The Secret Life of Installers: Understanding Contractor Practices in Heat Pump Installation and Commissioning

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ABSTRACT

As heat pumps become more common in residential applications, proper design, installation, and commissioning are critical for ensuring performance, efficiency, and customer satisfaction. However, field evidence suggests inconsistencies in installation practices, particularly in configuring and verifying variable capacity heat pumps (VCHPs) paired with non-communicating thermostats.

To better understand contractor practices and identify opportunities for improvement, a series of focus groups was conducted with residential HVAC contractors in three locations across California. Each group participated in a session that explored current practices and identified themes and concerns. All participants will return to take part in a second session designed to gather contractor feedback on guidelines for best practices.

This paper summarizes the study approach, key findings, and recommendations for improving field performance of VCHPs through contractor engagement, training, and tool development. Understanding contractor experiences is essential for identifying where field practices diverge from regulatory codes and utility programs expectations. It also reveals challenges in communicating and applying heat pump technologies in real-world situations. When contractors lack clear requirements or adequate training, they can default to workarounds. Utility programs and regulatory codes assume ideal practices, but there is often a gap between ideal practices and reality. Bridging this gap is critical for utilities, manufacturers, and policymakers aiming to improve system performance and ensure long-term success in the field.

Introduction

Residential heat pumps are one of the most important technologies needed to achieve decarbonization goals. While electrification of space heating is not a guarantee of decarbonization (since the electricity generation may still come from fossil fuels), it is impossible to eliminate fossil fuel use from space heating if gas-burning furnaces continue to be used. Heat pumps are therefore critical to achieving emissions-reduction goals, and their adoption is becoming more common due to growing policy support, market interest, and their potential to provide efficient space conditioning while improving energy affordability and resilience.

One type of heat pump that is gaining popularity is the variable capacity heat pump (VCHP), which improves efficiency by modulating heating and cooling output through adjustments to compressor and fan speeds. A study of a test house in Knoxville found that a VCHP used 17-38% less power during heating than a single- stage heat pump (EPRI 2016).

VCHPs typically are designed to rely on their proprietary original equipment manufacturer (OEM) controls to automatically modulate heating and cooling output and fan

speed. “Smart Thermostats” (Wi-Fi enabled devices that can automatically adjust heating and cooling settings or be controlled by a phone, tablet, or home automation system) may not be able to accomplish the necessary control. Ultimately, for good control, the heat pump needs to know zone temperature and setpoint to determine how well the system is meeting loads and optimize heat pump output (ramping up if more capacity is needed to meet the setpoint or ramping down if less is needed). But third-party thermostats can only communicate a call for heating or cooling (or high/low staging for two speed thermostats). Some heat pump manufacturers use sophisticated but unpublished algorithms to infer what the optimum output would be, but they are only guessing if they do not have access to all the data they need. Presumably some of these algorithms are better than others. This is the fundamental problem with using third-party thermostats for VCHP control.

A large number of VCHPs are expected to be installed in the coming years. Citing data from *Air Conditioning, Heating, & Refrigeration Institute, Monthly Shipments Report*, Rocky Mountain Institute (RMI) notes that heat pumps have outsold gas furnaces consistently since 2021, and in 2025 manufacturers shipped 12% more heat pumps than gas furnaces (RMI 2026). The uptake of ducted VCHPs in the Northwest is growing steadily, driven primarily by incentives, contractor recommendations, and customer interest (Kirszner, Hogan and Raishwan 2022). As adoption increases, it will be important to ensure that these systems are well specified, properly installed, and correctly configured, especially in the complex situation where products from different manufacturers are used together.

There are a number of types of thermostats available to control heat pumps. Note that the industry has yet to come up with a consistent nomenclature or definitions of these. A functional description of each is provided in Table 1.

Table 1. Thermostat types

Name	Example	Often referred to as…	Functional description
Programmable	Honeywell, White Rogers	Standard, 24V, Third-Party	Uses thermostat interface to define schedule of setpoints
Smart	Nest, Ecobee	Connected, 24V, Third-Party	Uses occupancy sensors, local network, and internet to provide information needed to optimize operation
OEM	Lennox, Carrier, etc.	Proprietary, Communicating	Provides proprietary digital control that provides information from thermostat to the outdoor unit and indoor unit

There is growing evidence that VCHPs may not perform optimally when paired with third-party thermostats unless they are carefully configured. In seasonal monitoring of a test house in Stockton, CA, Conant and MacFarland (2026) found that when a VCHP was controlled by a third-party thermostat instead of the OEM thermostat, seasonal cooling energy use was projected to more than double, while estimated seasonal heating energy use showed little difference. They also found differences in system behavior that influenced how and when the

energy use occurred. Conversations with manufacturers have revealed that sometimes within the company there is not a clear understanding of how these controls work.

Similarly, utility-funded incentive programs have reported that newly installed VCHPs did not perform better than single- or multi-speed systems, and the use of third-party thermostats is a suspected explanation (DNV 2024). At least one program manager noted that they are considering disallowing incentives for VCHPs when they are installed with anything other than the OEM thermostats.

A review of product literature found that manufacturers may indicate that their VCHPs can operate with a third-party thermostat, but a deeper review of their installation manual indicates that performance and energy-efficient modes of operation cannot be guaranteed. Some manufacturers require an adapter, but information on how to configure it is often difficult to find. Different manufacturers use different workarounds and methods to configure the system for optimal efficiency, making it challenging not only to determine the correct configuration but even to recognize that careful configuration is necessary. If VCHPs with third-party thermostats are not configured correctly, their rated efficiency, (which is federally controlled), will be meaningless.

The solution is that installers must understand the importance of correctly configuring a VCHP with a third-party thermostat and must have access to clear instructions on how to do so. Currently, building codes and incentive programs typically do not require provision of this information or testing to ensure that variable capacity systems are installed correctly. This uncovers an underlying problem in the HVAC industry. Traditionally, HVAC systems have been fairly easy to install, and the industry has developed with this expectation. Customers do not anticipate paying more for a thoughtful, detailed installation, and contractors do not expect to spend additional time working with persnickety technology. This dynamic was observed in an extensive study of residential end-users behavior (Barriga and Heinemeier 2012).

Since VCHPs with third-party thermostats are a relatively new technology, there is limited knowledge about how contractors install them or even how they *should* be installed. There are few examples of how codes and standards or program guidelines could be used to ensure correct installation. Do installers know the proper procedures? Do they take the time to do it correctly? Are they aware of how important it is to install these systems properly and that failure to do so can lead to poor performance?

The objective of this research was to understand contractor attitudes, knowledge, skills, and behaviors related to the installation of VCHPs with third-party thermostats. The study was not intended to evaluate the performance of systems that are installed incorrectly, but rather to explore how contractors approach these installations. To address this objective, the paper describes a series of focus groups, including the methodology that was used, key findings, and overarching themes. It concludes by providing recommendations for ways to ensure better installations and better performance of VCHPs with third-party thermostats.

Focus Group Methodology

Study Design

This study used a qualitative research approach consisting of a series of focus groups with HVAC contractors and technicians. Focus groups were selected for the study because they

enable participants to provide detailed, open-ended perspectives that may not be captured through surveys. In addition, the group discussion format allows participants to respond to and build on each other's experiences, generating insights that may not emerge in one-on-one interviews.

The focus groups were initially designed to solicit feedback on proposed measures under consideration for the 2028 update of California's residential building energy code, California Title 24 Building Energy Efficiency Standards (CEC 2024). However, legislation enacted during the study period paused all residential code adoption in California by state and local agencies until 2031. As a result, the planned topics were adjusted to remove discussion of the proposed measures intended for the 2028 code cycle.

The revised discussions focused on best practices for designing, installing, and commissioning VCHP systems to achieve intended performance, as well as insights to inform future code updates and voluntary programs. Additional topics included contractor perspectives on heat pump system design and experiences with relevant energy code requirements.

Three groups of participants were recruited throughout California in Sacramento, Stockton, and Los Angeles. The study was designed as a two-session process. This paper reports findings from the first session, which was conducted in-person in each location and served as an exploratory phase focused on documenting current practices related to system HVAC installation, and commissioning, understanding installer concerns, and beginning to identify solutions. All participants committed to attend a second session, to be conducted virtually in early fall 2026. This second session will solicit feedback on a finalized set best practice guidelines for configuring and verifying controls for VCHP systems, which will be provided to utility partners to inform program development.

Recruitment

The target size for each focus group was six to eight participants. Participants were recruited from the population of residential HVAC contractors, installers, technicians, and business owners operating within California utility service territories relevant to each focus group location. Recruitment leveraged industry networks and program partners, including utility outreach channels and participant lists from the TECH Clean California and Quality HVAC Program. Participants were recruited from a variety of sources to reduce the potential for bias associated with oversampling contractors who participate in utility programs and may be more familiar with HVAC performance issues.

Outreach methods varied by region. For the Sacramento focus group, recruitment was conducted in collaboration with a local utility partner that implements a heat-pump replacement program. Members of the research team gave a presentation during several virtual "Open Office Hours" meetings hosted by the utility and invited contractors attending the sessions to sign up to participate. The utility also sent a notification of the opportunity to all their program participants. For the Stockton and Los Angeles focus groups, recruitment primarily consisted of direct email invitations sent to contractors identified through participation in the TECH Clean California and Quality HVAC programs.

Participation was voluntary, and participants were offered a $500 thank-you gift for participating in both phases of the study (reflective of the roughly 3 hours of their time that was requested, plus travel). To ensure representation across different companies, participation was

targeted to include only one individual per HVAC company. Contractors were also required to operate within the participating utilities' service territories.

Attendance varied across the three focus groups. In Sacramento, eight contractors confirmed participation and six attended the session. In Stockton, eleven contractors confirmed participation and four attended. Finally, in Los Angeles, nine contractors confirmed participation and seven attended.

Logistics

The Sacramento focus group was held at the Sacramento Municipal Utility District (SMUD) Customer Service Center in Sacramento from 3:00 PM to 5:00 PM on July 8, 2025. The Stockton focus group was held at a Pacific Gas & Electric (PG&E) regional office in Stockton from 1:00 PM to 3:00 PM on November 7, 2025. The Los Angeles focus group was held at the Los Angeles Cleantech Incubator (LACI), locate on the Los Angeles Department of Water and Power (LADWP) La Kretz Campus in Los Angeles, from 1:00 PM to 3:00 PM on May 15, 2026.

The group sizes ranged from four to seven participants, representing a total of seventeen contractors or technicians from fifteen HVAC companies primarily serving residential customers within the participating utilities' service areas.

All sessions were facilitated by an experienced moderator from Frontier Energy, with up to two additional team members providing note-taking and logistical support. Utility representatives attended the focus groups as observers. To maintain a productive discussion environment, no other individuals were present. With the permission of all participants, the sessions were audio-recorded to accurately capture responses and impressions. Table 2 summarizes the focus group sessions.

Table 2. Summary of focus group sessions

Location		Date	Duration	Number of Participants	Companies Represented
SMUD Customer Service Center	Sacramento	Jul 8, 2025	3:00–5:00 PM	6	5
PG&E Regional Office	Stockton	Nov 7, 2025	1:00–3:00 PM	4	4
LADWP Los Angeles Cleantech Incubator	Los Angeles	May 15, 2026	1:00–3:00 PM	7	6

Format

Presentation slides were used to introduce discussion topics and provide background information to guide the focus group discussion. The facilitator encouraged responses and discussions from all participants and also used flip charts and sticky notes to record participants' thoughts during brainstorming activities. These activities encouraged participation and helped identify common themes across participants' experiences.

The session began with participant introductions followed by an icebreaker activity to encourage participants to engage with one another. This was designed to get the participants talking about common concerns and challenges, and warm them up to the topic of heat pump

performance. For this section, participants were paired in groups of two and asked to discuss their experience installing HVAC system in compliance with California Energy Code requirements. Each pair was instructed to discuss the following topics and record their thoughts on sticky notes:

- What are the biggest challenges with installing systems in compliance with the energy code?
- What do you see as the biggest benefit?
- What is one challenge with installing heat pumps that you think doesn't get enough attention?

After discussing for ten minutes, each pair shared their responses with the larger group.

The next portion of the focus group focused on VCHP systems, with emphasis on thermostat compatibility and the trade-offs between OEM and third-party thermostats such as Nest and Ecobee. A presentation slide provided background information to get a common basis for understanding some of the issues related to VCHP performance. Then participants were asked:

- Do you use VCHPs with third party thermostats? Why or why not?
- How do you configure them? Is it hard to find instructions?
- How confident are you that they are going to actually vary?

Participants were also asked to review proposed guidance for installing a VCHP with a third-party thermostat. The guidance was developed to explore approaches for verifying variable-capacity operation when VCHPs are paired with third-party thermostats, with the broader goal of informing best practices for incentive program requirements, and potentially also for code compliance. The guidance presented three steps for installing VCHPs with third-party thermostats:

- First, installers would confirm that the heat pump model is compatible with third-party thermostats and will be able to vary capacity. The mechanism for this first step could vary, but an actively maintained product list may be one option.
- Second, installers would document that manufacturer configuration instructions were accessed, reviewed, and followed. The configuration instructions would be submitted with project documentation as evidence of compliance. The theory behind this requirement is that the main barriers are awareness of and access to configuration instructions, and that accessing the instructions increases the likelihood of proper implementation.
- Finally, installers would conduct a functional performance test to confirm that the system responds appropriately to load. The test results would also be submitted with project documentation.

The proposed guidance was presented to the group, followed by an open discussion to elicit feedback and suggestions for improvement.

A secondary objective of the focus group was to explore two topics that are key to heat pump performance: the use of supplementary heating and the role of load calculations in system design. Supplementary heating is a strip-heater or backup furnace used to provide heating during defrost, when the capacity of the heat pump is not sufficient to meet the load, or during emergencies. Load calculations are a critical best practice to ensure optimum performance of any HVAC system. Load calculations have long been required by the energy code in California, but designers are not required to submit the results. Most jurisdictions do not confirm that the calculations are done, and there is evidence that they are not done in a significant majority of projects. During these discussions, participants recorded their responses on sticky notes and placed them on flip charts for group review. Example questions included:

- Do you use supplementary heat when you install heat pumps? Why or why not? In what situations?
- Do you do load calculations on your jobs? Why or why not? When are you most likely to?

Data Collection and Analysis

Focus group discussions were documented using a combination of audio recordings and note-taking. Research staff recorded key points and participant comments during the sessions using written notes.

Where applicable, written materials generated during activities (such as sticky notes or flip chart notes) were collected and incorporated into the dataset. Audio recordings were used to verify notes and ensure accurate capture of participant feedback.

Review of this dataset included word searches, and manual identification of common themes, concerns, and approaches. This selection of direct quotes provides a vivid illustration of the themes.

Results

Icebreaker

The icebreaker activity produced a range of responses regarding the challenges and benefits of installing systems to code.

When asked, “What are the biggest challenges installing systems to code?”, three participants highlighted challenges related to electrical work. They explained that running additional wiring or upgrading existing wiring increases both project costs and installation time. Electrical upgrades, such as updating the main electrical panel or adding new breakers, were also identified as potential barriers during installation.

One participant offered a contrasting perspective, suggesting that these concerns may sometimes be overstated:

> *“Most of the time the heat pump is putting less load on the panel than the original AC ... and we find that the wiring is just fine.”*

Another major challenge identified by a majority of participants [n = 8] was navigating jurisdictional differences in building codes. Participants noted that requirements can vary across cities and counties, or even by individual inspector, making it difficult to stay current with regulations. As one participant explained:

> *"My biggest impediment would be that [code] does vary from jurisdiction to the jurisdiction and … new codes sometimes come about and … we're just not aware of it."*

Similarly, at least three participants described experiences in which inspectors required changes to a completed project, despite receiving prior approval during the plan check.

Overall, participants' understanding of code requirements appeared to be shaped through their interactions with local inspectors and building departments, rather than through direct engagement with the code itself. One contractor suggested that contractors could receive a list of specific requirements for each project so that "*if you don't meet these, you fail*," which further reflects reliance on enforcement-based feedback and a general lack of awareness of code requirements and resources.

In the Sacramento and Stockton focus groups, participants consistently identified the efficiency of heat pumps and the associated energy savings as key benefits of installing systems to code. Several participants [n = 3] also noted strong customer interest when these benefits are clearly explained. For example, participants noted:

> *"When you explain the benefits ... the customer really sees the benefit."*

> *"Equipment operation, quietness, efficiency — that's what people notice."*

In the Los Angeles focus group, participants similarly identified both customer-facing and contractor-oriented benefits of installing systems to code. The primary benefit was the assurance it provides the customer of a safe [n= 1] and high-quality [n=1] installation. Two participants also noted the role of code-compliant projects in home sales as the primary benefit.

Variable Capacity Heat Pumps with Third-Party Thermostats

Current practices.

This portion of the focus group explored thermostat compatibility with VCHP systems, specifically the trade-offs between OEM and third-party thermostats (such as Nest and Ecobee).

Most participants [n = 9] identified customer preference as the primary reason for choosing third-party thermostats:

> *"The Nests and Ecobees … Well, some people do love it. They require or request for it."*

> *"We use third-party thermostats because you don't lose as much functionality ... [and] customers prefer it."*

Several participants [n = 4] noted that most customers still prefer third-party thermostats over the OEM alternatives, even after the potential disadvantages are explained to them. As one participant observed:

"Most consumers think [in terms of] hot and cold … that's when we have to pull ourselves out of the technical mindset".

Participants cited reasons such as the desire to control the system remotely via cell phone or a preference to use their existing thermostat when explaining why customers may opt for third-party thermostats.

Several participants [n = 7] expressed little to no concern about installing a VCHP system with third party thermostats and confirmed that they do so when requested by customers. One participant explained that having trained technicians, rather than just installers, configure the thermostat increases confidence that a VCHP will operate correctly. At least three contractors stated that they rely on installation manuals and call technical support if necessary.

However, some participants [n = 3] reported difficulty reaching manufacture technical support. One participant recalled that *"one of our Spanish-speaking guys waited for 8 hours for a rep."*

Other participants described the use of thermostat adapters or converter kits as relatively straightforward, characterizing the process as simply *"wires into wires"* or a matter of configuring programming settings and dip switches.

Participants also described several methods for verifying that a system was operating properly after installation. Listening to the system ramp up and ramp down was commonly cited as a way to confirm modulation. As one participant explained:

"You can actually hear it go up and down. You let it run for a while and you sit there as it equalizes … and just let it run. You could hear it cycle up and down."

Some participants [n = 4] were more skeptical, arguing that communicating thermostats offer superior control and reliability, and that pairing VCHP systems with third-party thermostats can result in lost functionality. A participant summarized the issue by stating that using a non-communicating thermostat with a VCHP would be like *"running your Tesla like a Fiat".*

Concerns about modulation were a common theme among these participants. Several expressed low confidence in the ability of third-party thermostats to properly modulate VCHP output. Two participants attributed this concern to the lack of published performance parameters for VHCP systems operating with non-OEM thermostats.

Proposed guidelines and feedback from installers.

The discussion then turned to the proposed guidance for installing VCHP systems with third-party thermostats.

Participants seemed supportive of a compatibility list identifying variable-capacity heat pumps and third-party thermostats that have been verified to work together. As one participant stated:

"We'd prefer a list. Just put in on a list and we can review the list."

However, one participant expressed concern that adhering to such a list could be difficult in practice, citing the communication needed between staff and field personnel, rather than

simply purchasing a thermostat from a local supplier that they know will work for the installation.

Increasing accessibility of configuration instructions or requiring their submission as part of project documentation was not well received by participants. Two participants expressed skepticism about this proposed requirement, noting that a thermostat must be configured correctly in order to operate, making documentation of the configuration process irrelevant.

Participant feedback on the proposed in-field functional performance test was mixed. One contractor expressed concern about the burden this could place on installers:

> *"There are always new burdens placed on the contractors, which hurts the bottom line and makes it harder to be in business and do what you are supposed to."*

Two participants noted that effectiveness of such functional tests depends on having appropriate ambient conditions. For example, heating performance cannot be meaningfully evaluated on a hot day, and cooling performance cannot be meaningfully evaluated on a cold day. On the other hand, participants noted that some manufacturers offer modules and diagnostic tools that allow technicians to record and monitor heat pump operating data, which could facilitate performance testing. They suggested that relevant performance information may be accessible directly from the outdoor unit control board.

During the Sacramento focus group, the discussion shifted to the possibility of mandating installer factory training (through the energy code). Manufacturers currently provide training to educate installers on proper system installation. Three participants seemed open to requiring training in the code, noting that the trainings are free and ultimately benefit HVAC installers:

> *"You have to invest in your guys, send them to the trainings."*

Two participants pushed back, arguing that installer training should not be mandated in code because HVAC professionals already have sufficient incentives to take manufacturer training.

Overall, there was a general sentiment across all focus groups that the responsibility for ensuring heat pump and thermostat compatibility should rest with distributors or manufacturers. This view sparked a broader conversation, with participants emphasizing that manufacturers should bear the primary responsibility:

> *"Code should focus on manufacturers. For example, with automobiles, everyone can plug a computer into the car and read the machine. HVAC is just a machine that blows cold and warm air. Manufacturers should build to a standard, then we can buy our tools and plug them in to say, 'What's wrong with the machine?'"*

> *"Education is very important... but manufacturers should be responsible for that — not the code."*

Supplementary Heating

Participants were asked whether they typically use supplemental heating when installing heat pumps, and how they size and control it when used. Most reported that they generally do not, as the climates they work in rarely create emergency conditions that would require it. The group agreed that strip heat is largely unnecessary in California climates, particularly with modern heat pumps. One participant noted:

"Modulating systems warm up quickly, and emergencies are not much of a factor."

Another contractor emphasized that the best approach is to size the system appropriately for the home. When pressed about whether supplemental heating is ever needed during defrost cycles, participants maintained that it is not something they typically install.

While all participants worked in relatively mild climates, some acknowledged that supplemental heat may be considered in the mountains or colder regions. However, as one participant point out, heat pump equipment specifically designed for cold-climate applications reduces the need for supplemental heating even in colder areas. This perspective was widely shared among the participants.

Load Calculations

When asked whether they routinely perform load calculations, participants responded candidly. Most participants [n = 5] reported that they do not perform load calculations on every project, citing time and efficiency as the main factors. One participant explained:

"To do a proper room by room [load calculation], it takes hours. It's me and another guy, and we're measuring windows and heights."
"I've been stung by paying too much to do a load calc."

When moderators asked whether a load calculation could potentially support a more competitive bid by allowing contractors to recommend a smaller system, one participant noted that homeowners often have strong expectations based on their existing equipment:

"They [the homeowners] know the house the best, and if they know they have a 3-ton system, you're not going to be able to sell them a 2-ton system".

There was also a perception that load calculations were less necessary with VCHP systems[1]:

"With variable capacity, I haven't seen any complaints about not enough heat or cooling. Variable speed seems to mask anything so that you're not seeing any problems."

[1] This perception is common and may not be accurate. For example, one study found that oversizing VCHPs leads to slightly improved performance (Cummings and Withers 2014), while another found that in some climates undersizing a VCHP can provide slightly improved performance (Smith 2022). Differences in system efficiency and the presence or absence of supplementary heating make this a complex analysis, and more guidance is needed.

The discussion of load calculations occasionally shifted toward code compliance, enforcement, and perceptions of an uneven playing field within the HVAC industry. Participants across all focus groups expressed frustration that best practices, such as conducting load calculations, are not consistently followed or enforced.

During the Los Angeles focus group, a participant suggested that load calculations should be mandated. When the moderator reminded the participant that load calculations have been required by California Energy Code for several years, and that previous loopholes have now been closed, the conversation shifted to questions of compliance and enforcement rather than the requirement itself. One participant asserted:

> *"In order to get a permit, a load calculation needs to be done, and it needs to be enforced."*

Another participant stated that California should require some form of certification to sell HVAC equipment. In response, another participant challenged these ideas, claiming that 85% of HVAC jobs are completed without permits (although the source for this statistic was not stated).

Discussion

In each of the focus groups completed, the conversation started slowly. By building rapport between the facilitator and participants and encouraging the participants to share their challenges and experiences, the participants gradually opened up. By the end of each session, all participants were enthusiastic about the event and seemed to feel genuinely heard. They provided specific responses to direct questions and shared ample examples and stories, including both successes and lessons learned. Some participants were more vocal than others, but it was not difficult to elicit input from even the quiet participants or to keep the more vocal participants on topic and attentive to others' contributions.

Several key insights emerged from the discussions:

- **Awareness of challenges:** Participants were mostly aware of the risks and challenges of installing VCHPs with third-party thermostats. Participants tended to have preferred systems that were known to perform well with Nests and Ecobees. Bosch was commonly mentioned in the SMUD focus group, and Trane in the PG&E focus group.
- **Regulatory burden:** Participants felt that there were too many expectations placed on them in already complex incentive programs, code, and regulatory environments. Proposed updates to programs and codes that required testing or training for VCHPs with third-party thermostats were unfavorable for that reason.
- **Manufacturer responsibility:** There was a strong perception that it should be the responsibility of the manufacturers to clearly communicate thermostat compatibility rather than leaving this burden on contractors.
- **Load Calculations:** Load calculations were seen as a challenge and unnecessary for variable capacity systems. Despite being required by California Energy Code, participants reported that load calculation didn't seem important because city and county authorities don't enforce this requirement. Some participants felt that the time and money

required to perform a load calculation put them at a disadvantage compared to contractors who skipped them.
The impression that load calculations aren’t necessary if a VCHP is used emerged as an interesting result that should be validated or refuted with clearer guidance for the industry.

Customers were reported to value their third-party thermostats, because of their usability and additional functionality, suggesting that the technical nuances of VCHP performance do not always factor into customers' decision-making processes. Despite this, many participants felt that customers should be encouraged to install OEM thermostats, as these are seen as necessary to achieve full system performance. To ensure proper installation and configuration, participants emphasized that installers should receive factory training and possibly certification on working with VCHPs and third-party thermostats. Not all installers currently receive this training, and its quality may vary by manufacturer, but it was seen as the only way to ensure consistent and proper configuration.

Participants shared some real concerns that must be addressed to achieve better performance in the field. Complying with California Energy Code is challenging due to differences across jurisdictions and an ever-changing set of requirements and expectations. Participants felt that new burdens were continually added, making it increasingly difficult to do business, particularly with respect to load calculations.

Overall, the conversations highlighted uncertainty among participants regarding current code requirements, and a broader perception that contractors who follow code and industry best practices compete against others who face few consequences for noncompliance. At the same time, participants frequently expressed frustration with permitting requirements, code compliance processes, and what they viewed as excessive regulatory oversight. This created a notable tension in the discussion: participants wanted stronger enforcement to create a more level playing field while also expressing concerns about the burden associated with existing regulations.

Conclusions

A series of focus groups were conducted to explore considerations for the design and installation of VCHP systems with third-party thermostats. Although the groups were small in size and may reflect some participant bias, the sessions provided valuable insight into best practices for ensuring better system performance.

The focus groups revealed that there is a range of awareness regarding the importance of ensuring proper installation, concern about getting it right, and knowledge of how to do it. Some participants felt that third-party thermostats can work well with VCHP systems, while others felt that they should be avoided and that customers should be discouraged from installing them.

Overall, participants expressed significant resistance and skepticism toward the need to invest more time in system configuration. Many practical concerns were raised, and some of these challenges may be difficult to overcome when developing guidance for best practices.

Future Work

Following this first phase of the focus groups, guidelines for best practices will be developed. These will likely include recommendations for obtaining manufacturer training and for manufacturers to provide clearer and more readily available guidance. Indeed, wherever possible, new requirements or efforts should start with manufacturers and distributors rather than installers. The second phase of the focus groups will be important for vetting these guidelines with installers to ensure they are feasible and effective.

There is a clear need for more research on the implications of various system parameters and configurations. The focus groups presented in this paper provided insight into contractors' approaches to system design and commissioning, but a field study can examine what installers are supposed to do, what they actually do, and the benefits that will accrue if different practices are adopted. To address this need, a field study is currently underway as a complement to the focus groups, examining how VCHP systems with third-party thermostats are configured in practice. The field study will cover at least two regions of California and target a sample of 40 homes to characterize the configurations of VCHP systems paired with third-party thermostats. Together with the focus group findings, the results will help determine appropriate requirements for commissioning VCHPs with third-party thermostats.

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