


TABLE 17. HVAC REPLACEMENT SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	$1,215	26%	Marketing and/or customer education	$384	$569	$46	$524	84
			Bid preparation	$600	$519	$298	$716	69
			Project signing/contracting	$231	$168	$119	$298	93
Project Design	$248	5%	Designing, scoping, and customizing the project	$248	$190	$131	$294	97
Installation	$2,337	50%	Installation labor	$2,337	$1,021	$1,566	$3,132	95
Transaction Costs	$582	12%	Obtaining permits	$320	$278	$150	$412	93
			Acquiring and maintaining trainings, certifications, and licenses	$261	$316	$65	$319	90
QA/QC	$251	5%	QA/QC activities	$185	$175	$70	$211	98
			Required callbacks to the customer to assist with equipment issues/ servicing	$66	$199	$8	$54	95
Recruiting & Hiring	$68	1%	Recruiting and hiring employees	$68	$101	$0	$87	82

Cadmus also collected data to construct estimates for six specific soft cost categories that contributed to the total soft cost estimate, as summarized in Table 17. Of component costs, installation costs were highest at $2,337 per HVAC replacement project (50%), making up one-half of the estimated project soft costs. Marketing costs, including bid prep costs, made up the second-largest soft cost category at $1,215 per project (26%). These installation and marketing soft costs were very similar to those for whole-home efficiency and insulation and air-sealing prototypical projects, showing consistency in soft costs across the residential sector.

In the data set listed in above and graphed in Figure 25, Cadmus found a wide variation in component soft cost estimates. Installation costs and marketing and customer acquisition costs have the largest spreads in costs estimates. This spread suggests that there is an opportunity for effective contractor training to reduce component soft costs. Efforts focusing on reducing installation costs for contractors that have higher estimated installation cost would likely produce the greatest savings in total soft costs. Another explanation for the wide variation in component soft cost estimates is the diversity of equipment in the HVAC space. As one market expert Cadmus interviewed noted, soft costs tend to be greatest for new equipment, as contractors need to market them differently, be trained in installation, and learn how to establish end-user trust in the systems.

SOFT COST DRIVERS

Cadmus utilized linear regression models to assess the degree that HVAC replacement project soft costs could be explained by firmographic variables, collected by and constructed from the survey data. This section details drivers of total soft costs, installation labor, and marketing and customer acquisition. Table 18 shows regression analysis results for total soft costs; predictive (independent) variables can account for 19% percent of the variations in soft cost responses.

FIGURE 25. HVAC REPLACEMENT SOFT COSTS VIOLIN PLOT

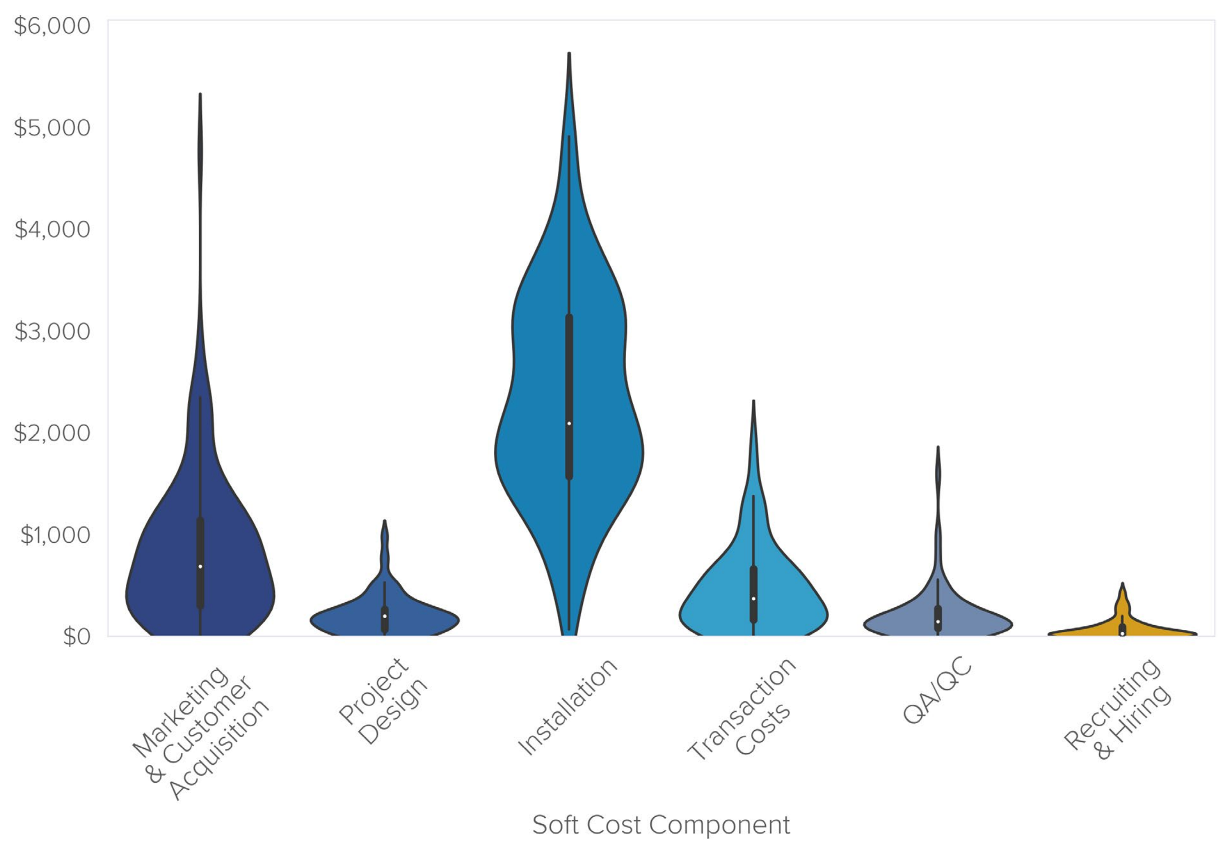


TABLE 18. HVAC REPLACEMENT TOTAL SOFT COSTS REGRESSION ESTIMATES

DEPENDENT VARIABLE: TOTAL SOFT COSTS			
INDEPENDENT VARIABLE	COEFFICIENT	STANDARD ERROR	P-VALUE
Intercept	7347.60	1556.89	0.00***
Region (=Upstate)	-815.60	977.86	0.41
Employees	45.08	22.62	0.05**
Installations	-2.95	4.74	0.54
Percent revenue bin (1-5)	175.71	383.57	0.65
Win rate	-38.54	16.40	0.02***
n	58		
R^2	0.263		
Adjusted R^2	0.192		

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

LARGER FIRMS EXPERIENCE HIGHER SOFT COSTS [MEDIUM CONFIDENCE]:

The regression analysis indicates that, when controlling for all the other variables, increasing a firm's number of employees by 1 will increase soft costs by $45 per project. Firms responding to this survey ranged in size from one employee to 125 employees. These results indicate that, on average, larger firms experienced higher soft costs. For example, the regression predicts that a firm with 50 employees will have an additional $2,205 worth of soft costs per project than a firm with only one employee:

49 *Employees**$45/*Employees*=$2,205 *Additional Soft Costs per HVAC Project*

Cadmus believes several possible factors could explain why larger firms tend to have higher soft costs than smaller firms:

- Larger firms may have more junior staff learning the trade, thus requiring training
- Larger firms may have a stricter interpretation of OSHA standards, which could add more time.
- Smaller firms are more likely to be owner operated, with incentives to reduce costs, while larger firms may have employees whose only compensation comes from wages, not from incentivizes to find efficiencies.

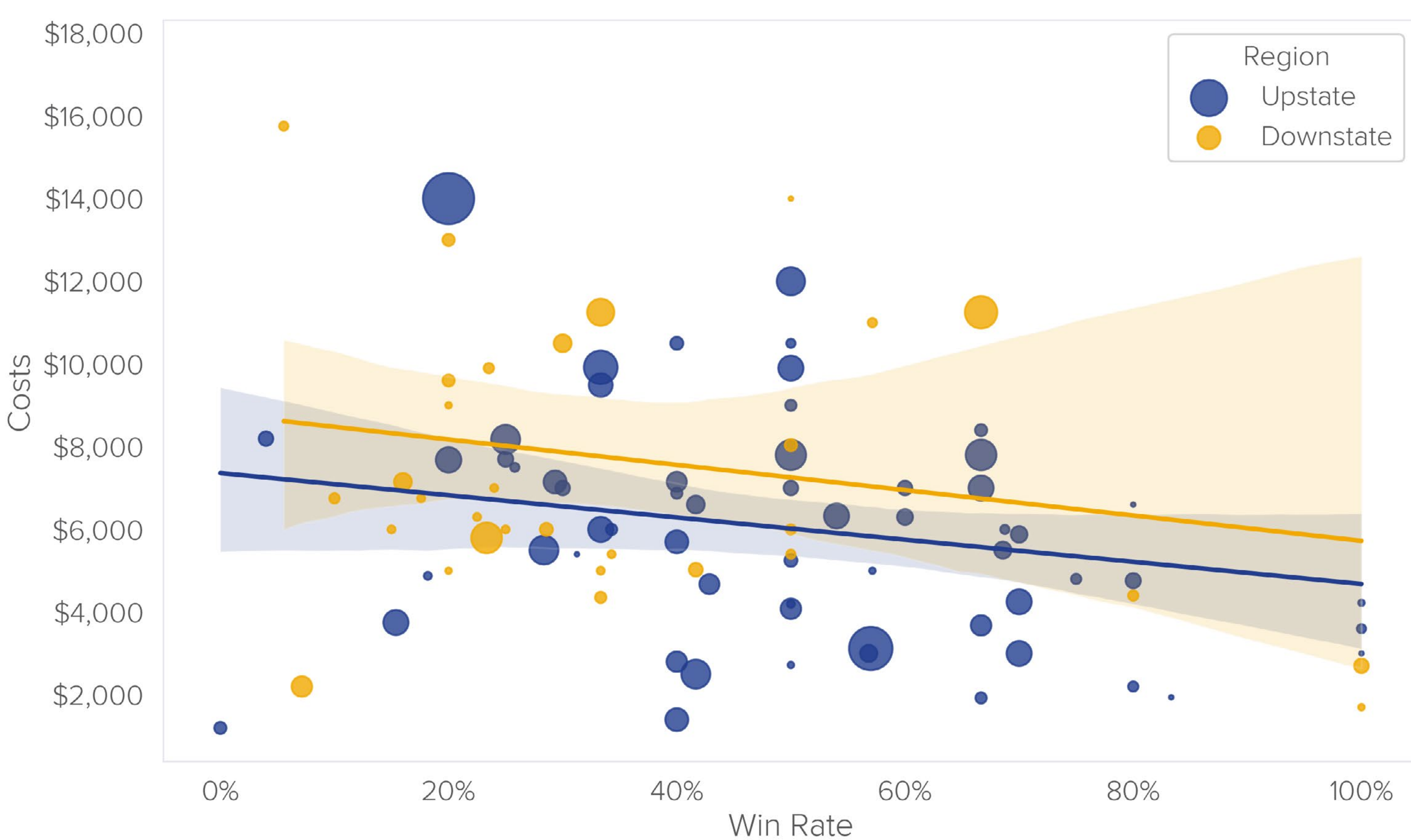
FIRMS WITH HIGH BID WIN RATES HAVE LOWER SOFT COSTS [HIGH CONFIDENCE]:

Through the regression analysis, Cadmus found with very high confidence that increasing a bid win rate will decrease total soft costs. Specifically, an increase in the bid win rate by 1% will decrease total soft costs by $38 per project. This trend can be seen in Figure 26, which shows a scatter plot of bid win rate and soft costs. In this graph, the size of the points indicates the relative size of each company by number of employees. The relatively denser grouping of small points in the upper left side of the graph indicates that firms with the highest bid win rates (over 75%) were typically medium and small firms. One possible explanation is that larger firms likely have more administrative staff whose jobs may include preparing a large number of bids, while smaller firms may rely more on referrals and networking for customer acquisition.

The bid win rate may also serve as a proxy for other firmographic characteristic not captured through the survey. For example, firms with higher bid win rates may have higher referral rates, are more selecting in submitting bids to customers that are not comparing bids, or perhaps firms with high bid win rates acquiring most projects through utility or government programs at a higher rate than other contractors.

Interestingly, the number of annual installations has very little impact on the regression models' predictions, suggesting that firms performing many HVAC replacements each year do not have lower soft costs than firms only performing a few installations. Additionally, the regression finds that firms with a greater percentage of revenue from HVAC projects (a measure of specialization) do not significantly have lower soft costs.

FIGURE 26. BID WIN RATE VS. TOTAL SOFT COST



INSTALLATION LABOR

Cadmus calculated installation labor costs using the number of hours that survey respondents reported were required to install the project, multiplied by a blended labor rate. As Cadmus used different labor rates downstate than upstate to reflect market conditions, the analysis examined the number of installation hours rather than the installation labor costs.

The survey asked several questions about firm characteristics. Using multiple regressions, Cadmus isolated the firm characteristics that influenced the time that contractors estimated were required to install a prototypical HVAC Replacement project.

For this regression analysis, Cadmus examined the influence of the same variables on the installation-hours estimate as those used in the prior regression. Four different regression models, incorporating increasing numbers of interaction terms, were compared. The study found, however, that the simplest model provided results similar to the more complex models. Table 19 presents the regression analysis results. The predictive variables accounted for 27% of the response variation for the time required to do an HVAC replacement project.

FIRMS WITH HIGH BID WIN RATES SPEND LESS TIME ON PROJECT INSTALLATION [HIGH CONFIDENCE]:

The regression analysis found that firms with higher bid win rates estimated fewer hours required to install the HVAC project. Controlling for all other variables, a firm with a 50% win rate would be expected to take 3.5 hours longer to install the prototypical HVAC replacement project than a firm with a 75% win rate. No apparent causal link exists between bid win rates and installation times. Therefore, as discussed earlier, bid win rate may serve as a proxy for another factor, such as referral rate, the firm's selectivity in submitting bids, or participation in utility/government programs.

LARGE FIRMS SPEND MORE TIME ON PROJECT INSTALLATION [HIGH CONFIDENCE]:

Larger companies, as measured by the number of employees, estimated longer installation times for the prototypical HAVC project. All other things being equal, this suggests that a firm with 20 employees would take 3.8 hours longer to install the prototypical HVAC replacement project than a firm with only 10 employees. There are several possible explanations for this: (1) smaller firms are more likely owner-operated, which might incentivize faster, more efficient labor, while larger firms have employees likely paid by the hour with few direct incentives to work faster and more efficiently, or (2) larger firms may have more defined and rigid installation and project management procedures, which could add time to installations.

UPSTATE FIRMS SPEND LESS TIME THAN DOWNSTATE FIRMS ON PROJECT INSTALLATION [MEDIUM CONFIDENCE]:

All else being equal the regression results suggest that upstate firms take 6.6 fewer hours on an ASHP installation then downstate firms.

Notably, some factors did not influence the time required to install the HVAC project. No connection emerged between the number of employees a firm has and the time estimated for installation; no connection occurred between the number of annual HVAC installations and the time estimated for installation; and no connection occurred between how specialized a firm is (measured by the percentage of revenues coming from HVAC installations) and time estimated for installation.

MARKETING AND CUSTOMER ACQUISITION

Marketing and customer acquisition posed the second-largest component of HVAC replacement soft costs with an average cost of $1,215 per project. Marketing and customer acquisition costs are comprised of bid preparation costs ($600/project), marketing and customer education costs ($384/project), and project signing costs ($231/project).

TABLE 19. HVAC REPLACEMENT INSTALLATION LABOR HOURS REGRESSION ESTIMATES

DEPENDENT VARIABLE: INSTALLATION LABOR HOURS			
INDEPENDENT VARIABLE	COEFFICIENT	STANDARD ERROR	P-VALUE
Intercept	29.49	-0.15	0.00***
Region (=Upstate)	6.57	3.76	0.09**
Employees	0.23	0.08	0.01***
Installations	0.00	0.02	0.90
Percent revenue bin (1-5)	0.23	1.62	0.89
Win rate	-0.15	0.06	0.02***
n	55		
R^2	0.340		
Adjusted R^2	0.273		

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

Cadmus performed a regression analysis of both bid preparation costs and marketing and customer education costs against the same set of firmographic variables previously listed. In both cases, Cadmus found no variables that significantly influence bid preparation or marketing and customer education costs. Cadmus found the bid preparation finding particularly interesting because there is no evidence of bid preparations costs being reduced through economies of scale as measured by firm size or by number of annual installs.

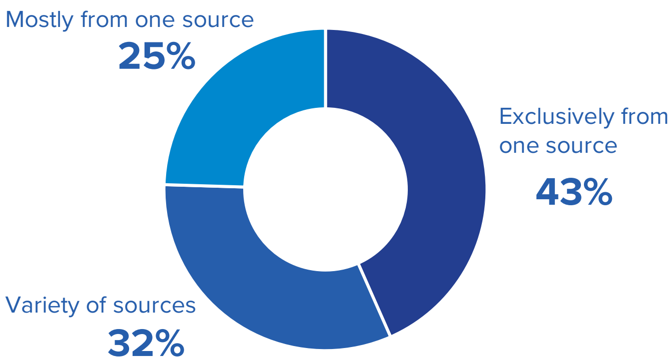
ADDITIONAL TOPICS

Outside of the topics covered above, Cadmus asked HVAC replacement contractors about their product sourcing practices, emergency situations (i.e., when a customer's HVAC system failed), and client financing.

EQUIPMENT STOCKING

Most respondents purchased their ductless heat pump equipment from a distributor (95%; n=70), but respondents split on the number of sources from which their equipment was purchased. Less than a quarter (12%; n=106) of respondents kept ductless heat pump equipment in stock to have it readily available for customers. Of those who responded, 16% have encountered issues acquiring equipment needed to install ductless heat pumps (n=69). The two most common issues were suppliers not having equipment in stock (seven respondents) and shipping delays (two respondents).

FIGURE 27. HVAC EQUIPMENT SOURCING



Source: Residential Service Provider Survey Q E3 "Which of the following best describes the way you purchase ductless heat pump equipment?" (n=106)

HVAC EMERGENCIES

Over one-half of HVAC contractors surveyed (70%; n=105) said they encountered emergency situations within the past year where customers contacted them due to failing HVAC systems. Of those encountering emergency situations, 34% charged a mark-up price for emergency situations, 66% charged the same amount, and no contactors said they charged a lower amount (n=74). Eight contractors charged a 1-10% mark-up, ten charged 11-25%, two charged 25-50%, and two charged a 51% or more mark-up for emergency HVAC situations (n=22). Contractor mark-ups ranged from four percent (one respondent) to a 100% mark-up (one respondent) and on average, charged a 36% mark-up. These findings are particularly important, as one market expert interviewed explained that, from their experience, "nearly all HVAC replacements are done on an emergency basis."

FINANCING

Cadmus asked respondents if they encountered any issues with clients securing the financing necessary to complete their projects. Less than a quarter of respondents (11%; n=105) said they encountered clients who experienced financing issues. Eleven of 12 contractors who responded said they encountered clients with low credit scores or were unable to qualify for financing and one said they encountered clients with budget limitations.

KEY FINDINGS: HVAC REPLACEMENT

Soft costs for downstate contractors are on average $1,360 higher per HVAC replacement installation than upstate contractors. Additionally, soft costs for downstate contractors have a larger spread, suggesting increased variability and complexity with operating in this market.

Cadmus did not find evidence that economies of scale exists in the residential HVAC market, as larger firms (based on number of employees) spend more time installing ASHPs.

Contractors with higher win rates tend to have lower soft costs, suggesting less time spent on preparation of non-productive bids.

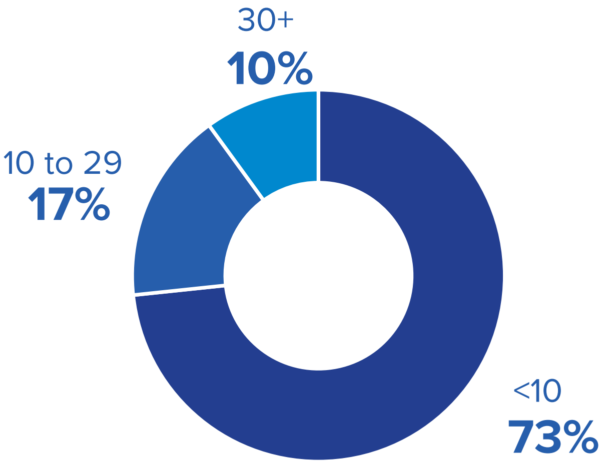
Over half of contractors reported encountering situations where a customer's HVAC system had failed and tended to charge an average 36% mark-up for responding to these jobs.

INSULATION AND AIR SEALING

This section details soft costs for the residential insulation and air sealing project, specifically reviewing the prototypical project soft cost estimates, soft cost drivers, and additional related topics.

Cadmus gathered responses from 39 residential contractors who completed an insulation and air sealing project within the past 12 months. More than one-half of respondents (62%; n=39) said 60% or more of their company's revenue came from projects involving insulation and air sealing improvements in single-family homes. Of respondents reporting their company's size, 21 reported having fewer than 10 employees, four reported between 10 and 29 employees, and two reported more than 30 employees. Almost three-quarters of respondents (73%) worked in a contracting company that employed less than 10 employees, as shown in Figure 28.

FIGURE 28. NUMBER OF EMPLOYEES FOR INSULATION AND AIR SEALING CONTRACTING COMPANIES



Source: Insulation Contractor Survey "Including yourself, approximately how many employees work for your company in New York state?" (n=30)

PROTOTYPICAL PROJECT COST ESTIMATES

Cadmus asked contractors to provide information on their hard and soft cost expenditures within the last 12 months as well as estimates regarding the residential insulation and air sealing prototypical project, outlined in Table 20.

Table 21 summarizes high-level results. For an average installed project cost of $6,317, 35% of costs were hard (equipment-related) costs, while soft costs were nearly twice that at 65%. Additionally, the percentage of total project cost attributed to soft costs was approximately 10 percentage points higher for insulation and air sealing projects compared to HVAC replacement and whole-home efficiency projects.

TABLE 20. INSULATION AND AIR SEALING PROTOTYPICAL PROJECT DETAILS

ATTRIBUTE	DEFINITION
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; R19 insulation
Existing Conditions	R19 insulation in ceiling; crawl space/basement uninsulated; typical attic leakage in bypasses
Equipment to be Installed	R49 insulation (blown-in) for ceiling and R30 insulation (fiberglass) for crawl space/basement; air sealing for whole house, attic and basement bypasses

TABLE 21. INSULATION AND AIR SEALING HARD COST AND SOFT COST ESTIMATES

METRIC	MEAN	STANDARD DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Total Installed Cost	$6,317	$2,738	$5,000	$7,000	26
% Soft Costs	64.6%	11.8%	60.0%	73.5%	27
Value Soft Costs	$4,130	$1,953	$3,000	$5,200	25
% Hard Costs	35.4%	11.8%	26.5%	40.0%	27
Value Hard Costs	$2,260	$1,188	$1,463	$3,000	25

FIGURE 29. INSULATION AND AIR SEALING SOFT COSTS VS. HARD COSTS

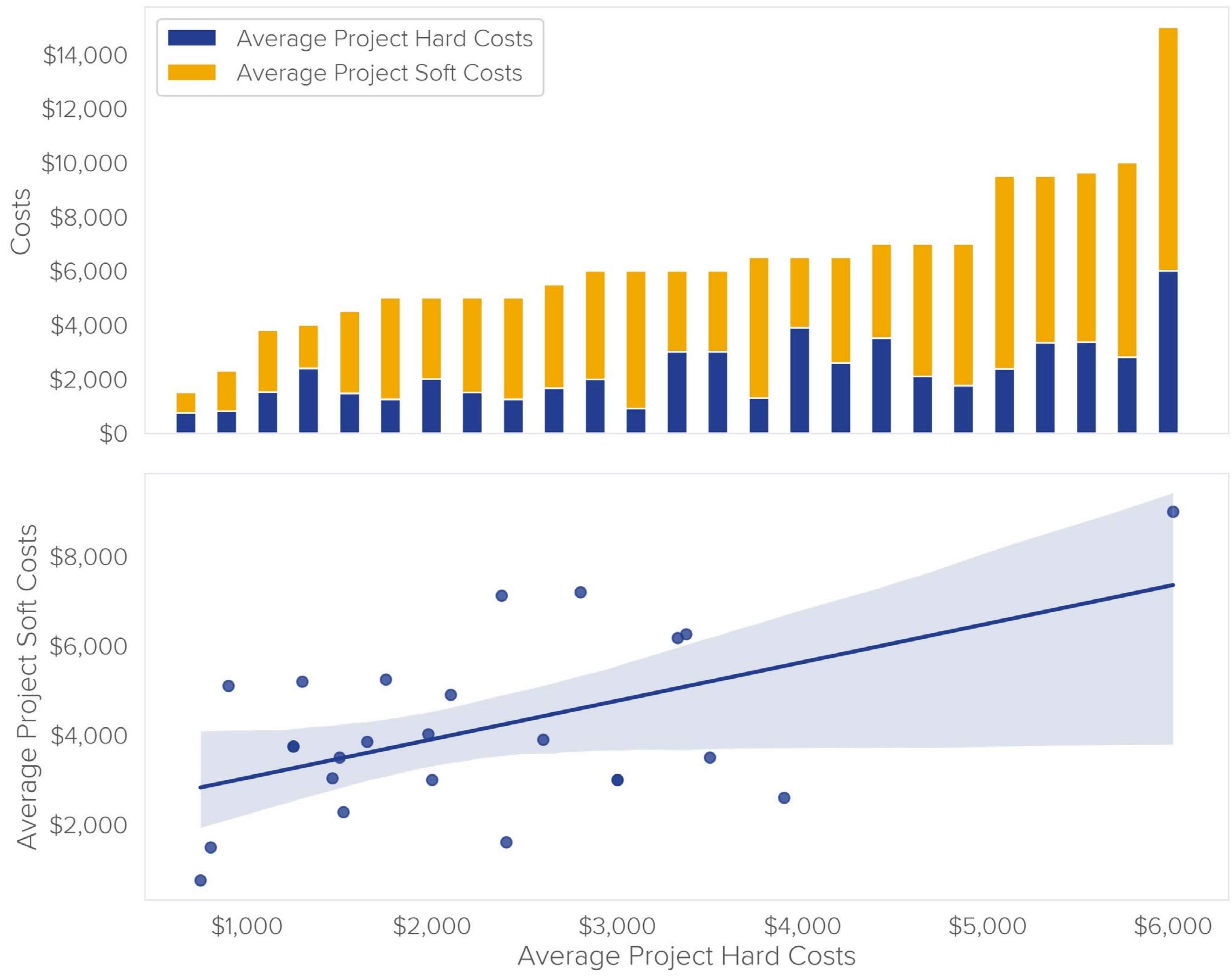
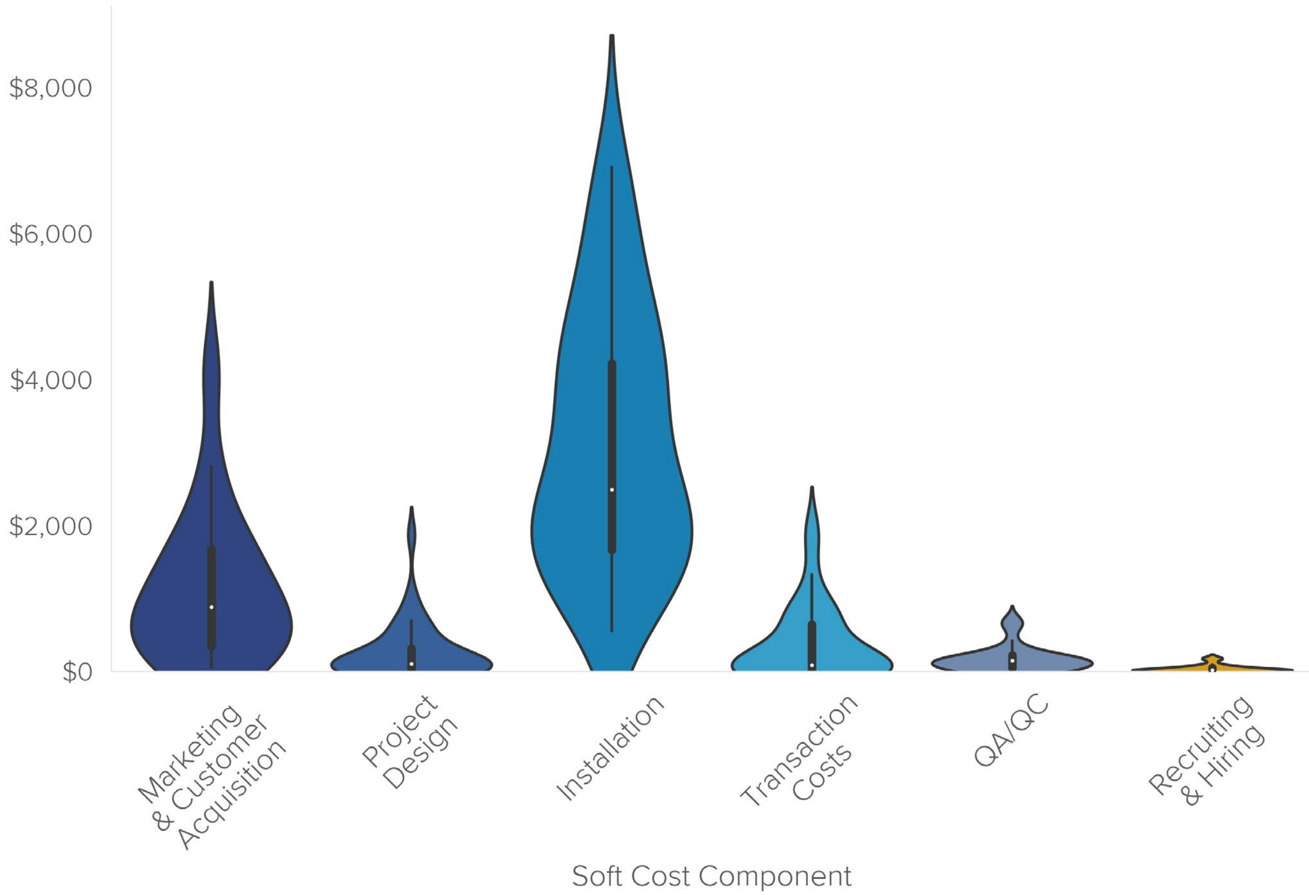


TABLE 22. INSULATION AND AIR SEALING SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	$1,565	27%	Marketing and/or customer education	$416	$406	$90	$602	27
			Bid preparation	$750	$909	$191	$882	25
			Project signing/ contracting	$398	$347	$167	$508	26
Project Design	$357	6%	Designing, scoping, and customizing the project	$357	$411	$78	$545	26
Installation	$3,138	54%	Installation labor	$3,138	$1,757	$1,661	$4,216	28
Transaction Costs	$523	9%	Obtaining permits	$186	$263	$0	$213	25
			Acquiring and maintaining trainings, certifications, and licenses	$337	$420	$36	$588	25
QA/QC	$229	4%	QA/QC activities	$205	$162	$76	$230	25
			Required callbacks to the customer to assist with equipment issues/ servicing	$24	$41	$0	$27	30
Recruiting & Hiring	$35	1%	Recruiting and hiring employees	$35	$51	$0	$44	22

FIGURE 30. INSULATION AND AIR SEALING VIOLIN PLOT



As with residential HVAC replacement and whole-home efficiency projects, firm-by-firm analysis shows that hard costs and soft costs are positively correlated, as shown in Figure 29. That is, companies with higher hard costs tend to have higher soft costs. The corresponding bar graph, however, helps show that these variables do not perfectly correlate.

As shown in Table 22, Cadmus also collected data on and constructed estimates for six specific soft cost categories that make up the total soft costs estimate. Of these components, installation costs are the largest at $3,138 per insulation and air sealing project (54%), making up over one-half of estimated project soft costs. Marketing costs, including bid preparation costs, were the second-largest soft cost category at $1,565 per project (27%). These proportions of installation and marketing soft cost components are very similar to those for whole-home efficiency and HVAC replacement prototypical projects, showing consistency in soft costs across the residential sector.

SOFT COST DRIVERS

Cadmus utilized several linear regression models to assess the degree that contractors' soft costs can be explained by firmographic variables collected by and constructed from the survey data. Regression results, with installation costs specified as dependent variables, tended to be most revealing, as variations in installation costs make up the majority of variations in total soft costs.

In general, regression results show collected firmographic variables have little explanatory power over variations in installation costs, both in terms of statistical significance and magnitude of effect. Two reasonable explanations exist for the model's lack of explanatory power:

- Insulation and air sealing installation costs are driven by firmographic data not collected by the surveys (such as the average contractor experience or the size of installation teams).

- Installation costs may be minimally affected by firmographic variables. Instead, installation costs may be largely a function of project-specific attributes (such as installation difficulty, the building's age, the home's layout, and wall types).

Of the independent variables included in the model, only the percent revenue bin variable had a statistically significant effect on insulation and air sealing installation costs. This effect can be interpreted as follows: for every 20% increase in a firm's insulation and air sealing-related revenue, firms spend $45 to $1,377 less on installation labor per project, based on a 95% confidence interval, controlling for other firmographic variables included in the model.

This most intuitive explanation for this finding is that firms depending more heavily on insulation and air sealing revenue had a larger incentive to develop insulation and air sealing expertise, thereby obtaining installation efficiencies that non-specialist firms cannot. In other words, the data suggests the existence of "specialization" effects. Figure 31 supports this hypothesis, which shows that firms that nearly entirely specialize in insulation and air sealing tend to have the lowest installation costs per project. This finding of specialization-related efficiencies in insulation and air sealing installation is the most pronounced trend found in the residential insulation and air sealing data.

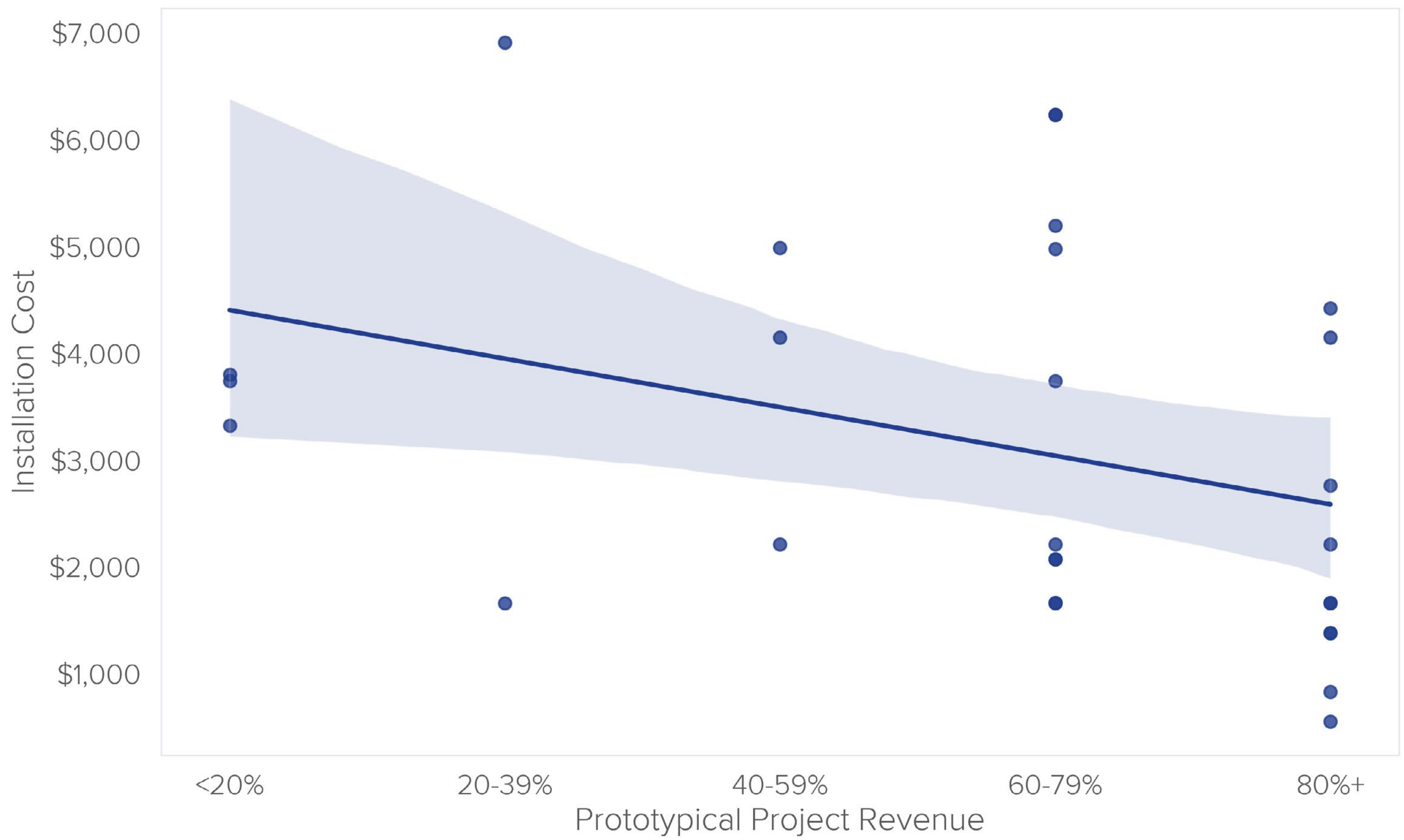
Market experts interviewed commented on this specialization effect, noting that it makes intuitive sense based on their experience in the market. One explained that the more times a company completes a specific energy efficiency project, the less likely the company is to come across situations they have not seen before which could slow down the installation process and contribute to additional project soft costs. In order words, companies that complete more of a specific project have the "cost of learning" spread across more projects than do companies that complete fewer of a specific project, thereby decreasing average soft costs per project for "specialist" companies.

TABLE 23. INSULATION AND AIR SEALING INSTALLATION COSTS REGRESSION ESTIMATES

DEPENDENT VARIABLE: INSTALLATION COSTS			
INDEPENDENT VARIABLE	COEFFICIENT	STANDARD ERROR	P-VALUE
Intercept	6750.37	1578.51	0.00***
Region (=Upstate)	-1043.71	725.51	0.17*
Employees	-18.48	14.49	0.217
Installations	-0.79	0.86	0.37
Percent revenue bin (1-5)	-710.96	318.27	0.04***
Win rate	7.57	13.15	0.57
n	25		
R^2	0.320		
Adjusted R^2	0.141		

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

FIGURE 31. INSTALLATION COSTS VS. PERCENT REVENUE FROM INSULATION AND AIR SEALING



ECONOMIES OF SCALE

Several other notable trends emerged from the insulation and air sealing data. First, bid prep costs and marketing costs—the next two largest soft cost components—tend to vary little (if at all) by company size or by the number of insulation and air sealing projects conducted in a year (job count). Cadmus evaluated these relationships by splitting the data on the median value of the independent variable of interest (that is, bid prep costs and marketing costs) and by plotting these variables' distributions. For bid prep costs, shown in Figure 32, and marketing costs, shown in Figure 33, company size and job count appear to have little effect on bid prep and marketing costs, with only slightly lower bid prep costs among firms that complete more installations.

These findings differed from Cadmus' hypothesis that larger companies should achieve bid preparation and marketing cost advantages through economies of scale. Based on the data, however, little evidence of economies of scale emerged for bid prep or marketing costs among insulation and air sealing contractors.

Cadmus discussed the prospect of economies of scale in energy efficiency markets with market experts. While some market experts expected there to be more evidence of economies of scale, one market expert noted that he was not surprised by this. This market expert suggested that larger companies completing a greater number of projects are still not completing *enough* projects to outpace the additional overhead accompanied with greater project volume.

FIGURE 32. BID PREP COSTS BY COMPANY SIZE AND INSTALL COUNT

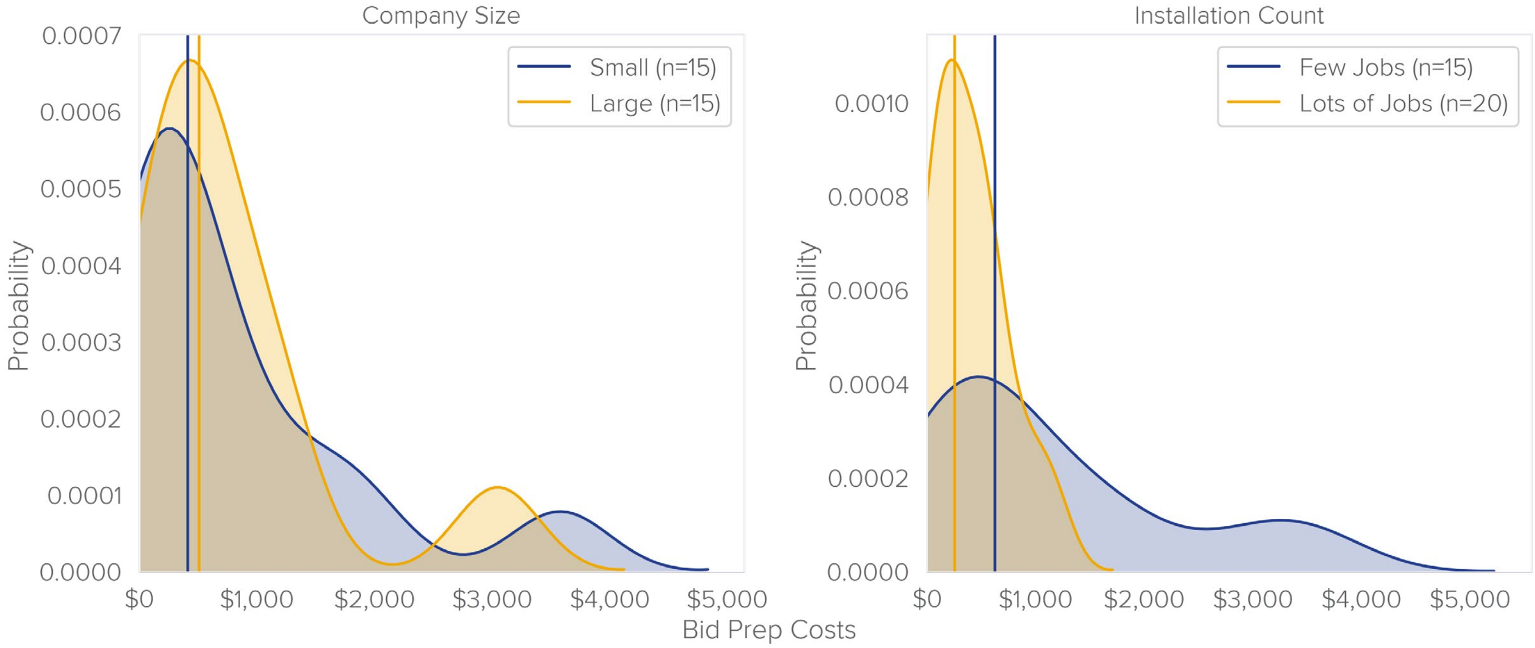


FIGURE 33. MARKETING COSTS BY COMPANY SIZE AND INSTALL COUNT

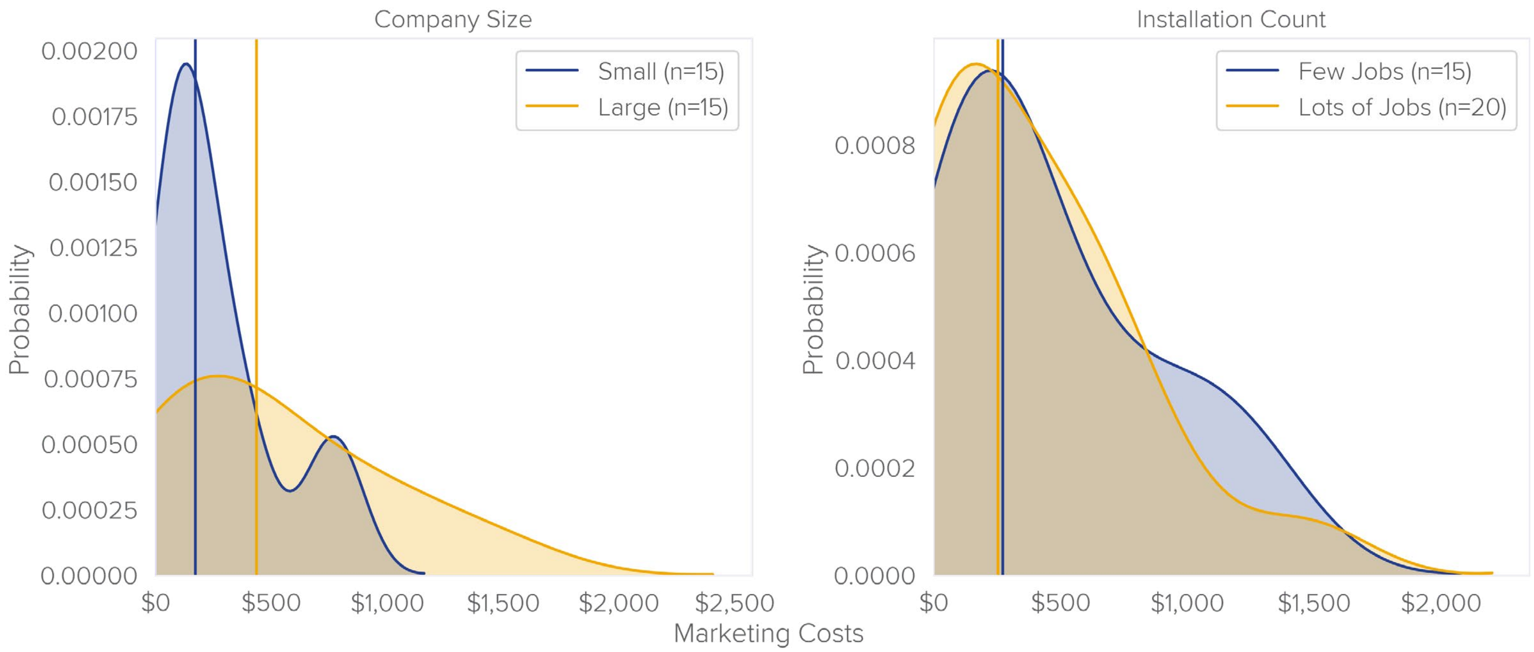
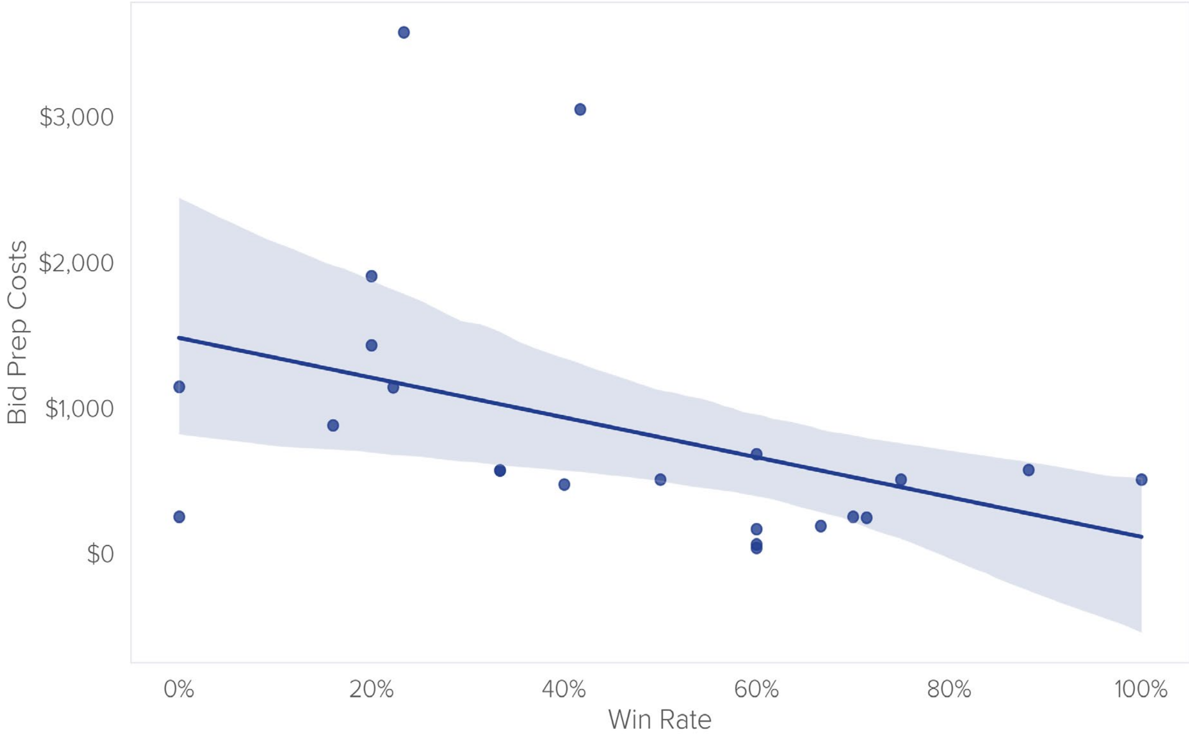


FIGURE 34. INSULATION AND AIR SEALING BID PREP COSTS BY WIN RATE



WIN RATE

Cadmus found that firms with greater win rates tended to have lower bid prep costs. Specifically, companies with win rates greater than the median reported spending $762 less on average than companies with win rates lower than the median. This is somewhat counter-intuitive, as companies spending more time on bid prep might be expected to win bids with greater frequency.

As shown in Figure 34, the insulation and air sealing data suggest the opposite effect. This finding may be considered additional evidence in favor of an "expertise" effect, whereby some firms have higher proficiency with bid prep, yielding high win rates at lower costs. As discussed in the whole-home efficiency section, this finding is even more pronounced for whole-home efficiency projects.

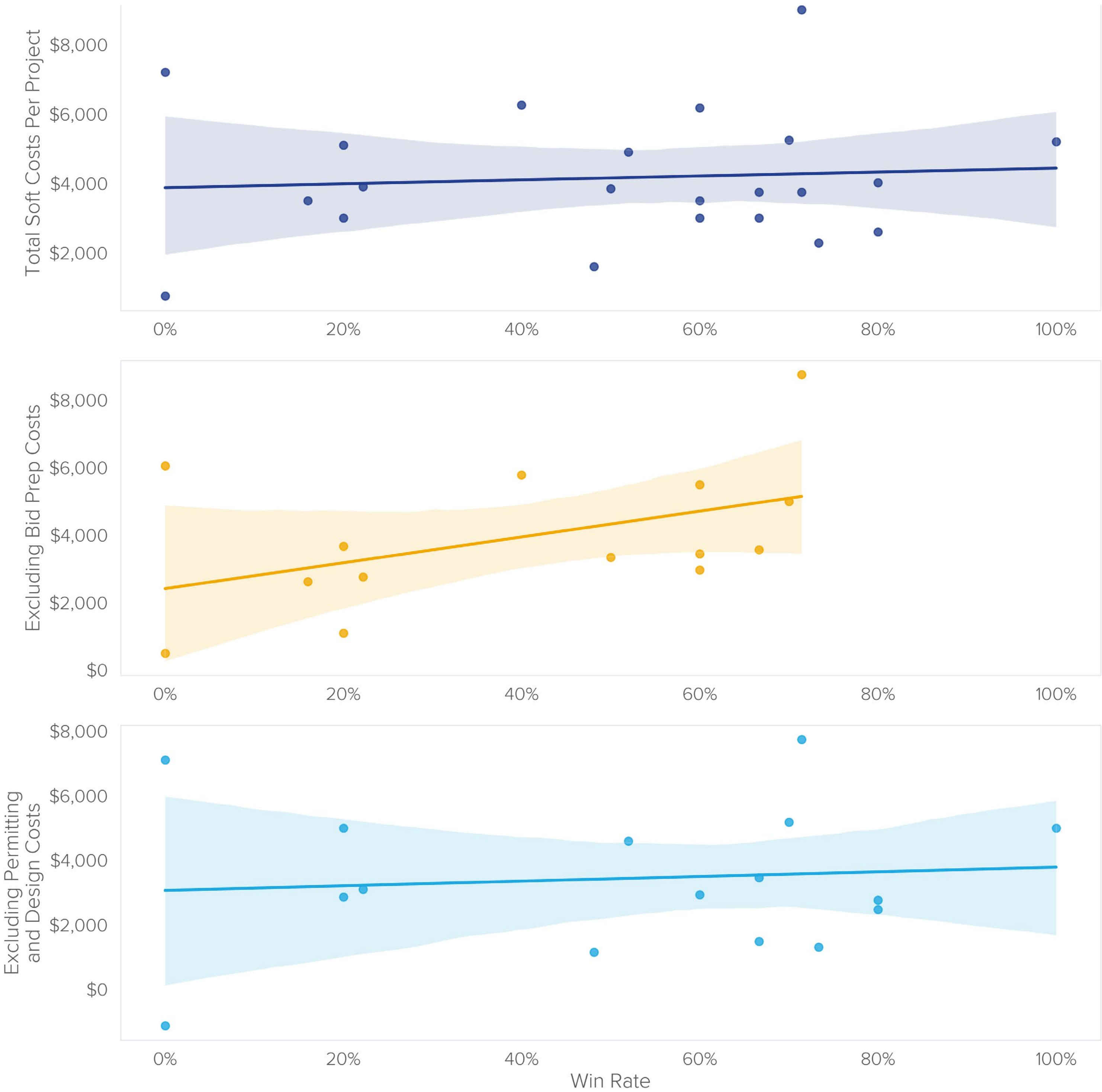
As shown in Figure 35, Element 1 (dark blue), total soft costs were lower among firms with greater win rates. As discussed, Cadmus attributes this negative relationship primarily to lower bid prep costs among companies with higher win rates. Upon excluding bid prep costs from total soft costs, as shown in Figure 35, Element 2 (yellow), the trend reverses.

Bid prep costs, however, are not the only soft cost category that explains this negative relationship, however. Figure 35, Element 3 (light blue) demonstrates that, when excluding permitting and design costs from total soft costs, the trend essentially disappears, suggesting companies with higher win rates tend to spend less on permitting and design than companies with lower win rates.

CONTRACTOR REGION

Cadmus found slight differences in the distributions of permitting costs between upstate and downstate New York contractors, though median permitting costs are similar in both regions. Specifically, while downstate New York contractors' permitting costs tend to be narrowly distributed close to zero, upstate New York contractors' permitting costs tend to be much more widely distributed and slightly larger on average, as shown in Figure 36. These findings suggest that upstate New York has subregions or instances where permitting costs are disproportionately high, indicating a possible intervention opportunity from NYSERDA.

FIGURE 35. INSULATION AND AIR SEALING TOTAL SOFT COSTS VS. WIN RATE



Note: Center figure correlation line is abbreviated due to missing data needed to construct total soft costs per project excluding bid prep costs variable (y axis).

FIGURE 36. INSULATION AND AIR SEALING PERMITTING COSTS BY REGION

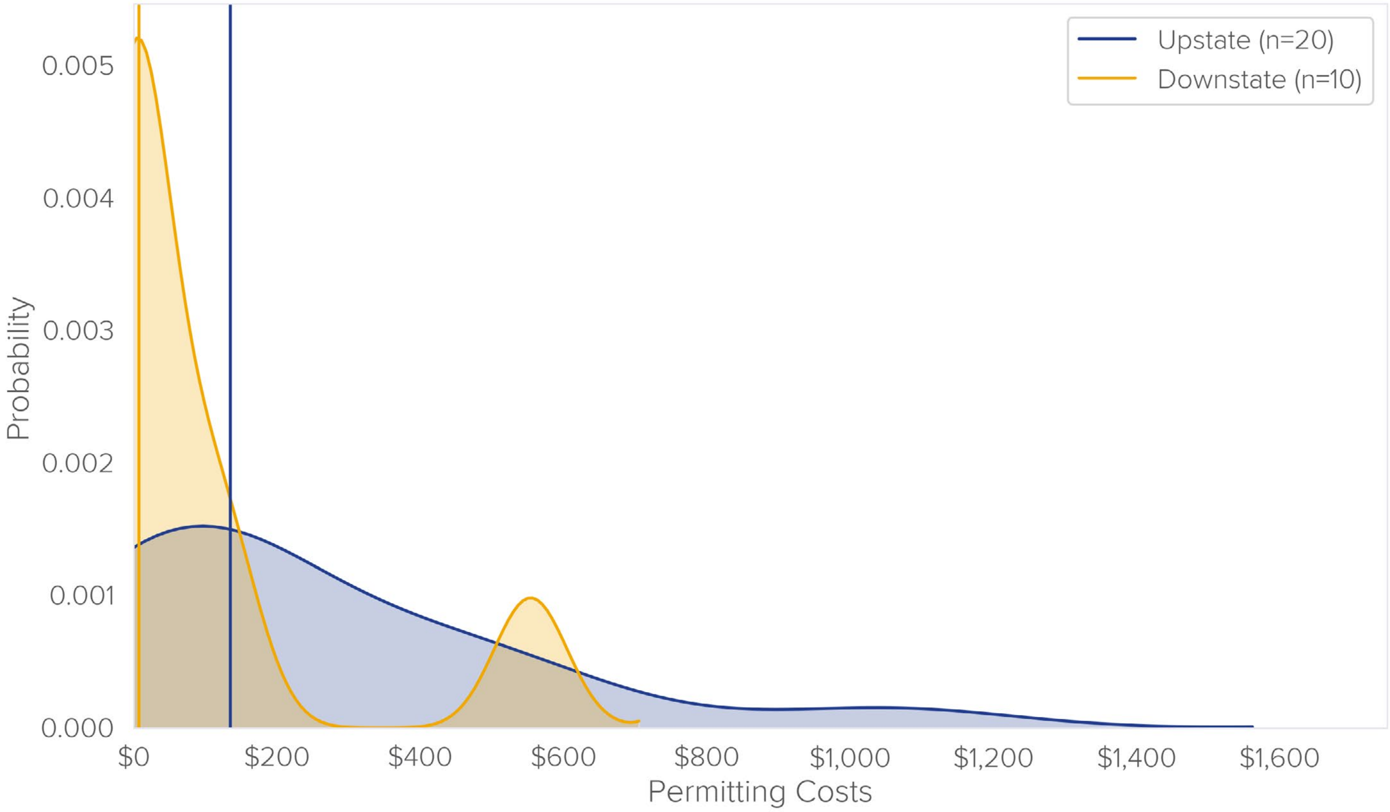
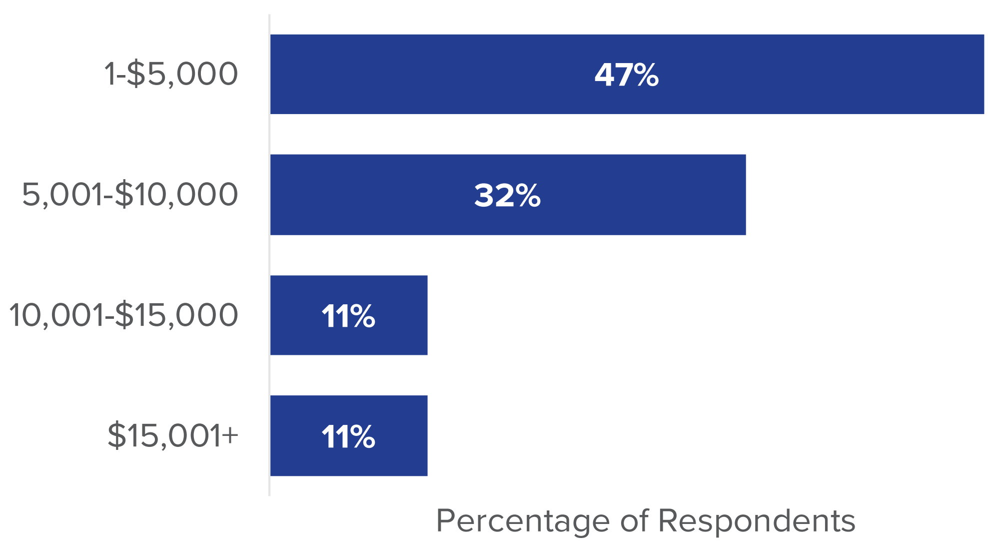


FIGURE 37. INSULATION STOCKING



Source: Residential Insulation Service Provider Survey Q F3 "Approximately how much insulation and other materials (in terms of dollars) do you keep in stock to have it readily available for customers?" (n=19)

ADDITIONAL TOPICS

This section details additional topics not covered by soft cost quantification, specifically product stocking, client bids, and financing.

INSULATION STOCKING

Most contractors said they primarily used cellulose insulation (73%; n=33), with 15% using spray foam for residential insulation improvements. Sixty-three percent of contractors (n=32) kept insulation in stock, having it readily available for customers. In general, contractors kept anywhere from $500 to $60,000[16] worth of insulation and other materials in stock. Figure 37. presents these results in detail.

CLIENT BIDS

Cadmus also asked insulation contractors about the detail level they provided in customer bids. Most contractors (51%; n=39) typically provided customers with a single, fixed price, inclusive of all materials and labor for the work, while a smaller number of contractors provided itemized pricing for materials and labor (21%). Of those responding, 79% also said they provide potential customers with energy savings estimates (n=34), nine of which provide a list of savings by improvement type.

FINANCING

Cadmus asked respondents if they encountered any issues with clients securing the financing necessary to complete their projects. Less than one-half of respondents (41%; n=32) said they encountered clients who experienced financing issues. Similar to HVAC contractors, insulation contractors encountered clients with low credit scores (seven respondents), unable to qualify for loans or financing (three respondents), lack of incentives (two respondents), and budgeting restrictions (one respondent).

KEY FINDINGS: INSULATION AND AIR SEALING

Firms with a greater share of insulation and air sealing-related revenue tend to have lower insulation and air sealing installation costs, all else equal, suggesting the existence of expertise-related efficiencies.

There is little evidence of economies of scale in bid prep and marketing costs among residential insulation and air sealing contractors.

Companies with higher win rates tend to spend less on permitting and design than do companies with lower win rates.

Insulation and air sealing permitting costs tend to be slightly more widely distributed for upstate New York contractors than for downstate New York contractors.

More than half (62%; n=39) of contractors reported that 60% or more of their company's revenue came from projects involving air sealing improvements in existing single-family homes, which was a larger percent of revenue than HVAC and whole-home contractors.

[16] This analysis excludes one outlier response of $200,000.

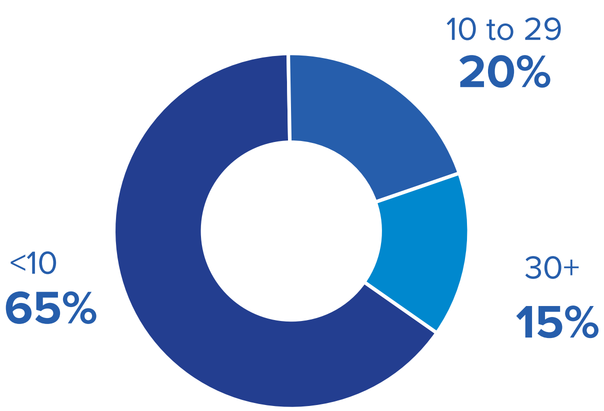
WHOLE-HOME EFFICIENCY

This section details soft costs for the residential whole-home efficiency project, specifically reviewing the prototypical project soft cost estimates, soft cost drivers, and additional related topics.

Cadmus gathered responses from 32 residential contractors who completed a comprehensive whole-home efficiency project in a single-family home within the past 12 months. Due to the lower sample size than other residential prototypical projects, it was not possible to analyze the data at the same depth.

More than one-third of respondents (38%; n=32) said 80% or more of their company's revenue came from whole-home efficiency projects in single-family homes. Almost two-thirds of respondents (65%) worked in a contracting company employing less than 10 employees, as shown in Figure 38.

FIGURE 38. NUMBER OF EMPLOYEES FOR WHOLE-HOME EFFICIENCY FIRMS



Source: Residential Whole-home Contractor Survey "Including yourself, approximately how many employees work for your company in New York state?" (n=20)

PROTOTYPICAL PROJECT COST ESTIMATES

Cadmus asked contractors to provide information on their hard and soft cost expenditures within the last 12 months as well as estimates regarding the residential whole-home efficiency prototypical project, outlined in Table 24.

TABLE 24. WHOLE-HOME EFFICIENCY PROTOTYPICAL PROJECT DETAILS

ATTRIBUTE	DEFINITION
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; R19 insulation
Existing Conditions	**HVAC:** Gas-powered condensing boiler; standard thermostat **Insulation:** R19 insulation in ceiling; crawl space/basement uninsulated; typical attic leakage in bypasses; typical metal ductwork
Equipment to be Installed	**HVAC:** ASHP minisplit (ductless) with 1 outdoor unit and 3 indoor heads. **Insulation:** R49 insulation (blown-in) for ceiling and R30 insulation (fiberglass) for crawl space/basement; air sealing for whole house, attic and basement bypasses

Table 25 summarizes the high-level results. According to contractors, the average total installed cost of a residential whole-home efficiency project was $17,826, the largest of the three residential prototypical projects. Of the average total installed cost, 45% of costs were hard (equipment-related) costs, while 55% were soft costs. This proportional share of soft costs remained highly consistent with that of residential HVAC replacement and about 10% lower than that of insulation and air sealing.

TABLE 25. WHOLE-HOME EFFICIENCY HARD COST AND SOFT COST ESTIMATES

METRIC	VALUE	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Total Installed Cost	$17,826	$7,506	$15,000	$23,500	19
% Soft Costs	55%	14%	47%	65%	20
Value Soft Costs	$9,119	$4,397	$4,688	$12,638	18
% Hard Costs	45%	14%	34%	52%	20
Value Hard Costs	$7,474	$3,612	$6,270	$9,750	17

FIGURE 39. WHOLE-HOME SOFT COSTS VS. HARD COSTS

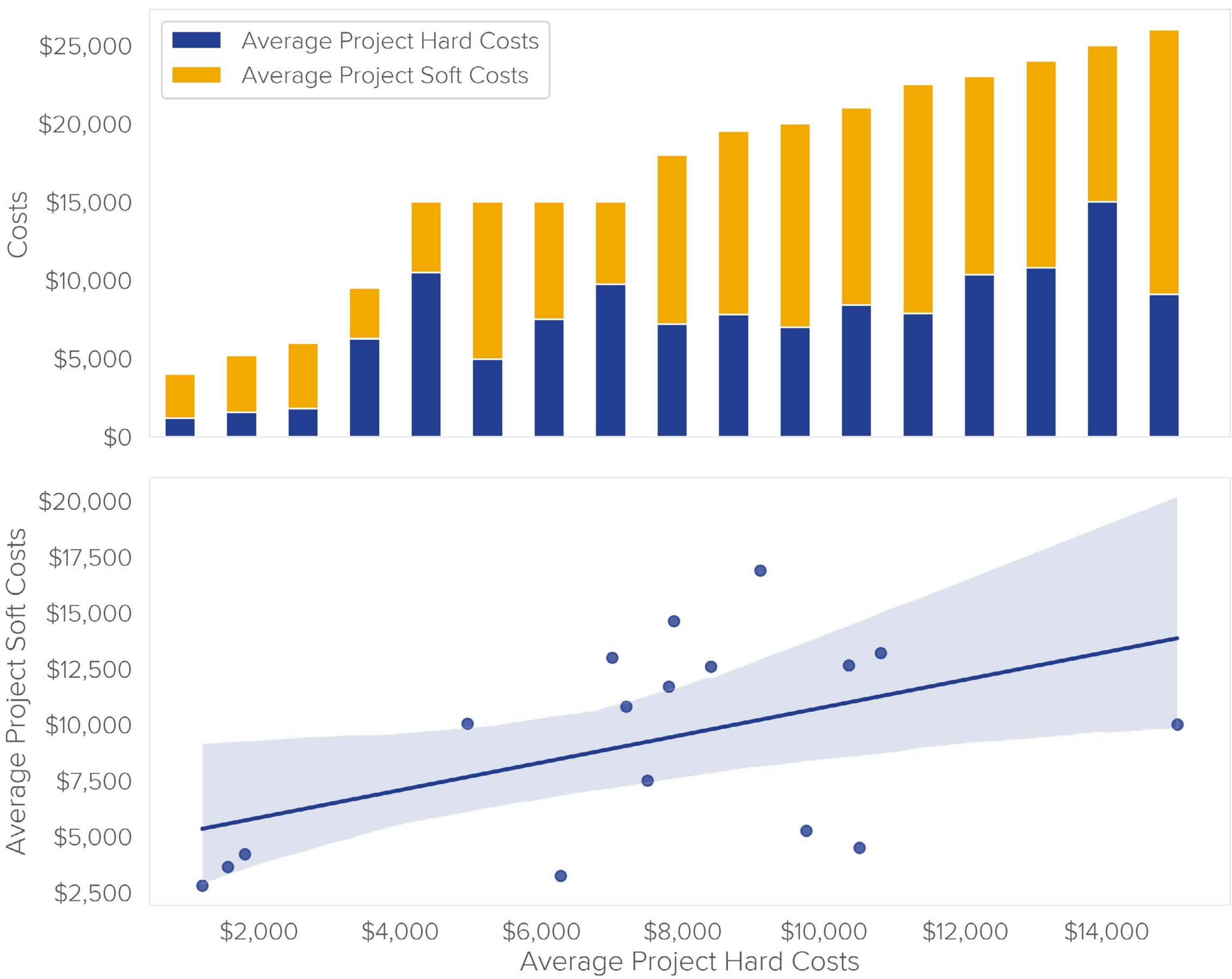


TABLE 26. WHOLE-HOME EFFICIENCY SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	$2,834	28%	Marketing and/or customer education	$815	$1,223	$137	$1,093	30
			Bid preparation	$1,629	$1,600	$357	$1,905	21
			Project signing/ contracting	$390	$274	$223	$625	20
Project Design	$416	4%	Designing, scoping, and customizing the project	$416	$345	$130	$521	20
Installation	$5,259	53%	Installation labor	$5,259	$4,350	$2,837	$5,864	19
Transaction Costs	$1,105	11%	Obtaining permits	$200	$155	$81	$255	20
			Acquiring and maintaining trainings, certifications, and licenses	$906	$1,137	$172	$912	21
QA/QC	$328	3%	QA/QC activities	$287	$184	$140	$351	21
			Required callbacks to the customer to assist with equipment issues/ servicing	$41	$50	$4	$57	19
Recruiting & Hiring	$46	0%	Recruiting and hiring employees	$46	$77	$0	$42	18

Note: Sum of "Per Project Cost" column will not add to "Value Soft Costs" data point from Table 25 as those estimates are from a different question set than the data points in this table.

As with residential HVAC replacement and insulation and air sealing, firm-by-firm analysis shows hard costs and soft costs positively correlate, as shown in Figure 39). That is, companies with higher hard costs tend to have higher soft costs. The corresponding bar graph, however, helps illustrate that these variables did not perfectly correlate.

Cadmus also collected data on and constructed estimates for six specific soft cost categories making up the total soft costs estimate shown in Table 26. Of these components, installation costs are the largest at $5,259 per project (53%), making up over one-half of the average project's soft cost. Marketing costs, including bid prep costs, is the second-largest soft cost category at $2,834 per project (28%). The proportions of installation and marketing soft cost components are identical to those of residential insulation and air sealing.

Figure 40 conveys the distribution of soft cost category estimates. The relative distributions of each soft cost component remain roughly consistent with those of HVAC replacement and insulation and air sealing.

SOFT COST DRIVERS

Cadmus utilized several techniques to examine the whole-home efficiency project soft cost data collected from contractors. Analysis of whole-home efficiency data was limited by a slightly lower sample size relative to HVAC replacement and insulation and air sealing data. In general, firmographic variables had relatively low explanatory power over total soft costs. Additionally, whole-home efficiency soft cost trends were highly consistent with those of HVAC replacement and insulation and air sealing. The following subsections explore prominent trends in the whole-home efficiency soft cost data in greater detail.

ECONOMIES OF SCALE

As for HVAC replacement and insulation and air sealing, Cadmus evaluated the presence of economies of scale for whole-home efficiency project marketing and bid prep costs. This was evaluated by splitting the data on the median value of the independent variable of interest (bid prep costs and marketing costs) and plotting the distributions of these variables.

FIGURE 40. WHOLE-HOME EFFICIENCY SOFT COST COMPONENT VIOLIN PLOT

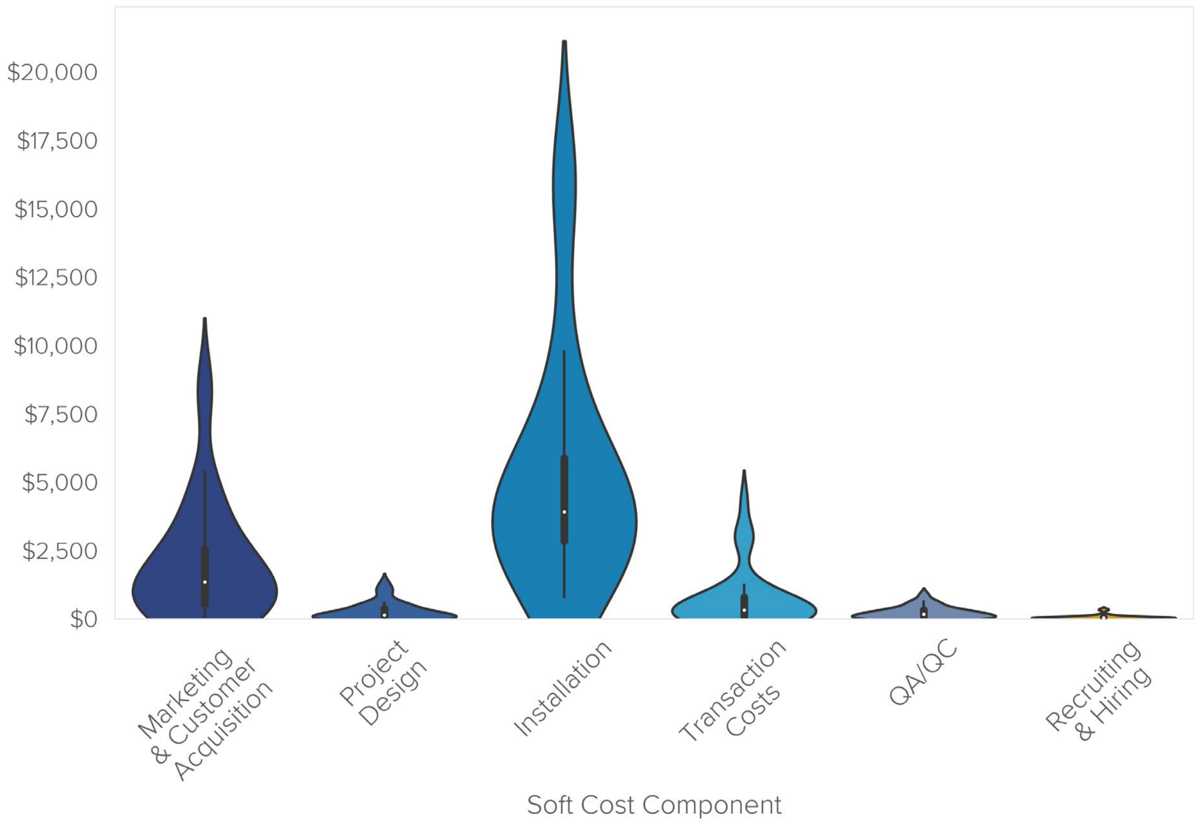


FIGURE 41. WHOLE-HOME EFFICIENCY BID PREP COSTS BY COMPANY SIZE AND INSTALL COUNT

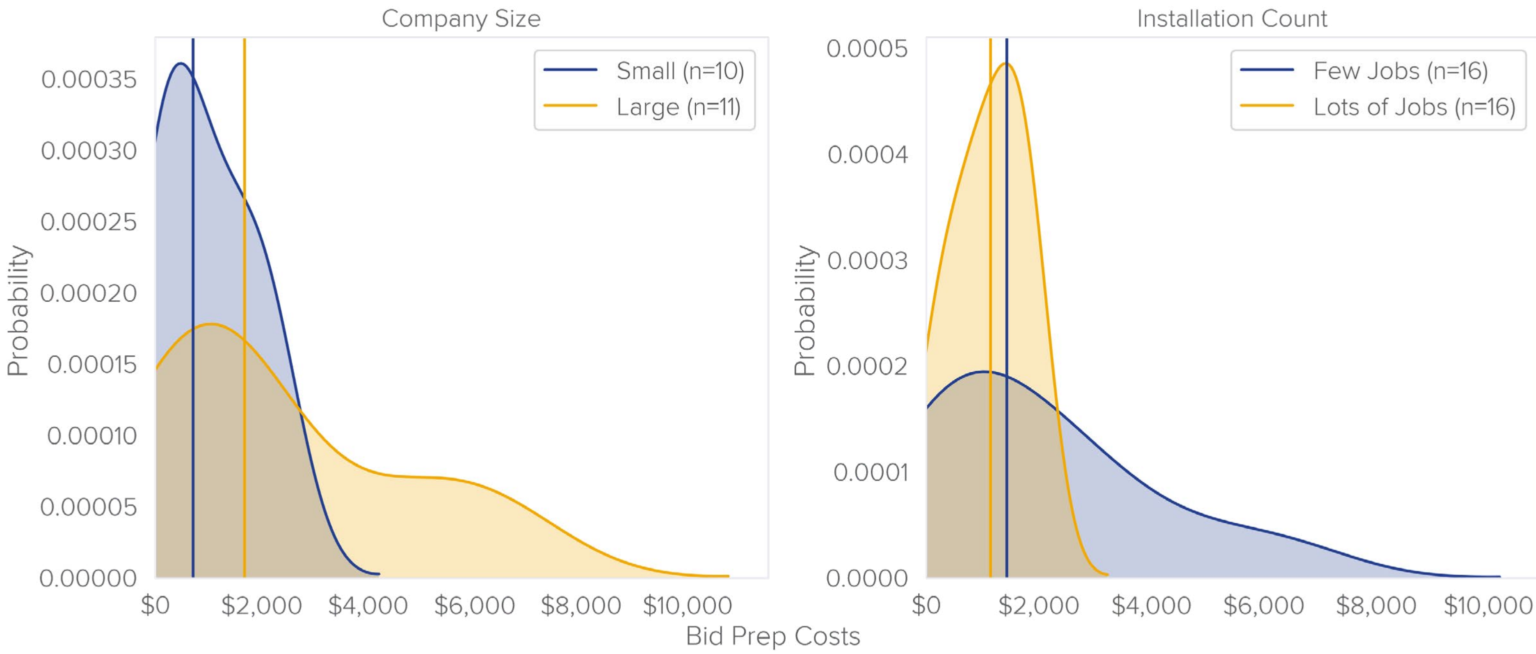


FIGURE 42. WHOLE-HOME EFFICIENCY MARKETING COSTS BY COMPANY SIZE AND INSTALL COUNT

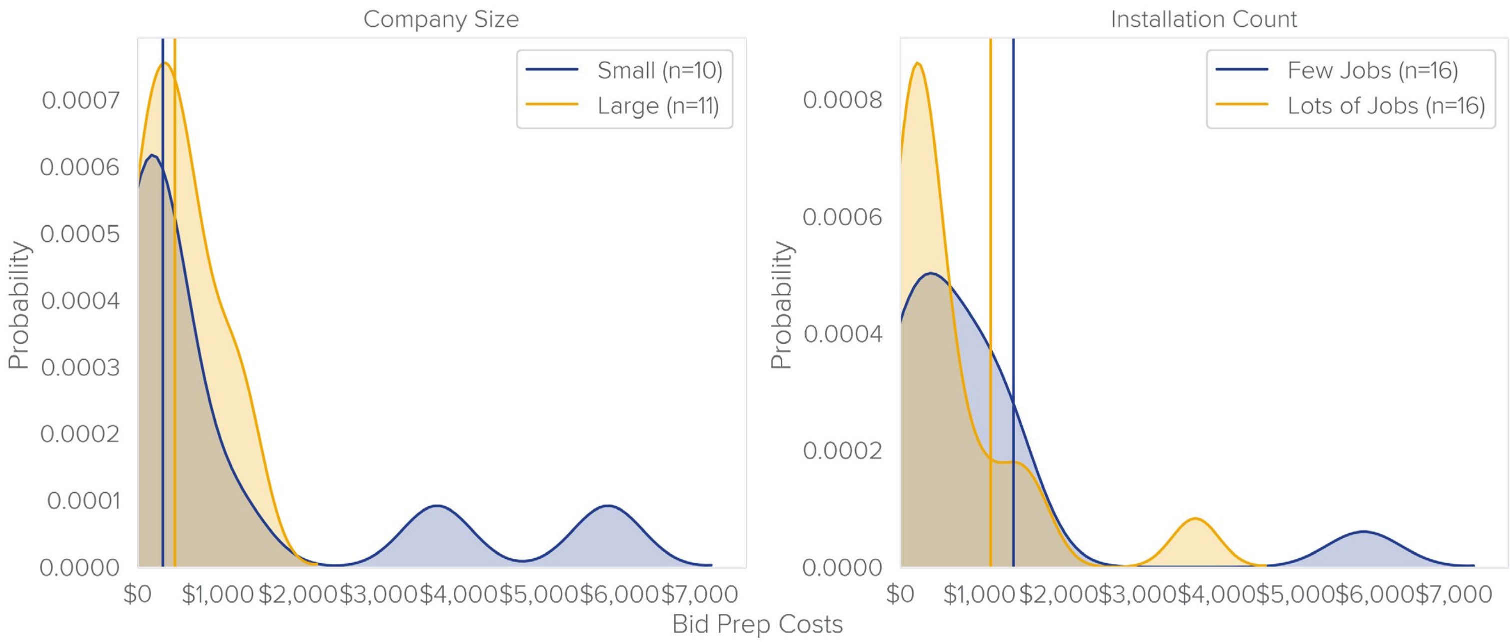


FIGURE 43. WHOLE-HOME EFFICIENCY BID PREP COSTS BY WIN RATE

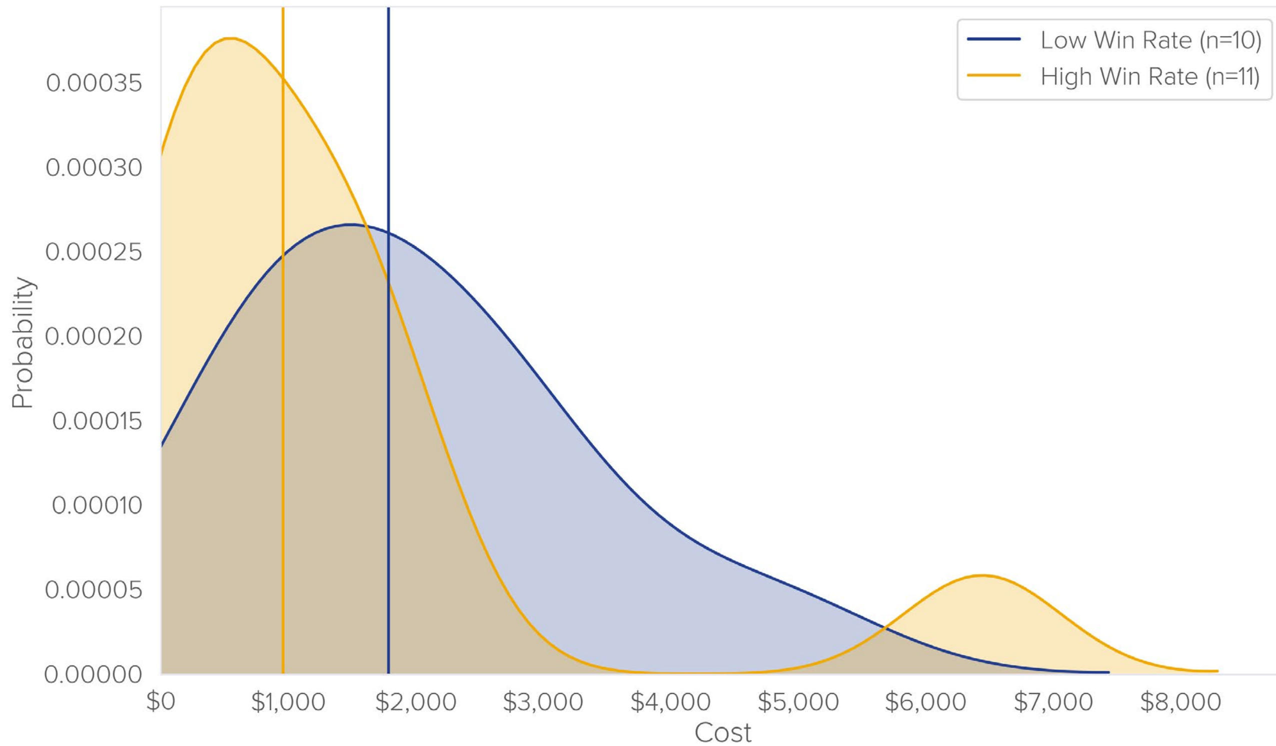
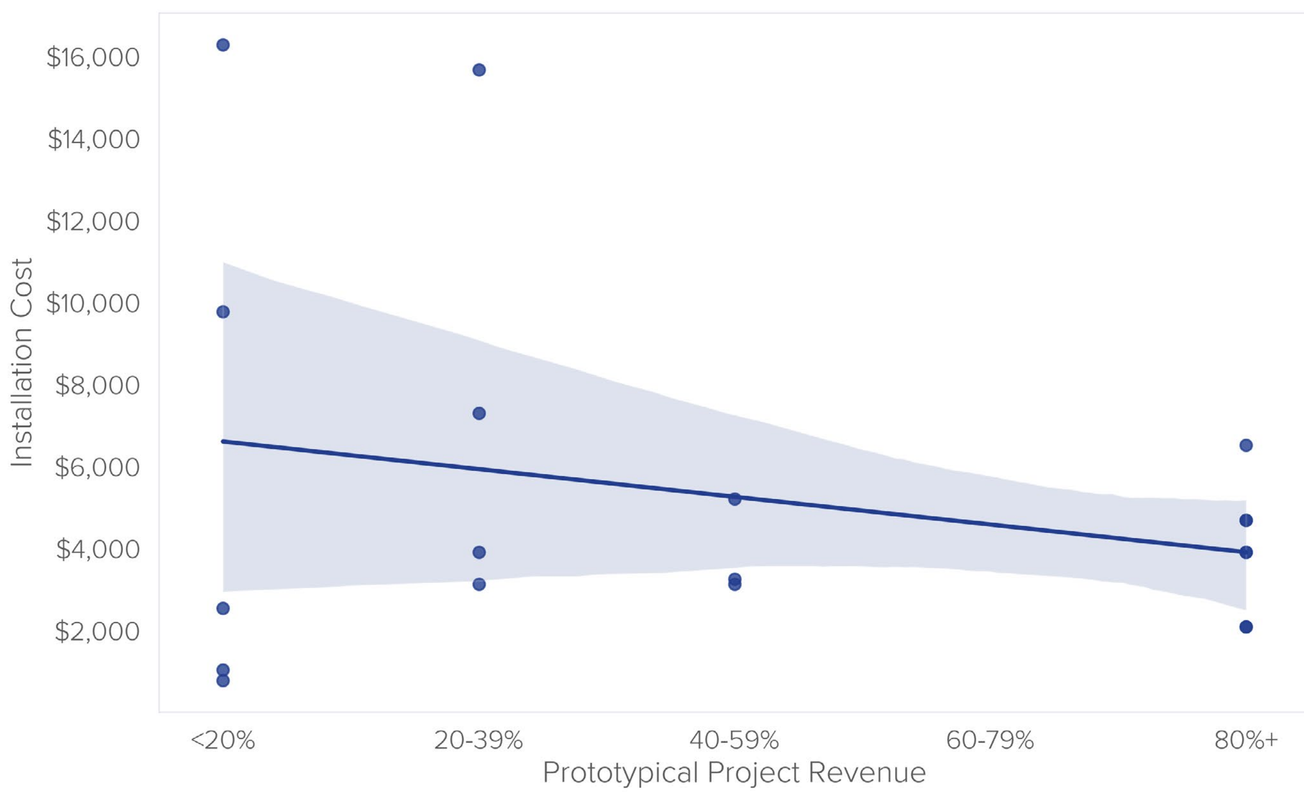


FIGURE 44. INSTALLATION COSTS VS. PERCENT REVENUE FROM WHOLE-HOME EFFICIENCY



In general, there is little evidence of the existence of economies of scale in bid prep and marketing costs among whole-home efficiency contractors, as shown by the closely spaced vertical lines indicating the median values of the respective soft cost distributions. Figure 41 and Figure 42 provide little additional evidence to support the hypothesis of economies of scale.

WIN RATE

As with HVAC replacement and insulation and air sealing, Cadmus found that firms with greater win rates tend to have lower bid prep costs. This finding supports the hypothesis that some companies are particularly adept at bid prep, yielding a high win rate at a lower cost. The degree of this effect, however, is somewhat smaller than that for insulation and air sealing projects. Figure 43 illustrates this relationship.

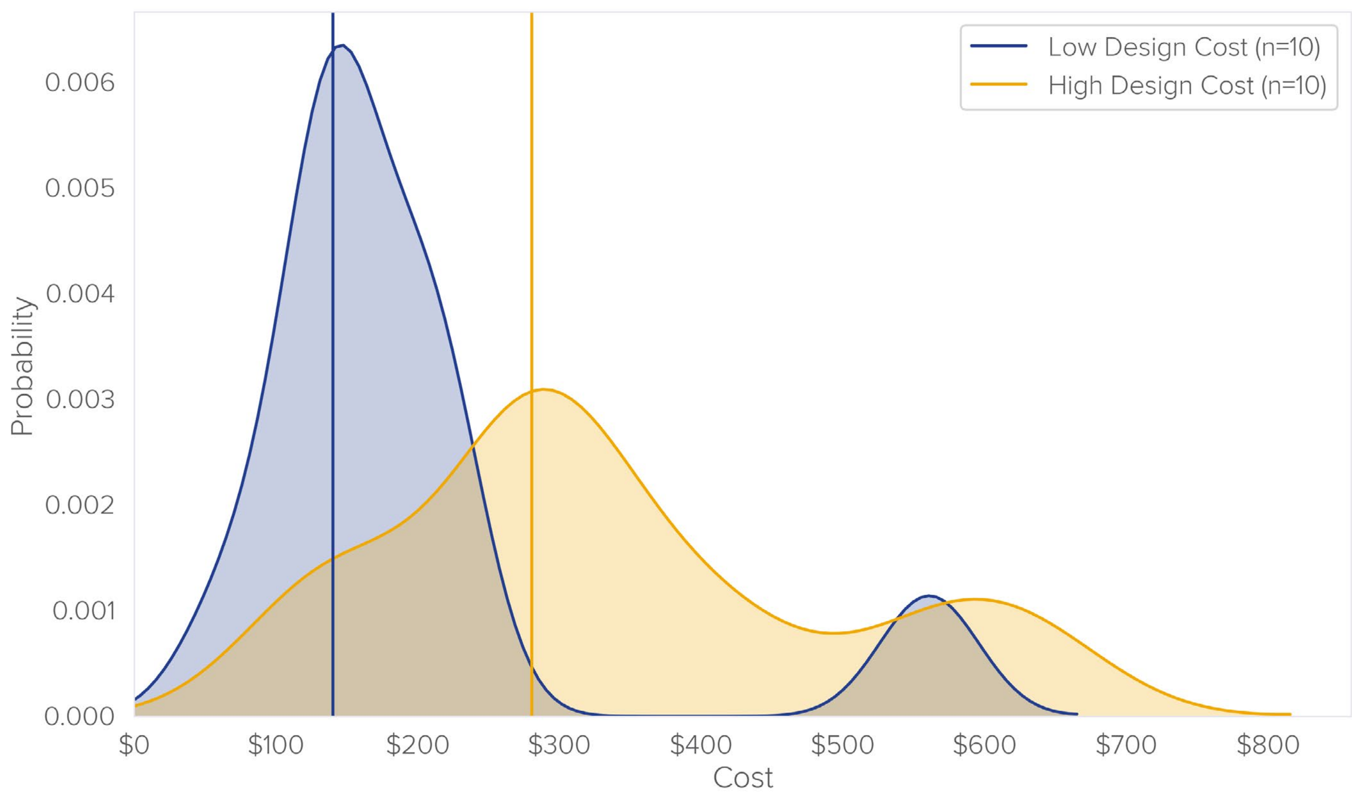
INSTALLATION COSTS

As with insulation and air sealing projects, there is evidence that firms which have a larger share of whole-home efficiency-related revenue tend to have lower installation costs. Figure 44 illustrates this trend and adds additional evidence to support the hypothesis that firms which specialize in a particular measure tend to develop expertise in the installation of that measure, thereby obtaining efficiencies that non-specialist firms cannot

QA/QC AND DESIGN COSTS

Cadmus also analyzed the extent to which a company's spend on design is related to the company's spend on QA/QC. Cadmus found for each project category that companies which spend more on design also tend to spend more on QA/QC, suggesting that there may be varying degrees of thoroughness or inclination for detail among residential contractors. Figure 45 illustrates this relationship for whole home, showing that companies spend less on design costs also spend less on QA/QC costs..

FIGURE 45. WHOLE-HOME EFFICIENCY QA/QC COSTS BY DESIGN COSTS



ADDITIONAL TOPICS

This section details additional topics not covered by soft cost quantification, specifically product stocking, client bids, and financing.

INSULATION STOCKING

Thirteen of 20 contractors said they primarily use cellulose insulation and five use spray foam for whole-home efficiency projects. Fourteen contractors said they (n=20) keep insulation in stock to have it readily available for customers.

CLIENT BIDS

Cadmus also asked whole-home efficiency improvement contractors what level detail they provide on bids to customers. Contractors were split by providing itemized pricing for materials and labor (12 respondents) and providing a single, fixed price inclusive of all materials and labor for work (13 respondents). Additionally, 23 of 31 contractors said they typically provide energy-savings estimates with bids they provide to the customer. Of those contractors, 17 used energy modeling software to generate energy savings estimates for customer bids, two used a list of savings by improvement type, and three said they used general rules of thumb.

FINANCING

Cadmus asked respondents if they encountered any issues with clients being able to secure financing to complete their projects. Eight of 20 respondents said they encountered clients who experienced financing issues. Similar to HVAC replacement and insulation and air sealing contractors, whole-home efficiency contractors encountered clients who were unable to qualify for loans or financing (4 respondents), had low credit scores (2 respondents), and lack of incentives (1 respondent).

KEY FINDINGS: WHOLE-HOME EFFICIENCY

Soft and hard costs for whole-home efficiency are the largest of all residential prototypical projects

Consistent with findings for residential insulation and air sealing, firms with a greater share of whole-home efficiency-related revenue tend to have lower whole-home efficiency installation costs, all else equal, suggesting the existence of expertise-related efficiencies.

There is little evidence of economies of scale in bid prep and marketing costs among whole-home efficiency contractors

Consistent with findings for other residential prototypical types, companies that spend more on project design also tend to spend more on QA/QC, suggesting that there may be varying degrees of thoroughness or inclination for detail among residential contractors.

COMMERCIAL SECTOR

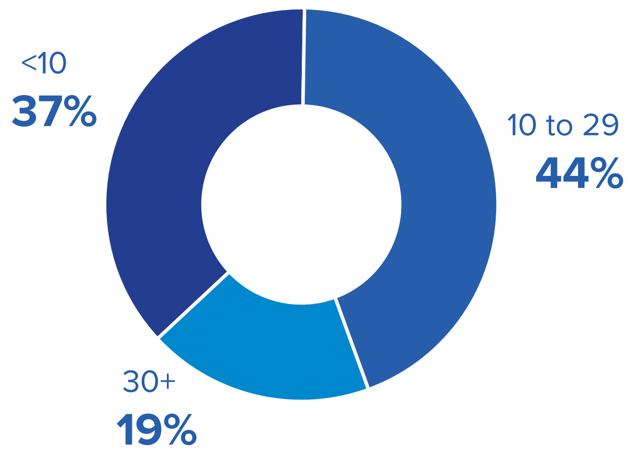
This section details soft cost results for the commercial sector and reviews results at the sector level, with breakouts for prototypical projects, as applicable. The section contains the following types of information:

- Soft cost estimates for prototypical projects
- Drivers of soft costs variation (i.e., win rate, contractor region)
- Additional soft cost-related topics (i.e., supply chain/stocking, project financing)
- Decision-maker findings

PROTOTYPICAL PROJECT COST ESTIMATES

Cadmus conducted surveys with a variety of commercial contractors to investigate soft costs associated with a series of five energy efficiency projects. Cadmus gathered responses from 52 commercial contractors, 21 of which completed a VRF project, eight completed a RTU project, nine completed a commercial lighting project, eight worked on an energy performance contract, and six completed a building management project within the past 12 months. Of surveyed contractors, 45% primarily worked in upstate NY and 55% worked downstate (n=44). More than one-third of respondents (37%) worked in a company employing less than 10 employees, as shown in Figure 46.

FIGURE 46. NUMBER OF EMPLOYEES FOR COMMERCIAL CONTRACTING COMPANIES



Source: Commercial Contractor Survey Q F1 “Including yourself, approximately how many employees work for your company in New York state?” (n=43).

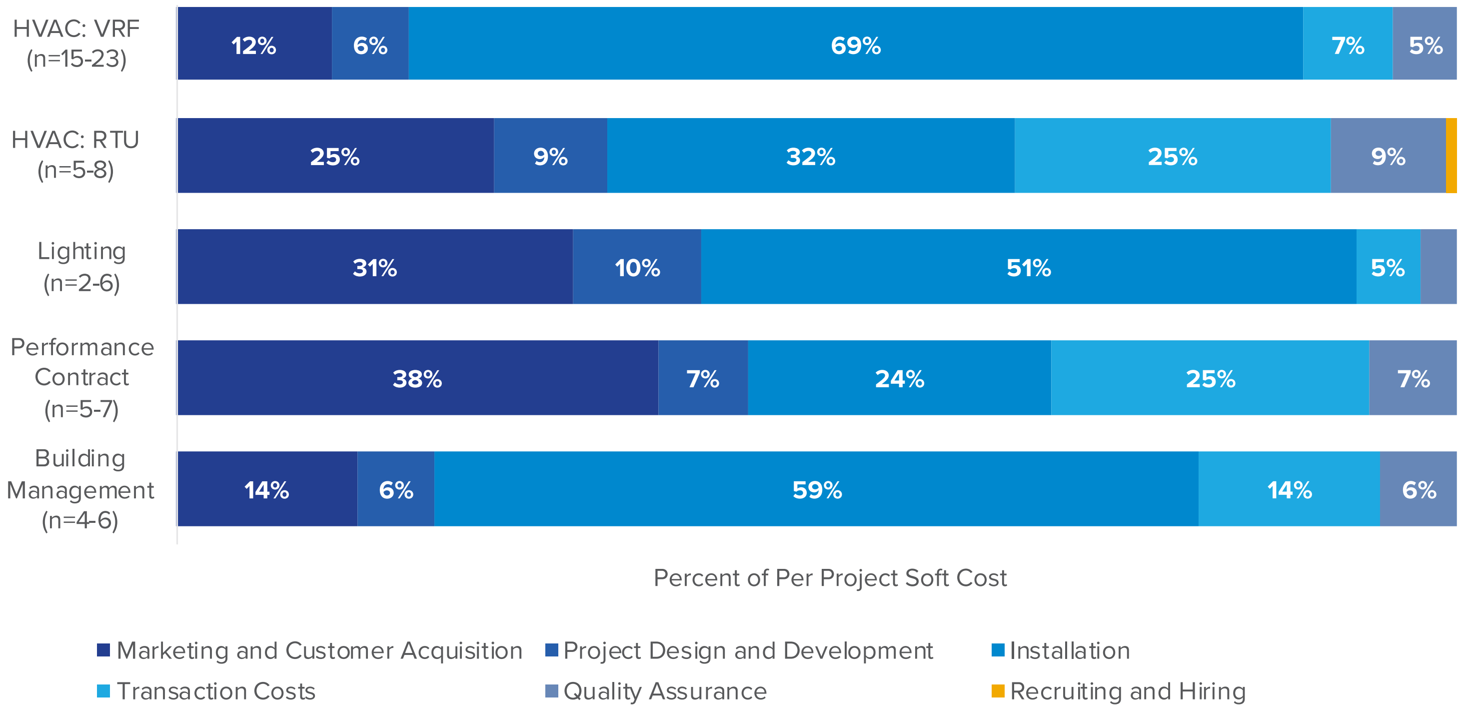
More than one-third of commercial service providers (35%) said less than 20% of their company’s revenue came from their respective projects in commercial buildings. Table 27 shows these results by prototypical project.

Figure 47 shows the breakdown of soft cost categories across each commercial prototypical project. As discussed, a relatively high level of variability occurs within soft costs for the commercial sector, likely driven by significant differences in scope, timelines, and measures included and by comparatively lower sample sizes than for the residential sector.

TABLE 27. PROTOTYPICAL PROJECT PERCENTAGE OF REVENUE

PERCENT OF REVENUE	BUILDING MANAGEMENT SYSTEM (N=6)	LIGHTING RETROFIT (N=9)	ENERGY PERFORMANCE CONTRACT (N=8)	HVAC: RTU (N=8)	TOTAL (N=31)
<20%	0	4	3	4	11
20-39%	0	4	4	1	9
40-59%	2	0	1	2	5
60-79%	2	0	0	0	2
80%+	2	1	0	1	4

FIGURE 47. SOFT COST ESTIMATE BREAKDOWN FOR COMMERCIAL PROTOTYPICAL PROJECTS



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

Across the five commercial prototypical projects, the HVAC VRF retrofit project had the largest share of soft costs going to installation labor at 69%. Of all prototypical projects, this was one of the most complex installations from a technological perspective, leading to a longer install time and the need for more specialized labor. Additionally, as this was a newer technology, contractors answering the survey were less certain on the time investment needed to complete an installation. This tended to cause contractors to overestimate the time required to complete the project compared to a technology with which they were more familiar.

Marketing and customer acquisition costs made up a significant portion of the performance contract, lighting, and HVAC RTU retrofit prototypical projects. In contrast to the HVAC VRF retrofit, lighting and HVAC RTU retrofit projects were well-known by contractors, so respondents were less likely to inflate installation labor estimates. The performance contract prototypical project covered a large array of measures (e.g., HVAC, lighting, building envelope) and had a long time-horizon (typically 10 years). This led to a very long customer acquisition process, including identifying potential customers, multiple assessments of the job site, and a detailed project design process. One market expert from an ESCO discussed the investment they make into customer acquisition, saying: “It can sometimes take years to sign an energy performance contract.”

Table 28 shows the absolute values for each soft cost category by prototypical project, which helps to provide context for the relevant findings. For example, service provider estimates for the HVAC VRF and RTU retrofit projects were relatively equal across all soft cost categories excepting installation labor, which was over five times as much for the VRF retrofit as for the RTU retrofit, which can present a significant barrier to building electrification. High marketing and customer acquisition costs are more evident in this table than in Figure 47 for the performance contract prototypical project.

Based on the prototypical project specifications (building size and type), Cadmus estimates that a 40-ton system would be the proper size for the HVAC: RTU project and a 25-ton system for the HVAC: VRF project.[17] This equates to soft costs per thermal ton of $724 for HVAC: RTU and $2,949 for HVAC: VRF.

[17] The baseline for both commercial HVAC prototypical projects specifies a 40-ton system capacity. Typically, gas-fired heating units are oversized relative to the space the units are providing heating and cooling for (30,000 square foot commercial office). In the HVAC: RTU project, Cadmus assumes the capacity will remain the same (40 tons), as is common for gas-fired system replacements. For the HVAC: VRF project, Cadmus assumes that the system will be sized appropriately for a VRF system, which is typically 20-30 tons for a commercial building with these specifications. As such, Cadmus used an average of 25 tons for the HVAC: VRF system size.

TABLE 28. SOFT COST CATEGORY ABSOLUTE VALUE ESTIMATES BY COMMERCIAL PROTOTYPICAL PROJECT

SOFT COST CATEGORY	HVAC: VRF (N = 12-20)	HVAC: RTU (N = 5-9)	LIGHTING (N = 2-7)	PERFORMANCE CONTRACT (N = 5-7)	BUILDING MGMT. SYSTEMS (N = 4-6)
Marketing and Customer Acquisition	$8,755	$7,188	$13,862	$52,388	$14,683
Project Design	$4,213	$2,494	$4,721	$9,540	$6,709
Installation	$50,471	$9,191	$23,241	$32,262	$61,384
Transaction Costs (Trainings, Certifications, Permits)	$5,437	$7,149	$2,203	$33,644	$15,025
Quality Assurance	$3,690	$2,675	$1,214	$8,907	$6,726
Recruiting and Hiring	$151	$250	$0	$166	$305
Total Soft Costs[1]	$73,718	$28,948	$45,242	$136,907	$104,833

Note: Sample sizes are small, so values are directional only. Percentage breakdowns (as shown in Figure 47) are more appropriate to use.
[1]Total soft costs are likely underestimated for larger or longer-term projects (such as Performance Contracts), as contractors’ cost estimates increase in uncertainty.

FIGURE 48. COMMERCIAL SECTOR SOFT COSTS VIOLIN PLOT

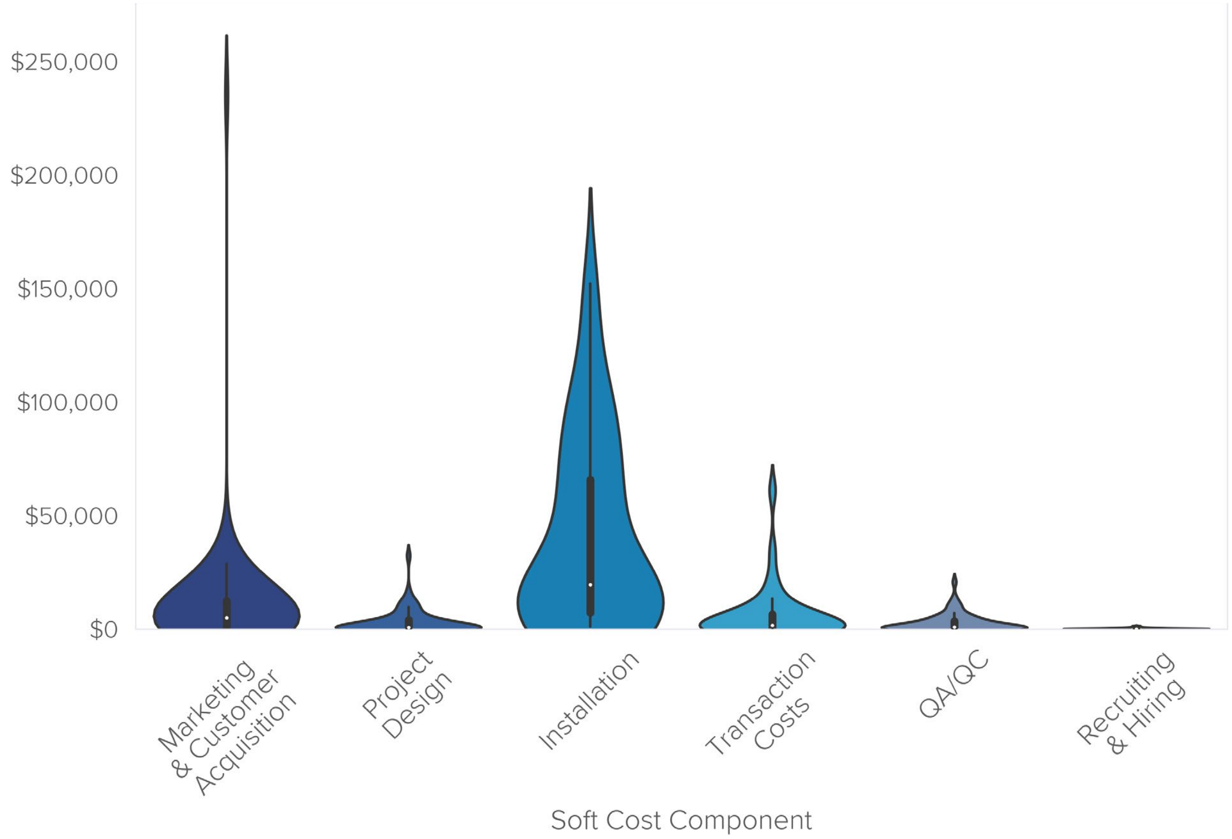
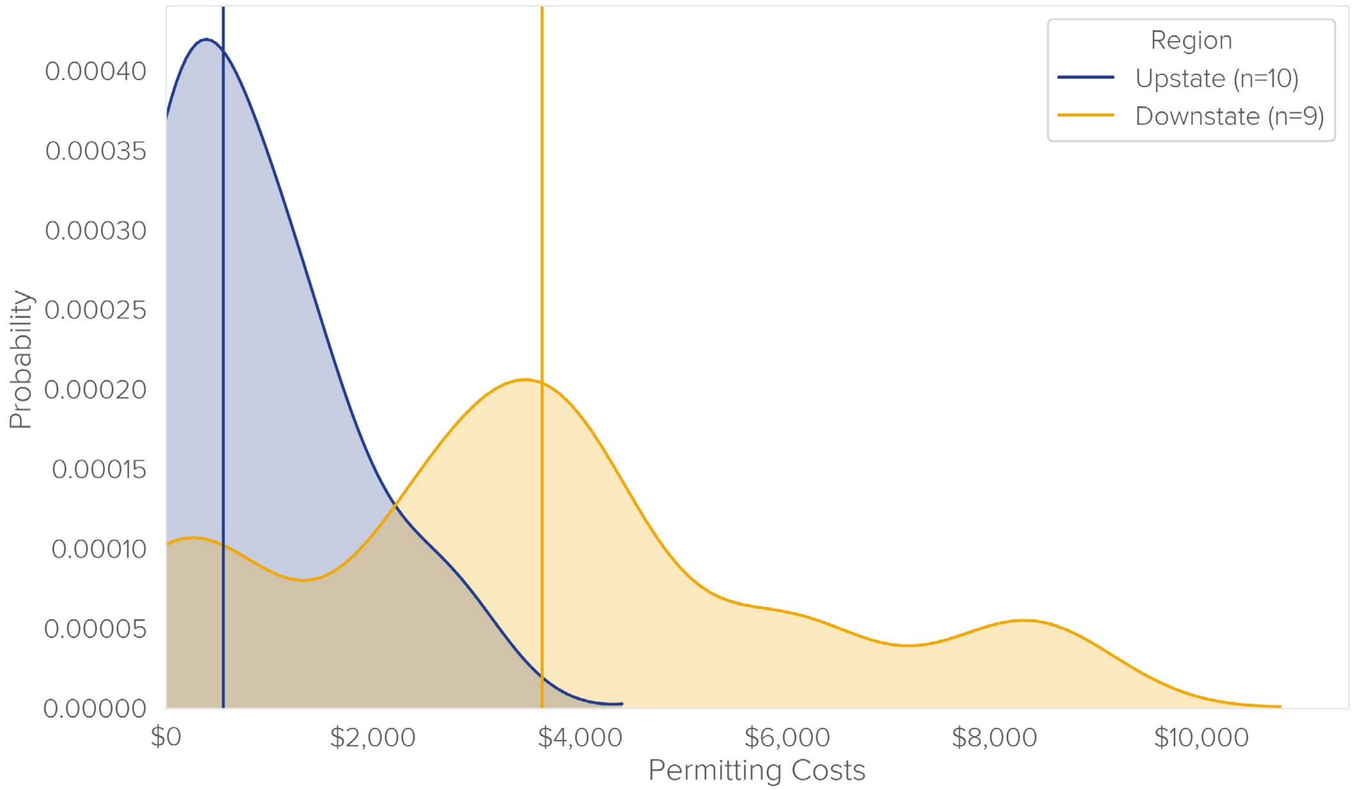


FIGURE 49. COMMERCIAL SECTOR PERMITTING COSTS BY REGION



As shown in Figure 48, the distribution within each soft cost category varies significantly more than in other sectors. Given the differences in the set of commercial prototypical projects compared to residential, this is expected. Across the commercial sector, project design, QA/QC, and recruiting and hiring costs are the most consistent, while marketing and customer acquisition, installation labor, and transaction costs have greater variability.

Full soft cost estimate data for each prototypical project can be found in *Appendix B. Expanded Commercial Prototypical Project Results*.

PERMITTING

Cadmus explored the relationship between the contractor's region and permitting costs, as sector-level findings show differences in the distributions of permitting costs for upstate and downstate contractors. As shown in Figure 49, contractors downstate have a larger spread of permitting costs compared to upstate contractors, whose permitting costs are clustered closer to zero. This figure plots the distribution of commercial permitting costs for upstate and downstate contractors, with the vertical lines indicating median values for each group. The differential between median permitting costs for downstate and upstate New York contractors, as indicated by the respective vertical lines, show that downstate New York contractors spend more on average than do upstate New York contractors.

ADDITIONAL TOPICS

In addition to the soft cost-related questions, Cadmus asked contractors questions designed to provide context around their soft cost responses or to explore topics of interest from the NYSERDA team, provided these could not be incorporated into the soft cost quantification. For the commercial sector, this related to equipment stocking and project financing.

EQUIPMENT STOCKING

Cadmus asked questions regarding equipment stocking practices. Less than one-third of respondents (20%; n=41) said they kept equipment in stock to have it readily available for customers; and less than one-quarter of respondents (16%; n=43) said they encountered issues in acquiring equipment. While sample sizes were small, contractors working with lower-priced components were more likely to keep equipment in stock—for example, controls contractors (those completing the building management system project) and lighting contractors. Contractors noted long lead times, manufacturer delays, and ordering obsolete equipment as barriers to equipment acquisition. Table 29 shows equipment stocking practices for each prototypical project type, while Table 30 shows equipment stocking issues.

TABLE 29. EQUIPMENT STOCKING PRACTICES BY PROJECT TYPE

EQUIPMENT IN STOCK	HVAC: VRF	HVAC: RTU	LIGHTING	PERFORMANCE CONTRACT	BUILDING MGMT. SYSTEMS	TOTAL
Yes	1	1	2	0	4	8
No	20	6	5	0	2	33

Source: Commercial Contractor Surveys "Do you keep [EQUIPMENT TYPE] in stock to have it readily available for customers?" (n=41)

TABLE 30. ISSUES ACQUIRING EQUIPMENT BY PROJECT TYPE

STOCKING ISSUES	HVAC: VRF	HVAC: RTU	LIGHTING	PERFORMANCE CONTRACT	BUILDING MGMT. SYSTEMS	TOTAL
Yes	1	1	2	0	3	7
No	20	6	5	0	3	36

Source: Commercial Contractor Surveys “In the past year, has your business encountered any issues with acquiring the needed equipment to install [PROJECT TYPE]?” (n=43)

FINANCING

Cadmus asked respondents if they encountered any issues with clients securing financing to complete their projects. Almost one-quarter of respondents (24%; n=42) said they encountered clients who experienced financing issues, as shown in Table 31. The top three financing issues for clients were a limited budget (three respondents), low credit scores (two respondents), and a lack of external funding (one respondent).

TABLE 31. CLIENT FINANCING ISSUES

FINANCING ISSUES	HVAC: VRF	HVAC: RTU	LIGHTING	PERFORMANCE CONTRACT	BUILDING MGMT. SYSTEMS	TOTAL
Yes	4	0	2	2	2	10
No	16	7	5	0	4	32

Source: Commercial Contractor Surveys “In the past year, have you encountered any issues with your clients being able to secure financing to install [EQUIPMENT TYPE]? (n=42)

DECISION-MAKERS

Cadmus gathered three responses from decision-makers who completed lighting retrofit projects and one response from a decision-maker who completed a HVAC system replacement project in within the past 12 months in a commercial property. The average total installation cost for three lighting retrofit projects was approximately $104,833; however, two of the three lighting projects cost less than $50,000, while the third project cost $250,000 for a 1,300,000 square foot property. The HVAC decision-maker spent $12,000 on total installation costs for their project.

Three of four decision-makers used an energy audit to identify the need for their respective projects. One decision-maker said their energy audit cost $1,000 to complete, one said it cost $275, and one did not pay any out-of-pocket costs. All three energy audits were used to inform a lighting retrofit project, taking an average of nine internal staff hours to complete.

Before signing a contract to complete their projects, the three lighting retrofit decision-makers spent an average of 9.3 hours preparing a bid package; the one HVAC decision-maker said they spent three hours prepping a bid package. Table 32 shows the average number of labor hours decision-makers spent on project-related tasks.

Cadmus asked decision-makers about quality assurance and quality control costs needed after completing projects. Of the three commercial decision-makers, one had to call their contractor back for repair and maintenance issues. This callback was for a lighting retrofit project, which required 20 staff hours to identify the issues and to scheduling a contractor to resolve the issues. The contractor's work for the repair issue cost $10,000. Another lighting retrofit decision-maker performed internal repairs that required 15 hours of staff time and $5,000 for materials.

TABLE 32. LABOR HOURS FOR COMMERCIAL DECISION-MAKERS

TASK	LIGHTING RETROFIT (N=3)	HVAC REPLACEMENT (N=1)
Bid prepping	9.3	2.5
Researching contractors	8.3	N/A
Work site preparation	10.0	0
Managing contractors	21.7	2

KEY FINDINGS: COMMERCIAL SECTOR

Commercial sector soft costs are highly variable, with installation labor and marketing and customer acquisition contributing at varying levels to project-level soft costs.

Reviewing soft cost absolute values for the HVAC: VRF and RTU prototypical projects shows the high degree of complexity involved with installing a VRF system and the significant barrier this can present to building electrification.

Commercial contractors reported rarely stocking equipment, especially for projects involving larger and more expensive equipment.

MULTIFAMILY SECTOR

This section, which details soft cost results for the multifamily sector, contains the following types of information:

- Soft cost estimates for prototypical projects
- Drivers of soft costs variation (i.e., win rate, contractor region, etc.)
- Additional soft cost-related topics (i.e., supply chain/stocking, project financing, etc.)
- Decision-maker findings

PROTOTYPICAL PROJECT COST ESTIMATES

Cadmus gathered responses from 15 contractors who have completed an energy efficiency retrofit project in multifamily buildings within the past 12 months. Of surveyed contractors, three primarily worked in upstate NY and nine work downstate. Three respondents worked in a company that employed less than 10 employees, five in companies that employed 10 to 29 employees, and four in companies that employed 30 people or more. Almost half of multifamily service said less than 20% of their company's revenue came from their respective projects in multifamily buildings (n=15).

Cadmus asked contractors to provide information on their hard and soft cost expenditures within the last 12 months as well as estimates with respect to a prototypical multifamily building efficiency project, outlined in Table 33.

For an average installed project cost of ~$171,000 (n=12), about half of costs were hard (equipment-related) costs, while the other half were soft costs (Table 34). The percentage breakdown for hard vs. soft costs was relatively consistent, with an IQR of 40%-60% (20% spread). In comparison, the total installed cost is more widely dispersed, with an IQR of $57,500-$237,500 ($180,000 spread). This shows that multifamily contractors are in relative agreement on the contribution that hard costs make to total project cost but have different expectations and estimates related to how much the example prototypical project would cost the customer.

TABLE 33. MULTIFAMILY PROTOTYPICAL PROJECT DETAILS

ATTRIBUTE	DEFINITION
Building Type	Pre-war walk-up apartment building (market-rate)
Building Size	24 units (4 stories)
Existing Conditions	**HVAC:** Gas-fired, one-pipe steam system **Insulation:** Low ceiling/attic insulation level **Lighting (indoor—in-unit and common areas):** CFL (in-unit) and linear fluorescent (common areas) **Lighting (outdoor):** HID
Equipment to be Installed	**HVAC:** ASHP minisplits **Insulation:** Add blown-in insulation to ceiling/attic **Lighting (indoor—in-unit and common areas):** LED; no fixture replacement **Lighting (outdoor):** LED; no fixture replacement

TABLE 34. MULTIFAMILY SECTOR HARD COST AND SOFT COST ESTIMATES

METRIC	MEAN	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Total Installed Cost	$171,767	$159,949	$57,500	$237,500	12
% Soft Costs	49%	16%	40%	60%	12
Value Soft Costs	$82,978	$86,698	$29,500	$87,625	12
% Hard Costs	51%	16%	40%	60%	12
Value Hard Costs	$88,789	$83,630	$36,000	$116,250	12

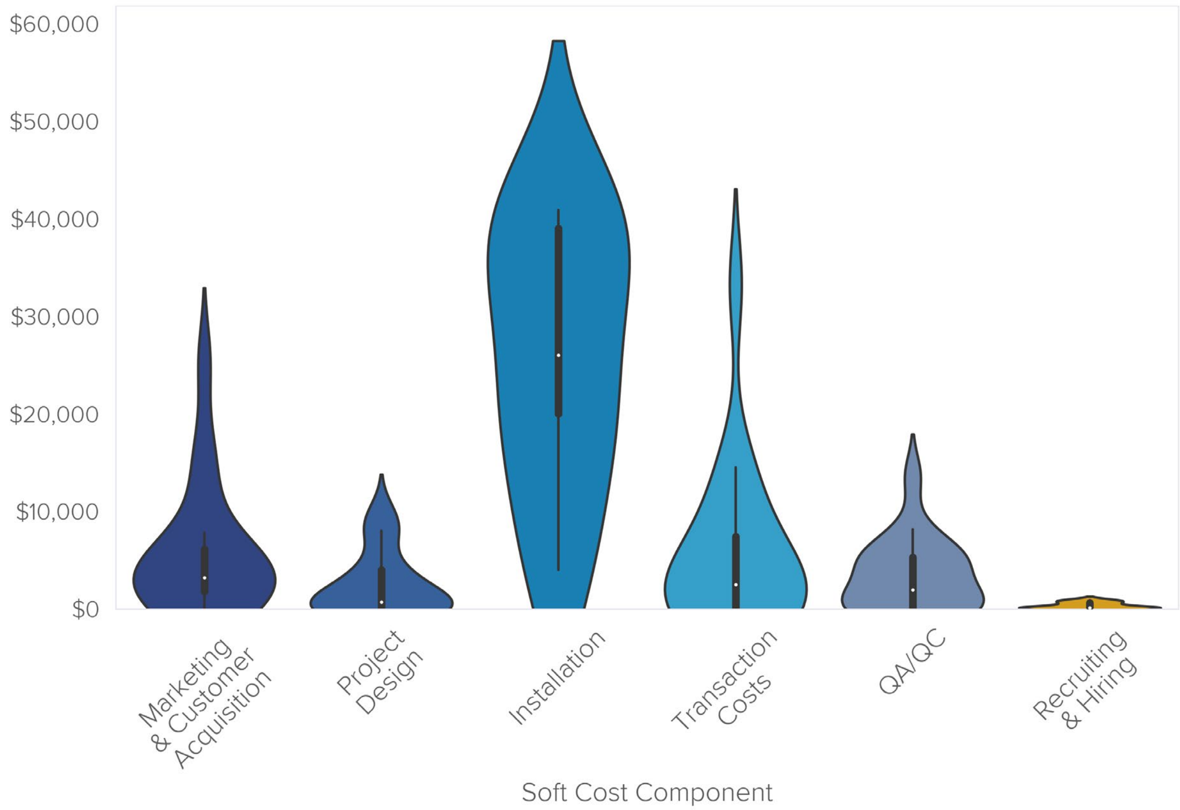
Table 35 shows multifamily prototypical project soft costs broken down by category and component. As with other sectors, installation labor is the largest contributor to project soft costs. After that, however, multifamily contractors report transaction costs as the second highest contributor to project soft costs, specifically permitting costs. The IQR for permitting costs is quite large – approximately $10,000 – which shows a large variation in what contractors need to put in to acquire permits for multifamily building work.[18] Multiple market experts corroborated this finding, noting that "permitting rules vary greatly by locality, which can be confusing and difficult to deal with." Another expert noted that he has experienced multiple cases where permit acquisition delayed construction by multiple months due to numerous application revisions."

[18] Unfortunately, the sample size is too low to split this data by region.

TABLE 35. MULTIFAMILY SECTOR SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	**$7,489**	**14%**	Marketing and/or customer education	$954	$990	$386	$945	12
			Bid preparation	$4,947	$7,087	$580	$5,316	12
			Project signing/ contracting	$1,588	$674	$991	$2,057	10
Project Design	**$4,093**	**8%**	Designing, scoping, and customizing the project	$4,093	$3,435	$1,373	$7,001	10
Installation	**$25,981**	**48%**	Installation labor	$25,981	$13,748	$20,002	$39,004	10
Transaction Costs	**$10,790**	**20%**	Obtaining permits	$9,735	$9,866	$3,648	$13,296	9
			Acquiring and maintaining trainings, certifications, and licenses	$1,055	$1,017	$385	$1,025	10
QA/QC	**$5,139**	**10%**	QA/QC activities	$4,795	$3,632	$2,931	$5,612	11
			Required callbacks to the customer to assist with equipment issues/ servicing	$344	$330	$95	$570	12
Recruiting & Hiring	**$303**	**1%**	Recruiting and hiring employees	$303	$339	$51	$588	10

FIGURE 50. MULTIFAMILY SECTOR SOFT COSTS VIOLIN PLOT



When looking at the distribution of soft cost categories in Figure 50, it is clear that there is a set of data points drawing the average for transaction costs higher. Interestingly, the main "body" of the violin plot for both transaction costs and QA/QC are nearly identical, but the mean for transaction costs is twice as much as QA/QC costs. This shows the importance of viewing data distribution along with averages, as neither tells the complete story on its own.

ADDITIONAL TOPICS

In addition to the soft cost-related questions, Cadmus also asked contractors a set of other questions to help provide context to their soft cost responses or to explore topics of interest from the NYSERDA team that couldn't be incorporated into the soft cost quantification. For the multifamily sector, this related to customer acquisition, equipment stocking, and project financing.

CUSTOMER ACQUISITION

Cadmus asked respondents to compare the customer acquisition costs for multifamily energy efficiency retrofit projects for affordable housing buildings to market rate buildings. Seven respondents said customer acquisition costs would be the same for affordable housing buildings and market rate buildings, three said the costs would be higher for affordable housing buildings, and one said costs would be lower. Two respondents who said costs would be higher commented on the higher incentives that affordable housing owners require to go forward with a project (i.e., lack of funding to finance the project internally) and this market segment is harder to reach overall.

EQUIPMENT STOCKING

Cadmus asked questions regarding equipment stocking practices. Two out of 12 respondents said they keep equipment in stock to have it readily available for customers and three respondents said they encountered issues acquiring equipment (n=12). These issues included long lead times and equipment availability specific to lighting and HVAC equipment. One respondent said they typically keep lighting and heat pump equipment in stock and one kept lighting fixtures and bulbs to have it ready for customers.

FINANCING

Cadmus asked respondents if they encountered any issues with clients being able to secure financing to complete their projects. Three of 12 respondents said they encountered clients who experienced financing issues. These three contractors mentioned low credit scores and budget limitations as financial issues for their clients.

ECONOMIES OF SCALE

While the size of the multifamily sample limited Cadmus' ability to adequately assess economies of scale, one market expert Cadmus interviewed provided insight on the topic. This market expert explained that there may be scalability opportunities in the multifamily sector. They explained, "the project process should be more standardized than it currently is. It's currently mostly smaller contractors doing customized projects." Standardizing multifamily projects may enable increased economies of scale at the cost of customization.

DECISION-MAKERS

Cadmus gathered nine responses from decision-makers completing building efficiency retrofit projects that involved insulation, HVAC, and/or lighting improvements in a multifamily residential property with five or more units. The average total installation costs for the nine projects ranged from $0 (two respondents) to $750,000 (one respondent). On average, these projects cost $129,611 (n=9).

Three of nine decision-makers used an energy audit to identify the need for their respective projects. One decision-maker said their energy audit cost $28,000 to complete, and one completed the audit using in-house resources. The respondent completing the energy-audit in-house said it took staff four hours. The respondent paying for their energy audit did not spend internal staff hours to complete the audit.

Before signing a contract to complete their projects, nine decision-makers spent an average of 7.6 hours reviewing bids from potential contractors, which was slightly higher than bid prep for commercial and residential decision-makers. Table 36 shows the average number of labor hours that decision-makers spent on each project-related task.

TABLE 36. LABOR HOURS FOR MULTIFAMILY DECISION-MAKERS

TASK	STAFF HOURS
Bid review (n=9)	7.6
Researching contractors (n=6)	6.8
Work site preparation (n=9)	3.8
Managing contractors (n=9)	25.2

Cadmus asked decision-makers about quality assurance and quality control costs needed after completing projects. Of the nine decision-makers, two had to call their contractors back for repairs and maintenance issues. One call back required 20 hours of staff time to oversee repairs, while the other call was minor and only took one-half hour. Two other decision-makers performed internal repairs, which took an average of 2.5 hours to complete. One internal repair cost $2,000; the other cost $15,000.

BARRIERS TO ASHP ADOPTION

In addition to the surveys, Cadmus interviewed a set of NY-based multifamily energy efficiency contractors/market experts to gather additional context as to why ASHP uptake has been slow to date. These market experts identified various barriers to increased adoption of ASHPs as a retrofit measure for multifamily buildings:

- **There is a lack of trust in the reliability of ASHPs among both building owners/managers and contractors**, with owners/managers not believing that ASHPs can provide the heating they need and contractors wanting to avoid a dissatisfied customer unable to adequately heat their building. The market experts felt that providing compelling case studies and lessons learned with proper ASHP operation could help to reduce this barrier.
- **Maintenance staff are trained on existing** equipment, so building owners/managers are less likely to switch HVAC equipment due to the cost of retraining.
- **Owner/manager labor is required for a large construction project,** which can create a bottleneck when customers don't have the capacity to complete projects. One market expert noted that this cost is not only for managing the contractors, but also for managing the tenants.
- **The cost of natural gas is projected to stay low for the short- to mid-term,** reducing a financial incentive for building owners/managers to electrify their buildings.
- **Building structure and design can make an ASHP retrofit challenging,** both from the placement of units and upgrading the electrical distribution system to meet the increased demand.

Market experts noted that easy-to-operate incentive programs will be an important driver to reduce barriers in building retrofits, as building owners/managers are time-constrained and struggle with traditional incentive programs. Additionally, one expert noted that the increasing number of gas moratoriums could have a big impact in the new construction space.

KEY FINDINGS: MULTIFAMILY SECTOR

The ratio of soft costs to hard costs is relatively consistent across responses but total project costs have increased variation, showing general agreement on the contribution of hard costs.

After installation labor, transaction costs, specifically permitting, contribute significantly to multifamily prototypical project soft costs. The high spread in permitting costs suggests an area for further exploration.

Contractors identified funding issues (and relatedly the level of incentives available) that are more prevalent in affordable housing buildings compared to market-rate buildings.

CONCLUSIONS AND RECOMMENDATIONS

This report quantifies the soft costs associated with energy efficiency 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. Importantly, research to date has not identified a "silver bullet" for achieving soft cost reductions in New York's energy efficiency market. Instead, research shows that the New York energy efficiency market is complex, regionalized, fragmented, and diverse—and all of these factors influence the soft costs associated with any given energy efficiency installation.

Nonetheless, as discussed below, research findings do provide insights that NYSERDA (or other entities) can leverage to influence or assist market actors in reducing soft costs, though the direct impacts of interventions remain uncertain. In other words, the development of energy efficiency soft cost reduction strategies in New York will likely remain more of an art than an exact science. Recommendations in this report have focused on technical assistance programs that NYSERDA can implement to stimulate soft cost reductions. 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 reduce costs.

In the following section, Cadmus builds on NYSERDA's past research by analyzing soft cost reduction strategies—which were initially presented in the *Renewable Heating and Cooling Policy Framework*[19] —in light of the detailed findings presented in this 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 soft cost reduction strategies in New York. Recommendations are organized around four soft cost reduction strategies, including: (i) marketing and customer acquisition, (2) technical and engineering assistance, (3) standardized equipment and design, and (4) unified permitting processes. Additionally, the box at the end of this section provides recommendations for future research, which can help policymakers deepen understanding of energy efficiency soft costs in New York.

[19] NYSERDA. *Renewable Heating and Cooling Policy Framework*: *Options to Advance Industry Growth and Markets in New York.* February 2017.

MARKETING AND CUSTOMER ACQUISITION

Research shows that customer acquisition for contractors—comprising time spent finding potential customers, drafting bids, and conducting initial site assessments—requires a significant investment of time and energy.

- Marketing and customer acquisition costs are one of the largest contributors to soft costs, making up approximately 20-25% of total project soft costs (and second only to installation labor at the sector level). This is significant, as time spent on generating business is a direct cost to a contractor, a cost they need to recover through project work.
- When examining soft costs at the prototypical project level, differences by sector emerge. There is significant variability in marketing and customer acquisition costs in the commercial sector (12-38% of project soft costs) but more consistency in residential (26-27% of project soft costs).
- Win rate—or the percentage of bids a contractor reports winning—is a key explanatory variable of sector-level soft costs. For example, residential contractors at the 75th percentile of win rates (i.e., with a win rate of 67%) report soft costs $1,250 lower than contractors at the 25th percentile of win rates (i.e., with a win rate of 28%). It is reasonable to infer that by reducing time spent on losing bids, contractors can significantly reduce soft costs.
- Market experts noted that there is a lack of education about newer technologies among customers and contractors, causing them to be less likely to trust that these technologies will meet their needs. This leads to an increased customer acquisition cost, as contractors need to spend additional effort getting customers on-board. Out of the prototypical projects included in this study, this is most prevalent with VRF systems.
- The evidence suggests that programs that reduce contractors' customer acquisition and procurement barriers can reduce soft costs.

Given the large contribution of marketing and customer acquisition to total project soft costs, NYSERDA initiatives that assist contractors to identify prospective customers quickly and efficiently could lead to cost savings.

RECOMMENDATION:

NYSERDA may consider **continuing the development of resources that assist contractors with identifying the highest-potential customers.** Resources can include building fuel usage and heating application maps, existing installations of key technologies, and home turnover maps, among others. Additionally, NYSERDA could provide education resources to help contractors understand and utilize the mapping tools (and other information they collect) to assess if a building is suitable for a particular technology. These resources were originally recommended through the *Renewable Heating and Cooling Policy Framework* and are still relevant based on the results of this study. One market expert Cadmus interviewed stated that they consider these tools helpful, but their value must be demonstrated to contractors to drive wider adoption.

RECOMMENDATION:

NYSERDA could **leverage existing, successful community outreach channels to identify additional opportunities not covered under current campaigns.** For example, NYSERDA could work with community organizers they have a strong relationship with to identify other needs in their communities outside of their specific campaign, such as weatherization in a Solarize campaign community. Due to the prior work through NYSERDA outreach channels, these communities can be expected to have a lower barrier to entry than communities without prior activity.

RECOMMENDATION:

NYSERDA could **identify opportunities for customer aggregation,** such as targeting large portfolio owners where multiple buildings can be packaged into a larger energy efficiency retrofit contract.

TECHNICAL AND ENGINEERING ASSISTANCE

The inclusion of newer technologies in a project—or the requirement of extensive pre-installation procedures/assessments—can lead to increased customer acquisition, design, and installation costs.

- Projects that include newer technologies (e.g., VRF systems, ASHPs), exhibit higher installation costs as a percentage of total soft costs (installation labor is 69% of total HVAC VRF project soft costs). This may be due to reduced contractor familiarity with the installation process and thus a lack of efficiencies gained through experience.
- Performance contracts, by design, cover a large array of measures across a long time-horizon (typically 10 years) and require detailed energy savings calculations, which leads to a significant investment in initial work at potential customer sites. Contractors reported marketing and customer acquisition costs 62% higher than installation costs for performance contracts, primarily due to the amount of preparation work that goes into a performance contract.
- The results from this study suggests this trend is strongest in the commercial sector, though it is reasonable to assume that the same would be true of larger multifamily buildings.

Given the complexity of some large commercial and performance contracting installations, NYSERDA initiatives that provide greater financial and engineering support in these sectors may be warranted.

RECOMMENDATION:

NYSERDA may consider **creating or expanding initiatives that provide greater technical and engineering assistance and project development support** for large, multi-technology, or otherwise complex projects in key market segments. Support could include initial assessments, including site suitability assessments; feasibility studies to establish lifecycle costs for potential measures; design support to ensure the systems are designed by certified professionals; or measurement and verification to increase the confidence in outcomes and replicability of success.

RECOMMENDATION:

NYSERDA may consider **creating or expanding the development of tools that assist contractors with streamlining components of the project development process,** such as remote audits or standardized technical analyses.

STANDARDIZED APPROACHES

Total soft costs are highly impacted by the cost associated with project design and installation work, which accounts for the majority of soft costs across all sectors.

- Installation labor is the largest soft cost category across all sectors (48-53% of total soft costs at the sector level) and nearly all prototypical projects (excluding performance contracts). When added with project design costs, it comes to nearly 60% of prototypical project soft costs. However, there is a high degree of variation in installation labor estimates across all three sectors, showing opportunities for labor efficiencies.

- There is evidence of a "specialization effect" among insulation and whole-home contractors, whereby those that have a higher percentage of their revenue coming from the specific prototypical project tend to have lower installation costs. Interestingly, this effect was not also observed among residential HVAC contractors.

- Project design costs are positively correlated with QA/QC costs in the residential sector, suggesting that some contractors tend to spend more "non-installation time" on project work than others. Educating contractors around best practice procedures can help reduce unnecessary work by contractors that may not be leading to increased system performance.

- These results suggest that identifying ways to improve efficiencies in project design and installation can lead to potential soft cost reductions.

Given the large contribution of project design and installation costs to total project soft costs, NYSERDA initiatives that assist contractors to standardize installations (where possible) could lead to cost savings. Several market experts Cadmus interviewed provided support for the hypothesis that trainings and best practice standards can help reduce project soft costs.

RECOMMENDATION:

There is evidence to support investment from NYSERDA to **create or expand facilitation of standardized installation, design, and quality control approaches by encouraging industry best practice and/or through requirements in incentive programs.** Specific examples could include:

1. standard installation procedures, including optimized (sequenced and/or integrated) outdoor and indoor installation work;

2. standardized design guides/ software that contractors can use to design and specify systems, satisfy the needs of most building conditions, and that minimize the need for skilled trade labor;

3. standardized approaches to quality control schemes, including standardized and efficient training and accreditation schemes for installers and designers, as well as system inspection processes.

An alternative market intervention to NYSERDA-facilitated training would be for NYSERDA to subsidize trainings that adhere to a specific, NYSERDA-approved best-practices curriculum. While the study did not investigate specific aspects of the project design or installation process that could be improved, the above recommendations represent a best estimate based on market knowledge.

RECOMMENDATION:

NYSERDA may consider **working with key manufacturer partners to standardize approaches and offer contractor training programs on design, installation, and quality control best practices.** These efforts would be particularly effective for newer technologies, where there is a lack of market knowledge and fewer qualified professionals to complete installations. It is reasonable to assume that workforce development initiatives can accelerate the adoption of newer technologies into contractors' business models.

One market expert Cadmus interviewed specifically provided support for this recommendation, noting that **training will be particularly helpful for overcoming skepticism of new technologies among contractors and, subsequently, their customers.**

RECOMMENDATION:

Relatedly, NYSERDA may also consider **creating or expanding programs that recruit contractors to specialize in new or high growth business areas** (like ASHPs). Increasing the number of specialized contractors in the market can both create a base of contractors with the skills necessary to install new technologies and drive innovation in project design and installation processes due to their increased experience.

UNIFIED PERMITTING PROCESSES

Permitting can be a driver of variability in project costs, with substantial differences observed across sectors and contractor regions.

- Contractor estimates for transaction costs (which includes permitting costs) are one of the most variable soft cost categories examined in the study, typically with the third highest spread after installation labor and marketing and customer acquisition.
- While median permitting costs in the residential sector were similar both upstate and downstate, the distributions of permitting costs differed considerably. Specifically, while upstate contractors' permitting costs tend to be grouped close to zero, downstate contractors' permitting costs tend to be much more widely distributed and slightly larger on average. Commercial contractors' permitting costs followed a similar trend. This suggests a more complex permitting landscape that downstate contractors need to navigate.
- A few market experts noted that there are differences in how municipalities interpret state codes, which can drive differences in local codes, making the permitting process more complex than needed.

Given the variability and impact of permitting costs, especially in downstate New York, NYSERDA initiatives that seek to streamline and reduce permitting could lead to cost savings.

RECOMMENDATION:

NYSERDA may consider **developing a unified, streamlined permitting process for key technologies and encourage adoption across NYS municipalities.** This would entail the creation and dissemination of model codes for various technologies. There are several examples in New York State where model codes have been developed regionally and at the State level for various renewable energy technologies: Long Island Unified Solar Permit Initiative (LIUSPI), NYS Unified Solar Permit, Suffolk County Model Geothermal Code.

RECOMMENDATION:

NYSERDA may also consider **creating or expanding training and education programs for building inspectors.** Specifically, once model permitting codes are developed, building inspectors and permit reviewers will also need to be trained on key technologies, performance history, and installation best practices. In addition, it will be important for New York State to establish an incentive for municipalities that adopt the model codes.

RECOMMENDATION PRIORITIZATION BY SECTOR

Through discussions with NYSERDA stakeholders and the Strategic Advisory Committee, Cadmus prioritized each recommendation based on the sector where it could have the largest impact or is most applicable. These prioritizations are shown in Table 37.

FUTURE RESEARCH: ENERGY EFFICIENCY SOFT COSTS

As discussed in the body of the report, Cadmus and NYSERDA identified options for changing the design of future iterations of this study.

COMMERCIAL SCOPE

This baseline study assessed soft costs across a broad set of projects, which allowed for sector-level comparisons. Due to the diverse set of projects in the commercial sector, results at the commercial sector level are less insightful than for specific prototypical projects. In future study iterations, NYSERDA may choose to select a smaller number of higher-priority prototypical projects in order to increase the achievable sample sizes within a given budget.

MULTI-FAMILY PROTOTYPICAL PROJECT SPECIFICATION

NYSERDA included an ASHP in the multifamily prototypical project in order to gain a view of what soft costs for multifamily projects may look like in the future when building electrification technologies are more widely adopted. This caused a significant reduction in the population of contractors qualified to answer the survey, as one of the requirements was to have done this type of work in the past (i.e., a multifamily building energy efficiency retrofit including ASHPs). In future iterations, NYSERDA may choose to switch the ASHP measure to a more efficient steam system, as this is the majority of installations happening today and is predicted to remain popular in the near- to mid-term.

TABLE 37. RECOMMENDATION PRIORITIZATION BY SECTOR

RECOMMENDATION	RESIDENTIAL	MULTIFAMILY	COMMERCIAL
MARKETING AND CUSTOMER ACQUISITION			
NYSERDA may consider continuing the development of resources that assist contractors with identifying the highest-potential customers.	High	Moderate	Lower
NYSERDA could leverage existing, successful community outreach channels to identify additional opportunities not covered under current campaigns.	High	Moderate	Moderate
NYSERDA could identify opportunities for customer aggregation, such as targeting large portfolio owners where multiple buildings can be packaged into a larger energy efficiency retrofit contract.	Moderate	High	High
TECHNICAL AND ENGINEERING ASSISTANCE			
NYSERDA may consider creating or expanding initiatives that provide greater technical and engineering assistance and project development support for large, multi-technology, or otherwise complex projects in key market segments.	Moderate	High	High
NYSERDA may consider creating or expanding the development of tools that assist contractors with streamlining components of the project development process, such as remote audits or standardized technical analyses.	High	Moderate	Moderate
STANDARDIZED APPROACHES			
There is evidence to support investment from NYSERDA to create or expand facilitation of standardized installation, design, and quality control approaches by encouraging industry best practice and/or through requirements in incentive programs.	High	Moderate	Moderate

RECOMMENDATION	RESIDENTIAL	MULTIFAMILY	COMMERCIAL
NYSERDA may consider working with key manufacturer partners to standardize approaches and offer contractor training programs on design, installation, and quality control best practices.	High	High	High
NYSERDA may also consider creating or expanding programs that recruit contractors to specialize in new or high growth business areas (like ASHPs).	High	High	High
UNIFIED PERMITTING PROCESSES			
NYSERDA may consider developing a unified, streamlined permitting process for key technologies and encourage adoption across NYS municipalities.	High	High	High
NYSERDA may also consider creating or expanding training and education programs for building inspectors.	High	High	High

APPENDIX A.

SOFT COST QUANTIFICATION METHODOLOGY

This section details the methodologies used to quantify soft costs, calculate blended labor rates, and clean and analyze the final data.

SOFT COST CATEGORY AND COMPONENT CALCULATIONS

Cadmus used different methods to calculate various soft cost components. For each, Cadmus asked about the soft cost in terms of dollars, labor hours, or both. Cadmus identified which unit would be most appropriate through interviews with market experts and conferring with internal Cadmus subject-matter experts. Table 38 presents each soft cost component (column second from left) and the method used to transform each survey response into a dollar estimate. Soft cost components with multiple rows indicate when the soft cost component is composed of multiple data points. Soft cost components then roll-up to soft cost categories (far left column). In all cases where the unit is “hours”, the data point is multiplied by the blended labor rates from Table 45 to convert all data into dollars.

TABLE 38. SOFT COST CATEGORY AND COMPONENT CALCULATIONS

SOFT COST CATEGORY	SOFT COST COMPONENT	DATA POINTS USED	SCALE OF DATA	UNITS	HOW TO QUANTIFY	NOTES
Marketing & Customer Acquisition	Marketing and/or customer education	Amount spent on marketing and customer education	Yearly	Dollars	Divide by number of projects	Some surveys asked for the % specific to the prototypical project technology
		Hours spent on marketing and customer education	Yearly	Hours		
	Bid preparation	Hours spent on bid preparation	Per bid	Hours	Multiply by number of bids and divide by number of projects	
		Dollars spend on bid preparation	Per bid	Dollars		Only asked for Performance Contract
	Project signing/ contracting	Hours spent on project signing	Per project	Hours		
Project Design	Designing, scoping, and customizing the project	Hours spent on system design	Per project	Hours		
Installation	Installation labor	Hours spent on installation labor and project management	Per project	Hours		
Transaction Costs	Obtaining permits	Hours spent obtaining permits	Per project	Hours		
		Dollars spent obtaining permits	Per project	Dollars		
	Acquiring and maintaining trainings, certifications, and licenses	Amount spent on trainings and certifications	Yearly	Dollars	Divide by number of projects	
		Labor hours spent on trainings and certifications	Yearly	Hours		
QA/QC	QA/QC activities	Hours spent on QA/QC	Per project	Hours		
	Required callbacks to the customer to assist with equipment issues/ servicing	Hours spent on callbacks	Yearly	Hours	Divide by number of projects	
Recruiting & Hiring	Recruiting and hiring employees	Hours spent on recruiting and hiring	Yearly	Hours	Divide by number of projects	
Final Roll-Up	Total project cost	Cost to customer	Per project	Dollars		
	Hard cost	Percentage equipment and materials	Per project	Percentage	Subtract from 1 to get % soft costs	

BLENDED LABOR RATES CALCULATION

To accurately transform hours estimates into dollars, Cadmus calculated blended labor rates. Blended labor rates have three components: burdened labor rates, prototypical project adjustments, and soft cost category adjustments. This appendix describes how Cadmus calculated each of these.

BURDENED LABOR RATES

Burdened labor rates account for other business costs not explicitly included in the soft costs survey, such as worker's compensation insurance, fringe benefits (e.g., vacation pay, employer-paid health benefits, pension costs), and fixed overhead (e.g., federal and state unemployment costs, social security taxes, builder's risk insurance costs, public liability costs).[20] RSMeans data were on a national scale (i.e., all United States average), customized for 41 specific trade types. Though RSMeans provided trade-specific base hourly rates, including fringes and worker's compensation insurance, it used the same fixed overhead value for all trade types.

In addition to burdening base hourly labor rates with the costs described above, Cadmus needed to adjust the rates to be more specific to this study. First, as the data were on a national scale, Cadmus used location factors from RSMeans to account for the contractor's location (upstate or downstate).[21] The location factors were on a county-by-county level compared to the national average. To calculate a location factor for the two regions (upstate and downstate), Cadmus averaged all labor-specific location factors for counties included in each region. This led to increased upstate rates by 10.5% and downstate rates by 66.1%. Second, Cadmus only included trades that would work on the prototypical projects included in the study. Further, Cadmus selected specific trade types in consultation with NYSERDA and the SAC. Table 39 (upstate) and Table 40 (downstate) show burdened labor rates and inputs used in the study and Equation 2 shows the equation to calculate burdened labor rates.

EQUATION 2. BURDENED LABOR RATE CALCULATION

$$Labor\ Rate_{Burdneed} = Labor\ Rate_{Base+fringes}$$

$$\times\ Location\ Adjustment\ \times$$

$$Worker's\ Comp\ Insurance \times Fixed\ Overhead$$

[20] Source: RSMeans Labor Rates, Overhead, and Profit, 2018.

[21] Source: RSMeans Location Factors, 2018.

TABLE 39. BURDENED LABOR RATES, UPSTATE

TRADE TITLE	BASE HOURLY RATE INC. FRINGES (US)	ADJUSTED BASE RATE (+10.5%)	WORKER'S COMP INSURANCE	FIXED OVERHEAD	BURDENED LABOR RATE
Helper (average)	$38.85	$42.92	14.20%	18.30%	$56.87
Administrative[1]	$32.00	$35.36	10.80%	18.30%	$45.65
Electricians	$60.05	$66.35	4.90%	18.30%	$81.74
Insulation Workers	$57.35	$63.36	10.10%	18.30%	$81.36
Plumbers, Pipefitters, and Steamfitters	$63.55	$70.21	5.80%	18.30%	$87.14
HVAC and Refrigeration Mechanics[1]	$45.93	$50.75	10.80%	18.30%	$65.52
Maintenance and Repair Workers, General	$30.80	$34.03	12.00%	18.30%	$44.34

[1]Not in RSMeans data; see below for calculation method.

TABLE 40. BURDENED LABOR RATES, DOWNSTATE

TRADE TITLE	BASE HOURLY RATE INC. FRINGES (US)	ADJUSTED BASE RATE (+66.1%)	WORKER'S COMP INSURANCE	FIXED OVERHEAD	BURDENED LABOR RATE
Helper	$38.85	$88.68	14.20%	18.30%	$114.48
Administrative[1]	$32.00	$64.52	10.80%	18.30%	$85.48
Electricians	$60.05	$53.15	4.90%	18.30%	$68.61
Insulation Workers	$57.35	$99.72	10.10%	18.30%	$122.86
Plumbers, Pipefitters, and Steamfitters	$63.55	$95.24	5.80%	18.30%	$122.28
HVAC and Refrigeration Mechanics[1]	$45.93	$105.53	10.80%	18.30%	$130.97
Maintenance and Repair Workers, General	$30.80	$76.28	12.00%	18.30%	$98.47

[1]Not in RSMeans data; see below for calculation method.

TABLE 41. ADMINISTRATIVE AND HVAC WORKER BASE HOURLY RATE CALCULATION

TRADE TITLE	MEAN ANNUAL WAGE	INDEX TO ELECTRICIANS	BASE HOURLY RATE INC. FRINGES (US)
Electricians	$79,160	100	$60.05
Administrative	$42,190	53.3	$32.00
HVAC and Refrigeration Mechanics	$60,550	76.5	$45.93

The RSMeans data do not include two trades—administrative and HVAC and Refrigeration workers. For these, Cadmus used yearly income data from the New York Department of Labor to compare total compensation in these trades to a category included in RSMeans (electricians). As shown in Table 41, Cadmus calculated an index for these trades to properly scale the electrician base hourly rate. Cadmus used the average worker's compensation insurance for both trades.

PROTOTYPICAL PROJECT ADJUSTMENTS

Because each prototypical project is completed by a different set of contractors, Cadmus created a set of prototypical project-specific burdened labor rates. To do this, Cadmus consulted with NYSERDA and the SAC to identify the contractor types that work on each prototypical project. These results are shown in Table 42. Cadmus then averaged the rates for the contractor types relevant to each prototypical project to calculate an average burdened labor rate per prototypical project, as shown in Table 43. The helper and administrative rates are consistent across all prototypical projects.

SOFT COST CATEGORY ADJUSTMENTS

The final step to calculate blended labor rates is to adjust the rates for the percentage of time spent by the three different labor types presented in Table 43: contractors, helpers, and administrative staff. Table 44 shows the percentages of labor assigned to each labor type for each soft cost category. These percentages are based on the solar soft costs study from NREL and LBNL[22] and discussions with internal Cadmus subject-matter experts, NYSERDA, and the SAC.

[22] NREL and LBNL (2012). *Benchmarking Non-Hardware Balance-of-System (Soft) Costs for U.S. Photovoltaic Systems Using a Bottom-Up Approach and Installer Survey*. 2012.

TABLE 42. PROTOTYPICAL PROJECT ADJUSTMENTS

TRADE TITLE	COMMERCIAL					MULTI-FAMILY	RESIDENTIAL		
	LIGHTING	HVAC: VRF	HVAC: RTU	PERF. CONT.	BLDG. MGMT.		HVAC	INSULATION	WHOLE HOME
Helper	X	X	X	X	X	X	X	X	X
Administrative	X	X	X	X	X	X	X	X	X
Electricians	X	X	X	X	X	X	X		
Insulation Workers				X		X		X	X
Plumbers, Pipefitters, and Steamfitters		X		X					
HVAC and Refrigeration Mechanics		X	X	X		X	X		X
Maintenance and Repair Workers, General				X					

TABLE 43. PROTOTYPICAL PROJECT-SPECIFIC BURDENED LABOR RATES

TRADE TITLE	COMMERCIAL				MULTI-FAMILY	RESIDENTIAL		
	LIGHTING	HVAC: VRF	HVAC: RTU	PERF. CONT.		HVAC	INSULATION	WHOLE HOME
Upstate								
Contractor	$81.74	$78.13	$73.63	$72.02	$76.21	$73.63	$81.36	$73.44
Helper	$56.87	$56.87	$56.87	$56.87	$56.87	$56.87	$56.87	$56.87
Administrative	$45.65	$45.65	$45.65	$45.65	$45.65	$45.65	$45.65	$45.65
Downstate								
Contractor	$122.86	$117.43	$110.66	$108.24	$114.54	$110.66	$122.28	$110.38
Helper	$85.48	$85.48	$85.48	$85.48	$85.48	$85.48	$85.48	$85.48
Administrative	$68.61	$68.61	$68.61	$68.61	$68.61	$68.61	$68.61	$68.61

FINAL BLENDED LABOR RATES

Using the percentages in Table 44, we calculated a blended labor rate that is customized for each prototypical project, contractor region, and soft cost category. These rates are presented in Table 45.

TABLE 44. LABOR PERCENTAGES BY SOFT COST CATEGORY

SOFT COST CATEGORY	PERCENT CONTRACTOR	PERCENT HELPER	PERCENT ADMINISTRATIVE
Marketing and Customer Acquisition	50%	0%	50%
System Design	50%	50%	0%
Installation Labor	50%	50%	0%
Transaction Costs	30%	0%	70%
Training and Certifications	70%	0%	30%
QA/QC	80%	20%	0%

TABLE 45. FINAL BLENDED LABOR RATES USED FOR QUANTIFICATION

	COMMERCIAL						RESIDENTIAL		
	LIGHTING	HVAC: VRF	HVAC: RTU	PERF. CONT.	BLDG. MGMT.	**MULTI-FAMILY**	HVAC	INSULATION	WHOLE HOME
Upstate									
Marketing and Customer Acquisition	$63.70	$61.89	$59.64	$58.84	$63.70	$60.93	$59.64	$63.51	$59.55
System Design	$69.31	$67.50	$65.25	$64.45	$69.31	$66.54	$65.25	$69.12	$65.16
Installation Labor	$69.31	$67.50	$65.25	$64.45	$69.31	$66.54	$65.25	$69.12	$65.16
Transaction Costs	$56.48	$55.40	$54.04	$53.56	$56.48	$54.82	$54.04	$56.36	$53.99
Training and Certifications	$70.91	$68.39	$65.24	$64.11	$70.91	$67.04	$65.24	$70.65	$65.10
QA/QC	$76.77	$73.88	$70.28	$68.99	$76.77	$72.34	$70.28	$76.46	$70.13
Downstate									
Marketing and Customer Acquisition	$95.73	$93.02	$89.64	$88.43	$95.73	$91.58	$89.64	$95.45	$89.50
System Design	$104.17	$101.46	$98.07	$96.86	$104.17	$100.01	$98.07	$103.88	$97.93
Installation Labor	$104.17	$101.46	$98.07	$96.86	$104.17	$100.01	$98.07	$103.88	$97.93
Transaction Costs	$84.89	$83.26	$81.23	$80.50	$84.89	$82.39	$81.23	$84.72	$81.14
Training and Certifications	$106.58	$102.79	$98.05	$96.36	$106.58	$100.76	$98.05	$106.18	$97.85
QA/QC	$115.38	$111.04	$105.63	$103.69	$115.38	$108.73	$105.63	$114.92	$105.40

APPENDIX B.

EXPANDED COMMERCIAL PROTOTYPICAL PROJECT RESULTS

The following section (Table 46 to Table 50) contains the expanded set of soft cost category and component breakdowns for the commercial prototypical projects.

TABLE 46. HVAC: VRF SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	**$8,755**	**12%**	Marketing and/or customer education	**$1,023**	**$1,289**	**$84**	**$1,874**	**15**
			Bid preparation	**$6,336**	**$6,902**	**$1,289**	**$10,233**	**23**
			Project signing/ contracting	**$1,396**	**$1,373**	**$426**	**$1,953**	**16**
Project Design	**$4,213**	**6%**	Designing, scoping, and customizing the project	**$4,213**	**$4,105**	**$675**	**$5,400**	**17**
Installation	**$50,471**	**69%**	Installation labor	**$50,471**	**$46,706**	**$9,258**	**$70,919**	**15**
Transaction Costs	**$5,437**	**7%**	Obtaining permits	**$4,348**	**$4,893**	**$416**	**$7,081**	**20**
			Acquiring and maintaining trainings, certifications, and licenses	**$1,090**	**$1,528**	**$167**	**$1,387**	**17**
QA/QC	**$3,690**	**5%**	QA/QC activities	**$3,012**	**$2,807**	**$740**	**$4,442**	**18**
			Required callbacks to the customer to assist with equipment issues/ servicing	**$679**	**$785**	**$49**	**$1,110**	**18**
Recruiting & Hiring	**$151**	**0%**	Recruiting and hiring employees	**$151**	**$334**	**$0**	**$2**	**15**

TABLE 47. HVAC: RTU SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	**$7,188**	**25%**	Marketing and/or customer education	**$535**	**$767**	**$47**	**$591**	**8**
			Bid preparation	**$4,659**	**$4,125**	**$1,060**	**$7,049**	**8**
			Project signing/ contracting	**$1,993**	**$1,056**	**$2,386**	**$2,386**	**5**
Project Design	**$2,494**	**9%**	Designing, scoping, and customizing the project	**$2,494**	**$1,836**	**$1,305**	**$2,942**	**5**
Installation	**$9,191**	**32%**	Installation labor	**$9,191**	**$7,278**	**$4,176**	**$13,050**	**5**
Transaction Costs	**$7,149**	**25%**	Obtaining permits	**$1,624**	**$1,335**	**$742**	**$2,467**	**6**
			Acquiring and maintaining trainings, certifications, and licenses	**$5,525**	**$6,753**	**$680**	**$8,529**	**7**
QA/QC	**$2,675**	**9%**	QA/QC activities	**$2,334**	**$1,614**	**$2,113**	**$2,811**	**5**
			Required callbacks to the customer to assist with equipment issues/ servicing	**$341**	**$445**	**$14**	**$703**	**5**
Recruiting & Hiring	**$250**	**1%**	Recruiting and hiring employees	**$250**	**$457**	**$0**	**$220**	**8**

TABLE 48. LIGHTING SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	$13,862	31%	Marketing and/or customer education	$3,360	$3,111	$1,386	$4,167	5
			Bid preparation	$4,585	$7,309	$705	$3,965	6
			Project signing/contracting	$5,917	$7,469	$510	$12,739	5
Project Design	$4,721	10%	Designing, scoping, and customizing the project	$4,721	$7,968	$554	$4,998	4
Installation	$23,241	51%	Installation labor	$23,241	$26,072	$8,871	$34,307	3
Transaction Costs	$2,203	5%	Obtaining permits	$894	$392	$714	$1,103	3
			Acquiring and maintaining trainings, certifications, and licenses	$1,309	$683	$938	$1,465	4
QA/QC	$1,214	3%	QA/QC activities	$716	$469	$461	$921	3
			Required callbacks to the customer to assist with equipment issues/servicing	$498	$702	$0	$923	5
Recruiting & Hiring	$0	0%	Recruiting and hiring employees	$0	$0	$0	$0	2

TABLE 49. PERFORMANCE CONTRACT SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	**$52,388**	**38%**	Marketing and/or customer education	**$42,770**	**$90,292**	**$649**	**$20,479**	**6**
			Bid preparation	**$6,642**	**$5,439**	**$2,650**	**$8,825**	**7**
			Project signing/ contracting	**$2,976**	**$3,228**	**$735**	**$3,904**	**6**
Project Design	**$9,540**	**7%**	Designing, scoping, and customizing the project	**$9,540**	**$13,171**	**$1,289**	**$9,667**	**5**
Installation	**$32,262**	**24%**	Installation labor	**$32,262**	**$36,825**	**$12,889**	**$25,779**	**5**
Transaction Costs	**$33,644**	**25%**	Obtaining permits	**$32,307**	**$27,966**	**$7,415**	**$58,570**	**5**
			Acquiring and maintaining trainings, certifications, and licenses	**$1,337**	**$890**	**$792**	**$1,921**	**7**
QA/QC	**$8,907**	**7%**	QA/QC activities	**$8,640**	**$7,693**	**$5,185**	**$10,349**	**5**
			Required callbacks to the customer to assist with equipment issues/ servicing	**$268**	**$360**	**$11**	**$376**	**6**
Recruiting & Hiring	**$166**	**0%**	Recruiting and hiring employees	**$166**	**$172**	**$0**	**$256**	**5**

TABLE 50. BUILDING MANAGEMENT SYSTEMS SOFT COST COMPONENT ESTIMATES

SOFT COST CATEGORY	PER PROJECT COST	PER PROJECT %	SOFT COST COMPONENT	COMPONENT COST	STD. DEVIATION	1ST QUARTILE	3RD QUARTILE	SAMPLE SIZE
Marketing & Customer Acquisition	**$14,683**	**14%**	Marketing and/or customer education	**$5,652**	**$4,827**	**$2,452**	**$8,691**	**6**
			Bid preparation	**$3,715**	**$3,423**	**$1,240**	**$5,489**	**4**
			Project signing/ contracting	**$5,316**	**$2,847**	**$3,185**	**$7,659**	**6**
Project Design	**$6,709**	**6%**	Designing, scoping, and customizing the project	**$6,709**	**$3,773**	**$3,465**	**$8,334**	**6**
Installation	**$61,384**	**59%**	Installation labor	**$61,384**	**$49,810**	**$8,317**	**$104,169**	**5**
Transaction Costs	**$15,025**	**14%**	Obtaining permits	**$13,971**	**$14,838**	**$2,884**	**$23,009**	**4**
			Acquiring and maintaining trainings, certifications, and licenses	**$1,054**	**$638**	**$819**	**$1,504**	**4**
QA/QC	**$6,726**	**6%**	QA/QC activities	**$6,456**	**$5,032**	**$3,071**	**$9,212**	**5**
			Required callbacks to the customer to assist with equipment issues/ servicing	**$270**	**$340**	**$92**	**$336**	**4**
Recruiting & Hiring	**$305**	**0%**	Recruiting and hiring employees	**$305**	**$247**	**$171**	**$462**	**4**

APPENDIX C.

EXPERT INTERVIEW FEEDBACK

Cadmus interviewed 13 experts to help refine the soft cost categories and definitions as well as the prototypical project scenarios to be included in the survey of energy efficiency service-providers and decision-makers. These experts represented diverse experiences across the residential, commercial, and multifamily sectors, and they offered expertise addressing a range of technologies, including HVAC equipment, insulation, energy performance contracts, and building controls.

PROTOTYPICAL PROJECT DEFINITIONS

For prototypical projects in each sector, experts provided feedback on proposed building sizes, existing conditions, and equipment to be installed in the future. This high-level feedback summarized by sector follows.

- **Multifamily prototypical project:** Experts recommended modifying the building types to focus on pre-war walkups—typically four-story walkups with 24 units. In addition, experts recommended small modifications to existing conditions. For instance, existing lighting typically uses all CFLs, not a mix of CFLs and fluorescents, and HVAC equipment installed in the future will more likely be high-efficiency boilers, not air-source heat pumps.
- **Residential prototypical projects:** Among the three prototypical projects for residential buildings, experts agreed with the scenario Cadmus described for the insulation and air sealing project. They recommended, however, improving the HVAC replacement and whole-home efficiency project descriptions with more context and detail for the ASHP installation.
- **Commercial prototypical projects:** Experts offered only minor feedback regarding the four project scenarios provided,23 recommending small modifications to existing equipment and proposed upgrades.

After incorporating expert feedback, Cadmus worked with NYSERDA and Cadmus subject-matter experts to further refine and build out the full prototypical project definitions. The final prototypical projects are listed in the *Prototypical Projects section in the Methodology*.

[23] Cadmus and NYSERDA added the HVAC: RTU prototypical project after the expert interviews.

SOFT COST CATEGORIES

For each soft cost category, experts provided recommendations on how to improve and refine the definitions to be more relatable to energy efficiency service providers and decision-makers. These specifically included the following.

- Marketing and Acquisition: Experts called attention to two key improvement opportunities. First, they recommended providing more details on marketing types falling under “other” marketing or customer education costs, such as email marketing and trade shows. Second, they recommended elaborating upon some acquisition stages, including completing a “light audit” to identify the building’s potential energy efficiency opportunities and to create the contract.

- Project/System Design and Development: The experts’ key concern was needing to clarify the difference between the “light” audit, completed during the marketing and customer acquisition phase, versus a “deep” audit and customized solutions resulting after signing the contract. Only the latter type would fall under project design and development.

- Installation Labor: Several experts recommended separating some components classified under installation labor, particularly costs associated with training and certifications. They also recommended adding project management time under installation costs, rather than focusing exclusively on the hours required to install an energy efficiency project. This led to the creation of a new component (trainings and certifications) which fell under transaction costs.

- Transaction Costs: The experts’ largest point of feedback was around making the distinction between permitting and licensing. The experts noted that licensing typically occurred on an annual basis to enable a company to continue performing their energy efficiency project work, while permitting is project-specific, focusing on meeting relevant local, state, and federal regulations.

- Project Financing and Cash Flow: Experts emphasized the challenges of quantifying this soft cost at the project level due to costs often determined by non-project-specific factors, such as a company’s financial health or a facility’s size.

- Supply Chain/Stocking: Experts identified similar challenges in quantifying stocking costs on a per-project basis, as these costs are typically measured on an annual basis.

- Quality Assurance/Monitoring and Verification: Feedback focused on incorporating additional details to more clearly convey what fell under this category. More specifically, experts recommended clarifying that this category incorporates QA/QC work and completing customer callbacks to help with equipment issues and servicing but should exclude monitoring and verification, as this is completed by a third party.

- Recruiting and Hiring: Experts felt that recruiting and hiring skilled workers was missing from the originally defined soft cost categories.

By making these modifications, Cadmus arrived at final versions of soft cost categories and definitions, summarized in the *Soft Cost Categories section in the Methodology*.