Lessons from California's Large-Scale Deployment of Efficient, Flexible Heat Pump Water Heaters

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ABSTRACT

Heat pump water heaters (HPWHs) offer significant energy efficiency (EE) and decarbonization benefits compared to incumbent technologies. Demand-flexible HPWHs can shift electricity consumption and align operation with time-varying rates to reduce customer costs and improve affordability.

This paper shares lessons from the innovative program design of TECH Clean California (TECH), the state's flagship heat pump market transformation initiative. From late 2023 through 2025, the initiative's incentive program rebated more than 12,500 demand-flexible HPWHs. To qualify, the program required that customers enroll in a demand response (DR) program, HPWHs operate according to a time-of-use (TOU) rate schedule, and customers apply to a connected load shifting program. Although this fleet presents a significant source of flexible load in California, harnessing this load proved challenging due to low contractor familiarity with demand flexibility features, technology and connectivity gaps, and limited customer awareness and program comprehension.

To address these challenges and increase compliance with the requirements, the program educated contractors on product capabilities and on how to set up demand-flexible operation during HPWH installation. Strong collaboration between the incentive program, the load shifting programs, and product manufacturers streamlined customer participation and helped address technical issues and improve load shifting performance. This paper presents customer demand flexibility participation rates and load impacts resulting from the TECH Clean California HPWH incentive program and discusses best practices to ensure success for future large-scale program designs that effectively integrate efficiency, decarbonization, and demand flexibility.

Introduction – Importance of Demand-Flexible HPWHs in California

Water heating electrification is critical to achieve California's climate goals, including 100% clean electricity by 2045 and six million heat pumps installed by 2030. Although water heating accounts for 59% of household gas usage, California has low electric water heater adoption at 6%, creating substantial decarbonization potential (DNV GL 2021, 6, 9). HPWHs move heat rather than generating it, making them three to five times more efficient than standard electric, gas, and propane water heaters (ENERGY STAR® 2026).

Load shifting, a type of demand flexibility, can offer additional benefits by aligning electricity demand with the availability of inexpensive, clean, intermittent renewable generation, which is key to making California's grid more clean, reliable, and affordable.[1] The thermal storage capability of HPWHs makes them a natural fit for load shifting without compromising

[1] Gerke et al. (2024) estimate that load shed and shift, two types of demand flexibility, would provide $1.8 billion and $88 million, respectively, in avoided system costs in 2025. They note that $88 million from load shift resources may be underestimated since the Avoided Costs Calculator (ACC) was designed for EE and shed-type DR.

comfort. They can be configured to prioritize heating during low-demand periods and draw hot water from storage during peak periods. Unlike other distributed energy resources, water heaters are ubiquitous, with near universal use, allowing more Californians to participate in and benefit from demand flexibility. Harnessing this capability could translate to significant load flexibility benefits across California's nearly 15 million housing units.

This paper highlights opportunities to close the gap between the current deployment and the full technical potential of HPWH load shifting via integrated demand side management (IDSM) program design and HPWH technology developments. We also discuss the significance of the installation contractor's role since they are the primary TECH program participants.

Background

Program Descriptions and Overview of IDSM Requirements

This paper draws on implementation experiences from these California programs:

- TECH/the Self-Generation Incentive Program for HPWH (SGIP HPWH): a statewide technology incentive program that required demand flexibility measures.
- Pacific Gas & Electric (PG&E) WatterSaver and Southern California Edison (SCE) SmartShift Rewards: two similar load shifting programs for connected water heaters.[2] To receive TECH incentives, PG&E customers were required to apply to WatterSaver and SCE customers were required to apply to SmartShift Rewards.

TECH and SGIP HPWH. TECH is the California Public Utilities Commission's (CPUC) statewide market transformation initiative for clean heating technologies.[3] Heat pump HVAC and HPWH incentives for single family and multifamily projects are paid to enrolled contractors, who apply those incentives to their customers' project costs. TECH's statewide incentives launched in December 2021.

Soon after TECH's incentives launched, the CPUC created SGIP HPWH–a new HPWH incentive program for single family, multifamily, and commercial projects. This new program's funding was carved out from the longstanding SGIP, which incentivizes technologies that help reduce peak electric demand. The CPUC allocated $80 million of SGIP funding to SGIP HPWH, with half of residential funds dedicated for income-qualifying customers—defined, for single family, as either 1) at or below 80% of the area median income, or 2) at or below 250% of the federal poverty level. The CPUC also established specific demand flexibility requirements and directed the program implementer to coordinate with TECH. Because of this directive, and because the market was already familiar with the TECH brand and processes, SGIP HPWH incentives were branded as and implemented through TECH. Energy Solutions, with support from its partner organizations, implemented both and launched the SGIP HPWH incentives in late 2023, marketing them as a new round of TECH HPWH incentives with new requirements.

[2] The Association for Energy Affordability (AEA) and Energy Solutions implement both water heater load shifting programs, with AEA leading WatterSaver and Energy Solutions leading SmartShift Rewards.

[3] As a market transformation initiative, TECH focuses on achieving broad, holistic impacts. Beyond statewide incentives, its market interventions include pilots and quick start grants, workforce education and training, and data reporting to inform broader policy and market development. TECH maintains the most comprehensive public project dataset in the United States, providing data on costs, bill impacts, and peak demand impacts to inform a targeted strategy for building electrification.

SGIP HPWH incentives came with the following CPUC-defined demand flexibility requirements; all requirements applied to single family customers and a subset applied to commercial and multifamily customers:

1. Customer must switch to a TOU electric rate if not already on one.
2. HPWH must be set up to use Joint Appendix 13 (JA13) TOU control features, meaning that the HPWH will shift operation to minimize costs based on a selected TOU rate.[4]
3. Where available, customer must enroll in a "qualifying" DR program as defined by the CPUC. We refer to this as "event-based DR" or "DR" going forward.[5]
4. Starting December 2024, where available, customer must also apply to a connected water heater load shifting program.[6] The next section describes these programs in more detail.

These requirements made SGIP HPWH a large-scale example of IDSM, a program model that combines multiple demand-side measures. With the addition of the SGIP HPWH's requirements, TECH became the first statewide HPWH IDSM incentive program. SGIP HPWH incentives were available between late 2023 and the end of 2025. These incentives funded over 12,500 HPWHs, serving over 15,000 spaces—including multifamily units served by central systems—with roughly 260 contractors having at least one installation. After SGIP HPWH ended, for subsequent TECH HPWH incentives, TECH generally maintained these demand flexibility requirements, with some modifications in consultation with the CPUC.

WatterSaver and SmartShift Rewards. PG&E WatterSaver and SCE SmartShift Rewards are electric storage water heater load shifting programs. The programs connect to HPWHs—either via integration with a manufacturer platform enabled by customer Wi-Fi, or via CTA-2045 communication modules—to send daily preheating and load shed signals, providing more active load shifting than JA13 TOU control.[7] These programs do not fund the HPWH technology itself but provide enrollment and participation rewards. WatterSaver launched in March 2022, and SmartShift Rewards launched in May 2024.

Importance of IDSM

The IDSM program model can help maintain a reliable electric grid as electrification and renewable generation expand. Berkeley Lab's IDSM Scoping Study describes IDSM as a combination of technologies and flexibility measures to improve customer and grid benefits, and discusses barriers and opportunities for implementation (Potter, Stuart, and Cappers 2018).

The IDSM program model is especially important for water heaters. Compared to smart thermostats, for example, users are less likely to interact with their water heater every day and

[4] JA13 is an appendix to the California energy code (Title 24, Part 6) that credits projects with demand-flexible HPWHs. Under JA13, HPWHs must have the capability to store at least five TOU rates and must support several demand management capabilities, such as the ability to operate to minimize costs under a TOU rate schedule.
[5] CPUC's definition of "qualifying" DR was first published in D.22-04-036 and then expanded in D.23-12-004. The newer four-part definition of "qualifying" includes a variety of event-based DR programs, mostly ones that are California Independent System Operator market-integrated and count for resource adequacy.
[6] The three water heater load shifting programs available were PG&E WatterSaver, SCE SmartShift Rewards, and San Diego Community Power Smart Home Flex.
[7] The ANSI/CTA-2045-B (2021) Standard defines a modular communications interface for device energy management. It specifies both a physical connection from a communication module to a device (i.e., a CTA-2045 port) and a communications protocol for exchanging energy management messaging.

less likely to proactively set up their water heater smart app for demand flexibility. Additionally, compared to other products, water heater connectivity may require an additional control module or may be difficult to maintain due to the product's location relative to a Wi-Fi signal.

Through the IDSM program model, TECH leveraged large technology incentives to activate demand flexibility at the critical moment of technology installation. This approach proved more successful than reaching out to customers after the fact to ask them to activate demand flexibility by enrolling in a program, installing a controller, turning on a feature, or doing all of the above.

Scope of This Paper

The IDSM learnings discussed in this paper are based on experience implementing TECH's contractor-facing HPWH incentives. However, some lessons are broadly applicable to other types of IDSM programs—both those that incentivize other demand-flexible technologies and those that focus on a different market actor as the main participant and incentive recipient, such as distributors or end-use customers.

Though TECH HPWH incentives were available to single family, multifamily, and commercial customers, this paper focuses on single family participants since those projects had the most demand flexibility requirements.[8] Additionally, contractors are especially important in the single family residence context because each contractor interacts with multiple individual customers, bypassing the significant initiative, effort, and proficiency it would take for each customer to independently learn about and successfully fulfill demand flexibility requirements. IDSM approaches for multifamily projects were not thoroughly tested in this program, but may involve leveraging a single point of contact (e.g., building owner or property management company) and enabling flexibility during tenant turnover.

This paper's lessons learned and recommendations are based on IDSM requirements for SGIP HPWH as defined by the CPUC and implemented under the TECH brand; these requirements could not be modified and provide context for the learnings shared in this report. For future IDSM programs, we recommend a simpler, more flexible approach, as discussed in subsequent sections.

IDSM Program Implementation and Feedback Methodology

Contractor Education and Engagement

TECH-enrolled contractors install HPWHs and pass incentives on to the customer; the TECH team typically does not interact with customers. To successfully participate in TECH, contractors needed to develop new subject matter expertise for customer conversations on demand flexibility. They also had to devote additional administrative effort to activities beyond typical product sales and installation, including training staff, convincing customers to agree to multiple requirements, tracking customer follow-through, and troubleshooting enrollment and configuration issues. Contractors received no extra incentive or compensation for these efforts; instead, it was part of the process to qualify for the large TECH HPWH incentive. However, these time-consuming efforts affect the contractor's bottom line and can increase the cost of installations for customers. Therefore, a key effort for the program team was to set contractors up

[8] TECH is a residential-only initiative, whereas SGIP HPWH also provided commercial incentives.

for success through education and live support. In 2022, prior to SGIP HPWH, the TECH Load Shifting Pilot trained over 300 contractors on HPWH load shifting concepts and gathered contractor feedback.[9] Leading up to and after TECH's launch of the SGIP HPWH incentives, the team created and iterated upon resources such as contractor support articles, customer-facing webpages and flyers, and training webinars. The team also continued to support contractors via contractor support office hours, one-on-one calls, and emails.

Collaboration with Other Market Actors

The program relied on close coordination with HPWH manufacturers, utilities, third-party DR providers, and the connected load shifting program teams. This collaboration was critical to raise and address issues flagged by participating contractors, including updates to the JA13 TOU control interface and setup instructions, connectivity troubleshooting, and workarounds for DR enrollment difficulties. One large collaboration effort was the creation of training content for contractors about JA13 TOU controls. Some manufacturers already had content available such as short videos or sections of product installation manuals, but some content was created specifically for the program. TECH's TOU Setup contractor support article provides background on the functionality and instructions for all brands. It has over 17,000 views and is used by audiences beyond contractors. One HPWH manufacturer shared that the article was helpful to understand implementation of TOU control features across the HPWH market.

Implementation and Enforcement of IDSM Requirements

Implementation and enforcement approaches were based on CPUC regulatory requirements, in consultation with CPUC staff. Customers agreed to all IDSM requirements via TECH's Terms and Conditions. The requirements were further implemented and enforced as follows:

- **TOU rate enrollment:** The program worked directly with utilities to facilitate customer TOU rate enrollments. The SGIP HPWH regulatory language required customer TOU rate confirmation prior to incentive payout.
- **JA13 TOU control setup**: As a precursor to incentive payment, contractors were required to upload a screenshot from the HPWH manufacturer app showing completed setup.
- **Event-based DR enrollment**: The program took a phased approach to enforcement, initially paying incentives to contractors and then verifying customer DR enrollment directly with DR program providers. However, early data indicated that most customers were not enrolling. The program team then had one-on-one conversations about the DR enrollment requirement with over 40 contractors to reinforce expectations, clarify confusion, coach, troubleshoot, and gather contractors' recommendations for success to share out with other contractors. The program then introduced a requirement for

[9] The TECH HPWH Load Shifting Pilot pivoted to supporting TECH's SGIP HPWH incentive launch once the CPUC created the SGIP HPWH program. The pilot was active until late 2024, and issued a Final Report and two-pager, *Blueprint for Better Integrated Demand-Side Management* (Kehmeier et al. 2024; TECH 2025). These represent learnings from before and after SGIP HPWH launched under the TECH brand, through the summer 2024 contractor survey. These results are a snapshot in time, before the event-based DR enrollment requirement was enforced and the water heater load shifting enrollment requirement was introduced, both in December 2024.

contractors to upload proof of DR enrollment, e.g., enrollment confirmation email or screenshot, when submitting for incentive payment.
- **Water heater load shifting application**: Contractors were given instructions and encouraged to help customers apply. The program team shared TECH customer data with WatterSaver and SmartShift Rewards, which reached out to any not-yet-enrolled customers to encourage them to apply, or to complete their HPWH connection if the application was already submitted.[10]

Information Sources

The findings in this report draw from qualitative and quantitative data collected throughout the TECH HPWH program, including communications with contractors and market actors, enrollment data from DR and load shifting programs, and two contractor surveys:[11]

- **Summer 2024 survey:** This large contractor survey was implemented by the TECH evaluator, Opinion Dynamics, and included seven questions about DR. Due to the timing of the survey, contractors were asked about the event-based DR program enrollment requirement and not the load shifting program requirement that was later added. This survey was also administered before contractors were required to upload an image proving DR enrollment. Fifty-nine contractors responded.
- **Winter 2025/2026 survey:** The survey was designed in coordination with Verdant Associates (Verdant), the SGIP HPWH evaluator. It asked ten multiple choice questions (with additional optional fields to elaborate) about the updated set of DR and load shifting requirements that were added in December 2024. It was sent out in December 2025, with responses collected into January 2026. Twenty-nine contractors responded.

Results

IDSM Enrollment and Enablement Results

Event-based DR programs. As described in the Methodology section, enforcement of the DR requirement was phased in. Initially, just over one third of customers enrolled in DR. After adding the requirement to upload proof of enrollment, nearly 80% of customers enrolled in DR. While multiple programs qualified as event-based DR, 90% of eligible customers enrolled in OhmConnect, a voluntary "behavioral DR" program, since it was broadly available to all electric investor-owned utility customers and required no device connections.

Water heater load shifting programs. Figure 1 below displays application rates for TECH HPWH customers across all possible application statuses.[12] "Enrolled" means all application steps were completed and the water heater was connected to the program. "Pending" means the

[10] The implementation approach for water heater load shifting enrollment was determined in consultation with the CPUC. Placing the responsibility on the load shifting program teams was meant to reduce contractor burden.
[11] Summer survey results are covered in full the TECH Load Shifting Pilot Final Report (2024) and the Opinion Dynamics Process Evaluation of the TECH Clean California Initiative (2025). Winter survey results will be discussed in Verdant's forthcoming Final Evaluation Report for SGIP HPWH.
[12] This only includes customers who participated in TECH HPWH after the load shifting program requirement was added in December 2024.

application was submitted but the customer still needs to connect their water heater to the load shifting program. "Archived" means the customer was either unresponsive to outreach from the load shifting program related to their pending application, or voluntarily unenrolled after connecting. Figure 1 also displays whether applications were "program-led" (attributed to load shifting program outreach efforts) or "contractor-led" (customer applied prior to outreach from the load shifting program, most likely aided by the TECH contractor).[13]

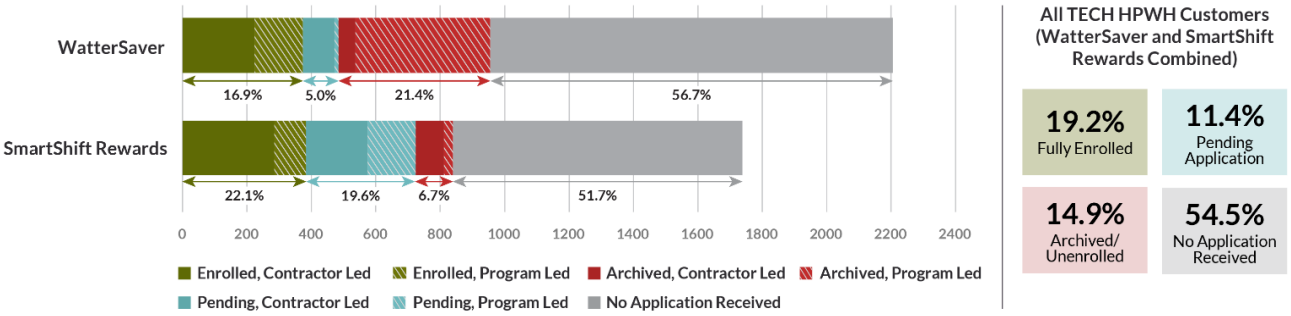

Figure 1. TECH customer statistics: applications to load shifting programs

Figure 1 shows that 45.5% of all TECH customers applied to the load shifting program available to them. The team was intentional about the requirement being a submitted application instead of full enrollment, due to both product eligibility gaps (not all TECH-eligible HPWH models could connect to the load shifting programs) and a variety of technical hurdles to successful connection. Because of the various troubleshooting needs that can arise, some of which require significant time and/or experience to resolve, TECH contractors were able to help customers connect who may not have been able to themselves. The conversion rate from applications to enrollments supports this finding—contractor-led applications have a 54% conversion rate, compared to 29% for program-led applications.

JA13 TOU enablement. A screenshot proving successful JA13 TOU control setup was required since the start of the program, and contractors have become familiar with the process. In the 2025 survey, when asked "How confident are you and your colleagues in helping customers set up a time-of-use rate schedule via the manufacturer app," 52% of respondents chose "very confident," 35% chose "moderately" or "somewhat confident," and only 0% and 14% chose "a little" or "not at all" confident, respectively. These confidence levels were significantly higher than contractors' reported confidence with DR and water heater load shifting program enrollment.

Beyond reviewing each TECH incentive application for a valid JA13 TOU control setup image, the program could not confirm ongoing TOU control functionality for all projects, since this feature requires insight into customer water heaters that may not be internet-connected. During interim evaluation efforts, Verdant found that for one manufacturer, 56% to 73% of HPWHs installed through the program had JA13 TOU control enabled. Most of the non-enabled units were likely due to an app bug that caused a TOU control setup success message even

[13] The delineation between "program-led" and "contractor-lead" is estimated. We consider an application to be contractor-led if the customer applied within 30 days of their TECH HPWH install date, unless they enrolled via a specific trackable link provided by WatterSaver. Otherwise, the load shifting programs did not commonly reach out to TECH customers within 30 days of the HPWH install date.

though the rate schedule had not actually been enabled. Issues with setting up JA13 TOU control are discussed further in the JA13 TOU Control Load Shifting Lessons Learned section.

Load Shifting Results – Scheduled and Signaled

Load shifting results for the 4 to 9 p.m. peak period, which was the standard electric rate peak period across the state at the time of the program, are summarized below for both JA13 TOU control ("scheduled") and connected load shifting programs ("signaled"). These results come from Barsun et al. (2026), which compares scheduled and signaled load shifting results from Verdant's interim evaluations of SGIP HPWH and WatterSaver. The summaries below provide high-level insight, and final results are expected to change once both programs' final evaluations are complete. Results are based on the specific approaches implemented, i.e., manufacturers' chosen operating logic for JA13 TOU control and program algorithms, and are not necessarily representative of results from alternative or future approaches.[14]

JA13 TOU control (scheduled). Verdant found that JA13 TOU control shifted 370 watt-hours (Wh) out of the peak period during weekdays and 360 Wh during weekends without substantially increasing overall energy consumption. These results were based on telemetry data received from one manufacturer for a subset of HPWHs installed through the program.

Load shifting programs (signaled). Verdant found that WatterSaver's signaled approach shifted 250 Wh (basic load up control) to 470 Wh (advanced load up control) out of the peak period. These results were based on control algorithms that have since evolved. Readers should refer to Besson, Barsun, and Liu (2026), which analyzes how various controllable variables impact load shifting results for results based on the updated control algorithm. Additionally, these results are only for devices that successfully received and responded to control signals, which were successful 82% to 85% of the time.

Lessons Learned

Contractor Education and Support

With adequate support and education, contractors can drive demand flexibility. In the Summer 2024 survey, 75% of TECH contractors shared that they were at least somewhat comfortable explaining DR to their customers. In a subsequent Winter 2025/26 survey, that rate dropped to 67%, potentially due to the newer requirement, added December 2024, to provide confirmation of DR enrollment prior to incentive payout. In that same survey, 85% of contractors shared that they were at least somewhat confident setting up JA13 TOU control programming. Far fewer contractors reported confidence facilitating enrollments into water heater load shifting programs, a requirement that was also introduced in December 2024 and was not enforced.

In contractor-led programs, program education and support are critical to ensure that contractors understand demand flexibility requirements well enough to effectively explain them to customers and address customer concerns. Opinion Dynamics (2025) summarizes responses

[14] New Buildings Institute's meta-analysis (Gabriel 2024) compiles load shifting results from prior HPWH load shifting studies, and our results roughly align with prior findings. Of the three studies with peak periods most aligned with ours (4 to 9 p.m. and 5 to 9 p.m.), the average load shift results were 170, 341, and 315 Wh.

from the Summer 2024 survey and highlights the sophistication required for contractors to help customers through these requirements. For example, contractors reported that the most common customer challenges related to the DR enrollment requirement were concerns with how their equipment will operate when enrolled in DR and trouble understanding what DR is and/or why it's required. Contractors' top-reported strategy for success was coming prepared to answer customer questions. Other top contractor-reported strategies include introducing the DR requirement early, sending an email with direct enrollment links and calling to follow up, helping the customer enroll in-person if the utility accountholder is present, having staff enroll in the DR program so they can share firsthand experience, emphasizing benefits (e.g., participation rewards, energy conservation, preventing brownouts), and reminding customers that the requirement earns them a large HPWH incentive.

One-on-one support is critical. One-on-one support for contractors was ranked as the most helpful support resource in the two contractor surveys, followed by training videos and webinars, support articles, and group office hours. IDSM program implementers are well-positioned to act as the initial point of contact for contractor troubleshooting and can direct contractors to external support, such as a DR program provider or product manufacturer, as needed. Implementers can also proactively check in with contractors, especially high-volume installers, to identify and resolve points of confusion about requirements—for example, based on customer feedback or information provided by the contractor on incentive applications.

Simplicity minimizes confusion and reduces support needs. Though contractors can learn to be demand flexibility leaders, TECH HPWH's complex design, with four distinct demand flexibility requirements, led to heavy contractor burden.[15] In the 2024 survey, when asked about top DR program enrollment challenges, 49% of contractors chose "getting the customer to agree to enroll" and 47% chose "distinguishing the DR requirement from the required TOU rate plan enrollment and HPWH TOU scheduling." Having multiple related requirements complicated program communications. For example, multiple DR programs qualified as event-based DR programs per the CPUC's criteria. TECH used DR as an umbrella term. When the requirement for water heater load shifting program enrollment was added, TECH used "water heater rewards program" to distinguish these programs from event-based DR. Since load shifting programs are commonly considered DR programs by the industry, this led to frequent confusion. One-on-one email and/or phone support were often necessary to identify and resolve points of confusion. Though education and support are a critical component of IDSM programs, these efforts would be more efficient and effective with a simpler program design.

IDSM Program Design to Scale Demand Flexibility

IDSM program design can greatly increase load shifting participation, especially with contractor support. As shown in Figure 1, 46% of TECH customers applied to a load shifting program and nearly 20% successfully enrolled, representing a significant enrollment pipeline. Figure 2 demonstrates the magnitude of this TECH-to-load shifting program pipeline by comparing WatterSaver and SmartShift Rewards enrollment statistics of TECH participants

[15] Multiple contractors mentioned hiring or designating dedicated staff to manage the demand flexibility requirements. In the winter survey, one contractor stated that "we had to hire a separate person just to make sure we had every single thing needed..."

versus non-TECH participants. It displays enrollments by application submission date, before and after the TECH water heater load shifting program application requirement launched.

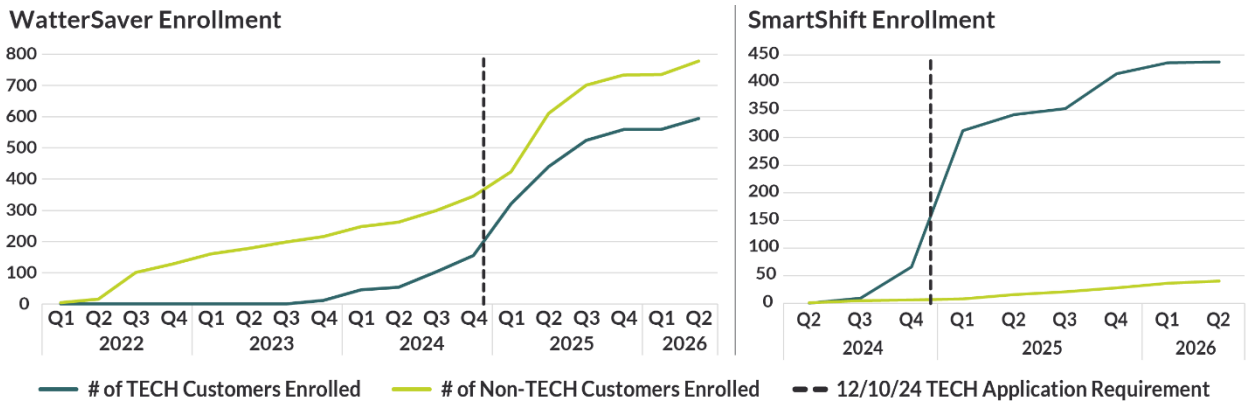

Figure 2. WatterSaver (left) and SmartShift Rewards (right) TECH and non-TECH quarterly enrollments.[16]

TECH participant enrollment volume is comparable between the two programs and provides a steady influx of participants especially as compared to non-TECH participant volume, which is entirely dependent on recruitment efforts by the programs. SmartShift Rewards launched six months before TECH's December 2024 load shifting program requirement and focused on leveraging the TECH customer pipeline until Q1 2026 when outreach to non-TECH participants began in full. This approach is why the program has relatively few non-TECH participants compared to WatterSaver. WatterSaver has significantly more non-TECH participants due to efforts to market the program to these customers. Regarding efforts by load shifting program staff to drive enrollments, TECH contractor support of customer enrollment required the least effort from program staff with the highest success rate, followed by program-led follow up with TECH customers that did not complete enrollment. This strategy required more effort than a mass marketing campaign, but the success rate was high enough to merit the extra effort.

Within the IDSM program design, contractor facilitation of demand flexibility requirements was effective in increasing program enrollments and JA13 TOU control enablement. The importance of the contractor is demonstrated by the data in Figure 1. In summary, of the TECH customers who enrolled in load shifting programs, more were driven by contractors ("contractor-led") than by enrollment reminder messages and support from the programs themselves ("program-led"). Additionally, contractor-led applications turned into completed enrollments at a higher rate than program-led applications. Contractor expertise reduced the burden on individual customers to understand and act on these requirements. One contractor shared in the winter survey that "most familiarity is based on applied experience doing these. If we were to hire a brand new admin to handle this, I feel like we'd be starting at square one." Two contractors that drove significant load shifting program application volume flagged customer concerns over utility control as a common challenge but shared that they were able to "answer most concerns" and "most [customers] were ok with it after some explaining." Additionally, some contractors put in extra effort to help hard-to-reach customers work through

[16] Enrollment means the customer successfully connected their water heater. We display all enrollments here, including customers who later unenrolled; pending and archived applications are not included.

issues. For example, roughly two thirds of SmartShift Rewards customers are low-income, primarily due to one high-volume contractor who is dedicated to helping their customers enroll in SmartShift Rewards to reduce their costs.

Aligning demand flexibility requirements with the installed technology reduces complexity and may improve customer and grid outcomes. Requiring multiple overlapping demand flexibility measures can create conflicts that reduce the effectiveness of technology-specific requirements. For example, the DR enrollment requirement sometimes blocked TECH customers from enrolling in the water heater load shifting program. Some customers could enroll in OhmConnect directly from their connected water heater app, but the app could only connect to one program. Therefore, customers that connected their water heater to OhmConnect could not connect to the water heater load shifting program. This affected nearly 4% of TECH customers who applied to WatterSaver. To address this issue, WatterSaver and SmartShift Rewards sent TECH customers instructions to disconnect their HPWH from OhmConnect and connect to the load shifting program, but not all customers followed through. Since HPWHs provide greater grid support in a daily load shifting program than in an occasionally dispatched, event-based program like OhmConnect, this conflict prevented customers from maximizing grid benefits.

Additionally, multiple requirements caused contractor confusion and frustration and in some cases led them to take a less hands-on approach with customers than they may have under a simpler design. For example, one contractor shared that they thought the program team facilitated customer DR enrollment directly with the utilities, as was done for TOU rate enrollment. When the water heater load shifting requirement was added, several contractors shared that they left enrollment up to the customer and focused on getting DR enrollment confirmation since that was required for the incentive application. The SmartShift Rewards and WatterSaver teams have also heard from frustrated contractors who thought they needed a load shifting program enrollment confirmation to receive their incentives, but this was only required for event-based DR. Therefore, limiting the demand flexibility requirement(s) to those that are directly relevant to the installed technology is recommended to reduce complexity and improve customer, contractor, and grid outcomes.

Strict enforcement increases compliance but with drawbacks; alternative contractor-centric approaches also show promise. Strict enforcement of demand flexibility measures can significantly increase compliance (see Results). However, this should be weighed against drawbacks. In the winter survey, 49% of contractors said that the DR enrollment confirmation was “rarely” or “never” simple, 28% said “sometimes,” and only 24% said “often” or “always” simple. To elaborate, contractors shared that customers, especially those who are less tech-savvy, needed significant handholding and that gathering an acceptable screenshot from the customer could be difficult. One contractor mentioned they needed two to three callbacks per job for this, which in turn increased their project costs. Similarly, Opinion Dynamics (2025) shares: “TECH contractors offering SGIP HPWH incentives have reported more dissatisfaction and challenges with the TECH Initiative than HVAC contractors. Specifically, they found the TECH enrollment application more confusing and burdensome. …When asked to explain what made the incentive applications difficult, the most commonly reported challenges for the HPWH application related to collecting information about a customer’s enrollment in a TOU rate (21 of 28; 75%) and the time it takes to gather all documents required for submission (20 of 28; 72%).” If using strict

enforcement, a phased approach allows contractors to adapt and troubleshoot before financial consequences are on the line (TECH 2025).

Even without strict enforcement, high-volume contractors who understand the importance of demand flexibility can push it at scale, and implementers can offer dedicated support to these champions rather than imposing a strict requirement on all contractors. For example, as discussed in the Methodology section, the water heater load shifting application requirement was not a prerequisite for paying out TECH incentives. Instead, the program team had individual conversations with contractors and shared customer contact information with the load shifting program teams. Based on data from mid-2026, 50% of the TECH customers who applied to WatterSaver were driven by five contractors. For SmartShift Rewards, over 86% of TECH customer applications were driven by two contractors.

Responses to the winter survey highlight that some contractors who understand customer and grid benefits will go the extra mile to help customers through these requirements. These contractors mentioned wanting units to be TOU-optimized to help reduce lower-income customers' bills, working closely with manufacturers to solve connectivity difficulties, spending time with customers to assuage concerns about "utility control" of their water heaters, and helping customers understand the efficiency and electric bill benefits of these programs.

For an enforced demand flexibility requirement, allowing exemptions is important. Barriers can hinder DR enrollment, and configuration issues sometimes prevent successful JA13 TOU control configuration. Even savvy contractors familiar with technology features and processes run into product-specific issues that require manufacturer action or multiple site visits to troubleshoot. Contractor responses to the 2025 survey highlighted the wide variety of issues that can arise in the field; in many cases, these issues disproportionately impact low-income and older customers. Examples include situations in which the main household point of contact is not home during product installation, technology-challenged customers, forgotten logins, and technical difficulties such as manufacturer app bugs and connectivity issues.[17] Programs should be strategic about the level of effort expected from a contractor prior to incentive payment for installed equipment and allow for flexibility in meeting requirements, if feasible.

JA13 TOU Control Load Shifting

JA13 TOU control did achieve daily load shifting for many TECH-incentivized HPWHs. However, JA13 primarily targets new construction, lacks a third-party verification mechanism, and the TOU control feature was not broadly utilized before TECH's requirement. TECH sparked broader enablement of this feature, illuminating various issues across brands, which caused confusion and delays in HPWH incentive payments. Manufacturers addressed some of these product issues, but others require future improvements.

[17] Example survey quotes from contractors: "Many of the customers we target and try to support are in disadvantaged communities and often struggle with technology, which can make adoption difficult."; "Most of the time DR enrollment is straightforward. It becomes a problem when working with elderly or tech challenged folks."; "You are asking plumbers… to learn how to program multiple brands… figure out the customer's Wi-Fi login, navigate issues when the unit won't connect to the app which happens regularly. At this point, I end up having to make a special visit to get the units programmed and regularly end up spending over an hour with tech support."; "While we are familiar with major manufacturer platforms, not all water heaters are successfully connected in the field. In practice, we often encounter system limitations such as outdated firmware or software, inconsistent Wi-Fi connectivity, weak signal strength at the water heater location, and app stability issues... These factors can limit reliable TOU scheduling despite proper installation and customer interest."

Rate-based "scheduled" load shifting like that achieved by JA13 TOU control should continue to be promoted, ideally beyond California. Compared to connected HPWH load shifting programs, TOU control has potential benefits of longevity (programs may sunset) and lower cost and effort (in most cases it does not require an add-on controller, persistent Wi-Fi connection, nor connection to a utility or third party). However, this feature would benefit from updated codes and standards that provide more specificity on desired product behavior in response to TOU rates. JA13 does not have a test procedure to verify compliance with the requirements or performance of required features, so manufacturers lack instruction on how to ensure their implementation is "correct." As an appendix within the California building energy code, JA13's reach is limited, so it is not necessarily the right place to add detail on implementing TOU scheduling requirements for HPWHs. Future standards efforts may be able to provide greater standardization for rate-responsive flexibility requirements. This could include updates to voluntary standards such as AHRI Standard 1430 and ENERGY STAR Connected Product Criteria for HPWHs, or the implementation of state flexible demand appliance standards.

TECH HPWH's JA13 learnings, along with connectivity and control insights compiled by load shifting program teams, can inform future programs and standards.

Functionality gaps and bugs. A notable gap was a bug in one manufacturer's Android app that caused, in many cases, an app display indicating successful TOU control setup even though the rate schedule had not actually been enabled. This issue was discovered during Verdant's embedded evaluation efforts. The manufacturer subsequently deployed an update to resolve this issue moving forward and pushed an update to cloud-connected units to remotely complete the TOU rate setup. This issue significantly impacted program-wide load shifting results, since the majority of HPWHs were not cloud-connected and were unable to receive the retroactive fix. Updating standards for TOU rate-based scheduling of HPWHs to include testing and performance verification could mitigate this issue, and developing a process to make TOU scheduling standard practice should provide substantial benefits with minimal costs.

App functionality gaps and bugs frequently created confusion and delays for customers and contractors, and direct assistance from manufacturers was often required. Examples included: locational gaps, where customers entered their zip code to find rate options in their area, but the app in some cases showed no rates; and a bug that impeded customers from initiating a temporary override of TOU control, a capability required by the JA13 specification. Additionally, one manufacturer's TOU control interface became completely inaccessible as soon as the CTA-2045 module was plugged in, making completion of both program requirements—JA13 TOU control and load shifting enrollment—difficult if JA13 was not set up first. One manufacturer did not provide an option to connect to the TOU control interface without Wi-Fi until 2024, when they adapted their software to allow Bluetooth connection. An experienced contractor shared that one manufacturer required entry of the customer's email address during setup and then required the customer to open a link from the email on their phone, but a major issue was that these emails were not going through to Gmail inboxes.

App user interface improvements and increased customer control. The team worked with manufacturers to improve TOU control interfaces based on participant feedback. Examples included: using TOU rate names instead of "Schedule 1," "Schedule 2," etc., updating in-app notifications to share the goal of TOU control, i.e., "minimize energy use during peak hours," and avoid the misconception that the utility actively controlled the HPWH. Before these updates,

multiple customers emailed TECH sharing that, based on the app messaging, they'd called their utility for help on TOU control, and the utility did not know what they were talking about.

Some usability issues remain. At least one manufacturer does not allow customers to update their TOU rate or disable TOU control within the app, requiring a call to product support. The program team received multiple customer inquiries on how to turn off the TOU control feature, in some cases after they had already contacted their utility and/or water heater load shifting program without success. This waiting and rerouting was a frustrating experience. Ideally, customer consent requirements in future standards would address the ability for customers to make changes to their products' demand flexibility participation.

Making TOU rate-based control more flexible could improve the success of HPWH load shifting based on TOU control in future programs. TOU control operating logic is left to the manufacturer to determine without much ability for customers to define load shifting strategies that meet their preferences, though some manufacturers do allow customers to set preferences on level of desired cost savings. Products do not offer other customer-level customization, such as the ability to input priorities like avoiding compressor operation during the night for noise-sensitive customers. Updates to allow this customization could improve customer experience with this feature and avoid issues for future customers.

Rate handling. Future standards and program design efforts could help improve how HPWHs handle electric rate information. For example, many manufacturers do not currently auto-update rate information as rates evolve. Also, rate options are not comprehensive and choosing the "right" rate can be difficult when the customer's own rate is not available or when the customer does not know what rate they are on. The program team provided education and recommendations for these scenarios, but it remained a point of confusion. One contractor shared the following in the winter survey: "the client is required to first know their TOU schedule. To us, that seems simple, but to clients it's a challenge. Especially in low-income households it's difficult to even get a bill in the first place. Some clients even question why we need to look at their bill." Another shared, "Techs are just getting used to setting these HPWH and now they have to learn what time of use their customer should choose. They worry that they may recommend the wrong time of use." Other products, including some smart thermostats and electric vehicles, have more sophisticated means of storing and updating customer rate information; these implementations could inform HPWH rate handling in the future.

Conclusions and Recommendations

Conclusions. The SGIP HPWH program, implemented within TECH Clean California, included several demand flexibility components that inform best practices for large-scale IDSM as part of a broader market transformation strategy. The program's IDSM strategy capitalized on customer engagement in the HPWH incentive program and leveraged contractors to activate demand flexibility at the critical moment of technology installation. Through implementation, we found that intervention during product installation was more successful than reaching out to customers after the fact to ask them to enroll in a program, install a controller, turn on a feature, or do all of the above. However, the complexity and inflexibility of these requirements created participation difficulties for customers and contractors, resulting in participant dissatisfaction.

Programs need to be simple and flexible in both design and implementation. With TECH, contractors, customers, and other market actors struggled to understand and distinguish the various demand flexibility requirements. Customers reported confusion about why the HPWH

incentive program required enrollment in a DR program that was unrelated to their newly installed product in addition to a connected load shifting program, and the existence of multiple related requirements complicated program communications. Contractors were required to devote additional administrative effort to activities beyond product sale and installation. Additionally, in some cases DR and connected load shifting programs conflicted, inhibiting their success.

HPWH demand flexibility is still nascent, and information about product capabilities, manufacturer-specific load shifting behaviors, and interaction between flexibility options continues to evolve. TECH required use of JA13 TOU control features, which achieved daily load shifting and sparked more widespread enablement of that feature, but program implementation also revealed many issues with this feature across products, requiring ongoing manufacturer action to address issues. These examples illustrate the burden that extensive program requirements can place on participants and customers.

Recommendations. Based on these experiences, we recommend several improvements for demand flexibility requirements for future IDSM programs to ensure that demand flexibility benefits are more easily achievable, reduce participant burden and cost, and increase customer satisfaction. These recommendations apply to programs within California and beyond that aim to integrate demand flexibility with other demand-side measures.

- **Create goal-oriented requirements.** For program requirements, we recommend focusing on the demand flexibility goal (e.g., water heater load shifting to align new electric load with grid needs) and allowing specifics to be determined during the implementation phase rather than setting strict requirements early.
- **Plan for evolving program designs.** It is critical for program implementers to have the flexibility to evolve program designs to keep up with new products and features, new information, market shifts, and industry standards. For TECH, this could have included requirements that evolved with updates to industry standards and information from embedded evaluation or application of single-family learnings to multifamily requirements.
- **Focus demand flexibility requirements on the installed technology.** We recommend streamlining demand flexibility requirements to those directly relevant to the installed technology to facilitate effective communication, minimize confusion for market actors and end-use customers, and improve grid outcomes. For TECH HPWH incentives, this would have meant focusing on enrollment in a water heater load shifting program and/or TOU-rate-based scheduled load shifting, rather than also requiring enrollment in an event-based DR program unrelated to the HPWH, or a customer TOU rate option that applies to the entire customer load, not just the water heater.
- **Enforce requirements strategically.** Strict enforcement of demand flexibility measures, such as requiring documentation before paying an incentive, can increase compliance, but this enforcement may not be the only way to achieve desired outcomes and should be weighed against its drawbacks. TECH used different enforcement mechanisms depending on the demand flexibility requirement and found that even without withholding incentives, high-volume contractors who understood the importance of demand flexibility promoted it at scale. Even savvy contractors familiar with technology setup processes run into product-specific issues, which may require action from manufacturers or multiple site visits to troubleshoot. Therefore, we recommend that programs take an adaptable approach to enforcing demand flexibility requirements, including contractor coaching to

improve performance, a phased approach from lenient to strict enforcement, and reasonable exemptions to demand flexibility requirements, where necessary.

- **Prioritize future standardization efforts.** Finally, future standardization efforts can help address some of the issues identified in this paper. These efforts include industry-vetted test procedures, voluntary and mandatory standards, and third-party verification. These efforts would streamline demand flexibility requirements for products and provide information on acceptable and expected product responses, which would result in increased clarity for customers and a reliable, predictable demand resource for the grid.

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